NATONAL TECHNICAL
INFORMATION SERVICE

OCCUPATION SAFETY AND
HEALTH SYMPOSIA 1976

U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-274 716

Occupational Safety and Health Symposia, 1976

National Inst for Occupational Safety & Health, Cincinnati, O.

Prepared for

American Medical Association, Chicago, Ill

Jul 77

NIOSH

OCCUPATIONAL SAFETY AND HEALTH SYMPOSIA 1976

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

BIBLIOGRAPHIC DATA SHEET	1. Report No. NIOSH-77-179	2.	3. Recipient's Accession No.
4. Title and Subtitle OCCUPATIONAL SAFETY AND HEALTH SYMPOSIA - 1976 -			5. Report Date July 1977 6.
7. Author(s)			8. Performing Organization Rept. No.
9. Performing Organization Name and Address National Institute for Occupational Safety and Health 4676 Columbia Parkway Cincinnati, Ohio			10. Project/Task/Work Unit No. 11. Contract/Grant No. CDC-210-76-0118
12. Sponsoring Organization Name and Address Same as above			13. Type of Report & Period Covered 14.

15. Supplementary Notes

16. Abstracts

The third volume of the Occupational Safety and Health Symposia is a continuing product of cooperation between NIOSH and the American Medical Association aimed at developing information to assist private practitioners with part-time occupational medicine responsibilities. The volume consists of papers presented at the NIOSH co-sponsored 36th AMA Congress on Occupational Health Conducted at Rochester, N.Y in September 1976, and is published by NIOSH. The Symposium topics were medical roles in worker's compensation; what every physician should know about radiation; medical recordkeeping and surveillance; interdisciplinary teamwork in the health/safety professions; medical relationships with unions and management; when workers fly; how to do a walk-through survey; and women at work.

17. Key Words and Document Analysis. 17a. Descriptors

Industrial medicine
Ionizing radiation
Electromagnetic radiation
Preventive medicine
Medical services
Environmental surveys
Aerospace medicine
Aviation personnel

17b. Identifiers/Open-Ended Terms

Sex factors

17c. COSATI Field/Group 06/J

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Release unlimited	UNCLASSIFIED	164
	20. Security Class (This Page) UNCLASSIFIED	22. Price PAGE IN EACH

OCCUPATIONAL SAFETY AND HEALTH SYMPOSIA
1976

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
Division of Technical Services
Cincinnati, Ohio 45226

July 1977

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

DISCLAIMER

The contents of this report are reproduced herein as received from the contractor.

The opinions, findings, and conclusions expressed herein are not necessarily those of the National Institute for Occupational Safety and Health, nor does mention of company names or products constitute endorsement by the National Institute for Occupational Safety and Health.

NIOSH Project Officer: Loren L. Hatch

Contract # 210-76-0118

DHEW (NIOSH) Publication No. 77-179

FOREWORD

An important objective of the National Institute for Occupational Safety and Health is the coordination of delivery of occupational health care with general health care in the United States. Medical surveillance requirements in standards promulgated by the Department of Labor, based upon criteria recommended by the National Institute for Occupational Safety and Health, will continue to increase the demand for occupational physicians and nurses and other health professionals.

At present many businesses in order to provide needed services for their employees must rely upon physicians and nurses who have no experience or special training in occupational health. NIOSH cosponsored this 36th Congress with the American Medical Association in an effort to interest more physicians and other health professionals in the recognition of occupational health problems in their own practice.

The symposium speakers were selected because of their preeminence in the fields of occupational medicine, nursing, industrial hygiene, and safety with the hope of encouraging a continuing educational effort in this field, as well as to provide a review, for those interested, of the current status in occupational health.

John Finklea, M.D.
Director, National Institute for
Occupational Safety and Health

PREFACE

The papers herein presented were first prepared for delivery at the 36th AMA Congress on Occupational Safety and Health. They were edited for publication by the contractor.

These Symposia are intended to furnish, over several years, an introductory text highlighting the aspects of occupational medicine most significant to part-time plant physicians, to private medical practitioners generally, and to others with related interests. The concept arose from a 1974 NIOSH survey of AMA-member physicians to determine the special problems and information needs of these physicians. Publication by NIOSH extends the availability of this text to the thousands of such physicians unable to attend the AMA Congresses, although a copy of the appropriate volume is also sent to each registrant at that Congress.

These manuscripts do not necessarily represent the views of the National Institute for Occupational Safety and Health, but do reflect the concerns that NIOSH has for occupational safety and health. They are being published for the benefit of those unable to attend the conference and as a future reference for those interested in occupational health. Additional copies of the proceedings are available from the Division of Technical Services, NIOSH, Cincinnati, Ohio. Suggestions and comments for future Symposia are invited.

ABSTRACT

This third volume of the Symposia is a continuing product of cooperation between NIOSH and the American Medical Association aimed at developing information to assist private practitioners with part-time occupational medicine responsibilities. The volume consists of papers presented at the NIOSH co-sponsored 36th AMA Congress on Occupational Health conducted at Rochester, N.Y. in September 1976, and is published by NIOSH. The Symposium topics were medical roles in workers compensation; what every physician should know about radiation; medical recordkeeping and surveillance; interdisciplinary teamwork in the health/safety professions; medical relationships with unions and management; when workers fly; how to do a walk-through survey; and women at work.

The 1976 Congress was supported by a NIOSH-CDC Cost-Sharing Contract # 210-76-0118.

IN MEMORIAM

Shortly after completing his work on these proceedings, Henry F. Howe, M.D., passed away March 6, 1977.

He will be long remembered by those in the field of occupational medicine.

ACKNOWLEDGMENT

The NIOSH Project Officer wishes to convey appreciation to Henry F. Howe, M.D., and Barbara S. Jansson of the American Medical Association, Department of Environmental, Public and Occupational Health; Marilyn K. Hutchinson, M.D., of NIOSH; the individual authors who presented papers; and all who took part by their attendance and lively discussions.

Also appreciated are those NIOSH personnel listed below who took their time to provide critical review and offer helpful suggestions for improving the content.

Lonice Ede, J.D., DTS
Dawn Gillis, M.S.H., M.S. (Chem.), DSHEFS
Austin Henschel, Ph.D., Consultant, DTS
Bernadine Kuchinski, R.N. (COHN), M.S., DTMD
Charles Wisseman, M.D., DSHEFS

CONTENTS

Preceding page blank

MEDICAL ROLES IN WORKERS' COMPENSATION

INFORMATION GATHERING

Marvin L. Amdur, M.D.

Workers' compensation has been altered by time, social, political, and economic pressures. Most recently there has been a major effort to get the states to upgrade their workers' compensation systems. Recommendations of the 1972 National Commission on State Workmen's Compensation Laws have set minimal guidelines to bring all states into compliance with a number of recommended standards. The inference, of course, is that if the states do not put their respective houses in order to correct the existent defects, the Federal Government will do it for them. Some states are quite close to full compliance; others have a greater distance to travel. The major problems would seem to lie in the extent of coverage and in the levels of benefits paid. The love of money may seem to be the root of all evil as suggested by attempts to erode workers' compensation as an exclusive remedy device by those who yet insist that it maintain intact its no-fault principles. There is no question but that major defects do exist and these particularly in the areas of occupational disease.

However much the external appearance of workers' compensation changes, it never really changes its underclothes. It is basically an adversary procedure into which the physician may be thrust as a primary performer. Unfortunately, in the entire process he may become a tool rather than an instrument of justice and equity. Some areas of concern where I perceive the physician to have vital roles in this somewhat imperfect system include:

1. The determination of causality.
2. The determination of the nature and extent of disability.
3. The determination of the need for treatment, the appropriateness of treatment, and the application of the principles of rehabilitation to workers' compensation.

Physicians by training and by some subtle selective process are methodical, orderly in their thinking, professionally curious and not easily put down. Unfortunately, although we may place ourselves just slightly below the angels, we must admit to some rather common human defects. Having made a diagnosis, physicians frequently are loathe to retreat from that position. Some are priggish and therefore vulnerable to the blandishments and the manipulation of those who would control and direct our opinions. Medicine is an art, not an exact science, and for physicians to disagree is perfectly natural. Carrier and employer representatives, claimant representatives, and administrators all play their part in this same game, revolving like satellites around the central figure, the claimant, who may not exactly be a member of an endangered species. Whether the claimant alleges an industrial accident or an occupational disease depends upon the ease with which an administrative decision may be made under either. No real problem obtains in the instance of an industrial accident. If it is established that the incident occurred out of and in the course of covered employment, that is, during the period of some 8 hours of the 24 as opposed to the 16 hours of uncovered, non-employment exposure, then causal relationship for an industrial accident exists. Once a decision as to causality, as well as a decision as to disability, is made it can easily be determined whether a schedule or non-schedule award would be in order. In the instance of occupational disease, however, decisions of causality and the making of a non-schedule award is often something less than simple. It is not surprising, then, that under such circumstances the physician may be frustrated, confused as to issues, and therefore seemingly arbitrary in his opinion. As a result, he may perform in less than a satisfactory fashion.

There has been some activity of late seeking to facilitate the efforts of the physician by the establishment of guidelines. These, if followed, result in consistently more equitable determinations of causality, at least in matters of occupational disease. Two major sources of such potential help are the United States Department of Labor, Interdepartmental Task Force on Workers' Compensation and the National Institute for Occupational Safety and Health.

The complaint that too few instances of occupational disease get into the system either by failure to report, by not being recognized, or by purposeful concealment may well be true. Acute exposures do occur in occupational disease. The problems lie in the characteristics of chronic disease, especially the latency in onset and the lack of distinguishing features as reflected in the nature of the impairment. This impairment may be indistinguishable from the effects of normal aging or intercurrent disease. It may reflect social abuse of drugs, alcohol, or smoking; the adverse effects of medical treatment; or the contribution of hereditary predisposition. The disease may relate to organ system impairment and yet lack any specificity as to agent. Adding to the confusion is the multiplicity of exposure and the mobility of the work force which is the rule rather than the exception in this country. Finally, there is a possibility that occupational disease may be visited upon the innocent who may have no direct exposure in the work place. I refer, of course, to such things as beryllium and asbestos neighborhood disease, and disabilities affecting the unborn as a consequence of teratogenic and mutagenic effects of exposure agents. These all serve to make more difficult the role of the physician who must develop an opinion with regard to the work-relatedness of the disease. It is here that the physician exercises his orderliness of thought and must approach his decision of work-relatedness with reasonable medical certainty.

As in the diagnosis of disease due to an infectious agent where Koch's postulates must be fulfilled, so in an occupational disease, the physician must be satisfied that the exhibited effects of the disease are compatible with the known effects of the suspected agent. There must be adequate evidence of hazard exposure, and epidemiological considerations should tend to support rather than to deny any connection between the demonstrated disease, its impairment, and

the alleged agent. Unfortunately, these criteria may be fulfilled in a somewhat nebulous fashion, and it is therefore necessary for the physician to practice medicine as an art rather than as an exact science. The physician must be alert, perceptive in his approach to diagnosis and the assumption of causality. He does not have to accept only the obvious. Perhaps for too long a time, we have insisted on a body count before we recognize causality. Perhaps we should have been looking into the more subtle and less obvious aspects of ill health such as personality aberration, disturbances of sleep, psychiatric complaint, suicide, juvenile behavior defects, and learning difficulties.

A suspicion that nearly 85% of malignant disease may in fact be environmental in origin may well be true. If we accept this premise, we should also suspect that much of other illness may also be environmentally induced though not necessarily work-related. It may be related to diet, atmospheric pollution, use of agricultural chemicals, food additives, drugs, and the effects of a whole host of leisure activities.

Compliance with standards and codes does not insure the absence of disease in industry. Threshold Limit Values (TLV's) are rubbery standards, certainly inexact in their determination and inexact in their application. As physicians, our concerns must be not necessarily with the health of the environment but certainly with the health of the workperson who is of such a heterogeneous character as to defy any uniformity of exposure tolerance. This is the basis for the action level principle, which I sincerely endorse, and which you will find embodied in the Federal Regulations under the Occupational Safety and Health Act (OSHA). This sets a level of 50% of the exposure TLV, at which level there will be triggered the need for medical surveillance along with engineering and administrative controls by the employer.

If the physician finds it difficult to resolve the problem of causal relationship in primary occupational disease, then he is going to have infinitely more trouble in making such decisions of work-relatedness of disease when occupational exposure has been complicated by the effects of any of the three "A's," for example:

1. Activation, as one sees when tuberculosis becomes active in the presence of exposure to silica and siliceous materials.
2. Acceleration of disease, as in the relationship between smoking and bronchogenic carcinoma in asbestos workers.
3. Aggravation, as when one superimposes right heart stress as a consequence of pulmonary fibrosis upon an already existing left heart strain due to increased peripheral resistance for any reason.

Hopefully, the physician will not make his diagnosis of occupational disease by default but will diligently inquire and obtain a medical history to include travel, residence since birth, social habits, medication, and all leisure activities in which the claimant may engage. His occupational history too should include his military service, and should concern itself with each and every employer in a sequential fashion insofar as the claimant can recall. It should include the duration of employment, the nature of the work assigned, the materials employed, the physical aspects of the workplace, the use of personal protective equipment, and the activities of ancillary workers. Physical examination should be as complete as he can make it, and although it may increase the volume of the report, the inclusion of specific negative findings may be as valuable in the determination of causality as the reporting of the positive ones.

A discerning and disciplined approach to laboratory study is essential. It is improper and wasteful to order reams of laboratory work most of which may have but very little direct relationship to the problem in hand. The physician who would assess environmental sampling need not be qualified in the area of industrial hygiene, but he should be satisfied that the sampling is adequate, prop-

erly collected, and the analysis competently performed. He should be satisfied that it is reported in terms expressing a level of exposure relevant to the problem surveyed. Incidentally, most employers will welcome a personal inspection from a concerned physician seeking information.

The physician will not be so fortunate in his attempt to extract from a vendor or manufacturer information as to the composition of some of the products used in the workplace. Hopefully, this will soon change.

The physician must always remember that it is his role only to inform the administrator and not to adjudicate the claim. The doctor must not assume the role of an advocate for either the claimant or the employer. It is a fact that often a funny thing happens to a piece of good legislation on its way to an administrative decision. The decision may pervert the intent of legislation, but this is not the doctor's area of concern. The parties to dispute will exercise their prerogatives under the law and the doctor's function will be limited to his contribution to the record of the proceedings.

The history of "Black Lung" legislation is an illustration of what happens to physicians' functions in the determination of causality when social and political pressures become paramount. I mention this simply as an illustration of what may well happen if workers' compensation in general goes the same route as "Black Lung" legislation. If workers' compensation under federal control becomes part of a National Health Plan or is integrated in the Social Security System, then the decision-making process may no longer be dependent upon guidelines and reasonable medical diligence.

The Federal Coal Miners Health and Safety Act of 1969 provided black-lung benefits upon the demonstration of physical, physiological, or x-ray abnormality. Congress in its infinite wisdom in 1972 amended the Act to insure that no miner with at least 15 years of service in the mines would be denied any benefits. The presumption would then exist that whatever complaints he had were work-related. This, of course, bypasses the physician entirely. A diagnosis by presumption is worse than a diagnosis by default. It would hardly seem that this country could support a program where awards for occupational disease may be made on presumptions that fly in the face of fact. Moreover, one could not deny any worker in any mill, factory, shop, or office the same consideration offered the coal miner. Last year, Social Security Administration dispensed 1 billion dollars for black-lung benefits and this for a total work population of 120,000 coal miners. In the same period, a total disbursement for all other industrial accidents and disease for the entire covered population of these United States was 2.4 billion dollars. To ignore the physician and to exclude him from the decision-making process by substituting presumptions for his input may well bankrupt the nation.

With the state of the art as it is today, I can think of only one for certain and possibly a second medical problem which may by presumption be attributable to occupation. The first of these would be a mesothelioma, suggesting asbestos exposure; the second is angiosarcoma of the liver presumably as a consequence of vinyl chloride exposure. The first I would accept without question. The second may well be rebuttable.

The second area in which I believe the physician has a distinct role is in the determination of the nature and extent of disability. I should point out that disability per se is not a medical determinant. It is an administrative one. The physician must speak only in terms of impairment of function and to some extent this is a reflection of causality. The extent of disability is the basis for determining the level of compensation which is to be paid to the claimant. It is the physician who will define the impairment as total or partial and, if the latter, then to what degree. It is customary to speak in such terms as mild, moderate, or marked to denote the arbitrary gradations of 25%, 50%, and 75%. Where the claimant has some but relatively little productive capacity, one may refer to the level as a high partial and for all

practical purposes a total disability. The physician must also be prepared to classify such disability as being temporary or permanent. Wherever the matter of disability is not clear-cut, it behooves the physician to inquire not into what and how much disability, but rather into the "Why" of the disability. What are the claimant's opportunities for secondary gain? Do the high levels of payment and the seemingly inexhaustable nature of benefits sap the claimant's motivation to return to work? Does the disability reflect some interpersonal incompatibility in the workplace? Is disability a reflection of domestic turmoil? Does it reflect an effort on the part of the claimant to slough off moral and personal commitments which, in the absence of disability, society would demand that the claimant accept and respond to?

Let me briefly make comment on several devices I employ to assess medical impairment. These include observation of gait, and the ability to undress and dress again with ease. I have one examination area which can be reached by ascending a single flight of stairs. This serves as an excellent device to test tolerance to exertion. I frequently ask to see the claimant's operator's license to note such restrictions as may be described thereon and also to look for citations as a reflection of the claimant's behavior and personality. I regard as suspicious any claimant who drives to his examination and does not have a license with him.

Perhaps one of my most productive questions is "How is your sex life?" This usually takes the claimant by surprise. The level of interest and performance varies inversely with the level of disability. I do make inquiry as to the claimant's economic status. Is he living at home; does he own his own home? Is he married; is his wife working? How many children do they have? What is his aggregate monthly payment and from where is it coming? Armed with such information, I think the physician is in a fair way to make a determination with his head and not with his heart.

The third and final area where I regard the physician as having a vital role relates to treatment and rehabilitation. The relationship between the patient and the physician is a sacrosanct one, and no agency or individual in his right mind would presume to invade or to alter it—that is, just so long as the patient is responsible for his own care. Today, however, in an era of third party payers, be they employer, carrier, or agency of the federal, state, or local government, there is a sudden realization that pockets are not as deep as they were supposed to be, and that funds are not as unlimited as they seemed to be just a few months ago. There are all sorts of devices monitoring not only delivery of health care but its quality and its cost effectiveness. Workers' compensation is no exception. Carriers and employers have the right to question, but they cannot deny authorization or alter medical care without medical opinion. Administrators, too, in the instance of apparent impasse will seek to resolve it with impartial medical examinations, and I suppose in some jurisdiction there may be panels of examiners for the same purpose. In those instances of protracted treatment where the effects may be brief and of no enduring value, the recommendation to terminate such treatment may be made and the issues presented for administrative decision.

The companion process to workers' compensation is rehabilitation. It is this process which may keep workers' compensation programs from simply becoming dispensers of funds as awards for existent defects, or, as they sometimes seem to be, rewards for having been injured. Any program of workers' compensation which does not include a program looking to restoration, if at all possible, to former economic and social status is bereft of purpose and dignity. Only through the efforts of physicians dedicated to the goals of rehabilitation, can these aims be achieved. Physicians must assess impairment and plan for rehabilitation. They must begin to do this early in the course of any disability. Physicians require the expertise of those of us who understand the demands of the work environment, and our input is essential. There can be no rehabilitation without medical guidance. The physician

must be knowledgeable in areas of community resources including the functioning of the various government agencies, state education departments, Offices of Vocational Rehabilitation, Social Security Administrations, social welfare agencies, and those agencies whose names and functions are more popularly known, including Easter Seals and the blind and lung associations. All of this takes on special urgency as a consequence of the Federal Rehabilitation Act of 1973 with its affirmative action provisions and with its punitive provisions, particularly for those industries with federal contracts.

I have attempted to show how a workers' compensation system cannot function without physicians and how physicians might be well advised not to ignore their responsibilities. To do so will be to invite changes which will reduce and almost deny to the physician any function beyond that of treatment, and then probably in a most restrained and limited fashion.

PROFESSIONAL SERVICES

Harold R. Imbus, M.D., Sc.D.

Since the workers' compensation system is one designed to provide medical care and compensation for the worker who is injured or ill from his work, the physician has always had an important role. Traditionally, physicians have been involved with the diagnosis, treatment, rehabilitation, and assessment of disability for workers under the workers' compensation system. Some physicians have for many years been involved in preventive programs to keep the worker from needing compensation or medical care in the first place. This role is increasing rapidly in recent years. Finally, when it comes to policy decisions, both inside and outside the corporate and in the broader realm of public decision-making, physicians have had a varying role depending upon their influence and the locality, but in the years that I have been involved in occupational medicine their role seems to have been largely passive. I would like to discuss the physician's role in the workers' compensation system under the headings of: Prevention, Diagnosis, Treatment, Rehabilitation, and Input Into Policy Decisions.

PREVENTION

In my opinion, prevention should be the primary role of the physician. This is not a role the physician can assume alone. It is an effort involving multiple disciplines including management, the safety engineer, the industrial hygienist, the nurse, the ergonomist, the industrial engineer, and the worker. The physician is in a position to assess the interaction between the work environment and the worker. There is an increasing body of literature about these interactions, and certainly the physician on the work site should make his own observations. An outstanding example of this is the recent discovery of angiosarcoma of the liver due to vinyl chloride exposure by the astute physician, John L. Creech, M.D. at the B.F. Goodrich plant in Louisville, Kentucky. It is quite likely that other astute physicians will discover similar associations in the future.

Broad policy concerning prevention is now being determined by OSHA standards. The physician should have an input into the development of these and also in their local application in the plant. However, it is very likely that regardless of the excellence of preventive efforts, workers' compensation cases, especially for occupational disease, will continue to increase. There are several factors in this:

1. The discovery of new occupational diseases and associations between work environment and disease heretofore unknown.
2. A general trend of more broadly interpreted definitions of occupational injury and disease to include conditions previously not included in the system.

Therefore, those involved with the preventive effort will find it increasingly difficult to measure their success if they base it purely upon the number of workers' compensation cases. Though this may be discouraging to some and may be difficult to explain to some managements, real success in this effort should be based upon the number of individuals removed from exposure, the decreased incidence of clear-cut injuries and occupational diseases, the stabilization of chronic disease processes affected by exposure such as hearing loss, lung disease, and so forth.

DIAGNOSIS AND TREATMENT

Many fine articles and books have been written concerning diagnosis and treatment of these conditions. Until recently, for the most part, diagnosis was confined to diagnosing the extent of trauma. This is fairly clear-cut in most instances. However, problems, when they did arise, usually were in the form of a delayed and non-obvious manifestation of a trauma; for example, a patient with a leg injury two weeks later develops low back pain, and the question is whether there is a relationship. Though these problems are difficult, they in no way approach the magnitude and difficulty increasingly encountered in the diagnosis of occupational diseases. Long latency periods and the fact that occupational diseases can be indistinguishable from ordinary diseases make the problem of diagnosis extremely difficult in many cases. Nevertheless, in spite of these difficulties, there are rational approaches to the diagnosis of the individual patient, and there are epidemiologic measures which can be used to assess the incidence of occupational diseases in groups of employees.

With respect to individual diagnosis, there are several important aspects which are fairly obvious. Many of us, however, overlook one or the other at times, and therefore may make an erroneous diagnosis. The diagnosing physician needs to know the manifestations of occupational diseases. These manifestations may be specific or nonspecific. For example, silicosis and coal miner's pneumoconiosis have pathologic findings that are reasonably specific for these diseases. These findings would enable a diagnosis by a pathologist from a biopsy or autopsy specimen. However, most occupational diseases have a set of manifestations that are not specific, but are characteristic of the exposure. The organs of the body have a limited variety of responses to various external insults and may respond in a single way to a large number of agents. A thorough history and physical examination should be included in the diagnosis of occupational diseases. Laboratory tests would include those for the general assessment of health, nonspecific tests of exposures such as serum glutamic oxaloacetic transaminase (SGOT), lactic dehydrogenase (LDH), FEV_1, tests for the agent or its metabolite that indicate exposure, and tests that establish a high susceptibility to a disease or condition. An evaluation of exposure must be made both from occupational history and industrial hygiene data where it exists. Once the physician has made these evaluations, he must then exercise clinical judgment in making a diagnosis. In my opinion, making these diagnoses of relationship of the patient's condition to the workplace exposure in a careful and unbiased manner is one of the most significant roles that the physician has in the workers' compensation system as it presently exists.

TREATMENT AND REHABILITATION

Here the ultimate goal is to treat and to cure the worker, and where more is not possible, to rehabilitate—to enable the worker to continue working with some accommodation to his problem. Treatment of course involves the specific treatment for the condition. Added to this, however, is a consideration of the need to prevent or modify continued exposure, and the need to evaluate physical capability to do the job in question. In addition, the physician needs to understand some of the other interactions which are often peculiar to occupational problems--the feelings of the employee, good or bad, toward the employer, and vice versa; and the interactions and influence of those representing the employee, on the one hand, and those representing the employer, on the other hand. At times, he may be able to be an influence in modifying some of the adversarial relationships that develop. Though it is the role of those representing employee or employer to see that the respective security and financial interests are protected, the physician's primary role must be to see that the patient recovers and returns to productive activity, if at all possible. Sometimes the adversarial nature of the workers' compensation system actually impedes this process; and the physician, when he sees this developing, should use whatever influence he can to prevent these problems from delaying the ultimate rehabilitation.

Rehabilitation is an important medical role in the workers' compensation system. The injured worker loses physically, mentally, and financially while he is unable to work. Early return to work compatible with his capability often before full recovery has taken place, is beneficial, provided this is done with good medical judgment and care. For practical purposes, rehabilitation can be considered in two phases: (1) off-the-job rehabilitation and (2) on-the-job rehabilitation. The former includes those efforts of the attending physician and rehabilitation specialists such as physical therapy, vocational training, care and rehabilitation centers, sheltered workshops, specialized work capacity determinations (such as cardiac work-evaluation centers) to determine fitness to work in special situations. The physician should see that these resources are fully utilized.

In addition, an often neglected aspect to rehabilitation is the on-the-job rehabilitation. It is a team approach utilizing the combined services of attending physician, occupational physician and/or occupational health nurse, and employer. It is an extension of off-the-job rehabilitation, often overlapping with it. Necessary to on-the-job rehabilitation are the following:

1. Interest of the employer and the occupational health team during the illness.
2. Physical and psychological medical evaluation from an occupational viewpoint prior to return to work.
3. Job evaluation from a viewpoint of physical and emotional demands.
4. Employer's understanding of the employee's problem.
5. Motivation and reassurance of the employee.
6. Modified work and/or gradual resumption of full duties.
7. Follow-up by the occupational health team.

The physician should evaluate whether or not these elements are present at the work site, and his role would be one of attempting to see that satisfactory on-the-job rehabilitation programs are in effect. This will effect early return to work in many cases.

INPUT INTO POLICY DECISIONS

Methods and amount of compensation are basically political decisions decided upon by federal and state governments. Though the physician may participate in this political process, as any citizen, depending upon his convictions and affiliations, it seems that the real role of the physician is to see that adequate scientific information is delivered to the decision makers. In many instances workers' compensation legislation has attempted to use the best available scientific evidence. This is becoming increasingly

difficult due to the recognition of long latent periods in the development of such diseases as occupational cancer and occupational lung disease. We are increasingly recognizing the interaction of various chemicals and environmental agents with the person's genetic disposition, physical condition, and other off-the-job environmental exposures, such as noise, smoking, and air pollution.

As an example of one of our current problems, let us discuss occupational lung disease. Most present-day lung disease is environmental in origin, that is, due to some type of inhaled substance or microorganism. In fact, most of our serious lung diseases today are not due to microorganisms, but to non-living organic or mineral substances inhaled into the lungs.

Earlier classic forms of occupational lung disease often had fairly discrete clinical, laboratory, or pathological findings. Now, many of the occupational lung diseases which are being described, both neoplastic and non-neoplastic, cannot readily be differentiated by the aforementioned means from non-occupational lung diseases due to inhaled pollutants such as cigarette smoke or environmental air pollution. This is not surprising in view of the following:

1. Earlier described occupational lung diseases were discovered with far less sophisticated measures than now available and therefore would be expected to be more obvious.

2. Modern clinical, laboratory, and epidemiological methods of assessing groups and relating the health of these groups to more sophisticated environmental measurements would be expected to result in improved finding of lung diseases associated with the environment.

3. It is generally accepted that the lung, like other tissue, has only a limited number of ways in which it can respond to environmental insults. Thus, the response may be fibrosis, granuloma, bronchitis, emphysema, and so forth, and though in some cases these may be somewhat specific to the agent described, such as in the case of asbestosis or silicosis, this may not necessarily be so, as in the case of chemical bronchitis, chemical allergy, or chronic obstructive lung disease due to cotton dust.

Though this development of detection of heretofore undescribed occupational diseases creates significant opportunities for prevention, it also creates a dilemma for the clinician who is attempting to diagnose the condition.

Some of the choices that have been advocated to deal with this problem are presumptions, criteria of diagnosis, and specific diagnostic tests.

Presumptions have been advocated both as to the existence and non-existence of occupational disease. In the past, the presumption often was that a condition was non-occupational unless it could be proven to be occupational. More recently, presumptions are being advocated in the opposite direction. If a condition occurs that may be compatible with the exposure, it will be presumed that the condition is due to the exposure regardless of other interrelated factors.

In the workers' compensation area, the negative presumption may result in a number of workers not receiving workers' compensation for an occupational disease which they indeed do have, while positive presumptions will result in many employees receiving compensation for non-occupational disease. For example, a number of surveys of presumably healthy groups exposed to no known occupational pollutant have shown an incidence of significant chronic lung disease as high as 20%. Therefore, it is possible, under the positive presumption, that if a group exposed to an occupational pollutant has a 10% increased incidence of disability, over and above the non-exposed group, that 30% rather than 10% will receive workers' compensation.

Arguments for and against a system of nega-

tive or positive presumptions can be made, and in reality the ultimate choice must be a political decision based upon factors other than medical considerations. However, if society and its politicians are asked to make this choice, it should be on the basis of a clear presentation of dilemmas and the costs involved, to the worker, to industry, and/or to taxpayers. Possible injustices either to employees or industrial groups should be measured carefully. Even some of those who favor negative or positive presumptions admit that this is a course of last resort and one based upon the lack of exact scientific knowledge for diagnosis. In view of the tremendous potential costs involved on the one hand to employees who may not be compensated for an occupational condition, and on the other hand, to industry or taxpayers who may be compensating for non-occupational conditions such as smoking, it seems desirable to consider methods other than presumptions. In addition, if the presumption method does become widespread for large industrial groups, it is very likely that this will greatly change the present system of workers' compensation versus general sickness compensation for occupational versus non-occupational disease.

We have dealt above with some of the problems of using presumptions in the workers' compensation system. Other problems of presumptions are the fact that using them may result in some lack of motivation on the part of individuals, industry, and government to clearly define the causative nature of occupational lung disease and the interaction thereof. Environmental controls to reduce pollutants are expensive, and if all cases of lung disease are considered due to occupation whereas only a small percentage really are, there may be a feeling that there is a situation which cannot be controlled no matter what; and therefore, incentives to truly control it may be diminished. Money spent on compensation cannot be spent on abatement.

Regardless of whether a system of presumption is finally adopted, it appears in view of the aforementioned difficulties that other methods of delineating the etiology of lung disease in an exposed employee merit serious consideration.

Criteria of Diagnosis Presently with many occupational lung diseases there is enough similarity to non-occupational lung diseases that there is no definite way to make a diagnosis. However, there are situations in which epidemiological studies can assist in the development of criteria diagnosis. These are never as precise as specific diagnostic tests such as biopsy or enzyme determinations, as in alpha-l-antitrypsin deficiency. However, they often are of considerable assistance in making a diagnosis which can be used in guidance to the individual, to the industry, and for medico-legal purposes. For example, a criterion of diagnosis may be based upon a history of exposure to significant amounts of the offending substance, a demonstration of physiologic changes, such as pulmonary function, and/or radiological changes compatible with the occupational lung disease. Judgmental factors for other exposures such as cigarette smoking may or may not be inserted into the criteria.

Criteria for diagnosis have been used by clinicians for many years in both occupational and non-occupational conditions. An example would be the Jones Criteria for the diagnosis of rheumatic fever in which the presence of two major manifestations or one major and two minor manifestations indicate the high probability of the presence of rheumatic fever, if supported by evidence of a preceding streptococcal infection. However, such criteria of diagnosis will always be somewhat arbitrary and may tend to exclude positive or negative diagnosis. In spite of these deficiencies, they do offer criteria which in some cases can be generally agreed upon and which can offer definite guidelines for counseling with individuals, management, and for medico-legal purposes. Therefore, it is believed that thorough review and research concerning diagnostic tests and criteria for diagnosis of the various occupational lung diseases should be a high priority.

Specific Diagnostic Tests It is obvious that a specific diagnostic test for a particular oc-

cupational disease is the most desirable means of making the diagnosis. Specific tests have been developed for a number of medical conditions, usually non-occupational. Obvious examples would be cardiac stress testing, coronary angiography, and G.I. series for diagnosis of peptic ulcer. Though even the so-called tests may not be of absolute certainty, they nevertheless are considered in most cases highly reliable and offer a reasonable degree of medical proof that the condition does exist. In the area of new occupational diseases, especially lung diseases, there is a paucity of specific tests. This, obviously, is to be expected since many of the occupational lung diseases are confused with or represent a combination of etiologies. Nevertheless, due to the importance of this matter, research should be directed toward better diagnostic techniques utilizing specific tests if they can be developed. Obviously, research aimed at developing specific diagnostic tests may in many cases be premature, since the development of these tests would depend upon a better understanding of the etiology and pathogenesis of the disease. Conversely, work directed toward developing better diagnostic methods can add to our understanding of the etiology and pathogenesis of the condition. Some of the areas that deserve further research and evaluation are: immunology, physiologic tests, pathologic tests, and chemical laboratory studies.

Occupational lung disease is just one of many areas of concern. I have outlined some of these problems and proposed solutions facing us today. The medical/scientific community can make a very substantial contribution in dealing with these problems in developing adequate scientific evidence and methodology. When such evidence and methodology do not exist, the medical community can also make a substantial contribution by clearly defining and articulating the problems that do exist, by clearly letting the American public know when there is not adequate scientific evidence, and by pointing out the problems involved and the various choices available in dealing with this matter.

LEGAL ASPECTS

John H. Lewis, J.D.

I must admit to a bit of trepidation over being here today, since it is impossible to talk about this subject matter without expressing at least a small amount of criticism of the medical profession. I hope that you might be persuaded to listen with open minds: I want you to know that I have never filed a medical malpractice action!

The impact of medical services on workers' compensation is immense. Many states report that over 30% of the benefits delivered during the year are payments for medical services which means that we are talking about hundreds of millions of dollars. The direct monetary impact on the system, however, may actually be over-shadowed by the importance of the medical profession's indirect influence on the entire compensation program.

DEGREE OF IMPAIRMENT

Many doctors, when questioned about their role in compensation cases, profess to have only an incidental and technical involvement. They maintain that their only concern is to treat their patients, whether compensation recipient or private patient, and to report on the condition of the patient as treatment progresses, to the point of complete cure, or maximum medical improvement with residual physical impairment. It is then supposed to be up to the insurance carriers, attorneys, and agency personnel to resolve the troublesome issues that arise in compensation cases. The physician with that attitude evidently doesn't realize that his initial diagnosis may be the determining factor in deciding whether a claimant's condition is compensable, and thus may control the entire benefit package.

The duration of temporary disability benefits will be controlled almost entirely by a physician's opinion, generally that of the treating physician, as to the need for treatment and rest. If permanency exists,

and the injury is to a scheduled member, the benefits paid will be determined by a doctor's opinion as to the degree of impairment. Even when the award for permanency is based upon factors such as loss of wage earning capacity, the final determination is usually based upon medical opinion as to what physical activities the claimant is able to undertake. This is certainly more than an incidental impact.

COMPLEXITY OF CASE

The question of the physician's attitude is also important as it can be one of the major obstacles that exist to improved relations between physicians and others in the compensation system. Although my specific topic deals with the legal aspects of the physician's role in workers' compensation, due to the nature of the compensation system it is not only difficult but self-defeating to try to separate legal aspects from other aspects of the system. Many, if not all participants, look upon the doctor as anything but a neutral factor in the operation of the compensation program. It is seldom that an injured employee or his attorney will view a doctor selected by the employer or carrier as anything other than a "company doctor," a term which has extremely negative connotations for many compensation recipients. Similarly, employers and carriers look with equal distrust at physicians retained by claimants and their attorneys, and view them as part of the claimant's "team." Often these feelings are unjustified and without basis in fact, resulting only from institutional attitudes developed over the years. However, many physicians either intentionally or unintentionally conduct themselves in a manner which lends credence to these beliefs.

Such conduct, usually unintentional, is generally brought about by the immense pressures under which many physicians must operate, e.g., poor communication with a patient. This, particularly when the doctor has been selected in some way by the employer, can virtually destroy the doctor-patient relationship. All of us are familiar with many cases in which a routine injury has become a complicated case, primarily because of the patient's belief that he is not being treated fairly by his physician. Obviously these feelings may sometimes be unjustified, but you must realize that injuries are important events in the lives of workers, particularly when they cause loss of income and fears about one's ability to return to a productive life.

The demands of a busy practice can be overwhelming, but so can the effects of failing to provide the patient with a reasonable amount of information and reassurance about his condition. Quite often doctors make this problem even greater by simply informing the patient that they cannot provide him with any information whatsoever, and state that he has to confer with his employer, its insurance carrier, or an attorney in order to find out how he is doing and what his prospects are. I can assure you that this virtually guarantees that the individual will wind up with an attorney and in litigation, if for no other reason than to obtain a change of treating physician.

OBJECTIVITY OF OPINION

An equally important factor is the determination by a number of doctors that they are in fact not neutral and owe some type of obligation to the particular side that they are "representing." Most compensation programs make use of a procedure which permits the adjudicator or one of the parties to select a physician to conduct an examination, for the purpose of testifying at the hearing. There are conservative doctors and liberal doctors, in terms of their evaluation of a patient's condition, but one must question whether statements made by doctors that they feel an obligation to assist the side that has requested their services either comports with the physician's code of ethics or provides any meaningful assistance to the compensation system. The practical result is to require at least two physicians in each case, one "liberal" and the other "conservative," with a resulting decision that is more often than not somewhere in between the two opinions. In metropolitan areas this procedure has reached such levels of sophistication as to cause unnecessary expenditure of substantial sums of money.

In the area of no-fault automobile insurance, statutes in some states require that a "threshold" of lost wages and medical expense be reached before a suit can be brought against a negligent party. After the implementation of these statutes, injuries which never required more than $200 to $300 in medical services all of a sudden required weeks of hospitalization, serial x-rays, and other expenses which in many cases miraculously came to $10 or $20 above the threshold. This requires an unfortunate kind of cooperation between members of the medical and legal professions, and we know that the some cooperation exists in compensation cases with regard to issues such as duration of temporary disability, extent of permanent disability, and need for active treatment. Obviously the legal profession has to accept at least half the blame, but by the same token, these activities cannot occur without the active participation of some members of the medical profession. And it is not only claimants' representatives who are involved in these actions. Many insurance carriers have continuing relationships with physicians, and they expect consideration of that relationship when the time comes for the expression of medical opinions on issues of causation and extent and duration of disability.

I want to emphasize that I am not talking about differences of opinion. There are many subjective factors to be considered in developing a medical opinion, and even the use of the AMA Guides to the Evaluation of Permanent Impairment does not guarantee identical opinions when two doctors deal with the same case. This is to be expected. What we are talking about is the deliberate distortion of opinion by physicians who are supposed to be neutral participants in the compensation program.

EXTENT OF PROBLEM

The problem is getting worse, not better. Every year we see more and more cases coming into the compensation system, due to increases in the covered work force. Also, it appears that we are becoming more litigious and what was intended to be a system operating with a minimum of controversy is rapidly becoming a battleground. But there remains on the horizon another factor which may create an even greater strain on workers' compensation programs throughout the country. I am referring to the problem of occupationally-related diseases. We still do not know the magnitude of the problem in terms of the incidence of cases. What we do know is that occupational disease cases create difficult medical issues and present increased opportunities for abuse of the system.

When workers' compensation agencies fulfill their obligations and provide adjudicators who can often determine when a physician is playing an inappropriate role in a compensation case, and rule accordingly, the opportunities for abuse are minimized and the incentives to play these games are reduced. While a well trained and well motivated judge or referee can quite often develop the necessary skills to reach such determinations in cases involving traumatic injuries, it is virtually impossible to do so in instances of disease. The medical issues are far too complex and technical to be readily comprehended by even a skilled layman; and as a result, there must be almost complete reliance on medical experts in order to establish causation and the other legal issues which must be resolved in every compensation case.

There are many unanswered questions in the field of occupational disease, and a great deal of disagreement, even among the experts. We don't need to compound the difficulties that this state of affairs creates by having doctors testify on issues about which they have little knowledge, or try to treat cases which are beyond their expertise. This quite often happens with the best of intentions. The motives may be of the highest order, but the compensation system operates and is funded on the basis of a number of legal considerations, and altruism is not one of them. In addition, the compensation system is not intended to fill the roles of a national health program or a national income replacement program.

The problems do not all come from the

claimants' side. There has been a tendency for some physicians retained by individual firms or industry associations to take positions on the industrial causation or even the existence of disease conditions which lacked even a minimal degree of open-mindedness. I can recall in very recent years assertions that byssinosis was not a disease, but rather a figment of the imagination. Equally absurd opinions have been heard in the debate over pneumoconiosis, and I am certain that they will appear from time to time whenever another major disease problem is found.

In terms of the difficulties of the compensation system, there is more than a grain of truth in the statement made about malpractice: The medical profession could solve the problem if it would only police its own members. Obviously, the legal profession must take steps to find and discipline those attorneys who are abusing their role in the compensation system. To do this, medical testimony is often indispensable in proving misconduct, testimony that is often difficult to obtain even in the most blatant cases.

The experimental peer review programs which are now being used in some areas need to be refined and expanded so that the opportunities to defraud the compensation system will be minimized and made less attractive. Physicians need to be educated as to their proper role in the compensation program, so that they can go back to practicing medicine and leave the representation of claimants to the attorneys.

Why should the physician do anything for a system that quite often burdens him with paperwork, pays inadequate fees, and embroils him in controversies which take him out of his office and into the courtroom. Not from altruism, but out of enlightened self-interest. Based on experience in Florida in considering the adequacy, or inadequacy, of medical fee schedules, one of the major objections to increasing the level of fees, even when economically justified, is the deeply ingrained feeling that a good portion of such increases will go to doctors who are abusing the workers' compensation program. Employers and insurance carriers are often more than willing to pay customary and usual fees for services rendered in compensation cases as long as the services provided to compensation recipients are performed in the same manner and to the same extent as those provided to private patients, and that the doctors involved will retain the role of physician, and not advocate.

The same holds true for the burdens placed upon the physician by demands for form filing and testimony. Certain forms must be filed with compensation agencies and/or carriers to advise them of the treatment being provided and its costs. However, the frequency of these reports and the detail required, in part, reflect a lack of trust and an unwillingness to permit the physician to render medical care to compensation patients without close oversight to prevent abuse. This may appear unfair and unwarranted, but it is a sad reality that must be faced.

Similarly, the need for medical testimony can be reduced if the physician provides prompt, comprehensive, and lucid reports as to the issues which may be involved in a compensation case. The demand for testimony is quite often based not upon the need for information, but upon the often reasonable belief that a doctor will advocate a position, or expressions of opinion. If this is done without substantial basis, it can be exposed through cross-examination.

In conclusion, the objectives of a workers' compensation program are best served and the claimant is certainly best served, by a system which operates with a minimum of game playing and abuse. The achievement of such a system is not totally within the physician's control, but without his help, it is unattainable.

WORKERS' COMPENSATION ADMINISTRATION

J. Howard Bunn, Jr.

The main thing which I think is important to the relationship of the physician in the workers' compensation system is the need for physicians to know more about the system, to understand what it is for, and understand how it operates. We attorneys often criticize the medical profession for not understanding the workers' compensation system, its statutes and regulations; but the legal profession, my own profession, is just as guilty. The law schools spend very little time on workers' compensation laws, and I expect that the case is the same with the medical profession, that those of you who went through medical school got practically nothing about workers' compensation. This points out two things. There is a distinct need for the medical schools in this country to spend some portion of time during the curriculum to let students know generally what workers' compensation is about. There is also a need after physicians leave medical school for continuing education courses to teach them the provisions of workers' compensation laws in their state and how these laws are administered.

In a session of this type, we can give you only a broad overview of workers' compensation and some of the problems. Individual state workers' compensation programs are still strictly state programs; and while there are many similar problems in the various workers' compensation agencies and laws, there are also many differences in the laws, so that to really grasp how your particular agency operates or how your particular laws function you need to contact the workers' compensation agency in your particular state.

Secondly, the medical profession needs to assess the problems of the profession with workers' compensation in a given state. There may be a problem in fee schedules. There may be a need for special procedures to diagnose occupational diseases. There may be problems in understanding what the

workers' compensation agency wants in the way of ratings. There may be problems in understanding the forms they require. In these matters, the local medical societies could very well be of considerable help to the workers' compensation agencies by analyzing the problems it is having *vis a vis* workers' compensation and going directly to the agency. Many states do have advisory committees that work with the compensation agencies, but I would encourage you to do more than that, to actually visit the compensation agency personally. I realize that physicians frequently just don't have time to take off and go to the state capitol, where the workers' compensation agency may be located; but it is time well spent because a lot of the complaints that come from the medical profession result from a lack of understanding of how that particular workers' compensation agency operates and how the laws are implemented.

Next is a problem which very well may be a sore spot to many of you and that's the need for the compensation agency either to take direct testimony or to take depositions. It has been my experience that many physicians are reluctant to take the time to engage in the deposition-taking process or actually go to hearings. Now, there is no way of getting around the occasional incidents where there just has to be a deposition or there has to be a hearing. There are some cases that cannot be resolved on an amicable basis. I would like to point out to you, and I suspect most of you know this, that the great majority of workers' compensation cases are not litigated cases. Now the cases that give you problems are those that have some sort of nuance; those that take you out of your office to go to the trial deposition, or those that require you to give deposition in your office. But the great majority, the bulk of the workers' compensation cases, are not litigated but are handled by medical reports alone, so it's important for you to understand, first, the type of medical reports that are required. This in and of itself frequently can reduce litigation. Secondly, physicians should try to be as cooperative as possible in the litigative process. It has been my experience that many of the complaints that arise from the medical profession come from a misunderstanding about the deposition or the litigative process. To prepare yourself I would suggest that you talk to an experienced physician or lawyer who has handled a lot of workers' compensation cases or else talk directly to the compensation agency. Know how the procedure goes. It is essential that the physician, whether a general practitioner or a specialist, be willing to refer the patient to a specialist if it appears that there is a real need for it. I know this may sound rather elementary, and I think most physicians do this, but occasionally you will run into a problem where a physician may be perhaps the only practitioner in a given area, perhaps in a small town, and it may be very difficult to get that patient referred to a specialist. But my suggestion is that if you really feel there is a need, and you're having difficulty in getting the patient referred out or getting authorization from an insurance carrier, that you contact the workers' compensation agency and try to explain why referral is necessary.

Another thing which I think is becoming more important as the occupational disease problem begins to increase in workers' compensation is the need for physicians to understand the local industrial hazards that your patients are exposed to. If there is a particular kind of plant in the area, where most of your patients are going to be working, it would pay you to go out to that plant and take a tour of it if you can possibly get authorization and just learn as much as you can about the particular hazards to which your patients will be exposed. This is going to become more and more critical, as I say, as the occupational disease problems increase. Something that I would like to emphasize again is the necessity for the physician community to understand what is needed in the way of workers' compensation medical reports. Now this varies a great deal from state to state, and nearly every agency has a particular form that they want used or particular information that's critical for their decision-making process; and frequently if these forms are filled out properly, the agency can handle the case without any litigation. But when the forms are poor, when the physician is busy and just jots down a few notes that seem to serve the pur-

pose for the moment, there may be problems later; and consequently I would encourage you, as I mentioned a few minutes ago, to find out directly from the workers' compensation agency what it is they want in the way of a medical report. And also I would again suggest to you that you try to look to a physician experienced in workers' compensation if you have access to one in your area, and let him tell you about the problems from his perspective as one who has worked in the field for some considerable period of time.

Finally, I would like to encourage you as a community of physicians to be active in workers' compensation reform, particularly in those matters relating to the medical community, such as making sure that your state law has full or unlimited medical coverage. Most states today do have that, but there are still a few that have some exemptions, waivers, or provisions in the law which prevent complete medical coverage. Another thing you need to pay attention to is the occupational disease area. For many years it was the well-known occupational diseases like dermatitis, silicosis, and asbestosis that were the ones that you heard about. With all of the new chemicals that are being used you can expect to see more and more cases of occupational disease, and they are going to be very difficult for you to handle. And I would stress again that you learn as much as you can about the occupational disease area, but mainly that you be active in workers' compensation reform matters, particularly those matters which affect your profession. One which is vital to you is the area of fees. Not every state has a fee schedule. I think when workers' compensation began, it was the general practice that the various compensation agencies had fee schedules. Then we began to grow away from this process, and we got to the point where only a few states had a fee schedule. Now we're seeing the fee schedule come back into being again as medical costs escalate. It may not be something that you're interested in seeing returned, but it is something that very well may return in many areas, and if it returns or if you are in a state where it's always been active, I would suggest to you again that you need to work with your state workers' compensation agency to see that the fee schedules are reasonable and are schedules which comport with economic reality.

To conclude my comments this morning, I can't emphasize enough the need to understand how the workers' compensation agency operates in your state, to understand its laws, its nuances, its administrative procedures, its forms. This is where a large percentage of the problems exist. There are a lot of complaints that are due to plain old fashioned mixups!

WHAT EVERY PHYSICIAN SHOULD KNOW ABOUT RADIATION

PROBLEMS OF IONIZING RADIATION

J. Newell Stannard, M.S., Ph.D.

This presentation will be concerned with the so-called "high energy" radiations such as X and gamma rays (photons), beta particles (electrons), alpha particles (helium nuclei), neutrons, and related particles. Their mode of action differs markedly from the actions of so-called non-ionizing radiations being considered in other papers in this session because they interact with atoms, even the nuclei of atoms, and produce ions directly or indirectly by the deposition of energy in the KeV and MeV range. These ions may have considerable energy themselves and produce highly reactive free radicals in aqueous media or disrupt, by direct action, the atomic structure of the material in which the energy is absorbed. In contrast to many other types of radiation the absorption of high energy radiations is relatively nonspecific, i.e., it is not greatly modified by the exact chemical structure of the absorber. Direct ionization occurs by interactions with matter of charged particles having sufficient kinetic energy to produce ionization by collision. Indirect ionization occurs when uncharged particles (or waves) liberate directly ionizing particles by their interaction with atoms or by initiation of nuclear transformations.

So much for definitions. The title for this symposium has the phrase "What every physician should know." I wish devoutly that it were possible to address this broad subject fully, for I feel there is a small but very significant body of facts and attitudes that every physician should indeed know about ionizing radiation. The average medical school curriculum even today does a very inadequate job of preparing the physician for the role that he will inevitably have to play in the nuclear age as counselor, consultant, advisor, and possibly as attending physician. But this must be detailed at another time and place, for there is too much to say of direct pertinence to occupational health.

SOURCES OF IONIZING RADIATION

The largest single source of exposure to ionizing radiation in the United States is in the medical and dental uses of X-rays and radioisotopes. This is because they are by far the most numerous and most used sources. Those occupational physicians who have a sizeable medical department are undoubtedly well aware of the concern in organized radiology and among radiation protection specialists for reduction of unnecessary patient exposure and concomitant fuller protection of radiological personnel. Anyone wishing further details can consult publications from HEW,[1,2,3] the profession itself,[4,5,6,7] and others.[8,9,10] I am happy to state that the adversary relationship that developed some years ago between the radiologists and those primarily concerned with radiation protection is gradually being replaced by full cooperation and understanding. The radiologists, medical and dental, are now taking considerable initiative in policing themselves and their technical staffs, and the latter also have their own professional organizations and standards. There is much yet to be accomplished. But the occupational physician needs to be deeply concerned about these matters only if he has his own X-ray machine in the back room and operates outside the circle of organized radiology. In this case he should look to assistance from state and local authorities and from manufacturers of machines and film for ways to detect and eliminate any defects and to get the best results with minimal exposure of patient and personnel.

Those physicians who are connected with large nuclear energy establishments are already fully familiar with the variety of potential radiation sources present and have a well-trained health physics or radiation protection organization at their side in order to meet licensing and other federal requirements. What does need to be said here concerning the nuclear energy industry in relation to the ordinary part- or full-time practitioner of occupational medicine is that he should be more than a passive bystander regarding the radiation problems potentially associated with nuclear power operations. As a member of a closely related facet of the health industry, the occupational physician is likely to be looked to for professional judgment—even to lend a hand in the event of an emergency. He should be well ahead of the layman in his knowledge of the hazards involved and be neither blindly opposed or sanguinely disinterested because the chance of his needing to know anything about nuclear power seems so very remote. Again, I can only recommend that you make it your business to read some of the more objective literature on the subject[11,12,13,14] and consider it in the same category as a brush-up in physiology or pathology. What sources are left, after medical and nuclear energy installations, that should or could concern the physician in part—or full-time occupational health, and what is their significance? In terms of significance, they constitute probably ten percent of the users of radiation even in an industrial state.[15] But they are more likely than any other sources to be in the hands of relatively untrained personnel, to be difficult to supervise and monitor because they are frequently operating under mobile or field conditions or hidden away in process lines. Thus, the occurrence of accidental overexposures is quite out of proportion to the relative numbers of units in operation. For example, in Pennsylvania[15], non-medical analytical X-ray machines with only 150 facilities and 200 units out of over 10,000 users of radiation sources in the state contributed *all* of the 22 reported cases of industrial X-ray radiation injury requiring medical attention in the period 1957-1966. And four of the cases required amputation of fingers! Hence the significance of your most likely sources is far from trivial.

The primary sources are the cabinet X-ray machines used for non-destructive testing procedures or package examination, electronic equipment used for similar purposes, X-ray diffraction equipment, analytical X-ray equipment, neutron activation installations for analytical purposes, neutron sources used for other purposes, and radiographic equipment using sealed sources that contain radionuclides such as cobalt-60, cesium-137, indium-192, thulium-170, and radium-226 plus or minus

its decay products. Frequently weaker but still significant sources are found in thickness gauges, in-process control and measuring devices for flowing liquids, height and depth gauges for large, inaccessible containers, luminous signs and buttons, static eliminators, and the like. And we must not forget that the laboratory is as likely to have a potent radiation source lurking in an analytical tool operated by persons untrained in radiation protection as is the remote field unit testing welds in a newly laid pipeline.

Fortunately an excellent summary of both the sources and what can be done about them is contained in a symposium on Radiation Safety and Protection in Industrial Applications held in 1972 and available as a DHEW publication.[16] A few new aspects have been added since then but they are primarily quantitative changes to higher energies and more applications.[19] This, plus the annual and special reports from the Bureau of Radiological Health of FDA under Public Law 90-602—"The Radiation Control for Health and Safety Act"—counterpart reports from OSHA and NIOSH, and in the general literature,[17,18] provide excellent coverage of the variety and relative importance of these many sources. Let it be emphasized again that these sources are probably the most likely to be subject to accidental misuse or misunderstanding of all the extant radiation sources, and they fall squarely in the domain of the occupational health scientist.

CHARACTERISTICS OF THE SOURCES

Two broad categories exist:

1. Those that exert their action through highly penetrating ionizing radiation from a fully contained source, termed external radiation sources; and
2. Radioisotopes that enter the body through inhalation, ingestion, or a wound and act by irradiation of cells after deposition in the tissues of the body. The second category is frequently dubbed internal radiation or "internal emitters."

Most of the sources of interest to you are external radiation sources, even those containing large quantities of radioisotopes, since it is the penetrating radiation from their decay in a sealed source that is used. Similarly, physician interest in neutron sources would normally be as external radiation sources. There are a few procedures such as leak testing with krypton, or the exposure of miners to airborne radioactive dust, where the normal exposure mode in industry is to an internal emitter. But the primary concern with internal emitters will be through the accidental loss of radionuclide from a supposedly sealed source. In the case, for example, of a multicurie Co-60 source, any significant leakage presents a major problem. But even devices such as static eliminators, luminous buttons, and so forth, have been the source of unexpected and sometimes serious contamination incidents, because they went undetected long enough to allow much dispersion of the radioactive materials. Fortunately these accidental releases are infrequent. But the great difference between the problems of external and internal sources must be appreciated. These will be enumerated later.

With any given type of ionizing radiation the ability to penetrate matter depends strongly upon the energy. The higher the energy, the greater the penetrating power with certain constraints. Thus, industrial radiography has advanced in part by the development of higher and higher energy sources. Along with this comes the need for greater shielding, greater distance between the operator and source, and the application of image intensifying and other means to compensate for the increase in energy and to get the operator away from the primary beam.

But another factor, termed radiation quality, plays an important role. The electromagnetic radiations typical of X or gamma rays do not collide with atoms or nuclei directly and have very sparsely ionizing tracks except at their very end. Neutrons, alpha particles, and so forth, have much more densely ionizing tracks partly because of their greater mass, partly because of the electrical charge in the case of alpha particles, and

partly because they act by a different mechanism. They lose their energy in a much shorter track and thus have much less penetrating power. Conversely, they deposit a lot more of their energy in a small volume. The result of this is that an alpha particle source external to the body is easily shielded out by the thickness of the horny skin epidermis or even a sheet of paper and is thus relatively innocuous as an external source. But because of the high density of tracks produced, more accurately referred to as a high Linear Energy Transfer rate (LET), alpha particles can be very damaging if they do enter the body and deposit in tissue. Indeed, it is generally considered that a cell will almost certainly be killed by the traversal of a single alpha particle track through its nucleus. The same distinction applies to heavy nuclei from other sources and to a lesser degree to neutrons. Thus, the radiation quality (largely determined by the LET) is as important, frequently more important, than energy.

In radiation protection practice the importance of radiation quality is accounted for by the use of a practical number called the "quality factor." The range of this is shown in Table 1.[20]

PRACTICAL QUALITY FACTORS

Radiation type	Rounded-QF
Xrays, gamma rays, electrons or positrons, Energy >0.03 MeV	1
Electrons or positrons, Energy <0.03 MeV	1
Neutrons, Energy <10 KeV	3
Neutrons, Energy >10 KeV	10
Protons	1-10
Alpha particles	1-20
Fission fragments, recoil nuclei	20

Table 1. (Modified from Ref. 20)

The quality factor for neutrons is more dependent on energy than that of some other radiations and ranges from about 2 to 11, but this is detail beyond what every industrial physician should know and I will not expand upon the numbers here.

Finally, it should be emphasized that the mechanisms of interactions of irradiation with matter do not change whether the source is external to or within the body. The same phenomena occur. As described above, it is clear that a high LET radiation that penetrates poorly from outside the body can be very damaging once inside the body, but this effect is due to a difference in location of the source rather than a difference in mechanism. But still other major differences exist between external and internal sources. Usually the external source can be turned off or shielded, a process which is obviously impossible once a radioelement is deposited in cells or tissue. And finally the radioelement will be distributed (i.e., metabolized) in the body according to its chemistry. Thus, it may be or become highly localized in certain tissues such as bone, liver, lung, kidney, portions of the reticulo-endothelial system, or even gonadal tissue. These variables make the problem of internal dosimetry entirely different and more complex than those of external radiation. If you have an incident involving internal contamination and have not had experience with it, you would do well to have some telephone numbers for expert help readily at hand.

BIOLOGICAL EFFECTS OF CONCERN

As with most toxic agents the effects depend greatly on dose. At high radiation doses a well-described symptom complex, termed

the acute radiation syndrome, occurs. This has been very completely described by many[21,22] and can be found in most textbooks of radiation biology[23] or radiation protection.[24] Briefly, it is characterized by sudden onset of nausea and vomiting, diarrhea, followed by precipitous decline of both red and white cell counts, fluid loss, leaky capillary membranes, and at the very highest doses, early and pronounced central nervous system symptoms. Occupational physicians are unlikely to be involved in such an acute incident but should be well aware of what to look for and do. I especially recommend consulting the book by Saenger.[21] At lesser doses the changes are more subtle and take longer to develop. Table 2 presents one of many summaries of expected dose-effect relationships in man.[25]

REPRESENTATIVE DOSE-EFFECT RELATIONSHIPS IN MAN FOR WHOLE BODY IRRADIATION

Nature of effect	Representative absorbed dose of whole-body x or gamma radiation (rads)
Minimal dose detectable by chromosome analysis or other specialized analyses, but not by hemogram	5-25
Minimal acute dose readily detectable in a specific individual (e.g., one who presents himself as a possible exposure case)	50-75
Minimal acute dose likely to produce vomiting in about 10% of people so exposed	75-125
Acute dose likely to produce transient disability and clear hematological changes in a majority of people so exposed	150-200
Median lethal dose for single short exposure	300

Table 2. (Modified from Ref. 25)

There are many caveats for even these numbers, but they give some idea of the range over which a physician might expect to see something occur in an exposed individual under his care.

Note that the dose in Table 2 is given as whole-body dose. A different pattern would of course prevail for partial-body radiation as you can readily recognize. All of the numbers in Table 2 are far above any accepted level of occupational or population exposure when considered as whole-body exposures. They are pertinent here only in the event of relatively gross overexposure. Nevertheless, they are not without relevance to normal operations in occupational medicine. While gross overexposure of the whole body is unlikely without gross carelessness, acute overexposure of fingers, hands, or a localized body area has quite a finite likelihood of occurring even in current practices. Exposure to the direct beam of intense radiation from an X-ray diffraction or analytical machine, or even a radiography source cannot be ruled out; neither can the unwitting manipulation of an exposed sealed radioisotope source or the spread of contamination from a leaking source. In all instances except the one of contamination, one would look for some of the classical signs of acute radiation exposure of the skin such as skin erythema, inflammation, and ulceration that will not respond to normal therapeutic measures. (Recall that four of the twenty-two reported overexposures in Pennsylvania required amputation of an appendage.)

SKIN EFFECTS, SINGLE EXPOSURE

Exposure	Early effect	Chronic effect
50R	Chromosomal changes only.	None (Possible slight neoplastic alterations).
500 R	Transitory erythema. Transitory epilation.	Usually none. Risk of altered function increased.
2500 R	Temporary ulceration. Permanent epilation.	Atrophy. Telangiectasis. Altered pigmentation.
5000 R	Permanent ulceration (unless area very small).	Chronic ulcer, substantial risk of carcinogenesis.
50,000 R	Ordinarily necrotizing, but recovery possible when radiation has extremely low penetration.	Permanent destruction to a depth dependent upon radiation energy.

Table 3. (Modified from Table 3, Ref. 29)

EXAMPLES OF BIOLOGICAL RESPONSE IN HUMAN ORGANS AFTER EXTERNAL PARTIAL BODY IRRADIATION

Organ	Dose schedule	Single dose or extrapolated equivalent RADS	Effect in relevant organs
Ovary		200	Temporary amenorrhea, sterility
	1500 rads/10 days	800*	Permanent menopause, sterility
Testis		50	Temporary sterility
	1500 rads/10 days	800*	Permanent sterility
Bone marrow	25-75 rads in each of 5-10 days (Certain bone marrow segments require higher doses.)	200*	Hematopoiesis inhibited in irradiated volume. Usually compensated by marrow activity in unexposed sites
Kidney	2000 rads/30 days 3000 rads/40 days	650*	Nephritis, hypertension
Stomach	1500 rads/20 days 2500 rads/30 days	1000*	Atrophic mucosa, anacidity
Liver	3000 rads/30 days 4000 rads/42 days	1500*	Hepatitis
Brain and spinal cord	5000 rads/30 days 6000 rads/42 days	2200*	Necrosis, atrophy
Lung	4000 rads/30 days 6000 rads/56 days	2200*	Pneumonitis, fibrosis
Rectum	8000 rads/56 days	2700*	Atrophy. Limit of tolerance, most cases
Bladder	10,000 rads/56 days	3400*	Atrophy. Limit of tolerance, most cases
Ureter	12,000 rads/56 days	4000*	Atrophy. Limit of tolerance, most cases

*Extrapolated equivalent calculated from the empirical relation $D_e = D_0 t \exp(-0.27)$, where D_e is the extrapolated equivalent single dose, when an actual dose of D_0 is spread over the time t days. This relationship essentially assumes an equal daily dose schedule. Other formulations (e.g., the Ellis formula 52) give successful empirical results for some erratic fractionation schedules. Such refinements are not needed here; as in Table 1 these entries are meant to be descriptive, rather than definitive.

Table 4. (From Ref. 29)

You would also look for some of the effects of acute partial-body exposures (Table 4).[29] Usually the circumstances can be reconstructed sufficiently to get an idea of probable dose. But again, unless one has had experience, he should not try to go it alone; the smaller the operation, the more the need to call in outside help.

By contrast to these early, relatively acute effects, the long-term delayed effects of ionizing radiation of concern are primarily carcinogenesis in the case of the individual and genetic effects in consideration of the future of the human race. In the case of genetic mutations, the effects may take several generations to be expressed if they happen to be recessives. Frequently carcinogenesis has latent periods of twenty years or more.

We have direct and convincing evidence that ionizing radiation can cause cancer in man, and we are even accumulating some moderately satisfactory quantitative dose-effect relationships in the high dose realm.[26] For genetic effects we must rely entirely on data from animals, primarily the mouse. Detection of radiation-induced mutations in man, which are qualitatively identical to those from other sources and those occurring spontaneously, is manifestly impossible. But there is no reason to doubt that radiation can produce genetic changes in man. Thus, because of these long-term effects and the current state of our knowledge of the dose-response relationships, it has been necessary to exert great caution in setting radiation exposure standards and to be ultraconservative relative to most if not all other agents. Useful and intentionally abbreviated summaries of both the phenomena and of dose-effect relationships can be found in the textual references already given and in the books by Andrews[27] and by Shapiro.[28]

Despite their importance to the field of radiation protection, these long-term effects are not something one can expect to identify positively in the practice of occupational medicine. They are statistical matters representing a small increase of risk and are not specifically or individually identifiable. This leads to my final section, a consideration of radiation protection standards.

BASIS FOR RADIATION PROTECTION STANDARDS

Unless physicians are in a situation where radiation sources are a very minor part of the operation, they have undoubtedly been exposed to the presence of an array of state, federal, and other standards governing the exposure of workers and of the population. I will not subject you to the numbers here, for unless you are already familiar with dosimetry and unitage, the numbers themselves have little meaning.

The basic philosophy of radiation protection has been for years the avoidance of any and all injury that would be unacceptable to the individual in relation to other possible hazards of living and/or employment, or that would be judged by competent medical authorities to be detrimental to the individual or the race. This view still holds. But a few years ago it was agreed that the most conservative interpretation of the probable dose-response relationship is the assumption that responses at low doses should be extrapolated from higher doses by assuming that a linear relationship holds and that there is no dose threshold. While acceptably conservative, this concept has the corollary that any dose, however small, may have some effect, however small. Thus, *judgment* has to enter as to what constitutes an undesirable effect both qualitatively and quantitatively. Also, the idea of not allowing any effect (i.e., risk of an effect) without some corresponding benefit has been superimposed on this first decisional process, and we have been treated to some elegant charades balancing risk against benefit. You can readily appreciate the dilemma of deciding *whose* risk versus *whose* benefit and the inevitable problems of comparing such grossly dissimilar entities in a population of workers, let alone in the general population.

Application of the linear no-threshold hy-

potheses as a model can generate calculations of numbers of excess cases of this or that effect to be expected, and these include estimates of numbers of people killed in the first or in subsequent generations. These calculations characteristically multiply some very low incidence rate by a large population theoretically receiving the dose (e.g., that of the United States) and get startlingly large figures. Sooner or later the fact that this calculation was based on a model gets forgotten and the numbers get treated like real deaths of real people. The cognizant national and international bodies in the field of radiation protection, such as the U.S. National Council on Radiation Protection and Measurement (NCRP) and the International Commission on Radiological Protection (ICRP), are carefully examining and reexamining all of the evidence. They have yet to be convinced that current standards are seriously under-conservative, although certain individual areas are clearly due for some changes.

Because industry has been able to operate far below these general standards, it has been convenient to add conservatism by the admonition to design and operate at levels "as low as practicable" or "as low as practicably achievable." Indeed the U.S. federal establishment finally yielded to pressure from the engineers for numbers and stated in the Code of Federal Regulations what the "as low as practically achievable" levels should be for design criteria for light water reactors. In a sense, attaching of specific numbers is in direct contradiction to the "as low as practicably achievable" principle but it had to be done.

But this discussion is somewhat aside from the standards applicable to occupational medicine types of operation. The current basic standards of NCRP, ICRP, the states, and the federal establishment are those you may need to be aware of. And these, while appreciably lower than in the years prior to the nuclear age, are still basically derived from experience in medical installations, the radium dial painters and patients, and related more recent experiences including the increasingly significant accumulation of data from the exposed Japanese. Quite adequate summaries of both philosophy and data are available in the books by Andrews[27], Shapiro[28], and Morgan and Turner[24], and in the recent reports of the NCRP[26,29] which give much of the philosophy as well as the recommendations.

Lauriston Taylor, President of NCRP, has stated eloquently on many occasions, including his chapter in the volume on Radiation Safety and Protection in Industrial Applications already cited[15], that the exercise of judgment is the key ingredient in radiation standard setting and evaluation. The standards are already so low that no one will be able to pick out a given individual and relate his particular disease to exposure at or below the level of the standards. The judgment must be made on a statistical basis with many non-science elements. Frequently this exercise of judgment, much akin to what the physician calls clinical judgment, seems to be submerged in a welter of numbers calculated in different ways and for different purposes. Indeed we seem to be in serious danger of over-regulation at the expense of the exercise of professional judgment. This trend is unfortunate for we have behind us in the radiation field the largest body of information in a large variety of life forms of any of the agents impinging on man and his environment. This is one fact I feel every physician should know about radiation. We are not working in the dark anything like to the extent we are in many of the areas of chemical toxicology, and we should make full use of what we have.

SUMMARY

This paper emphasizes those aspects of ionizing radiation sources and effects most likely to impinge on the practice of the full- or part-time occupational physician in an industry where radiation sources are only one of the many operations. It does, however, admonish the occupational physician to be cognizant of the main features of medical radiation exposures since these constitute the largest single source of man-made radiation exposure. He should also have some

knowledge of nuclear energy installations beyond what is available in the popular press. Leads are given to succinct yet informative reference material, and the need for having sources of expert help available and arranged for before an incident occurs is emphasized.

It is quite clear that there are some things the occupational physician **should** know about radiation primarily because he is a physician, other things because he is likely to encounter some rather difficult situations in practice due to remoteness and infrequency of the operations and the higher likelihood that the sources will reach untrained hands than is true of installations dealing primarily or exclusively with radiation sources. It is also emphasized that our radiation protection standards for ionizing radiation, even though there is much yet to learn, rest upon essentially the largest body of scientific information in either man or beast of all of the potentially hazardous agents on the industrial scene.

REFERENCES

1. Reduction of Radiation Dose in Diagnostic X-ray Procedures. DHEW Publ. No. FDA 73-8009. 1972.

2. Gonad Dose and Genetically Significant Dose from Diagnostic Radiology, U.S., 1964 and 1970. DHEW Report FDA 76-8034. 1976.

3. Radiation Safety Handbook for Ionizing and Nonionizing Radiation. DHEW Report FDA 76-8005. 1976.

4. A Practical Manual on the Medical and Dental Uses of X-rays with Control of Radiation Hazards. Am. College of Radiology. 1958.

5. How to Protect Patient and Physician During X-ray Examination. Installment 1: "Effects of Radiation." Installment 2: "Responsible Use of Diagnostic X-rays." Am Family Physician/GP 1(1):13. 1970 and 1(2):105. 1970.

6. Chamberlain, R.H. "Medical Radiation. Perspective in Risks and Rewards." Am J Pub Health 55:720. 1965.

7. Blatz, H. "Common Causes of Excessive Patient Exposure in Diagnostic Radiology." New Eng J Med 271: 1184. 1964.

8. Morgan, K.Z. "Adequacy of Present Standards of Radiation Exposure." Environmental and Ecological Forum 104. January 1971. USAEC, Office of Information Services. 1972.

9. Morgan, K.Z. Hearings before the Committee on Commerce of the U.S. Senate. Part I. Serial No. 90-49, pp. 31-64. GPO, Washington, D.C., 1968.

10. Health Physics in the Healing Arts. Proc. of Health Physics Society Midyear Topical Symposium, 1972. DHEW Publ. FDA 73-8029. 1973.

11. Lapp, R.E. "The Four Big Fears About Nuclear Power." New York Times. February 7, 1971.

12. Lapp, R.E. Series of four articles in New Republic beginning Jan. 27, 1971.

13. Jordan, W.H. "Nuclear Energy Benefits versus Risks." Physics Today. May 1970.

14. Foreman, H. (ed.) Nuclear Power and the Public. Univ. Minnesota Press. 1970.

15. Gerusky, T.M. "The States' Role in Industrial Radiation Safety." Symposium on Radiation Safety and Protection in Industrial Applications. DHEW publ. No. FDA 73-8012, BRH/DEP 73-3. 1972.

16. U.S. Department of Health, Education, and Welfare. Symposium on "Radiation Safety and Protection in Industrial Applications." DHEW Publ. No. FDA 73-8012 BRH/DEP 73-3. 1972.

17. Wrenn, M.D.E. and H.F. Schulte, L.V. Craley and P.R. Atkins (eds.) "Ionizing Radiation" pp. 179-217. Industrial Environmental Health. Academic Press, New York. 1976.

18. Voelz, G.L., and Carl Zenz (ed.). "Radiologic Health in Occupational Medicine Practice" pp. 499-551. Occupational Medicine, Principles and Practical Applications. Year Book Medical Publishers, Chicago. 1975.

19. Villiforth, J.C. Symposium on "Radiation Safety and Protection in Industrial Applications." DHEW Publ. No. FDA 73-8012. BRH/DEP 73-3. 1972.

20. Table 5, p. 83. National Council on Radiation Protection and Measurements (NCRP). Report No. 39, "Basic Radiation Protection Criteria." NCRP Publications, P.O. Box 4867, Washington, D.C., 20008, 1971.

21. Saenger, E.L. (ed.) "Medical Aspects of Radiation Accidents, A Handbook for Physicians, Health Physicists and Industrial Hygienists." U.S. AEC, Contract AT(30-1)-2106. 1963. Superintendent of Documents, Washington, D.C., 1963.

22. Hempelmann, L.H., H. Lisco, and J.G. Hoffman. "The Acute Radiation Syndrome: A Study of Nine Cases and A Review of the Problem." Ann Intern Med 36:280-510. 1952.

23. Casarett, A.P. Radiation Biology. Prentice-Hall, Inc., Englewood Cliffs, N.J. 1968.

24. Morgan, K.Z. and J.E. Turner. Principles of Radiation Protection. Robert E. Krieger Publishing Co., Huntington, N.Y., 1973.

25. Table 1 from NCRP Report 39, "Basic Radiation Protection Criteria." National Council on Radiation Protection and Measurements. NCRP Publications, P.O. Box 4867, Washington, D.C. 20008, 1971.

26. NCRP Report No. 43. "Review of the Current State of Radiation Protection Philosophy." National Council on Radiation Protection and Measurements. Washington, D.C. NCRP Publications, P.O. Box 4867, Washington, D.C. 20008. 1975.

27. Andrews, H.L. Radiation Biophysics. 2nd Ed. Prentice-Hall, Englewood Cliffs, N.J., 1974.

28. Shapiro, J. Radiation Protection. A Guide for Scientists and Physicians. Harvard University Press, Cambridge, Mass., 1972.

29. NCRI Report 39. "Basic Radiation Protection Cri[illegible]" National Council on Radiation Protection and Measurements. NCRP Publications, P.O. Box 4867, Washington, D.C. 20008. 1971.

RADIATION AND OCCUPATIONAL HEALTH

Sol M. Michaelson, D.V.M.

ELECTROMAGNETIC RADIATION

To provide a basis for understanding the biologic effects of radiation, a review of some fundamental aspects of electromagnetic (EM) energy is indicated. Strictly speaking, the EM spectrum comprises all energy that may propagate electromagnetically in space, and hence includes low frequencies, such as 50 Hz and 60 Hz used for power line transmission, radio frequencies, infrared through visible to ultraviolet light, X-rays, Gamma rays, and Cosmic rays.

The energies of the EM spectrum are propagated in the form of waves that act as small bundles of energy called photons or quanta. The energies residing in these photons (E) are directly proportional to the frequency (V) of oscillation of the specific electromagnetic radiation associated with them by the formula $E = hV$, where h is Planck's constant. The photon energy measured in electron volts (eV) and the frequency of an electromagnetic wave is inversely proportional to its wavelength. The longer the wavelength, the lower is the photon energy; the shorter the wavelength, the higher the photon energy.

For theoretical and practical convenience, the EM spectrum is divided into two subspectra according to whether or not the radiation involved is of a wavelength shorter than or longer than that required to produce ionization, which is in the X-ray region. Radiation at wave lengths shorter than this ionization wavelength are in the ionizing radiation spectrum; those longer are in the non-ionizing radiation (NIR) spectrum. For practical purposes, the NIR spectrum is further divided into three sub-spectra, historically termed optical, radiofrequency, and electrical. Although they coalesce, these spectra are technologically different.

The electrical spectrum is that in which energy is usually transmitted by wires or ca-

bles. By far, the greatest part of the man-made EM energy is in this spectrum, as 25 Hz, 50 Hz and 60 Hz electric power generation, transmission, and utilization. The electrical spectrum also covers the bulk of electronic devices, from control mechanisms to audio amplifiers. Its upper limit is traditionally a bit above the upper limit of human hearing, or about 20 kHz. Frequencies in this spectrum may, of course, radiate and hence propagate in space as do higher-frequency EM waves.

The radiofrequency spectrum, which is now a misnomer because it includes frequencies both below and above those of traditional radio, is that in which energy usually is caused to travel in space and is generated, directed, contained, detected, or utilized by electrical or electronic means. It is considered to extend from 10 KhZKkHz (very low frequency—VLF) to 300,000 MHz (extra high frequency—EHF). On an operational basis, frequencies in the region from 100 MHz to 300,000 MHz (300 GHz) are designated as microwaves.

The optical spectrum is that in which energy traditionally is associated with light or its neighboring radiations in the spectrum and is generated, focused, contained, detected, and utilized by optical means. Recently, the optical spectrum has been invaded by light-emitting diodes and lasers (an acronym for Light Amplification by Stimulated Emission of Radiation). But since even these devices rely mostly on optical techniques for their effective utilization, they still belong in the optical spectrum.

MECHANISMS OF ACTION

It has been determined that one ionization occurs on the average for every 34 eV of energy expended in air. The actual amount of energy needed to eject an electron from a molecule (ionization potential) ranges from 10 to 25 eV. The extra energy that is expended is used for excitation of molecules.

As an EM frequency decreases, the energy of the emitted photons is insufficient, under normal circumstances, to dislodge orbital electrons, and produce ion pairs. The minimum photon energy capable of producing ionization in water and atomic oxygen, hydrogen, nitrogen, and carbon is between 12 and 15 electron volts (eV). Inasmuch as these atoms constitute the basic elements of living tissue, 12 eV may be considered the lower limit for ionization in biological systems. Since the energy value of 1 quantum of non-ionizing radiation (NIR) is considerably less than 12 eV, the type of electronic excitation necessary for ionization is not possible no matter how many quanta are absorbed. NIR absorbed into the molecule either affects the electronic energy levels of its atoms, or changes the rotational, vibrational, and transitional energies of the molecules. Changes are produced in biological systems through either photochemical (ultraviolet) and/or thermal modes (infrared, microwaves).

Ultraviolet (UV) For the purpose of assessing the biological effects of ultraviolet (UV) radiation, the wavelength range of interest can be restricted to 100-400 nm.[1] This range extends from the Vacuum UV (100 nm) to the near UV (400 nm). The photon energy range for wavelengths between 100 nm and 400 nm is 12.4 to 3.1 electron volts respectively.

The biological action spectrum for erythema produced by UV[2] radiation of the skin has been the subject of investigation for many years. The most recent data show that a maximum erythemal effect is produced at 260 nm with the secondary peak at approximately 290 nm. The critical organs are the skin and eyes, and UV irradiation results in erythema, skin cancer, photosensitization, and keratoconjunctivitis.

While whole-body exposure to UV is possible, common articles of clothing are effectively opaque to ultraviolet. Skin cancer has been reported in workers exposed to industrial UV sources[2,3,4] or whose occupation requires them to be exposed to sunlight for long periods of time.

Excessive UV (200 nm-400 nm) exposure produces photophobia accompanied by redness, tearing, conjunctival discharge, sur-

face exfoliation, and stromal haze. Damage to the corneal epithelium by absorption of UV probably results from photochemical denaturation of proteins or other important molecules in the cells, such as deoxyribonucleic acids (DNA) and ribonucleic acids (RNA). The absorption is probably by selective sensitive portions of single cells.

Visible light The hazards to man from visible light are relatively few and mostly come from artificial sources such as lasers and certain high intensity lights. The penetrating ability of visible light is slight except for transparent materials such as the lens and humors of the eye. Light entering the eye from a bright source is focused on the retina and, therefore, the thermal irradiance is independent of the inverse square law for image sizes greater than the diffraction limit.[5] Because of its narrow depth of penetration, visible light in general does not manifest itself as a potential hazard. There are situations, however, in which it can become hazardous. Epileptiform responses have been produced in animals and children exposed to pulsating light near the alpha rhythm frequence of the EEG.

Normally intense and bright sunlight causes maximal constriction of the pupil that thereby reduces the energy density on the retina. Bright sunlight, furthermore, causes painful photophobia that will not permit prolonged direct and fixed observation of the sun. The lid reflex (approximately 150 ms) is another mechanism that protects the eye. The continuous action of these measures would be adequate under normal conditions to avoid burn injuries to the retina.[6]

Infrared energy Infrared (IR) extends from beyond the red end of the visible portion of the EM spectrum (750 nm) to about 1×10^6 nm. The IR spectrum is frequently *arbitrarily* divided into three bands: the near IR (750-3000 nm), the middle IR (3×10^3 - 3×10^4 nm) and the far IR (3×10^4 to approximately 1×10^6 nm).

There is little evidence that photons in the IR (i.e., less than 1.5 eV) are capable of entering into photochemical reactions in biological systems, because they are too low in energy to affect the electron energy levels of these atoms. The interaction that does occur upon absorption involves an increase in the kinetic energy of the system that produces a degradation of the radiant energy to heat.[7]

The most prominent direct effects of low wavelength IR on the skin include acute skin burn, increased vasodilation of the capillary beds, and an increased pigmentation that can persist for long periods of time. Under conditions of continuous exposure to high intensities of IR, the erythematous appearance due to vasodilation may become permanent. Many factors mediate the ability to produce actual skin burn, and it is evident that for this immediate effect, the rate at which the temperature of the skin is permitted to increase is of prime importance.[7]

Laser There are several mechanisms involved in producing a laser lesion. The initial physical trauma is followed by the biological reaction of the tissue itself. The types of physical trauma may differ, but only a few types of physical insults may call forth identical physiological reactions from the tissue. This tends to mask the different physical causations.[8]

There may also be amplifying factors in the biological reactions to physical trauma. These include reactions to thermally denatured protein or other parts of injured cells, and increased cellular activity from increased tissue temperatures accompanied by diminished cell survival. In the case of the photoreceptors themselves, the stimulation by light itself may cause a similar increase in metabolic rate. This deleterious effect of the light may synergize with a similar effect from an elevation of temperature.[9]

One important interaction of a laser beam with tissue is denaturation of protein, the extent of which is related to the incident energy or power per unit area and duration of exposure. The potential for injury to tissues also depends on the "accessibility" of the tissue to the radiation, which in turn is a function of the depth or penetration of the

radiant energy. When laser radiation impinges on tissue, the absorbed energy produces heat. Rapid and localized absorption may produce enough high temperature to boil the tissue water. The resultant steam production can disrupt cells or even produce dangerous pressure changes in an enclosed and completely filled volume such as the eye or skull.[9]

Photochemical reactions result in activation of molecules by the capture of quanta of energy. Such capture constitutes the primary ... nt in a photohemical reaction. Some of the photochemical reactions induced by laser exposure may be abnormal, or exaggerations of normal processes.[9]

The primary hazard from laser radiation is exposure of the eye. Exposure levels, if kept below those damaging to the eye, will not harm other tissues and organs of the body. The type of damage inflicted on the eye by laser beams ranges from a small and inconsequential retinal burn in the periphery of the fundus, to severe damage of the macular area, with consequent loss of visual acuity, up to massive hemorrhage and extrusion of tissue into the vitreous humor, with possible loss of the entire eye.[10] Long-term exposure of the retina to wavelengths in the visible spectrum, at levels not far below the burn threshold, may cause irreversible effects.

The large skin surface makes this tissue readily available to accidental and repeated exposures to laser energies. The biological significance of exposure of the skin to lasers operating in the visible and IR regions is considerably less than exposure of the eye since skin damage is usually reparable or reversible. Effects may vary from a mild erythema to blisters and charring. Depigmentation of the skin, ulceration and scarring and damage to underlying organs may occur from extremely high powered laser sources.

One cannot discuss potential hazards from laser energies without mentioning operationally associated hazards such as compressed gases, cryogenic liquids, ionizing radiation that may emanate from laser power supplies and components, and toxic materials used in laser targets or laser system elements. Adequate ventilation should be provided to eliminate or reduce exposure to toxic materials.[9]

Microwave Of the various NIR energies, the RF and the microwave bands have elicited the greatest interest and concern as well as confusion in consideration of the real and substantiated effects *vis-a-vis* unsubstantiated or speculative effects.

Microwave wavelengths vary from about 10 meters to about one millimeter in the frequency range of 30 MHz to 300 GHz. The ANSI and OSHA standards, however, define the microwave range as 10 MHz to 100 GHz. The region between 10 MHz and the infrared is generally referred to as the RF, or radiofrequency, region. Certain bands of microwave frequencies have been assigned letter designations by industry; other, notably the ISM (Industrial, Scientific, Medical) frequencies have been assigned by the Federal Communications Commission for industrial, scientific, and medical applications.[1]

The basic biological effects of microwaves occur in the presence of significant temperature rise in biological tissue. Such effects require exposure to relatively high levels of radiation intensity and a substantial exposure duration. Levels of microwave radiation are measured as power densities and usually expressed in terms of milliwatts/centimeter squared (i.e., mW/cm^2). To get some perspective one can refer to the conditions of microwave diathermy where moderate beneficial heating of a limited part of the body is produced by exposure to about 100-500 mW/cm^2 for 10-20 minutes.

At high microwave frequencies, well above the usual heating frequencies, the radiation is absorbed almost completely in the skin just as with infrared radiation, and produces heating of the skin. These frequencies are felt in several seconds at exposure levels of a few mW/cm^2. At the heating frequencies (ISM bands-918, 2450 MHz) the penetration is a few centimeters. At 2450 MHz

microwave exposure is sensed at levels of 20-50 mW/cm^2 in a few seconds. At lower frequencies, like those of television broadcast, penetration and deep heating both increase. At still lower frequencies the body shunts out or reflects the field so that less heating results even though the internal field is fairly uniform throughout the body.

Injury from microwaves can be in the form of burns. All the scientific evidence indicates that exposure greater than 100 mW/cm^2 and extended duration (many minutes) is required to produce such thermal damage.

At an exposure level ten times smaller, such heating may still be felt but is not hazardous. At still lower levels the radiation is not felt. Low levels of microwave radiation in the form of broadcast television radiation continually pass through our bodies. These levels approach 1/100 of heating levels in Class A reception areas and even closely approach heating levels (e.g., 1mW/cm^2) in certain high buildings or high terrain in the vicinity of television towers.

Electromagnetic interference Implant electronic cardiac pacemakers, without shielding or filtering, have been reported to suffer interference from auto and lawnmower ignition noise, electric shavers, electrical hobby devices like Tesla coils, microwave ovens, amateur radio transmitters, broadcast television transmitters and radar transmitters. The U.S. Department of HEW has recognized that the problem is in pacemaker susceptibility and advised against the generalized use of warning signs around transmitters. The medical profession in the USA believes that the pacemaker interference problem is not significant clinically and feels that there is no great danger to pacemaker patients in today's electromagnetic environment.

The most serious potential sources of interference to sensitive pacemakers are those of powerful transmitters where a person remains in a strong field. Newer pacemaker models are immune to most interference sources.

Electrical, magnetic, and electromagnetic fields of sufficient intensity to interfere with noncompetitive pacemaker function are not uncommon. Yet few patients notice interference phenomena, and even fewer are adversely affected. At the present state of the pacemaker art, the probability of interference-induced distress is very low because two unlikely events must occur simultaneously. First, the pacemaker must misbehave rather dramatically. Second, the patient must remain in the field for a significant period, an unlikely situation because most interference generators have an effective range of less than 1 foot.

PROTECTION GUIDES AND STANDARDS

Ultraviolet In 1948, the Council on Physical Medicine of the American Medical Association issued criteria for safe exposure to radiant energy from UV germicidal lamps. This group recommended that for the primarily used wavelength, 253.7 nm, exposures should not exceed 0.5μ W/cm^2 for periods less than 7 hours, nor 0.1μ W/cm^2 in the case of continuous exposure.

Infrared Protection guides for IR exposure are designed primarily for protection against ocular effects. The main difficulty, however, in devising protection standards against IR-induced cataracts is to correlate the information on the radiation emitted during industrial processes with cataract formation. The intensities of IR that cause cataract are unknown. Only a small amount of experimentation on animals has been done, but it has provided some knowledge of the way cataracts are formed; the numerical data obtained cannot be used in devising standards, due to the relatively massive and frequent exposures used in experiments, and possible physiological and anatomical differences in rabbit and human eyes.

Infrared radiation can be a problem in whole-body heating, particularly in some industries, such as steel and aluminum. Although there are no specific regulations currently, there has been a considerable effort to develop a heat stress standard at the

federal level, and there has actually been a NIOSH criteria document published on the subject. It proposed to measure the wet bulb-globe temperature (WBGT), which quantity is subject to radiant heat load, in addition to dry bulb temperature, humidity, and air velocity. Considerable "heat" has been generated over the heat stress document, and there is much sentiment that such a sweeping regulation is not really necessary.

The American Conference of Governmental Industrial Hygienists (ACGIH) has proposed threshold limit values for heat stress. These Threshold Limit Values (TLV) refer to heat stress conditions to which it is believed that nearly all workers may be repeatedly exposed without adverse health effects. The TLVs are based on the assumption that nearly all acclimatized, fully clothed workers with adequate water and salt intake should be able to function effectively under the given working conditions without exceeding a deep body temperature of 38°C.

Laser For the past several years, federal agencies have been taking an increased interest in laser safety. Attention is focused on protecting the user from eye and skin damage. Bureau of Radiological Health regulations apply to laser products sold to end users by laser manufacturers. The regulation places requirements on manufacturers only, not users. Component lasers sold to Original Equipment Manufacturers (OEMs) are not covered by these regulations. However, the OEM who incorporates these lasers into systems that are ultimately sold to end users must ensure that the system does comply with the regulations.

All laser products are divided into four classes. The power limits of each class are determined by the associated degree of risk of biological damage from exposure to laser radiation. Classes with higher risk have the most stringent safety requirements. The regulations also include a precise procedure for measuring power levels to determine the laser's class.

Class I limits laser power to levels at which no evidence of biological damage has been established. Class II to levels at which eye damage is possible from chronic exposure, and Class III to levels at which biological damage to human tissue is possible from acute direct exposure. Class IV includes the laser power levels at which biological damage is possible from acute direct or diffuse exposure.

The regulations that are being developed by the Occupational Safety and Health Administration (OSHA) will be more significant to the laser user than those established by BRH since the former will be directed at the operator of lasers. It is expected that these will be completed this year. In addition, both the American National Standards Institute (ANSI) and the American Conference of Governmental Industrial Hygienists (ACGIH) have prepared regulations that may apply to particular groups of laser users.

Microwaves/radiofrequency The standard used in the U.S. and most Western countries is that recommended by the American National Standards Institute (ANSI). The standard specifies to personnel the maximum microwave exposure to which they should subject themselves. This exposure is characterized by incident power density at the location of personnel and by exposure duration. The standard specifies safe unlimited duration whole-body exposure up to 10 mW/cm^2 or a maximum energy density exposure of 1 mW-hour/cm^2 in any 0.1 hour period. This standard is believed to be at least a factor of ten below damaging levels.

Exposure power densities are readily measurable today by hand-held survey probes that are commercially available. These survey instruments can read levels between 0.01 to 100 mW/cm^2. They use antenna pickups and sensors such as thermocouples for generation of current that is amplified and read out on a meter scale as mW/cm^2.

Microwave emission standards have been promulgated and specify the maximum leakage level close to the external surface of

equipment. It is the responsibility of the manufacturer to meet such standards. It is also important not to confuse emission and personnel exposure standards. In general, emission standards are far more conservative than exposure standards in that for a given emission level the potential exposure level decreases rapidly with distance from the point of leakage.

For a small leakage source, such as is typically found along a door seal of a microwave oven, the leakage level (in mW/cm^2) decreases approximately as the inverse-square law of distance from the leakage source. Thus, a leakage level of several mW/cm^2 at 5.0 cm from a device produces exposure levels of only about 0.01 mW/cm^2 at 3-4 feet from the leakage point.

Emission standards applicable to microwave ovens exist as federal regulations in the U.S. and Canada. The standard in the U.S. specifies a maximum emission level of 1 mW/cm^2 (at 5.0 cm) before purchase and 5.0 mW/cm^2 (at 5.0 cm) thereafter when the oven is operated with a 275 ml water load. In Canada the federal standard sets a maximum leakage of 1 mW/cm^2 (at 5.0 cm) when the oven is operated with a minimum load specified by the manufacturer. The Canadian standard also applies to microwave industrial equipment.

PROTECTION STANDARDS—PHILOSOPHY

In many areas of the industrial environment there is considerable divergence in standards used in Western countries in contrast to those adopted in the USSR and other East European countries. In any discussion of protection standards in the USSR, the recent publication by Glass[11] (1975) should be considered. Although this report deals with the concepts and principles applied to research and standards setting for air pollutants, these same criteria are applied to other chemical and physical agents in the environment. In general, Soviet standards are more numerous and generally more stringent than their American equivalents. This reflects differences in the concept of an environmental standard, the research applied to setting this norm, and the vigor with which the standard is enforced.

In theory, the Soviet government feels that a healthy environment can be preserved over the interest of individual polluters; that regulatory control over government enterprise should be easier to exercise; and that the results of government-funded research however tentative, should be enforceable as law.[12] In practice, attaining these ideals is substantially more difficult to achieve.[13]

Marxist science emphasizes the close tie between research and the solution of practical problems.[13] Duplication of scientific effort within the USSR is prevented, a policy that may result in insufficient verification of otherwise controversial results.[11] From research on standards to the practice of environmental regulation, the physician is the central figure, and all other scientists, feldshers, and engineers are auxillary. The bias created by this dependence on physicians is evident in every phase of environmental health research and practice.[11]

The Ministry of Health of the USSR is responsible for planning and promoting research on new pollutants, translating these results into national standards, and ensuring the enforcement of these maximum allowable concentrations (MACs).[14] The Soviet approach to standard setting is straightforward. The MAC (maximum allowable concentration) is defined as that concentration of a chemical that at intermittent or continuous exposure provokes neither disease nor reversible changes in the adaptive physiological mechanism of the organism acutely, in later life, or in future generations.[15] Soviet research in standard setting for air pollutants is based on the work and philosophy of V. A. Ryazanov[15] who felt that any chemical exposure that produced a measurable change in any biologic function, even if fully reversible, does not represent the optimum condition for human existence and should not be permitted by the government or tolerated by the people. The MAC is based on research to es-

tablish the threshold effect level of a substance. Since the standard reflects this threshold of the lowest measurable effect, a revision of the standard will usually make the MAC even lower.[11]

Environmental standards are based on research in health effects alone, without regard to considerations of available control technology, economic feasibility, or the ability to measure adequately these levels in practice. When a MAC is currently unattainable, it should represent a direction for future enforcement or a guideline for future research in control technology. Research on new standards follows a protocol established by Ryazanov. A "one exposure" or "short-term" standard is based on the threshold[16] of sensory stimulation in man (e.g., smell or taste), central nervous system sensitivity (e.g., electroencephalogram, conditioned reflexes), and reflex responses (e.g., changes in heart rate, respiratory rate, or blood pressure). The lowest concentration that can evoke some measurable change in these tests is proposed as the level for the short-term standard. The "long-term" or "24-hour" standard is based on long-term toxicologic experiments on animals, and the most sensitive indicator of a biologic change is accepted as important. These long-term standards are not monitored routinely in practice.

Much Soviet research on environmental standards may not be applicable to the West because their interest is in determining only the lowest concentrations producing a measurable biological change, regardless of its importance.[11] Full enforcement of present standards in the USSR remains an impossible task because these standards are numerous and in most cases extraordinarily stringent.[11]

One can draw a most interesting contrast with the United States in terms of the relative importance of research and practice. In the Soviet Union, environmental research is programmed, traditional, and directed toward determining no-effect thresholds. Nonetheless, standards are adopted rapidly and enforcement can be quite powerful, carrying the full backing of the government. In the United States the research effort is very creative, open-ended, interested in mechanisms of actions, and standards depend extensively on research from other scientific disciplines.[8]

REFERENCES

1. Wilkening, G.M. "Non-Ionizing Radiation." The Industrial Environment—Its Evaluation and Control, pp. 357-376. U.S. Dept. HEW, PHS, Center for Disease Control, NIOSH, Washington, D.C., 1973.

2. Emmett, E.A. "Ultraviolet Radiation as a Cause of Skin Tumors." CRC Critical Reviews in Toxicology, September 1973.

3. Emmett, E.A. "Occupational Skin Cancer: A Review." JOM 17:44-49, 1975.

4. Emmett, E.A. and S.W. Horstman. "Factors Influencing the Output of Ultraviolet Radiation During Welding." JOM, 18:41-44, 1976.

5. Buettner, K and H.W. Rose. "Eye Hazards from an Atomic Bomb." Sight-Saving Rev. 23:194-197, 1953.

6. Geeraets, W.J. "Radiation Effects on the Eye." Indust. Med. 39:441-450, 1970.

7. Matelsky, I. L.V. Cralley and G.D. Clayton (eds.) "Non-ionizing Radiations." Indus Hyg Highlights Vol. 1, pp. 140-179. Industrial Hygiene Foundation of America, Inc., Pittsburgh, 1968.

8. Wolbarsht, M.D. and D.H. Sliney. "The Formulation of Protection Standards for Lasers." Laser Applications in Medicine and Biology, Vol. II. Plenum, New York, 1974.

9. Goldman, L., W. Kapuscinska-Czerska, S.M. Michaelson, R.J. Rockwell, D.H. Sliney, B. Tengroth, and M. Wolbarst. "Health Aspects of Optical Radiation With Particular Reference to Lasers." Manual on Non-Ionizing Radiation Protection to be published by World Health Organization.

10. Curtin, T.L. and D.G. Boyden. "Reflected Laser Beam Causing Accidental Burn of Retina." Amer J Ophthal, 65:188-189, 1968.

11. Glass, R.I. "A Perspective on Environmental Health in the USSR: Research and Practice." Arch Environ Health 30:391, 1975.

12. Goldman, M.I. The Spoils of Progress: Environmental Pollution in the Soviet Union. MIT Press, Cambridge, Mass., 1972.

13. Zaleski, E. "Central Planning of Research and Development in the Soviet Union." Science Policy in the USSR. Committee for Science Policy Organization of Economic Cooperation and Development. SP (68) 5 Scale Z, 2 July, pt. 1. Paris, 1968.

14. Izmerov, N.I. "Control of Air Pollution in the USSR." WHO Public Health Papers, No. 54., Geneva, 1973.

15. Sanotskii, I.V. "Strategy for the Investigation of New Substances to Establish Their Safe Permissible Levels: Criteria for Harmful Action." WHO Consultation on Methods Used in the USSR for Establishing Biologically Safe Levels of Toxic Substances. WHO No 3636A, pg. 7, Moscow, Dec. 12-19, 1972.

16. Chizhikov, V.A. "Methods of Determining the Maximum Allowable Concentrations of Atmospheric Pollution." WHO Interregional Travelling Seminar on Air Pollution, USSR Ministry of Public Health CIFAMS, Moscow, 1967.

OCCUPATIONAL HAZARDS FROM NON-IONIZING RADIATION

Thomas S. Ely, M.D.

GENERAL COMMENTS

You have heard some background information on non-ionizing radiation hazards. I am going to carry this along with some brief thoughts about putting the information into practice in the kind of preventive medicine we call occupational medicine. The development of scientific information from basic research is essential in the control of occupational hazards, but it is only the first step in a sequence of activities that is necessary in this control. The information needed for control purposes must evolve through several stages including basic research, applied research, and the development of a consensus position leading to a practical standard. This may then evolve into a practical regulation. It is a fact of life that a regulation is often necessary to accomplish control that a consensus standard could not.

It would be as wrong to use the techniques of basic research to achieve control as it would be to use the techniques of control to conduct basic research. In basic research one strives for extensive and accurate data. For control purposes, such would almost always be impractical and unnecessary. I have frequently responded to proposed federal regulations requiring 5% accuracy with the comment that 20 or 25% should be plenty good enough. Factor-of-two accuracy is usually sufficient for control purposes. However, the realities of regulatory control are that a rigid set of requirements must lead to a rigid conclusion about compliance. Regulatory people are very uncomfortable with factor-of-two accuracy.

Unfortunately, sometimes there are missteps in the transitions between the steps I have mentioned. Good basic research can be followed by bad applied research. Good applied research can lead into a bad practical standard. A good practical standard can result in a bad regulation. In this last case we then have two kinds of hazard, a health

hazard and a regulatory hazard; and one needs to be careful to specify which he means. This is a most lamentable situation, where getting into compliance with the law actually increases the health hazard. Fortunately, I am aware of only a few such examples. More of a problem is busywork requirements diverting effort from more important hazards.

Also common is the case where the standard and the regulation are different but not mutually exclusive. For example, there are biological carcinogens and regulatory carcinogens, and the lists are not the same. Another example is the frequent case in which the regulation is of a "specification" rather than a "performance" type. Here it is frequently possible to have a safe situation but be out of compliance with the regulation. The point I am trying to make is that health hazard and regulatory hazard should not be confused in one's thinking.

A general thought I would like to introduce with respect to the development of occupational hazard standards is that it is immensely useful to have a "natural" source of whatever agent is under consideration for comparison purposes. For example, our sun is a familiar source of a wide range of non-ionizing radiation to which the human race has become more or less accustomed. The ability to relate quantitatively the various "artificial" sources in the occupational environment is a great help in the development of practical standards. It becomes a little silly to agonize over an ultraviolet radiation exposure standard that represents a small fraction of the dose the person gets on his way to or from the parking lot.

I would now like to discuss briefly some practical issues involving potential non-ionizing radiation hazards in the occupational setting.

ARC WELDING

Among several other non-radiation welding hazards such as the release of toxic chemicals, ozone production, and eardrum perforation, the significant non-ionizing radiation hazards are those from infrared, visible, and ultraviolet. The near infrared and visible portions of the spectrum could constitute a retinal burn hazard if intensity were adequate, but this is probably not a real problem for ordinary welding. The retinal dose seems to be less than that required to produce injury, and the warning properties are pretty good in that the welding arc is very uncomfortable to look at.

The classic non-ionizing radiation hazard from arc welding is that of "flashed eyes" or ultraviolet keratoconjunctivitis. This painful but temporary condition leaves a lasting impression on its victim, and it rarely happens to him the second time. Few of you who have been around industry for a while have not seen flashed eyes. It is interesting to note that the condition often occurs in a nearby associated person instead of the welder. In my Navy experience it was almost always the "fire watch"—the man posted nearby to observe any fires the welder might start. At Kodak Park we can recall five cases of flashed eyes in the last 20 years or so. All five were welder's helpers; none was the welder himself. In the same period, we have had no case of injury by infrared visible light, or ionizing radiation.

RADIO FREQUENCY HEATERS

Radio frequency power has been found very useful for its heating potential for which there are many industrial applications such as glue heaters, plastic sealers and welders, and dryers. The potential effects of overexposure include the direct biological hazard, and indirect hazards such as the influence on electronic cardiac pacemakers.

The applicable standard is American National Standards Institute (ANSI) C 95.1-1973, and the applicable regulation is Occupational Safety and Health Administration (OSHA) 1910.97 or its state equivalent. The standard covers a large frequency range, and was designed around the most hazardous part of that range. Thus, for many RF heaters in the lower frequencies, the standard is overly restrictive.

In making a practical evaluation of a potential RF hazard, I have found that an extremely useful first step is to determine the frequency. If this is **not** in one of the Industrial, Scientific, and Medical (ISM) bands of approximately 13, 27, 40, 915, 2450, 5800 or 22,000 MFz, the problem disappears. This is because the amount of leakage radiation permitted by the Federal Communications Commission because of communication interference is well below the level that would be of concern from an occupational health standpoint. If the frequency **is** in one of the ISM bands, the situation will need to be evaluated. The lower frequencies are rarely likely to be a problem as a direct hazard because of their poor and diffuse absorption. For the higher frequencies, we have a good standard.

One RF heater that has appeared on the scene lately in great numbers is the microwave oven, which is used in industry mainly to enable the employee to heat his lunch efficiently. In the occupational setting, the applicable standard is the same OSHA 1910.97, which is an **exposure** standard. Covering all microwave ovens in addition is a Bureau of Radiological Health (BRH) manufacturing regulation that is an **emission** requirement. In essence, it requires a maximum of 10W/m^2 (1 mW/cm^2) at the time of manufacture and 50 W/m^2 (5mW/cm^2) subsequently.

In Kodak in Rochester we now have some 70 microwave ovens. At the time the first oven was purchased, we decided to monitor radiation leakage from the ovens on a six-month interval basis. A few years ago, early in this experience, we found an occasional oven leaking more than it should, but certainly not at a hazardous level. The leakage could always be fixed by hinge, latch, or seal maintenance. Our more recent experience has been that significant leakages are rarely found, and we are thinking of decreasing the frequency of measurement. There is no regulation that specifically requires oven monitoring.

I feel that even an annual frequency of monitoring constitutes hyperscrutiny insofar as the actual potential for hazard alone is concerned. However, there are other considerations here such as confidence engendered in regulatory agencies and reassurance of users that justify the program.

INCANDESCENT FILAMENTS

Electrically heated wires in transparent envelopes can represent non-ionizing radiation hazard in infrared, visible, and ultraviolet wavelengths. In addition to the obvious case of whole body heating from large incandescent lamp arrays, the question of retinal hazard occasionally has arisen. In general, the bulb with frosted glass or some other diffusing arrangement is not a retinal hazard. The bare tungsten filament may be. Low wattage bulbs with thin filaments are probably not a retinal hazard; but we know that high wattage bulbs, particularly those with concentrated filaments such as projection lamps, can be. We know this not only from theoretical calculation, but there have been instances of retinal burns from such bulbs. Sometimes the question asked has been whether an unfrosted bulb operating at less than nominal voltage represents a hazard. On separate occasions, I have had to run out the calculation at several different temperatures, and would suggest that at temperatures above 2000 or 2100 kelvins a retinal hazard should be considered. At this temperature, the radiant emittance is of the order of a recommended maximum (not an injury threshold). Although not injurious in this range, such temperatures would certainly be uncomfortable. In the situation where these filaments must be watched for inspection or other purpose, a filter could be placed over the bulb, or the employee could wear standard goggles that would remove essentially all the infrared, and enough of the visible to make the operation comfortable. Since the infrared contributes nothing to the task, it might as well be removed.

High temperature filament operation combined with an envelope transparent to ultraviolet such as the relatively recently developed quartz-halogen lamps emit potentially injurious amounts of UV, and have caused "sunburn" and scratchy eyes. The

control is easy if the problems is recognized. Suitable glass or plastic windows with low UV transmittance is all that is necessary.

GAS DISCHARGE LAMPS

Low pressure lamps are rarely a concern from the retinal burn consideration, although low pressure mercury vapor lamps with a transmitting envelope can be an ultraviolet hazard.

"Blacklights," those low pressure mercury arc lamps with an envelope transmitting only near ultraviolet, are not a significant hazard. The most comforting and memorable reference material on this issue was an article on Go-Go dancers appearing in the American Industrial Hygiene Association Journal in 1969.

LASERS

Plenty has already been said about laser hazards, and little more needs to be offered here. There have been standards for laser hazard protection almost as long as there have been lasers. Naturally, these have increased in complexity over the years as more and more information has become available and as more and more thought has been given to the development of recommendations. The preeminent standard in the field now is ANSI Standard Z-136.1. It is a good standard. Verbatim it would be a bad regulation because of its complexity and detail. More than a smattering of optical physics is required to understand it. The only Federal occupational laser standard exists in the Part 1926 (OSHA construction) regulations. It is good, but covers only the construction occupations. I anticipate a Part 1910 (OSHA general industry) laser standard that will be based on (but I hope not identical with) ANSI Z-136.1. In the meantime, there are operable state regulations in some of the states. Some of the state codes are good and some are terrible. I fear that in some cases the regulation represents an overreaction to a new and mysterious hazard and is long on busywork and short on practicality.

ELECTRONIC CARDIAC PACEMAKERS

My philosophy about these devices in the industrial setting is approximately the following: If an employee is wearing an electronic cardiac pacemaker, we in the larger industries with medical programs will know it. This is because we will find it out when he is hired if he acquired it before that time. If he acquired it after that time, we will know about his reason for the absence when he had it installed.

Therefore, we will be able to ascertain whether the employee was counseled by his cardiologist or cardiac surgeon with respect to electromagnetic interference, and we will be able to advise him about potential sources in his work place environment. If he has not been counseled by his private physician, we can see that he is or do it ourselves. In any case, there are probably some areas, for example around some RF heaters, that this person should not go.

The issue of access by a non-employee is somewhat more difficult. Such a person may be a visitor, a salesman, an outside maintenance man, or perhaps a family member attending an open house. In these cases, it may be necessary to post signs, ask the question, or make certain areas off-limits.

There have been occasional expressions of concern over microwave ovens as potential sources of electronic cardiac pacemaker interference. This sometimes takes the form of suggestions that warning signs be placed on the ovens. There actually was such a military regulation promulgated.

On this issue, I fully subscribe to the position taken by the Bureau of Radiological Health in 1971 that the generalized use of warning signs at microwave oven installations would be impractical and unnecessary. This position is based on:

1. Such signs would focus attention on a single source and fail to warn about other sources of interference such as electric tools, household and industrial appliances, igni-

tion and lighting systems, radio, television, and radar systems, that could not be effectively delimited by signs.

2. The signs would label all microwave ovens as hazardous regardless of the quality of the oven. Microwave ovens have leaked less and less as time goes on, probably because of a combination of the BRH regulation and improved manufacturing techniques that would have occurred anyway.

3. Electronic pacemakers are becoming less and less sensitive to interference.

4. In the real environment, microwave ovens have not been shown to be a serious cause of electronic pacemaker interference.

MEDICAL RECORDKEEPING AND SURVEILLANCE

INTRODUCTION

Marcus M. Key, M.D.

This session on medical recordkeeping and surveillance was selected for inclusion in the scientific program of the AMA Congress on Occupational Health because of the profound changes going on in each of these areas and the potential of these changes to affect the practice of occupational medicine as well as the health of the worker.

There is a tendency to think of medical records as old, dusty, difficult to decipher, and quite boring, at least in retrospect. Medical records have been around for a long time--dating back to ancient Greek and Roman times. Sporadic attempts have been made to standardize medical records within institutions and specialty groups, but even so retrospective research based on clinical notes is almost impossible because of gaps and variations in recordings. One of the justifications for the Weed system of the Problem-Oriented Medical Record is the sorry state of medical records, but this is somewhat like one political party justifying its election bid on the miserable job the other political party has done. The problem-oriented approach may be fine for teaching and for care of the patient who presents an acute problem requiring integration of care, but I am not sure it has direct application to occupational medicine. However, some of the ideas from the Weed system should be useful in medical surveillance. For example, a Data Base in the front of the record would be a logical place to list occupational exposures requiring monitoring; and medical surveillance and worker education could be covered in an Initial Plan.

Unfortunately, medical recordkeeping like the practice of medicine is becoming too defensive and legalistic and hence time-consuming and costly. The proposed medical requirements in the so-called mini-standards now being produced by OSHA and NIOSH may well become self-defeating because of the reluctance of physicians to comply. Excellent analyses of this potential

problem have been made by the two panelists, Roy Joyner, and others, and you will be hearing some of these details this afternoon.

Other aspects of medical records are also undergoing change, in particular their ownership and the confidentiality of the information contained therein. I am sure that most of you are familiar with Dr. Irving Tabershaw's recent suggestion that the ownership of industrial medical records should be vested in the worker. There is much logic in support for this, but on the other hand there is the threat of increased litigation, such as that recently reviewed by George Annas in the *Journal of Occupational Medicine*. There are many practitioners in this country who could be persuaded to do medical surveillance of industrial workers, but it is primarily a medical practice they are interested in, not protracted or recurring litigation. Here again the resulting complexity may be self-defeating, and ultimately the health of the worker suffers if there are fewer and fewer physicians interested in this field.

These are some of the changes, actual and potential, going on in the field of medical recordkeeping, and when you hear Doctor Steiner's presentation of how one large industrial medical department deals with the problem now, I think you will appreciate how much more complex the problem may become in the future. Doctor Steiner makes a good point about fractionation of requirements for medical examinations, that is, based on separate standards for each substance with the likelihood of examinations and recordkeeping falling due at different and inconvenient times. I hope there will be time for discussion at the end regarding the simplification and coordination of examinations so as not to overburden the worker and the medical staff.

Medical surveillance in industry, the other subject to be covered in this session, will be presented by a physician who has devoted much energy to the study of this problem on a theoretical and practical basis. We are going to hear Doctor Dixon say that the term 'medical surveillance' is much to be preferred to biologic monitoring, and I wholeheartedly agree with him. However, I should point out that the term 'biologic monitoring' originated with the industrial hygienists and is indicative of their ability and intention of carrying out certain "health monitoring" procedures—limiting factors being cooperation of the worker and ability to collect blood, urine, and breath samples.

If and when OSHA recognizes the importance of biologic monitoring, access to monitored data will no doubt be given to OSHA hygienists. We need to recognize that medical surveillance is much broader than the biologic monitoring performed by industrial hygienists, and the confidentiality line must be clearly drawn if this should come to pass.

I would like to touch on one other subject in my introduction to medical records and surveillance and that is, the purpose of it all. I think we would all agree that medical recordkeeping and surveillance are not ends to themselves but part of a greater goal of assessing the adequacy of exposure control and protecting the health of the worker. Unfortunately, there is a tendency for requirements to be fixed and unyielding once they have been prescribed in enforcement language. Fortunately, OSHA has permitted alternative medical examinations for preplacement and medical surveillance under the vinyl chloride standard—and this without the need for a formal variance. I would like to see the same degree of flexibility carried forward in the mini-standards. Thus, we have potential problems with the trade-offs between flexibility and specificity. Doctor Dixon will make some suggestions in this area which are especially useful for multiple exposures. OSHA would do well to use Doctor Dixon's proposal as a model in writing OSHA medical requirements.

MEDICAL RECORDKEEPING

S. D. Steiner, M.D.

Medical records in the occupational setting have been and are a topic of discussion whenever occupational physicians meet. The reason is that the record contains not only the usual medical information of who, what, when, and where, plus treatment, but also involves why and how. When an employee has an occupational medical complaint and requires medical care, the reasons why and how for the illness or injury are important.

Occupational medical records are not for the sole use of medical department personnel. Others in the business organization may need portions of the information contained on the medical record. For example, the safety engineer will want to know how the employee was injured and why the accident occurred. If an employee suffers a hand injury while operating a machine, it is important to know just how the employee's hand was injured and why it was in the particular place at the time of injury. It is not enough to diagnose and treat the injury; it is important to prevent future injuries. This is the surveillance part of the medical record.

For our discussion, medical recordkeeping and surveillance will relate to two areas, one dealing with the use of medical treatment records to identify safety and health hazards, and the other dealing with physical examination procedures to assure that employee health is not being compromised because of the work exposure. Because medical surveillance and recordkeeping are so much of each new proposed OSHA standard, these aspects are discussed first.

Under the OSHA standards and proposed standards, medical recordkeeping and surveillance are being used in a coordinated fashion. The standards specify the type of examination that must be done, the records that must be kept, and the manner in which the records must be maintained.

Using the proposed Sulfur Dioxide Standard as an example, the standard provides a section on medical surveillance which spells out the medical responsibilities of the physician. For example, it stipulates that any employee exposed to sulfur dioxide above the action level or ceiling level must have:

1. Opportunity for medical examination.
2. The examination must be done by a licensed physician, during normal work hours and without cost to employee.
3. The extent of the examination:
   a. Work history and medical history with particular emphasis on respiratory symptoms.
   b. Examination to include chest film, pulmonary function tests, eye examination, and skin examination.
4. Periodic examination on at least an annual basis.
5. Opinion from physician as to whether or not the employee is at increased risk from exposure to sulfur dioxide and whether or not the exposure would aggravate any medical condition.
6. An opinion as to limitations upon the employee's exposure to sulfur dioxide and upon the use of protective equipment and respirators.
7. A statement that the employee has been informed by the physician of any medical conditions which require further examination or treatment.
8. A copy of the physician's written opinion shall be provided the affected employee.

Under the recordkeeping section it is stipulated that the employer shall keep an accurate medical record for each employee subject to medical surveillance. The record shall include:

1. Physician's written opinion.
2. Any employee medical complaints related to exposure to sulfur dioxide.
3. Any information provided the physician by the employer, such as:
   a. Description of the employee's duties as they relate to exposure to sulfur dioxide.
   b. The results of any exposure measurements, if available.
   c. A description of any personal protective equipment used.
   d. Employee's estimated exposure level.

To date, three standards have been adopted, some 40 have been proposed, and a total of some 400 are contemplated. Considering that each person exposed to levels of exposure warranting examination must be examined, the demand for physician time will be enormous.

Another facet of the magnitude of the examination program is that each standard requires certain specified examination procedures. For example, sputum cytology may be required for one type of exposure, an urological examination for another, liver function tests for yet another, and so forth. Consider, also, that one employee may have exposures to two or more materials and several special tests may be required. A physician doing these types of examinations will need some form of chart to quickly identify the total number of tests required. Tables I A-C show the varying tests required for only a few of the proposed standards. Extend this list with 40-100-400 standards and the physical requirements become awesome. It will be necessary as standards are established to set up such a chart. Only in this way will the necessary examination procedures be known.

One other item that must be taken into consideration in any medical surveillance program is the fact that employees at risk must be examined at the prescribed periodic times. As a general rule, examinations are prescribed on an annual basis. It is important that the examinations be repeated within the twelve months, fourteen or fifteen months are not good enough. One plant has used a system shown below in which the responsibilities of the medical department and controls are stated.

TABLE I - A
EMPLOYE MEDICAL SURVEILLANCE

October, 1975

Worker Exposure	Status*	Medical History	Occupational History	P.E. Termination/or complaint	Preplacement Exam	Periodic Exam Annual/Biennial	Physician Certification	Audiometric	Vision Acuity	EKG	Chest X-ray	Pulmonary Performance			LAB EXAMS - Urinalysis	Sputum Cytology	Urine Cytology	Complete Blood Count	Blood Chemistries— SGOT	SGPT	Alkaline Phosphatase	Total Bilirubin	GGTP	Lead	Others
Asbestos	P																								
	A	X	X	X	X	X	X				X	X				X									
Carcinogens	A	X	X		X	X					X				X		X	X	X	X	X	X	X		
Vinyl Chloride	A	X	X		X	X	X								X				X	X	X	X	X		
(1) Ketones	P	X		X	X	X	X																		
Lead	P	X			X	X	X								X			X						X	
Noise	P				X	X		X																	
(2) Ketones	P	X		X	X	X	X																		
*Status: A = Adopted P = Proposed																									

RECORDKEEPING AND SURVEILLANCE

TABLE I - B
EMPLOYE MEDICAL SURVEILLANCE

Worker Exposure	Trichloroethylene	p-tert-Butyltoluene	Cumene	Ethyl benzene	Alpha-Methyl-Styrene	Styrene	Vinyl Toluene				
Status*	P	P	P	P	P	P	P				
Medical History	X	X	X	X	X	X	X				
Occupational History	X	X	X								
P.E. termination/or complaint		X	X	X	X	X	X				
Preplacement Exam	X	X	X	X	X	X					
Periodic Exam Annual/Biennial	X	X									
Physician Certification	X	X	X	X	X	X	X				
Audiometric											
Vision Acuity											
EKC	X	X									
Chest X-ray											
Pulmonary Performance	X										
LAB EXAMS - Urinalysis	X										
Sputum Cytology											
Urine Cytology											
Complete Blood Count	X	X									
Blood Chemistries— SGOT											
SGPT											
Alkaline Phosphatase											
Total Bilirubin											
GGTP											
Lead											
Others											

*Status: A = Adopted
P = Proposed

TABLE I - C
EMPLOYE MEDICAL SURVEILLANCE

Worker Exposure	Status*	Medical History	Occupational History	P.E. termination/or complaint	Preplacement Exam	Periodic Exam Annual/Biennial	Physician Certification	Audiometric	Vision Acuity	EKG	Chest X-ray	Pulmonary Performance			LAB EXAMS - Urinalysis	Sputum Cytology	Urine Cytology	Complete Blood Count	Blood Chemistries— SGOT	SGPT	Alkaline Phosphatase	Total Bilirubin	GGTP	Lead	Others
Cyclohexane	P	X		X			X																		
Camphor	P	X		X			X																		
Mesityl Oxide	P	X		X			X																		
5-Methyl-3 heptanone	P	X		X			X																		
Ozone	P	X	X	X	X	X	X				X	X													
Toluene	P	X	X		X	X					X	X			X			X							
Beryllium	P	X	X	X	X		X				X	X													
*Status. A = Adopted P = Proposed																									

MEDICAL RESPONSIBILITIES

Requirements:

Preplacement — Within 30 days
Annual physical exams thereafter
Termination — Within 30 days unless examined within the past 1-year period

Controls:

Supervision supplies monthly record to medical
Medical checks files
Medical schedules those requiring physicals
Physical completed
Safety audits monthly

Supervision is responsible for sending to the medical department each month the names of exposed employees. Medical is responsible for determining that the employee has either been examined or, if not, an examination is scheduled and physical examination completed. The safety department must do monthly audits to be sure that everyone has done his job properly. The figures below show how the audit sheets are used.

MONTHLY ASBESTOS AUDIT

Department Lists Received by Medical (Prior Month).
All Lists Received: Yes _____ No _____
Number of Lists Not Received

	Department	Date Notified	Date List Submitted
1.			
2.			
3.			
4.			

Employees Scheduled for Physical Exam
All Employees Scheduled: Yes _____ No _____
Number of Employees Not Scheduled

	Name	Soc. Sec. No.	Date Scheduled
1.			
2.			
3.			
4.			
5.			

Employees Given Physical Exam
All Employees Scheduled: Yes _____ No _____
Number of Employees Not Examined

	Name	Soc. Sec. No.	Date Examined
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

The medical department must make certain that the employee lists from the departments where exposures occur are received. Once the employee lists are received, the medical department must list all employees scheduled for examination or the date examined.

Depending upon local situations and the number of employees involved, some form of accounting system for maintaining a proper examination schedule is necessary. The one described here is only one of many that might be used. This may seem like a lot of bookkeeping and it is; but if employees are to be protected, a system must be devised so that all exposed employees are known to the medical department and it is known that their medical examinations are not only current, but that examinations revealed nothing that prohibits the employee from working in the area.

Another area of medical records and surveillance deals with the OSHA Log Form 100 and Summary report Form OSHA 102. These two records contain the information about all employees who become ill or injured as a result of their work and also record the severity of the illness or injury. Analysis of these records is very helpful in discovering safety and health hazards in the work environment, provided the records are accurate.

Accuracy of these records, particularly OSHA 100, is not easy to achieve. There is difficulty in getting uniform recording of the nonserious cases. Recording is required for each occupational death and occupational injury or illness "which involves one or more of the following: loss of consciousness, restriction of work motion, transfer to another job or medical treatment (other than first aid)." Determining what cases are first aid and which are not causes the difficulty. Not infrequently, two plants with similar work forces and health and safety exposures will have wide differences in recordable cases. The difference is due to improper recording. Because the OSHA 100 identifies areas where injury and illness occur and reveals the breakdown in the preventive health and safety programs, proper recording is necessary. Some guidelines have been developed which have done much to obtain more uniform reporting.

The guidelines are as follows:

Prescription Medication Use of prescription medication normally constitutes medical treatment. The use of pain relieving medication may be prescribed in single or multiple doses without constituting a recordable case. Other medication when prescribed for objective findings will constitute a recordable case. Medication for preventive purposes, such as tetanus toxoid, does not in itself cause the case to be considered medical treatment and recordable.

Medical Treatment A case that normally requires treatment by a physician is considered medical treatment and recordable even though the treatment was provided by a registered professional other than a physician. A case that normally would not require treatment by a physician is considered first aid and should not be recorded even though the first aid was provided by a physician.

First Aid Treatment One-time treatment and subsequent observation and redressing of minor cuts, burns, splinters, and so forth, which would not normally require treatment by a physician.

Medical Treatment vs. First Aid The following are guidelines in determining the recordability of various types of injuries:

Lacerations

First Aid Treatment is limited to cleaning wound, soaking, applying antiseptic and/or medication (see Prescription Medication), bandaging, and/or the use of tape for closure of superficial lacerations. Follow-up visit is limited to observation, changing dressing and bandage, and additional cleaning and application of antiseptic where required by exposure to the environment.

Medical Treatment Injury requires sutures (stitches), treatment of infection, or other professional treatment.

Abrasions

First Aid Same as for lacerations, except ointments may be added on follow-up visits to prevent drying and cracking of skin.

Medical Treatment Injury requires removal of embedded foreign material, multiple soaking or whirlpool treatment to control infection or remove residual foreign material, treatment of infection, or other professional treatment.

Bruises

First Aid The bruise does not cause significant limitation of motion and does not require treatment by a physician.

Medical Treatment Cases in which the bruise causes significant limitation of motion, extended care, or use of prescription medication.

Splinters and Puncture Wounds

First Aid Treatment limited to cleaning wound, removal of foreign object(s) by forceps or other simple techniques, application of antiseptics and medications (see Prescription Medication), and bandaging on first visit. In follow-up visits observation, changing bandage, and additional cleaning and application of antiseptic are considered first aid where required by exposure to dirty environment. Tetanus booster injections are considered as a preventive treatment and do not in themselves constitute medical treatment for recording purposes.

Medical Treatment Injury which would normally require the attention of a physician due to depth of embedment, size or shape of object, or location of wound.

Burns, Thermal and Chemical

First Aid Treatment limited to cleaning or flushing surface, soaking, applying cold compresses, antiseptics and/or medications (see Prescription Medication), and bandaging on first visit and follow-up visits for observation, changing bandage, or additional cleaning. Most first and second degree burns are amenable to first-aid treatment.

Medical Treatment Injury requires a series of treatments including soaks, whirlpool, surgical debridement, and application of medications. Most third-degree burns require medical treatment. The amount of body surface burned, the depth of the burn, and the treatment rendered all contribute toward determining whether or not a case is recordable.

Sprains and Strains

First Aid Treatment is limited to soaking, heat treatment, microtherm, whirlpool, medication given for pain, and use of elastic bandage on first visit. Follow-up visits for observation, possibly including reapplying bandage.

Medical Treatment Injuries that significantly interfere with range of motion and require series of hot and cold soaks, use of whirlpools, diathermy treatment, or other professional treatment.

Fractures

First Aid Treatment considered as first aid when X-ray examination is made as a precaution and results are negative.

Medical Treatment Incident where X ray results are positive or other professional treatment is administered.

Eye Injuries

First Aid Treatment is considered as first aid when of a moist swab in order to remove adherent foreign body or material which has not disturbed the epithelial surface of the eye. If medication is used, refer to Prescription Medication. Precautionary visit to a physician is still considered first aid if treatment is limited to above items. Follow-up visits for observations only.

Medical Treatment Removal of embedded foreign material or remaining rust ring, treatment of any disturbance of the epithelial surface, such as an abrasion, would constitute cases involving medical treatment. Also, a case requiring the use of prescription medication (see above) or other professional treatment may be considered medical treatment. Severe welder's flash requiring patching, local anesthetic, or treatment by a physician should be recorded.

With the above guidelines, the OSHA Form 100 will list the meaningful injuries and illnesses. These are the individuals who have become ill or injured at work. These cases should be studied by the doctor, the safety

director, the industrial hygienist, and any others who have to do with the plant safety. Hazards can be identified and corrections made. This does not mean that hazards should not be identified and corrected before injury occurs. That is implied. But when an injury does occur, it should not be limited to treating the employee. More importantly, steps need to be taken to avoid the second case. Studying and using the OSHA 100 and 102 properly will accomplish this end.

In conclusion, recordkeeping and surveillance are not routine endeavors. If they become so, employees will not be properly protected and the full value of the medical department will not be realized. If regulations must be adhered to, then it is realistic to get the most benefit from them as is possible.

HEALTH SURVEILLANCE IN INDUSTRY

Ernest M. Dixon, M.D., Sc.D.

Several years ago at an American Occupational Medical Association meeting, I presented a paper entitled "Medical Surveillance in Industry." At that time I thought I knew most of the answers; now I am less sure—but also I am certain that no one else knows all the answers. However, having long been concerned and having given considerable thought to this subject, I envision my role on this program, at least in part, as being somewhat the devil's advocate.

I think of health surveillance, especially when we currently view it to be one of the means of assisting in the protection of the health of workers and in meeting compliance requirements of the Occupational Safety and Health Act, as being awesomely complex, limited in its capacity to accomplish what is expected and logistically difficult. In part this is due to extreme problems with our entire system of national health care delivery, and I find myself deeply troubled and concerned with the developments which I have seen of late. Hence, it is my intent in this presentation to share with you some thoughts that are perhaps non-traditional and some differing perspectives.

This being our Bicentennial Year, I wish to recall two quotations appropriate to these deliberations:

In 1782, six years after the Declaration of Independence, Jean de Crevecoeur stated: "*What then is the American, this new man? He is an American who leaving behind him all his ancient prejudices and manners, receives new ones from the new mode of life he has embraced, the new government he obeys, and the new rank he holds. The American is a new man, who acts upon new principles. He must, therefore, entertain new ideas, and form new opinions . . .*"

And in 1787, just five years later, that early and eminent physician Benjamin Rush

wrote: "*The American war is over. But this is far from being the case with the American Revolution. On the contrary, nothing but the first act of the great drama is closed. It remains yet to establish and perfect our new forms of government, and to prepare the principles, morals and manners of our citizens for these forms of government after they are established and brought to perfection.*"

What I'm driving at is that much of our traditional approach is of reduced relevance today; that innovation and new methods are desperately needed; and that the regulatory process remains disturbingly imperfect. It is, therefore, my purpose to review some of the problems and to allude to some possible solutions.

An analysis of the objectives of health surveillance requires consideration of some of the problems and inherent myths with which we are faced. As each newly proposed standard for a given chemical exposure issues, it has its unique specifications and language of health surveillance requirements for that substance alone. In the ideal circumstance such might be appropriate; but in the "real world" sense, this is very unsatisfactory and an imminent problem for a variety of reasons, prominent among which are the following:

Multiple Exposures It is rare for workers to be potentially exposed to a single substance only. Although such may occur at a given moment, over a period of time (days, weeks, or months), the probability of multiple exposures exists in most instances. Perhaps it was otherwise in times past—but certainly not now. Here we encounter the first stricture in the application of scientific principles and methods; when we know that health surveillance presently is incapable in all but rare instances of measuring any impact in the one-cause/one-effect relationship between an agent and reaction to it, how can we expect to realistically assess the multiple-cause/perhaps-more-than-one-effect condition? The application of Koch's postulates would be truly strained.

Multiple Effects of Individual Exposures There are many examples of varying effects from individual exposures to hazardous agents just as there are varying responses to naturally occurring diseases. Variations of response include the categories of acute versus chronic, localized versus disseminated, the reactions in various organ systems, and the impact in healthy versus unhealthy, young versus old, male versus female, and so forth. Good examples are the great imitators, lues and tuberculosis, which present greatly differing manifestations under differing circumstances.

Interaction of Occupational and Nonoccupational Factors The range of variability in human response is dramatic. In determining the interaction of a potentially hazardous agent, one must consider all of the variable characteristics of the individual such as his respiratory rate, size, metabolic pattern, genetic constitution, personal habits, multiple factor etiology, and other aspects of variability of response. In other words, the real measure of hazard to the individual is what is absorbed into his system and the physiologic response which this engenders. Inevitably this brings into play a dose/effect relationship—a concept which we must staunchly support and promote in contrast to an empirical zero tolerance outlook for which there is no physiologic justification.

Complexity of Health Evaluation This is a very real problem and is growing with the passing of time. Simple tests and observations of the past years have been supplanted by vastly more complicated and technically involved methods. The Report of the National Commission on State Workmen's Compensation laws states: "Technological advances have produced unfamiliar and often indeterminable physical and toxic hazards. Occupational diseases associated with prolonged exposures to unsuspected agents or to fortuitous combinations of stresses have undermined the usefulness of the 'accident' concept. While advances in medical knowledge have facilitated the treatment of many injuries and diseases, they have also enlarged the list of diseases that may be work-related. Simple cause/effect concepts of the past have yielded to an ap-

preciation of the many interacting forces that may result in impairment or death. In addition to genetic, environmental, cultural, and psychological influences, physicians must consider predisposing, precipitating, aggravating, and perpetuating factors in disease. Etiologic analysis, estimates of the relationship to work, and evaluation of the extent of impairment have become accordingly complex for many illnesses."

Thus, it is readily evident that our medical task is difficult. A basic predicament in occupational medicine is a limited technological capability for health surveillance analytical methods. When one considers the large number of chemical substances in use, in contrast to the few for which we have established and confirmed ability to assess absorption and effect reliably, the magnitude of the problem is readily apparent.

Several additional matters of great concern are our actual practices and standards for and inter-relationships between the following:

Health Surveillance First, I would issue a plea for universally adopting the term health surveillance, in place of medical surveillance, for all clinical and other measurements of human functions made on industrial workers. Since preparing this presentation, I have had access to Doctor Key's introductory comments. His statement concerning the origin of the term "biologic monitoring" has substantially influenced my thinking. He said, "I should point out that the term 'biologic monitoring' originated with the industrial hygienists and is indicative of their ability and intention of carrying out certain 'health monitoring' procedures—limiting factors being cooperation of the worker and ability to get blood, urine and breath samples."

The primary function of all of these measurements is to keep a vigil on the health of the workers. It should be a multi-disciplinary approach designed to protect the health of the workers and one designed to be positive—aimed at prevention, not treatment. Workers are people and must be treated in the most humane way possible—not as subjects of a scientific study—and for this reason, the term 'biologic monitoring' is not appropriate and too limiting.

I am troubled by the emergence of all kinds of new surveillance schemes and differing requirements under new standards. I certainly agree to the importance of allowing judgment and not circumscribing initiative, but lack of any uniformity will create a nightmarish set of problems and utter chaos in any effort to assess the value of surveillance. This is especially true where there are multiple exposures with differing medical requirements. In the latter, differing exposures occurring sequentially over a period of time might require numerous separate examinations as well as new tests relating to each new exposure. Administration within the industry or industries for whom the individual worked would be extraordinarily complex, cumbersome, and difficult to achieve. The physician or physicians charged with the surveillance responsibility would find the task confusing, troublesome, and difficult to coordinate; this is especially true for private practitioners to whom the bulk of the job would fall; indeed, we have already encountered physicians who have long provided good services to industry refusing to undertake surveillance because of its vagarious and capricious requisites. In addition, numerous physicians have indicated reluctance or unwillingness to attest that a worker has or has not encountered adverse effects from exposures, may or may not be physically fit to undertake working with specific agents, and may or may not be physically able to use protective devices, for example, respiratory equipment.

For these and many other reasons, it has long been apparent to me that the only reasonable answer is the adoption of a uniform basic core health surveillance scheme where surveillance is deemed essential. This would consist of a standardized medical history, physical examination, and clinical tests such as chest X-ray, pulmonary function, urinalysis, hematology, and blood chemistry tests. To that would be added, as set forth in the standard issued for a given

exposure, any unique or particular test or tests, if any, that would be specifically helpful or diagnostic for that substance. Thus, there would be a basic procedure common to all surveillance requirements—with the addition of other observations only when such is markedly indicated. The adoption of this plan would result in:

a. Simplification of surveillance for all concerned with avoidance of duplications and redundancies.
b. Greater ease in administration—especially for physicians.
c. Improved quality of examinations with attendant greater probability of attaining the intended objectives.
d. Facilitating comparative study—between different locations, companies, and so forth, and long-term retrospective or other epidemiologic study.
e. Provision of the basis for long-term audit of the results and the success or failure of surveillance to help in worker protection.

With respect to the latter, failure of the NIOSH-OSHA team to periodically audit and determine the value of surveillance plans would be a tragic mistake. I am aware of no such plan at present and believe it should be incorporated into the system virtually at its inception. Without it, necessary changes or corrections and new approaches will not be adopted.

I am pleased, however, to announce that such a core medical examination has been proposed by the physicians sub-committee of the Occupational Safety and Health Administration standards group of the Organization Resources Counselors Inc. It has been presented to the National Advisory Committee on Occupational Safety and Health and has been favorably received. We have learned that this scheme will probably be adopted, at least on a trial basis to be used when such examinations are given to employees of the Occupational Safety and Health Administration of the U.S. Department of Labor. This is a very encouraging development.

I must point out that our intent was not to encourage OSHA to require examinations of all employed persons. Rather, it is an attempt to standardize OSHA required exams to facilitate compliance, better worker protection, and to aid physicians in doing a better job.

Industrial Hygiene Monitoring Implicit in any venture to protect the health of workers from potentially hazardous agents is a suitable and effective appraisal of actual work place exposure levels. All too often in the past there has been an inadequate history of potential exposure and a lack of precise analytical monitoring. Great strides in developing precise analytical methods have been made in recent years and this effort needs to be pressed vigorously. It is obvious that such data should be coordinated with health surveillance systems; but too often this is not done or not properly understood—especially and understandably by physicians unfamiliar with industrial concerns or toxicological principles.

In this sphere of interest it is essential that there be concern for the possible influence of other unknowns such as coincidental exposures, contaminants in even trace amounts, and variations in content that may occur from time to time.

In no way do I wish to imply or even suggest that industrial hygiene analytical and related functions are in any manner less important than we have always considered them. They are, in fact, the cornerstone and basic foundation of our planning to prevent ill effects from toxic and other harmful effects in the work environment. In my judgment, purely industrial hygiene measures have contributed more than have purely medical activities in reducing the effects of toxic substances, radiation, and other forms of energy, noise, heat and cold stress, excessive work effort, and many other potentially harmful influences on our working people. Nevertheless, the most diligently applied industrial hygiene programs are inherently beset with the possibility of failure in that they cannot possibly provide absolute assurance that the worker is safe. Even if

Threshold Limit Values are observed scrupulously, there is no assurance that the individual adheres to practices that preclude excessive exposure. Breaks in techniques of safe working practices, such as unplanned skin exposure or handling contaminants just prior to meal time or smoking can totally invalidate the most exactingly careful precautionary plans. Newer methods utilizing personal sampling monitors which continuously measure the individual's actual environmental exposure may help greatly, but they do not take into account transdermal absorption or any failure based upon sudden, brief exposures at high levels beyond the capability of the instrument to cope. If fail-safe, continuous personal monitoring equipment capable of handling all levels of exposure with reliability are developed, then, except for dermal or oral exposure possibilities, health surveillance might no longer be needed for routine industrial health control. However, as Stokinger has indicated, air-borne concentrations as an index of exposure are also unreliable in situations of mixed exposures with metabolic interaction, individual peculiarities of work habits leading to abnormal intake, and additive exposure off the job. By reflecting all of the possible variables, health surveillance may become sufficiently advanced to provide both an index of exposure and an index of response. Accordingly, only health surveillance techniques, if available for the specific exposure, could ascertain that the individual worker is completely safe and has incurred no adverse effects. Much research and development of new methods is needed before that comfortable condition obtains. In interim it must be hoped that there is sufficient understanding and wisdom to accept the unavoidable but serious limitations with which we are now shackled.

Epidemiology The epidemiologic record related to occupational health and illness (and for that matter, of natural disease, too) traditionally has been appallingly inadequate. Without a valid and usable base of health surveillance and related worker exposure data, the best of epidemiologic schemes will be of only crude quality. This provides cogent emphasis as to the need and importance of auditing and scientific assessment of the results of our surveillance programs.

Disability and Workers' Compensation The quantification of disability and determination of the degree attributable to occupation truly defies or eludes us technologically today. This precludes the other perspectives of concern (moral, legal, and economic) from being dealt with objectively on a wholly fair and rational basis. Certainly exacting and proper recognition of occupational disease or adverse effects in the input side of the equation is the weakest link in the entire process. No magic answers are apparent in the immediate offing and there is a great need for long-term follow-up of the natural history of disability and its relationship to compensation practices. This particular consideration may not seem related to my topic—but this, plus our humane efforts, becomes the "bottom line" when we fail.

All of these issues indicate that there are many unsolved matters and that our work is clearly cut out for the future. It is obvious that there is an abundant need and clear urgency for major change and realignment of priorities and policies for overall national and occupational health care delivery systems. In order to achieve a successful capability for health surveillance of workers, several special needs emerge:

1. Record systems are critical and much needs to be done to make them more meaningful. Computerization is absolutely essential for correlation with work environmental data, comparative studies, proper and required record retention, and the audit function. Compatibility between systems on areas of primary concern is essential. This in no way precludes individual organizations from embellishing the scope to whatever extent they desire.

2. Improved science is imperative. Despite the remarkable advances in analytic capability, especially in the chemical area, much more is needed and capability in the biomedical sciences is far behind. This lag has, in fact, aggravated our problems in that

we can analyze for levels of exposure far lower than we can determine what, if any, physiologic effect has been induced.

3. In order to meet the work load increase that will be necessitated by health surveillance requirements, persons other than just physicians and nurses will have to become trained and utilized. The adoption of many screening procedures by technicians and other suitable paramedical personnel will become a must. The total task will require involvement of these individuals plus the physicians, nurses, industrial hygienists, toxicologists, and other support personnel engaged in a cohesive team approach.

Much more could be said, and I'm sure that extensive argument could be generated, but this has represented a general airing of the subject and some of the enigmas to be encountered. From these thoughts perhaps three hypotheses can be offered:

1. It is currently impossible to establish a rational basis for assessing the impact of all the combinations and permutations of exposure to many agents—single or multiple with differing characteristics and proportions.

2. The quantification of industrial hygiene measurement and of medical observations both are extremely important—but at this stage in the development of the art they can be highly deceptive and subject to gravely erroneous interpretation. We need better science and deeper understanding, judgment, and wisdom before the numbers will provide all the answers.

3. The sum effect on health is the consequence of interaction among:

a. A genetically constituted and uniquely constructed human being.
b. The influence of naturally occurring diseases.
c. The impact of occupational exposures.
d. All other environmental and personal endeavor influences.

Consistent with this state of affairs, I believe our greatest efforts should be directed less to the numbers game and more to establishing principles and systems that may help us all to accomplish our intended objective—protecting people from incurring adverse health effects resulting from their work. Finally, I urge the adoption and uniform usage of the term health surveillance.

INTERDISCIPLINARY TEAMWORK IN THE HEALTH/SAFETY PROFESSIONS

THE ROLE OF THE MEDICAL PROFESSION

William D. Hoskin, M.D.

As the first speaker for the panel, I would like to outline briefly a somewhat idealized comprehensive occupational health program. It exists in concept, and, for the larger part, in fact, at the Kodak Park Division of the Eastman Kodak Company, a manufacturing plant for sensitized photographic goods and chemicals, employing approximately 32,000 persons. Some elements of the health program are still under development or in prospect. I do not have direct experience with safety activities. However, safety is represented on the panel by an eminent safety professional, David MacCollum, who will speak from his very rich experience about that important program area.

There are four aspects to the occupational health program. They include clinical medicine, environmental health, health maintenance, and rehabilitation. In the clinical area, of first importance is the capability for emergency medical response. A plant-wide first-aid strategy is currently being reorganized under the direction and coordination of the Medical Department. An in-plant ambulance is crewed by a nurse or physician but maintained and operated by the Fire Department. A dispensary is open and staffed by health professionals 24 hours a day. It is equipped to provide emergency treatment for most medical emergencies including acute coronary occlusion.

Casual ambulatory patient services represent a major activity. Any company person may be seen in the Medical Department for illness or injury or for medical advice or evaluation. The service is intended to respond to the immediate medical needs of individuals at work. It permits early recognition of work-related illness, and provides prompt medical intelligence about illnesses currently present in the work force.

Where indicated, diagnostic studies are performed sufficient to establish a working diagnosis and plan of advice or management

for the patient's problem. The plan may include work recommendations or work prescription (we hope to be able to minimize use of the term "job restrictions" with all its negative implications). If the clinical problem is causally related to work, a specific plan of management may be initiated. On the other hand, if the illness or injury is not so related, only interim treatment is offered and referral is made for further management by the private physician or other community health resources.

A not inconsiderable effort is devoted to the clinical follow-up of persons with chronic illness or disability. At appropriate intervals the status of the patient's health is reviewed and consideration given to any changes in the patient's functional capacity or in requirements of the job.

The next major area of the occupational health program is that of environmental health. This is, in fact, the public health portion of the program. In the special community and environment of industry, disease-producing agents are seldom bacteria, spirochetes, or parasites; rather they are in those familiar categories of noise, chemicals, radiation, heat, mechanical stress, and emotional stress. Environmental health objectives are, of course, to recognize, to identify, to evaluate, and to make recommendations regarding the suspect hazards. Methods for dealing with such a hazard are, in order of preference, to eliminate the hazard, to substitute for it, to control it, or to protect the exposed individual. The monitoring and the investigation of the great variety of potential industrial hazards is a complex and technical matter, requiring the contribution of a number of disciplines in many cases.

The term preventive medicine implies noble objectives. However, when one attempts to translate the term into substantive programs or techniques, the body of practice and technology appears to be limited except in the classical areas of immunization and public health. New methods for observation and measurement of biological structures and functions, new applications of information processing, and an increasing understanding that many interrelated factors are involved in the causation of disease—all are contributing to a new dimension of illness prevention and health maintenance. They make it possible to better characterize the health of individuals and groups in terms of both pathology and function. Less advanced is our ability to influence the long term state of health of individuals, particularly in terms of deferring premature death or, even more importantly, improving the quality of individual lives.

In light of the above, it is our belief that health maintenance programs and activities are necessary to apply medical insights to the prevention of chronic illness and also to expand these insights. The basis for the health maintenance program is an extensive system of health appraisals performed for a number of different reasons which can be grouped under four headings. One heading is that of functional evaluations performed for the purpose of determining functional capabilities and functional impairments along with clinical evidence of illness or pathology. The occasions for these may be selective placement or licensure for special duties such as respirator use or vehicle operation.

Another very important classification is that of occupational hazard surveillance which includes those appraisals or examinations of persons potentially or actually exposed to environmental or occupational hazards. The purpose of the evaluation is to discern the earliest biological evidence of significant exposure to the hazardous agent. Evidence could range from simply the presence of the agent in the body through early reversible physiologic change to overt disease. Such surveillance calls for a comprehensive list of hazardous agents, arranged in a matrix form with appropriate examinations designed to elicit the necessary medical information.

A third and familiar category of health appraisal is the routine periodic medical examination. Purposes of these examinations include early disease detection, comprehensive risk profiling, and the establishment of vertical (individual) and horizontal (group)

health baselines. They should be scheduled for the entire work force at those intervals which are possible of accomplishment and which serve the defined purposes of the program.

Fourthly, a health appraisal system can also make it possible to study efficiently the health of a group of employees with some common identity, such as a department, an industrial operation, a vocational specialty, or a common work environment. Such a cross-sectional study can serve epidemiologic as well as personal health purposes.

Information developed in health appraisals can be applied in the form of advice or planning which will enhance the health of the individual or the group. The individual may be provided counselling and appropriate referral regarding disease discovered in the appraisal, or advice about measures to improve a high risk factor profile. Recommendations to supervision regarding safe work practices, improved job methods, or hazard controls may also be indicated when unexpected evidence of hazard exposure is revealed.

Where illness or disability exist, the ultimate objective of treatment and rehabilitation is to restore the individual to a maximum level of function. To participate and contribute in an effective, productive manner in a significant job may be the optimum rehabilitation end point. Historically, our role in the rehabilitation process has been a relatively passive one. Rehabilitation plans have been carried out for the most part outside the work place and without significant participation of the Medical Department. It is our belief that to preserve function and to prevent psychological and spiritual deterioration, a more active rehabilitation effort on the part of the Medical Department is necessary. An early, active, and specific rehabilitation plan should be formulated and carried out. The Medical Department should assist in the devising of support programs for those individuals incapable of continuing work on a long-term basis.

A special area of rehabilitation has to do with the counselling of the so-called "troubled person." Changes in work performance and attendance, development of uncharacteristic accident proneness, and changes in attitude or behavior are identifying characteristics of a troubled person. Depicting the reality of the declining job performance to such a person, as the initial part of a coordinated but voluntary rehabilitation plan, can be effective in helping such patients deal constructively with the "trouble," whether it be alcoholism, excessive unwarranted illness absence, or some other situational, behavioral, or health problem.

A number of resources and activities are necessary to support the occupational health program which we have briefly described. Among them are the usual ones such as diagnostic radiology, a clinical laboratory service, a medical record system, and administrative services. However, some of them are newer and less familiar.

The professional nurse, in the extended role which is evolving, has been able to make important new contributions to the program. With increased training and under medical supervision, the nurse has been able to carry out health appraisals, clinical evaluations, and problem solving to a degree which has not traditionally been possible. The nurse has become involved in environmental health activities and is expected to have a key role in the rehabilitation program.

The handling of occupational health information of many kinds has been enhanced, and in fact made possible to a large extent, by data processing technology. The storage and retrieval of clinical information and its selective confidential use for administrative and epidemiologic and other purposes depends heavily on computer services. The preparation of reports required by government regulation can be facilitated by these information systems. The identification and scheduling of individuals for health appraisals are heavily dependent on this kind of resource.

In addition to the special scheduling needs,

the health appraisal system will need other kinds of resources and support. For efficient operation, a facility must be designed to accommodate the volume and flow of subjects anticipated. Job descriptions should be devised for the professional, paraprofessional, and nonprofessional persons who will staff the program. The availability of physicians and nurses to give follow-up attention to the medical information generated by the system is a crucial and limiting requirement. For purposes of review and analysis, it is useful to have a summary of medical findings stored and recoverable in computerized form.

As the needs and opportunities for occupational health services change and expand, it becomes necessary to provide information, interpretation, and training about occupational health matters to all of the individuals and organizations concerned. Professional staff require ongoing training in the technical aspects of occupational health. Managers and supervisors must be advised regarding occupational health standards and practices and the capability of the health services to support them in those management responsibilities. Most importantly, individual operators must be informed of any health hazards in the work place or in the job operation to which they may be exposed, and they should be instructed in safe practices to prevent such exposure. Training efforts to satisfy all these purposes will vary in content and in manner of presentation. They will require intentional planning and competent training resources.

Success of an occupational health program depends very much upon the availability of occupational health science services. Important disciplines include toxicology, biochemistry, industrial hygiene, human factors, radiation physics, and bacteriology. Of increasing importance is the science of epidemiology. There is a notable lack of information and understanding about most of the potential health hazards in the work environment. Experimental evidence is closing some of the knowledge gap, but direct observations of human health experience in large groups with known environmental conditions will add much to our understanding of the problems. Large industrial organizations with substantial occupational health programs will need to consider the creation of occupational health science laboratories within their own organization. Most small industries, however, will probably not have use for full-time laboratory assistance but can arrange to have this consultation available.

No program can succeed without the strong moral and material support of management at all levels in the organization. Managers must be aware of their health responsibilities. There must be a clear understanding of goals and objectives. There must be firm management commitment to those objectives. Support in the form of facilities, staff, and funds is needed.

The purpose for and the ultimate objective of occupational health programs is to prevent illness and injury to the individual worker. In addition to the programs and resources described, there must be a high degree of personnel confidence in the health organization, the program, and the professional staff. Staff members must have professional credibility based on demonstrated competence and genuine concern for individual needs. The doctor or nurse must assume the role of, and be perceived as, the personal advocate in health matters. It should also be clearly evident that the doctor/patient relationship is a confidential one and that medical department procedures will assure that information obtained in the relationship will be secure.

The comprehensive occupational health program described represents the current state of the art as we see it. It also reflects new applications of other disciplines and technologies to that art. These programs are becoming more diverse, more complex, and more technical. It has become correspondingly more difficult for individual practitioners or professions to deal effectively with all of the ramifications of occupational health. The result is increasing compartmentalization and specialization among the occupational health disciplines.

These factors and a number of others combine to make it implicit that many occupational health problems should be dealt with by interdisciplinary teams. Industrial technology continues to change in the direction of increasing complexity and unfamiliar hazard. At the same time the ability to evaluate toxicologic, biochemical, metabolic, pathologic, and other biological effects of hazardous environmental agents is increasing and improving. Specialization is occurring in a number of professions in response to the need. These include medicine, nursing, industrial hygiene, human factors, toxicology, health physics, and others. Government regulations are requiring a higher degree of commitment and performance from industry, generally, in the area of occupational health. Supervisors are being assigned new and sometimes unfamiliar responsibilities for the health and well-being of the persons in the work force. New organizational styles call for participation in the setting of goals and design of processes by those whom the practices are designed to help.

The team process provides a variety of viewpoints, a ferment of ideas, a special interest in the resulting plan, and a sense of responsibility by the participants in making the plan succeed. On the other hand, the exchange and consideration of ideas is a time-consuming and laborious process. However, used well, the team process can be creative and can often contribute special wisdom to a complex problem.

In response to these many factors, teams can be useful for a number of purposes in the occupational health program. The basic health team may consist of the occupational physician, the most broadly, extensively trained member of the team and presumed team leader; the occupational health nurse, whose extended role will be described in greater detail later; and the secretary, who may be able to assume other coordinating and administrative responsibilities for the team than the usual secretarial role. This team should have the basic responsibility for carrying out the broad occupational health program we have been discussing.

To deal with environmental health questions, the area physician is considered the general practitioner of occupational health but will often wish to convene a team consisting of a representative of the operating division, an industrial hygienist, a human factors specialist, the safety engineer, and other technical specialties as needed.

A health appraisal center may be staffed by nurses in the extended role, technicians, clerical persons with limited clinical training, and an administrator to coordinate the activities of the team. A physician, of course, is needed to oversee the program.

Significant improvement in rehabilitation practices will probably also depend to a great extent on the ability to organize the efforts of several professionals for the purpose. Once more the occupational physician will need to give direction to the team, but special contributions can be made by the occupational nurse, by visiting nurses with rehabilitation training, by a medical rehabilitation consultant, and by the attending private physician. Not to be overlooked, and crucial to the rehabilitation plan, is the patient's supervisor. Finally, the patient should be included in the rehabilitation planning.

In summary then, under the influence of many social, political, economic, and technologic forces, occupational health programs are becoming more complex, more diverse, more technical, and more extensive than we have been accustomed to in the past. An example of such a comprehensive program has been described in this paper. The need for greater specialization in the practice of occupational health has been suggested, along with factors which have influenced that need. Some examples of interdisciplinary teams have been presented.

THE SAFETY ENGINEER'S VIEWPOINT

David V. MacCollum, P.E., C.S.P.

Our nation's safety and health problems cannot and will not be solved until *all professions* work together towards a higher degree of care. This teamwork must extend far beyond those who are professionally identified with either the safety or health fields. Let us identify some specific professional boundaries, so we can see who needs to be on the health and safety team.

Being an engineer, I see the professional boundaries relating to safety and health as a triangular pyramid—a three-dimensional solid contained by four plane faces in which each side directly interfaces with the other three sides. The four disciplines which form the faces of this health and safety tetrahedron are economics, law, medicine, and engineering. These basic relationships cannot be dealt with individually, as this would create an imbalance of the others. At first glance, this perspective may be questioned by many, but as we begin to examine the tetrahedron, I think you will see the close interrelationship of these disciplines.

First, let's take the one which appears to be most out of place and establish it as the base. This is "economics." We have never really addressed the cost of human destruction as a result of health and safety hazards. The cost of injury, death, or impairment of health is many times not borne by the party creating the danger. There are countless people on the tax rolls who have been disabled, widowed, or impoverished because of accidents and are a tax burden because health and safety were construed as unimportant considerations. The true cost of industrially induced health hazards and accidents is ultimately reflected in welfare benefits to the victims. Had the cost of prevention been included in the initial price of the machine, product, facility, or service, the far larger cost arising because of these accidents or health hazards would have been eliminated. Such waste is inexcusable. Today we know that carcinogens are delayed time bombs.

The health care relating to these carcinogens is largely picked up by health insurance, public health, or welfare programs. Thus the staggering cost of health care for black lung, asbestosis, and the like has been reverting to the public sector.

Years ago enterprise sought to stablize the cost of traumatic injury (such as loss of eyesight or limbs) or death as a result of physical harm in the workplace by relying upon workers' compensation to cover losses. Workers' compensation has provided incentives for the employer to provide a safe work environment, but the employer who has no intention of implementing a safety program only runs the risk of policy cancellation in the event of a large loss. This inflates the entire rate-making structure to the detriment of the good performer. In recent years casualty insurance has come under some measure of criticism for its inability to preselect the good risk from the bad, since good management still foots the bill with higher premiums to cover the losses of the poor performer.

Another facet of economics that often goes unnoticed as long as the employer pays the bill through workers' compensation is the responsibility of manufacturers to design safe machinery. Machinery is often defective and unsafe. Because the inherent dangers are often not readily anticipated by those who use the equipment, many injuries result. The burden of safety should not be upon the employee to do it right all the time, every time! These machines should be designed by manufacturers so that the operator won't suffer grievous injury if a misjudgment is made. Punch presses are good examples of machines that entrap the unwary if they happen to make an inadvertent movement. I consider punch presses to be "automated amputators," and they should be better designed by manufacturers.

Once the cost of prevention is recognized as infinitesimal when compared to the high price of restoration, disability, or dependent welfare, then economics will promote incentives for the obviously needed remedial measures to prevent injury in the first place.

In summary, I contend that the lack of economic analysis has been the major underlying reason for neglect of emphasis on preventive health and safety measures.

The next interlocking face of the tetrahedron is the profession of law. By pursuing the theory of tort liability, adversary concepts have focused upon economic inequities. When the pocketbook is hit by lawsuits arising from injury, impaired health, or death, the economics of prevention become clear. These court actions have fostered a concern for safety and health and have provided the stimulus for many laws on safety and health.

In many ways, the legal profession has been the catalyst which has *forced* the issue of health and safety to become a national priority. In the past, as long as the injured had no way to present a claim, no costs were incurred, and there was no economic incentive to improve safety and health conditions. Now, when injury, death, or health impairment can result in financial restitution, prevention takes on a new look and is considered "good business" and the sensible and essential way to go.

Let's turn to medicine. To me, this is the sunny side of the tetrahedron. Through pathology, medicine has perceived many silent killers, ameliorated the damage, and prescribed the cure to eliminate the danger. The research which has been done by the medical profession is outstanding in correlating some of the diseases of man with industrial contaminants. The engineer applies his talents to devise control methods for reducing the level of contaminants. The toxicologists in their research have been able to recommend the limits of exposure that the human body can tolerate without irreversible damage. In the area of human factors analysis, we have been able to determine the limits of physical and mental stress.

The fourth side of the tetrahedron is engineering, more specifically, safety engineering which applies physics, chemistry, and biology towards the control of physical hazards. It is my opinion that the

importance of sound engineering practice will become absolute in the future. We have reached the limit for reliance solely upon human behavioral patterns. It is now recognized that inadvertent errors should not result in catastrophic disability or damage.

The solution lies in fail-safe design and development of safer products, and these options are in the province of engineering. It can be expected that design improvement to industrial machinery will become a necessity, since perfect human performance is understandably unachievable. This concept is not new. Some very sound comments, showing keen perspective were made sixty years ago by prominent safety engineers:

"If you want your plant to be 100 per cent safe, the answer to the first question is—guard every moving part, wherever located, on which a workman might be injured if he came in contact with it in any way or from any cause whatsoever. If the moving part is in a place 'where nobody ever goes,' remember that someone is likely to go there sooner or later, in connection with the repair or maintenance or alteration of the machinery itself or of the building, or for some other reason which you cannot anticipate."[1]

"Along the line of getting men to do things I might 'spill a few beans.' I happened to be one of the Committee on Safety and Sanitation of the National Manufacturers' Association. At our last meeting we adopted a resolution that all manufacturers be asked to alter the design of their machines to incorporate safety to the full advantage of the factory to their product. We also went on record that we would advocate legislative action by the House of Representatives to compel every manufacturer in this country to send out his machines with all guards attached; no open gears; all movable parts enclosed, wherever possible; leaving only an opening sufficient to get the belt on.

"We have not heard from them yet, but I can assure you that we wrote to each Representative. I received a letter from our Representative, stating that he was heartily in favor of it, that it was a fine thing, and that he would do all in his power to pass such a law. So, gentlemen, you can see the trend is towards making everything as safe as possible, and when we get the House of Representatives interested in the matter, I think we are on the road to success."[2]

With all of our aerospace technology, we still have not come to grips with the **basics.** To enjoy absolutes, we cannot afford the luxury of allowing "half" a machine to be introduced into commerce without safeguards. Fancy laws, esoteric management programs, motivational training, and sexy posters are not going to assure human reliability. In the final analysis, it is the engineer with an understanding of safety who will provide design which takes the sting out of the variables of human behavior and makes the machine fail-safe.

The safety engineer will play an increasingly important role in the future because he has the special knowledge that will eliminate dangers that are not acceptable risks. The safety engineer can foresee and predict where accidents will occur; more importantly, it is he who applies available technology for design so accidents won't occur.

If the answers to our safety and health problems are so close at hand, why are we so far from success? The answer is as basic as the question: we fail to examine total economics and are inclined to consider safety and health in terms of initial expense rather than measuring the cost of safeguards against losses which can be incurred by their omission. Our present incentives are directed toward "chancing it," and we tend to risk large stakes for very small economies.

A few fresh trails have been broken in the direction of giving safety and health a first priority. The most notable example has been to place men on the moon with assurance of their safe return. This effort was accomplished by using a systems approach in which all disciplines were channeled into the safety and health effort. Every conceivable human error was considered, as well as

every possible mechanical or electrical malfunction; effective controls were included as fail-safe options. The result afforded nearly absolute safety.

The space program showed that when money is made available for safety and health, hazards can be controlled. We are also finding out in our free economy that the cost of incorporating safety and health in design is far less expensive than the losses we are experiencing when these items are overlooked.

From a safety engineering standpoint, I want to reiterate how important it is for the engineer to have the help of the pathologist who identifies the offending carcinogens or bacteria. The skills of the psychologist, who understands human behavior and why people err, are essential so the engineer can go back to the drawing board and design a safer world. We must work closely together. The old saying that engineers plant ivy to cover the cracks and physicians bury their mistakes will not cut it in today's world. Our fellow professionals on the other sides of the tetrahedron will get to us and focus on our shortcomings. Pure economics will force us to get with it or go broke.

All professions must become cohesive if a safer and more healthful world is to be achieved. Traditionally, it has been the role of the professions to provide the expertise upon which progress is made. When progress does not meet public goals, it is not usually the fault of the professions, but an inability of the establishment, either individually or collectively, to accept, adopt, and support the prescriptive measures defined by the profession.

I feel the time has come for the professions, which have given us the high quality of life we now enjoy, to hold the establishment accountable for safety and health. Nearly seventy-five years ago President Theodore Roosevelt said: "As modern civilization is constantly creating artificial dangers to life, limb, and health, it is imperative upon us to provide new safeguards against the perils."

We in the professions should express our impatient dissatisfaction, in unison, in view of these facts:

1. More than 105,000 men, women and children are killed each year by accident.
2. More than 11,000,000 per year are accidentally disabled.
3. Actual economic losses approach hundreds of billions of dollars each year.
4. Unknown numbers of workers are being exposed to harmful carcinogens and other disabling elements and are added to our already staggering tax burden through welfare and health care programs with no penalty imposed upon those who do not eliminate the cause of such disablement.

Interdisciplinary teamwork among all professions is the "base" upon which to build a safer world.

REFERENCES

1. Williams S J. National Safety Council 8th Safety Congress Transactions, 1919.

2. Williams W E. Packard Motor Car Company. National Safety Council 6th Safety Congress Transactions, 1917.

THE ROLE OF THE NURSE

Barbara Healy, R.N.

Occupational health nursing has been defined by the American Association of Industrial Nurses, Inc. as "the application of nursing principles in conserving the health of workers in all occupations. It involves prevention, recognition, and treatment of illness and injuries, and requires special skills and knowledge in the fields of health education and counseling, environmental health, and rehabilitation."[1]

Today's increased demands on the occupational health services has brought about a need for more complete utilization of the knowledge and skill of the occupational health nurse. The expanded role of the nurse began at Kodak with the recognition that nurses were interested in and eager to accept the challenge of new responsibilities and to increase their knowledge and skills. It was further recognized that nurses represent a vast—but partially untapped—potential of health care providers. It was hypothesized that the professional potential of our nurses could be utilized better by providing appropriate education programs and a proper setting in which to practice.

The Medical Department has been exploring ways to expand nursing responsibilities. To implement this action, a physician-nurse committee was appointed. One of its decisions was to enter a nurse in the University of Rochester School of Medicine's course for nurse practitioners. This course taught the techniques of the physical examination. Dr. Barbara Bates and her colleague, Joan Lynaugh, R.N., who jointly developed this course, suggested that one of our physicians participate as an instructor. This was done and provided the foundation for a course conducted on a continuing basis by one of our physicians on Kodak Park premises. The course for nurse practitioners at Kodak now consists of: 30 hours of training in the techniques of the physical examination; 6 hours in interviewing and history taking. In addition, approximately 15 hours per year

..re spent in continuing education programs on clinical syndromes and disease states. Over forty nurses have completed this program.

To adequately see the setting in which nurses apply this specialized training in their role, you must visualize Kodak Park. Kodak Park is a large manufacturing complex where approximately 32,000 people are employed in the production of photographic goods and materials. Because of the magnitude and complexity of operations, it is impractical to expect any one physician to be intimately knowledgeable of all the many processes, health hazards, equipment, and men and women involved. Recognizing this, the Medical Department established an "area physician" concept. An area is a grouping of departments which, insofar as possible, have similar functions. For example, the Research Laboratory complex is one area. Photo Paper Manufacturing is another, and so on. This enables the physician to periodically visit the area and to become familiar with the operations and personnel. Applying the Interdisciplinary Team approach, it was decided for a pilot program that an area could be served best by adding a secretary on a full-time basis and a nurse practitioner on an 8-hour per week basis.

Since then, other areas have been organized on a similar basis, and in some instances the nurse practitioner hours have been expanded. After five years of experience with this concept, we feel that to obtain team efficiency, members of these teams need to:

1. Be familiar with the established goals of the Medical Department.
2. Participate in the development of team goals and of an operating style which will effectively accomplish these goals.
3. Be familiar with the environment, jobs, and personnel of the area.
4. Know their own role and that of the other team members.
5. Have trust and confidence in their colleagues, respecting their knowledge and skill.
6. Be aware of the other interdisciplinary health personnel resources available to them.
7. Consult and collaborate with each other as needed.
8. Keep other team members informed.

Since each of our 14 teams operates in a style established to meet the needs of its area, I will attempt to outline the nursing and secretarial roles as a composite picture. The secretary is the administrative team member, responsible for scheduling and coordinating activities by working with the physician, nurse, and area management to provide the maximum utilization of time for all concerned. The secretary maintains records, assures their availability to the health professionals, is the first line of contact with the departments, and fields questions to the appropriate team members. The secretary is a key person in establishing an atmosphere of cooperation and team unity.

The area nurse in collaboration and consultation with the physician working by appointment from an office preferably near the area physician—performs pre-placement and health hazard examinations; periodic physicals; sees patients with self-limiting illness; follows progress of people with occupational injuries; teaches health maintenance; counsels individuals with emotional, family or absentee problems referring them to the family physician or appropriate community agency when needed; and follows persons with chronic illness, in conjunction with their family physician, helping the individual to manage his illnesses on the job. The area nurse also participates in organizing health surveys and develops or participates in health education programs for the area, such as breast self-examination and diabetic information sessions.

In the absence of the area physician, the nurse is the department's contact with the Medical Department. She or he follows through on problems, consulting with the necessary health care professionals—physician, industrial hygienist, toxicologist, visiting nurse, human factors group, and private

physician—to obtain necessary information for the department or to initiate appropriate treatment or action, consistent with the scope of the nurse's extended role.

The nurse's role at Kodak Park has also expanded in the dispensary operation. Our people have two avenues to the Medical Department: they may make an appointment to see the area physician or nurse, or they may walk into the dispensary, which has nurse coverage 24 hours a day, 7 days a week. The nurse is responsible for making a nursing assessment and plan. This is accomplished by interviewing; history taking; performing regional examinations as indicated; ordering laboratory, ECG, and X-ray studies; and evaluating the collected data (excluding X-rays and ECG's) as the basis for a plan. The nurse may decide to treat self-limiting disease with medication consistent with standing physician orders or in accordance with standard procedures, refer the individual to the family physician or community agency, collaborate with the dispensary physician to draw on his or her expertise to gain additional knowledge, or have the person seen by the dispensary physician for X-ray and ECG interpretation or medical diagnosis. We feel the setting offers unlimited opportunity for continuing education and teaching. Physicians are always willing to demonstrate, to counsel, or instruct. The nurses are eager to increase their knowledge and ability.

In the dispensary, the nurse uses the interdisciplinary approach in many other ways. For example: she informs the safety department when she becomes aware of a serious injury or unsafe condition in the plant, and they may contact the supervision or the area health team before writing a job restriction to insure that the prescribed conditions are feasible.

The occupational health nurse takes advantage of every opportunity to do health teaching, and to provide health guidance to employees. Since the dispensary service is intended to respond to immediate medical needs, we believe complex or chronic problems should be followed by the area team physician or nurse, who have a more complete picture of the work environment. The team can develop better continuity of care and rapport with the individuals.

The dispensary nurse communicates to the area team physician and nurse any unusual health situations or potential health problem with a person in their area, and refers appropriate cases or pertinent information to them. In addition, the nurse continues to administer first aid and treatment to anyone coming into the dispensary, as well as following progress of minor occupational injuries until full recovery.

A committee is currently studying how a health appraisal team would function. When implemented, it is anticipated that the nurse will be the on-line professional. The nurse in this capacity will participate in the development of the operational objectives and evaluation of the service. He or she will obtain histories, perform examinations, consult with the area team to identify groups to be examined and examinations to be performed. The nurse will work with technicians and the clerical staff to assure accurate data is reported to the area team for their appraisal and follow-up.

A committee is also studying the Medical Department's role in rehabilitation. In the event of serious illness or injury—early, active, specific intervention with a stated rehabilitation plan formulated by the area physician and/or nurse should include consultation with the personal physician and the Medical Department's rehabilitation consultant. We feel the Visiting Nurse should play a vital part in this team's effort, evaluating the home situation, progress, motivation, and adherence of the patient to the plan. This would include counseling and advising on methods, equipment, and management of the individual's illness and community resources, working with the area team and the rehabilitation consultant, and helping the area team evaluate the plan and the individual's progress.

CONCLUSION

While there are many areas in which the nurse may function independently, provisions should be made for medical supervision. This does not mean to say that the nurse is not fully accountable for his or her actions and totally committed to the ethical standards and scope of nursing practice. Communication lines for consultation and collaboration between the interdisciplinary team members should be established and maintained. Utilization of each other's professional skills not only enhances the occupational health service provided, but in so doing, assures nurses and other team members increased job satisfaction knowing their expertise is being utilized more completely.

REFERENCE

1. "A Guide for the Preparation of a Manual of Policies and Procedures for the Occupational Health Services," American Association of Industrial Nurses, Inc., New York, 1969.

THE INDUSTRIAL HYGIENIST'S VIEWPOINT

Franklin A. Miller

INDUSTRIAL HYGIENE, WHAT IS IT?

According to the American Industrial Hygiene Association, "Industrial hygiene is that science and art devoted to the recognition, evaluation, and control of those environmental factors or stresses arising in or from the work place which may cause sickness, impaired health and well-being, or significant discomfort and inefficiency among workers or among the citizens of the community." The three key words in this definition are "recognition," "evaluation," and "control." Thus, by definition, industrial hygiene includes studies on chemical hazards such as gases, vapors, dusts, fumes, and mists; physical hazards such as ionizing radiation, lasers, ultraviolet light, microwaves, heat, cold, and noise in the working environment and, in addition, air pollution and noise within the community.

How does an industrial hygienist recognize a potential health problem in the plant? Some of the means are:

Industrial Hygiene Inspections During an industrial hygiene survey or while doing a job in an area, an industrial hygienist will note conditions that should be investigated further.

Safety Inspections Safety personnel on a routine inspection of a plant may note conditions which they feel might be a potential health hazard. These should be called to the attention of the industrial hygiene group for action on their part.

Government Inspections Federal or state inspectors visiting the plant will issue citations if conditions exist that they feel do not meet health standards. These citations will normally be referred to the industrial hygiene group for follow-up. Also in the realm of governmental control we must now face a multitude of criteria documents and a deluge of "Mini-Standards" being written

under the Standards Completion Project. These documents are a prelude to standards that may spell out in detail medical, safety, and industrial hygiene work that must be done for an industry to be in compliance.

Visits to Plant Medical Department A person who has become ill might make a visit to the Medical Department. The physician or nurse should find out the reason for the problem; and if it is a chemically induced illness, the industrial hygiene group will be requested to investigate the problem.

Plant Physician The plant physician, who through inspections of the plant has become familiar with the working conditions, can request an industrial hygiene investigation to document contaminant levels around a certain process.

Operator Complaints A worker may find his job disagreeable because of odors or irritation to his respiratory tract. His complaint to a supervisor or a safety representative would in turn be reported either to the plant medical department or to the industrial hygiene group.

In this situation, one must consider the difference between individuals. What may be regarded as only a barely perceptible odor by one may be considered as strong and objectionable by another. Also, many vapors when continuously inhaled fatigue the sense of smell, making the use of odor as a warning signal unreliable or ineffective.

The first step in evaluation is to determine the concentration of contaminant to which a worker is exposed. Sometimes one can judge that concentrations are so low (or high) that quantitative measurements are unnecessary. However, in most cases the evaluation is done by sampling the workroom air for the known contaminant or contaminants. It is very critical, no matter how accurate and precise the analytical procedure, that a representative sample is collected to determine what the operator is actually breathing. Therefore, samples are taken as close to his breathing zone as possible. While at the work place, data are collected to determine the amount of chemical usage, exposure time, and number of employees exposed. Also, observations are made of handling procedures, housekeeping, and potential skin contact. This is necessary because, although the primary mode of entry of the contaminant into the body is the respiratory tract, contaminants can and do enter the body through ingestion and skin absorption. All this information is necessary if an accurate assessment of the operation is to be made, and it should aid the industrial physician in reaching a proper decision as to the safety of this working environment. Evaluation, therefore, may be defined as the decision-making process which establishes the degree of health hazard from chemical or physical agents in the industrial environment.

Industrial hazards can be controlled in various ways. These include:

Substitution This simply means substituting a less toxic agent for the one in use. In doing this it must be determined if the new agent is compatible with the process. Also, consideration must be given to the amount of agent required and the difference in physical properties (e.g., vapor pressure) of the agent. These last two considerations may negate any benefits derived from the substitution.

Local Exhaust Ventilation The exhaust should be located as close as possible to the contaminant source in order to most effectively control environmental concentration of the contaminant. Preferably, a competent ventilation engineer should design the system and check it after installation to be sure that it complies with all necessary regulations. Routinely thereafter the system should be measured to be certain the air flow is operating according to design specifications. It should be remembered that local exhaust ventilation provides control with relatively small quantities of exhausted air.

General Ventilation Good general room ventilation is only adequate in certain

limited cases, e.g., with solvents of low toxicity that are used in small quantities. The degree of hazard can be determined by consideration of the number of air changes per hour in the room, the room size, and the amount of solvent used per hour.

Job Rotation This simply means rotating operators so that their time-weighted average exposures do not exceed standards. This is not a particularly good method of control because of the problem of scheduling the labor force and the necessity of having another job available where there is no chemical exposure.

Improved Housekeeping and Handling Procedures It should be obvious that if chemicals are dumped or spilled on the floor and over the machine, the chance of over-exposure is much greater than if the operation is carried out in a neat and tidy manner. Sometimes poor housekeeping is not all the operator's fault but is the result of overcrowded conditions in an area. It is then a supervisory problem to correct this overcrowding.

Personal Protective Equipment There is a wide variety of personal protective equipment such as respirators, gloves, face shields, plastic aprons, plastic gloves, and boots. This type of control is considered as a last resort measure except, of course, in an emergency situation. It is unreasonable to expect a person to be required to wear respiratory protection, for example, for the entire workday or even routinely for shorter time periods. The situation should be corrected by one of the other mentioned methods.

Enclosure Completely enclosing a process or piece of equipment is another means of reducing human exposure. This has been successfully used on noisy pieces of machinery and also can be used on chemical emissions in conjunction with local exhaust ventilation.

Education of Workers This can be very successful. By educating the workers to the potential hazards of the materials they are working with, they will be encouraged to use protective devices that are supplied. Various techniques include slide/tape talks, written standard practices which the operator must read and follow, and demonstrations of the value of good housekeeping and handling procedures.

In order to carry out a good occupational safety/health program, it will be essential to have available the services of the following disciplines:

Toxicologist The toxicity evaluation of chemicals that are encountered in the plant is needed to determine the relative hazards of the chemical agents.

Health Physicist Ionizing radiation sources are in widespread use in many plant operations; thus health and safety aspects of these sources is best determined by a person trained in health physics.

Chemist The analysis of samples taken in the plant must be accurate and precise if one must rely on the results to reach a decision concerning a possible health hazard in the plant. Also, as new chemicals are introduced into the plant, new analytical procedures may be required. The analytical chemist is able to develop these methods.

Safety Engineer This person can be very helpful if, during his safety inspections, he notes any health problems and brings them to the attention of the industrial hygiene group. Also, by working with the industrial hygienist and the industrial physician, the safety engineer can help to implement programs that will improve working conditions in the plant.

Physician The final decision as to the potential health hazard of an operation is the physician's responsibility. This decision is based on both knowledge of the operation and the data supplied by the industrial hygiene group.

Human Factors Specialist This person

specializes in the design and layout of a process to minimize stresses caused by lifting, reaching, and bending.

Design Engineer He is called upon to design the proper local exhaust ventilation and to check and balance the system after installation. In addition, he should work closely with human factors people in the design of a plant layout.

Nurse Though nurses may not be familiar with a particular plant operation, they can aid in determining if a visit to the medical department may be due to a chemical exposure in the plant. This information can then be passed on to the physician and the industrial hygienist.

Industrial Hygienist The industrial hygienist is needed to take samples and also to gather the necessary data for the complete evaluation of an operation or process. Based on the analyses and the information gathered from the process or operation during sampling, the report will aid the physician in determining the potential hazard of this operation or process.

Up to this point we have considered only "firefighting" situations; that is, trying to correct a problem on an existing process or operation. Although this aspect of industrial hygiene will always exist, an attempt should be made to institute a preventive occupational health program. One approach to the preventive program is through the use of an environmental health team. This team would include representatives of the various disciplines including a physician, an industrial hygienist, a human factors specialist, and a safety engineer.

The objectives of this multidisciplinary team would be to:

1. Determine if there are any actual or potential health hazards in the work environment.
2. Create a knowledgeable health force that is familiar with all plant activities and that can advise management in maintaining a safe work place.
3. Make recommendations to management concerning health hazards, periodic monitoring needs (people and environment), and record maintenance.

The team would conduct surveys, evaluate new equipment and new processes. Its initial task would be to conduct a walk-through survey within each plant area; this would be followed by a series of surveys by each team member who would concentrate on those matters related to his specialty. Of particular concern should be areas that are prone to have:

Physical or behavioral problems
Excessive noise
Poor illumination
Excessive heat
Inadequate ventilation
Restriction of individuals who can perform the job
Awkward posture (man/machine interface)
Radiation exposure (ionizing and nonionizing)
Excessive vapor and dust exposure

It should be emphasized that this list is not intended to be all inclusive. The results of these surveys will be useful in the planning of both short- and long-term improvements of each plant area's working environment.

After this initial survey, the team should be familiar with operations and processes and also be aware of any potential health and safety problems. In the event of changes in operations and/or installation of new equipment and processes, plant management could meet with the environmental health team to review the impact of the changes. The design engineer should be included so he can review his proposed plans with the team and then revise these plans in view of any suggestions that might be made. This type of approach would help the plant management be more aware of their responsibilities as a result of the changes, and it

would also help the team keep abreast of changing operations within the plant.

Where can one go for professional industrial hygiene assistance if your plant does not have an industrial hygiene group? This is perhaps the case in a majority of small industries. One excellent source of help is your insurance carrier; many carriers have an in-house staff of hygienists or other health specialists. Another source is provided by listing of consultants and is available through the American Industrial Hygiene Association's business office in Akron, Ohio. This office also has available for sale many publications relating to the field of industrial hygiene. These include manuals on noise, analytical methods, monographs on various subjects, and a hygienic guide series.

Books are another excellent source of information on industrial hygiene. Some suggestions are:

1. Brandt A. Industrial Health Engineering. John Wiley and Sons, New York, 1947.

2. Industrial Hygiene and Toxicology. Frank A. Patty (ed.) Interscience Publishers, 1963.

3. Jacobs MB. The Analytical Chemistry of Industrial Hazards, Poisons, and Solvents. Interscience Publishers, 2nd ed. 1949.

4. Occupational Medicine: Principles and Practical Applications. Carl Zenz (ed.), Year Book Medical Publishers, Inc., 1975.

One final suggestion is your local safety council which is affiliated with The National Safety Council.

I have tried to point out that an occupational health program relies on many different disciplines, and the most successful program utilizes each of these disciplines to accomplish the primary objective of a safe and healthy working environment.

MEDICAL RELATIONSHIPS WITH UNIONS AND MANAGEMENT

AN OCCUPATIONAL PHYSICIAN'S VIEWPOINT

Alexander L. Strasser, M.D.

As the health advisor to management, the occupational physician interrelates with the local union leadership on all matters pertaining to occupational health and safety. It is vital for the success of any occupational medicine program that a spirit of cooperation exist between the occupational medicine department and the local union. This lesson is a difficult one for new occupational physicians, as labor relations have never been emphasized in occupational medicine or traditional clinical programs. The purpose of this paper is to outline areas where occupational physicians and organized labor interact and to show how it is in the interest of all parties that medicine and labor work together for the common benefit of the working man and woman. In their everyday duties, the occupational physician and local union steward have many points of contact. Some of the more important areas are the following:

1. Medical Absenteeism
   Accident and sickness insurance (group insurance)
   Workers' compensation insurance
2. OSHA Compliance
3. The Role of the Union Steward and the Supervisor in Health and Safety
4. Industrial Hygiene and Toxicology
5. Health Insurance
6. Medical Limitations and Job Restrictions
7. Confidentiality of Medical Records
8. The Occupational Physician and the Local Union Leadership
9. Alcoholism
10. The Labor-Management Agreement and the Occupational Physician
11. The Ethics of the Occupational Physician

Medical Absenteeism When it comes to medical absenteeism, the occupational physician is the person who must interrelate between the patient (employee), supervisor, union, and personal physician. Short-term

illnesses are often treated in occupational medicine departments and rarely cause any problems. It is in the area of long-term illnesses and injuries that conflicts are more likely to arise.

The etiology, diagnosis, treatment, and prevention of disease has received much attention in medical education. There has been little effort to assist the physician in deciding how long an ill or injured employee should stay out of work. Specific guidelines are absent; and in many parts of the country, patients are kept out of work for varying periods of time for the same illness.

When a difference of opinion arises between the company, medical department, and private physician over the length of a sick leave, the union steward and labor relations representative are contacted. Here the attitudes of labor, management, and the occupational physician become most important. While it is easy to agree with the philosophy that "sick pay is here to be used and not abused," it is in the specifics that agreements break down. How long should an employee with a cold stay out of work? When should an employee return to work after hernia surgery? The attitude of the company and union are influential in determining a return-to-work date. If there is friction between company and union, a sick or compensation leave could become the vehicle for an extensive legal disagreement leading eventually to a final decision by the National Labor Relations Board (NLRB).

It is not necessary for a case to go to the NLRB for controversy to arise. The attitude "you have X number of sick days coming, use them," could foster controversy between the local union and management. Many companies have a negotiated number of sick days that have been agreed upon at contract time, and how these sick days are used is a good barometer of the company-union relationship.

Medical absenteeism can be divided into accident and sickness insurance (group insurance) and workers' compensation insurance. Let us first look at group insurance and see how medical relationships between union and management are involved.

Accident and Sickness Insurance In a 16-article series on Medical Absenteeism that appeared in The Bulletin of the Monroe County Medical Society, I pointed out that motivation is the most important factor in determining when a sick or injured employee returns to work after a sick leave. Other contributing factors are the type of work the patient is doing; the attitudes of the supervisor, labor, and the personal physician; the basic health of the patient; the type of insurance coverage available; and the disease entity.

Both labor and management have a stake in the proper administration of group disability programs. It has been estimated that for every dollar spent on sick pay, a company loses $10 in lost productivity. It is thus easy to see why management does not want sick-pay programs abused. Labor also is interested in medical absenteeism. Unions want to make certain that fringe benefits are used when needed and that sick pay plans stay solvent. Neither responsible labor nor management wants to see sick-pay programs abused, as such action needlessly drives up the cost of doing business and could lead to loss of jobs and lowered profits.

Workers' Compensation Insurance Workers' compensation has been a traditional area of conflict between labor and management. Originally devised as a method of compensating injured employees, workers' compensation has been both an incentive for business to improve safety practices, and a form of "social legislation."

The definition of a workers' compensation case is simple in theory but complicated in practice. An employee who falls at work or gets his fingers caught in a machine obviously has a work-related injury. Whether a groin (inguinal) hernia is work-related or not is not always easy to decide. Most states do not mandate accident and sickness insurance, and the employees may not be covered by group disability insurance. Since

a workers' compensation case is usually more rewarding to an employee than a group disability claim, it is in the economic interest of the employee to file a workers' compensation case if there is any doubt as to whether his illness or injury is work-related.

A common example would be the employee who does heavy lifting at work and develops an inguinal hernia without remembering a particular incident that brought his attention to the hernia. Most inguinal hernias are congenital and are not related to physical stress. Unions have often taken the position that an employee with an inguinal hernia who does heavy lifting automatically has a workers' compensation case. Management finds this difficult to accept. Many times an employee will do heavy lifting at home, and business argues that the hernia could as easily have occurred from an injury at home.

Low back pain is another common problem seen in industry. Most of low back pain is due to discogenic back disease.[1] If an employee does heavy lifting at work and develops a "slipped disc," does this mean the heavy lifting caused the slipped disc? If the employee cannot recall a particular incident when he "hurt his back," management may not voluntarily accept the back disorder as work-related.

Workers' compensation questions still primarily deal with safety problems and work-related injuries. Recent advances in toxicology, however, have brought the question of work-related illnesses more into the forefront.

In today's complicated society, every American is exposed to many different chemicals in his daily life. There are chemicals at work, school, in the home, in the food we eat, and even the chemicals exposed to at play (swimming pools, and so forth). There are thus multiple exposures to potentially troublesome materials. If one of these substances does cause an illness (and this is not always known with any degree of certainty), then there still is the question of the possible etiological effect of the other chemicals to which the individual is exposed.

In times of economic decline, it becomes important to an individual employee whether or not his medical problems are ruled work-related. Lay-offs go by seniority, and many company-union contracts have provisions that give employees with occupational illnesses or injuries "bumping rights" that may help them keep their jobs.

When an employee is permanently unable to work due to a medical condition, there are two routes that he can go to collect benefits:

Medical disability under *social security*
Medical disability under *workers' compensation*

Employees may collect social security benefits before reaching the age of 62 when they are medically unable to work. Any medical condition can qualify an employee for total and permanent disability if his personal physician and the social security office agree that the employee is unable to work.

An employee can also apply for total and permanent disability under workers' compensation. From an economic standpoint, it does not make that much difference to the individual which route he goes for disability retirement. For industry, however, this is an important decision. Under workers' compensation, the insurance company (meaning the employer) pays for the benefits, while under social security, the payments come from the social security fund (not all from the employer). Many times there are major disagreements between company and union over the issue of disability retirement. In such a situation, the occupational physician can play an important role in helping the company and union reach an equitable agreement on which way the particular case should be handled. While there is always a legal pathway to handle disputes, it is in everyone's interest to have the disagreement between company and union settled between the two parties without having the case go to a third party for decision.

OSHA Compliance The passage of the Occupational Safety and Health Act in 1970

was brought about in great part by the combined efforts of organized medicine and organized labor. The occupational physician, working through the American Medical Association, the American Occupational Medical Association (then called the Industrial Medical Association), and other professional groups, was in the forefront of the effort to secure meaningful legislative changes that would help make the work place as safe and free from hazards as is humanly possible. In no other area do the interests of labor and medicine coincide as clearly.

OSHA brings together the occupational physician, labor, management, and government in a joint effort to improve working conditions. As with any regulatory agency, the possibility for an adversary situation exists; and in those plants where labor-management relationships are bad, OSHA can become a political football. Likewise, OSHA can be used as an impetus to improve working conditions and thus lead to a reduced incidence of occupational illnesses and injuries.

Despite the recent emphasis on environmental hazards, most OSHA violations are still in the area of "bread and butter" safety lapses. Unguarded machines, violations in walking and work surfaces, rails, ladders, signs, steps, improper utilization of machinery are the infractions most often cited. Here the local union steward is in a position to be of help to his fellow employees. If a union steward knows of a safety infraction, he should bring it to the attention of supervision for action.

The Role of the Union Steward and Supervisor in Health and Safety OSHA regulations clearly define management's responsibilities in areas of health and safety. It is the foreman's responsibility to ensure that these obligations are met. Employees should be personally instructed by the foreman in proper safety procedures, and hazards should be immediately corrected.

In factories where good rapport exists between management and labor, the first-line supervisor and steward cooperate in inspecting the area for health and safety hazards. Where appropriate, protective equipment is required such as safety glasses, respirators, ear plugs, and so forth. There is always a certain amount of reluctance by some individuals to use safety equipment, as is manifested by the public's failure to "buckle up" their seat belts on the roads of this country. The support of the local union steward is most helpful in getting the employees to wear and use protective safety equipment.

When an employee violates a safety rule, the attitude of the union steward becomes particularly critical. If he supports the foreman's effort to stress safe work practices, then future accidents may be averted. It is also important for the foreman to try to educate the workers to follow good safety practices, and together with the union steward, to prevent safety and health from turning into an area of controversy.

In many companies, health and safety has unfortunately become an issue of conflict between management and labor. When this happens, the occupational physician can serve as a catalyst to bring management and labor together to work for the common good of all the employees, be they represented or unrepresented. Neither management nor labor should monopolize health and safety. There is plenty of opportunity for both groups to make contributions in occupational medicine.

Industrial Hygiene and Toxicology The occupational physician must be well grounded in the principles and applications of toxicology and industrial hygiene. Toxicology is primarily concerned with the physiologic effects produced in individuals exposed to harmful materials. The toxicity of a material is not synonymous with its work hazard. Toxicity is the capability of a material to produce an injury or harm, while hazard is defined as the possibility that a material will cause injury or harm when an individual is exposed to a specific quantity of a chemical under specified conditions. Toxicity is primarily dependent on dose.

rate of dosage, site of absorption, general state of health, temperature, and individual variations. The industrial hygienist is the health professional who monitors the environment for toxic agents. He works with the occupational physician in trying to make the work place safe and h[illegible]y for all employees.

Recent concerns about the environment have highlighted the importance of industrial hygiene and toxicology. Many Americans are employed in a work setting that is minus the services of an industrial hygienist. It is therefore left to the occupational physician and safety professional to perform the functions of the industrial hygienist. Most labor unions do not have available the consulting services of an industrial hygienist. This lack of expertise can be looked upon as both a detriment and an asset. Obviously it would be good to have available the services of an industrial hygienist where such a need exists. On the other hand, the absence of the industrial hygienist can be used by labor and management as another reason to work together for the common good of the employee and the company. Good health practices are good business, and this is not always appreciated by all concerned parties.

In many industries, management and labor have cooperated on a more formal basis. Occupational physicians often make periodic tours together with the safety professional and management representatives from plant engineering and manufacturing. Union stewards are also known to make their own safety tours. Problems discovered in such tours are then corrected, and a better basis of understanding between management and labor results.

Health Insurance Fringe benefits make up about one-third of an employee's salary in many companies, and health insurance comprises a major part of the benefit plan. Ten years ago, a major company paid about 15 cents an hour per employee for health benefits. This has now risen to about 75 cents an hour. It is easy to see why labor and management are interested in health insurance. Both labor and management can seek advice from the occupational physician when it comes to questions on health insurance. It is therefore incumbent upon the occupational physician to keep up-to-date with health insurance developments in his area.

In addition to traditional fee-for-service medicine and major medical insurance, industry is now faced with many alternatives of health care that have been labeled under the general title of Health Maintenance Organizations. Under this heading are closed panel prepaid group practice plans, medical foundations, independent practice association (HMO's without walls). What should the attitude of labor and management be towards these groups? The provisions of the 1973 HMO Act will be followed, but in addition to this, the occupational physician is in a position to advise labor and management about the quality and qualifications of the particular HMO where the business is located.

Most Americans are covered by some form of basic health insurance. This usually includes hospitalization, surgical and inpatient medical care, and many contain a major medical provision. There may be options for drug riders, laboratory riders, outpatient X-ray coverage, and so forth.

Dental care has only recently received attention at the bargaining table. While still in their infancy, dental plans promise to multiply in the near future. Plan design and efficient claims control procedures are important so that the dental plans are not overburdened at the onset from a pent up demand for dental care. To this end, the occupational physician is in a good position to influence labor and management and help guide them to the best dental plan for the most number of employees.

There has been some discussion about making occupational medicine departments into HMO's, and this has brought the occupational physician into the limelight of the HMO controversy. Traditional occupational medicine departments have taken care of those employees suffering from occupational illnesses and injuries, and referred

non-occupational medicine problems to the personal physician of the employee. In Class I and II occupational medicine programs,[2] the occupational physician has treated some self-limited non-occupational illnesses and injuries and referred those cases that require ongoing medical care to the private practice sector of the medical community.

Some examples of those types of non-occupational illnesses and injuries taken care of by the occupational physician would be a streptococcal pharyngitis, viral upper respiratory infection, colds, sprains, contusions, pulled muscles, and so forth. Patients with complicated medical problems, such as diabetes mellitus, congestive heart failure, cancer, collagen diseases, and so forth, would be referred to their personal physician for care.

Occupational physicians as a group have generally resisted efforts to make occupational medicine departments into HMO's. There are many reasons for this. It was never the intent of occupational medicine to compete with the private practice sector of the medical community. The occupational physician has sought to supplement rather than replace the personal physician. In the early days of occupational medicine, some occupational physicians did take care of the entire worker populations in some factories. Most occupational physicians look at this as captive medical care and as being against the basic principles of free choice of physician and hospital that they feel every worker should have. For these reasons, there has been a genuine reluctance for occupational physicians to convert their medical departments into HMO's.

Medical Limitations and Job Restrictions It is not uncommon for an employee to have a medical problem requiring the placing of medical limitations. Some examples of medical limitations would be the following:

1. An employee with an uncontrolled seizure disorder would be prohibited from driving a power vehicle.
2. An employee who is colorblind would not be allowed to do work requiring critical color vision.

Medical limitations can become an area of dispute between management, labor, and the occupational physician. A limitation can have the effect of forcing an employee out on a lay-off or result in his or her being transferred to a lower labor grade with a resultant reduction in pay. When this happens, the union steward may be brought into the case by the employee.

It may be helpful to look at some common cases where medical limitations can bring about interaction between the union steward and the occupational physician. If an employee has a back disease, a medical restriction may have to be imposed limiting the amount of lifting and bending the employee can do. Should the job demands go beyond the restriction, then the employee would not be allowed to perform the job, and he would have to be transferred to a different job. Depending on seniority, the employee would then find himself in another job or possibly on lay-off.

Another case in point would be an employee with advanced, progressive rheumatoid arthritis. If such an employee is no longer able to do fine work with his hands, then a medical restriction would have to be placed. Not only must one consider the employee's ability to perform the job from a medical standpoint, but one must also take into account if the employee's illness would result in his actions affecting the health of his coworkers. An employee with advanced rheumatoid arthritis and poor grip in his hands would not be allowed to work with dangerous acids or chemicals for fear he may inadvertently hurt himself or others.

Whenever there is a dispute over a medical restriction, liaison between the union, employee, management, and occupational physician becomes most important. The employee's personal physician is always contacted, and his opinion and advice solicited. When company and union cannot agree on medical restrictions, the dispute can end up in arbitration. The latter step should not be necessary when labor, management, and the occupational physician are able to have an open and meaningful dialogue with one another.

Confidentiality of Medical Records The confidentiality of the medical record is as sacred to the occupational physician as to his counterpart in private practice. When a properly executed medical record release form is completed, then medical information can be freely disseminated through the appropriate channels. OSHA regulations on medical records are clearly spelled out and cause no particular problems.

There are occasions when company and union representatives need to have some medical information in order to be able to settle disputes between employees or between labor and management. Examples would be controversies over medical restrictions, sick leaves, workers' compensation leaves, working habits, to mention a few areas. Whenever possible, the occupational physician should supply only general parts of the medical record that do not invade the privacy of the employee. When confidential information is required, then written permission should be obtained.

Industry is responsible for the health and safety of its employees, and management cannot allow an employee with a medical impairment to perform a job that would be dangerous to his fellow employees. The occupational physician will at times have to discuss some parts of the medical record that could have a negative impact on the employee's ability to hold or perform a certain job.

It should be emphasized that those cases requiring the discussion of the medical records with company and union representatives are rare, and every effort must be made by the occupational physician to safeguard the privacy of the medical record.

The Occupational Physician and the Local Union Leadership Relationships between organized labor and organized medicine have been marked by misunderstandings for many years. The occupational physician has been greeted with a great deal of caution and misgivings by organized labor. The phrase "company doctor" has come to mean to some labor leaders that management "owns" the occupational physician. While there are a few bad apples in every barrel and in every profession or group, occupational physicians have resisted the label of "company doctor" as they worked hard and diligently to establish occupational medicine as a separate and distinct subspecialty of preventive medicine. In 1955, occupational medicine was finally recognized by the American Board of Preventive Medicine as a new specialty. A special occupational medicine training program was set up, and professionalism in occupational medicine was encouraged.

Whether the occupational physician is employed full-time in industry or serves as a consultant to local industry while maintaining a private practice in the community, it is important that the occupational physician encourage contact and liaison with the local union officers and stewards. An open-door policy will lead to dialogue between the union leadership and occupational physician and result in the settlement of disputes before they reach the rigid confines of arbitration. While some cases may eventually go to the National Labor Relations Board, most areas of dispute can be amiably settled if a sincere effort is made by both parties to arrive at a fair and equitable solution.

The basic goals and objectives of the occupational physician and union leader are to assist the employee and to be of service to the workers. With the employee's welfare always in mind, disputes between the occupational physician and local union leadership should not be a frequent occurrence.

Alcoholism Alcoholism is a common cause of medical absenteeism in industry. Since such general terms as "nervous reaction," "nervous agitation," "emotional fatigue," and "anxiety syndrome" are often used by the attending physician to describe symptoms of early or potential alcoholics on group insurance forms, the true incidence of alcoholism in industry is not known. Very often the signs of a drinking problem are not visible when the patient first sees his personal physician.

The problem of alcoholism is not unique to

occupational medicine. Excessive drinking leads to the deaths of 25,000 drivers on our highways annually and to countless broken homes and marriages. Writing in the February 1973 issue of *The Journal of Occupational Medicine*, Pell and D'Alonzo reported on "A Five-Year Mortality Study of Alcoholics" that showed alcoholics who stop drinking retain a considerable amount of excess mortality and morbidity (includes frequent absence from work).[3] Many alcoholics never stop drinking, and those who are able to kick the habit appear to have a poorer prognosis (medical outlook) than control groups. The identification and treatment of the early or "incipient alcoholic" therefore becomes more critical in the prevention and control of alcoholism.

Industry's approach to the alcoholic has varied from company to company. Some firms have taken disciplinary action. Other companies have encouraged the patient to seek appropriate medical care, and some businesses have just looked the other way until circumstances make it impossible to further ignore the problem.

The first signs of alcoholism are often noted at work. The boss may notice that Joe leaves early Friday and comes in late to work on Monday. Joe's lunch period becomes drawn out and the smell of alcohol becomes noticeable on Joe's breath on returning from lunch. Joe may start missing work due to "colds," "nervousness," "stomach upsets," and "viral illness"; and his work may start to deteriorate. Joe may use the term "work pressures" to describe his poor health to his family and rationalize his excessive drinking the same way.

Because Joe still does his work, the boss may be reluctant to mention anything about Joe's drinking. After all, "who doesn't have a drink once in a while?" The patient, meanwhile has excused his drinking as a means of coping with his "nerves and shakiness." Thus Joe's disease is overlooked until one day his wife calls the boss to say that Joe will be out of work several weeks. It may be at this point that the diagnosis of alcoholism is made and the occupational physician is contacted.

The etiology of alcoholism is not known, although there are many theories. There is no specific cure for alcoholism, but it is possible to keep alcoholics "on the wagon" and thereby productive workers. The job has a bearing on how the company reacts to alcoholism. A worker driving an industrial truck or operating power equipment could hurt someone else by a safety lapse. Alcohol is therefore entirely contraindicated on such a task.

While lacking in psychodynamic theory, the company can use the incentive of the job as a means to keep the employee off alcohol. It can be pointed out to the worker that if he continues to drink, he will lose his job; but if he stops drinking, the company will do all it can to assist the employee to get over his drinking problem. This type of approach is simple, to the point, and most effective. However, the cooperation and support of the local union is 100% necessary for this method to succeed. If both the company and union make it clear to the drinking employee that the price of continued drinking is loss of his job and that the reward for abstinence is support of his efforts to get off the bottle, then the employee will have the incentive to stop drinking. This approach has been tried in several industries, and it has worked very well.

The line between social drinking and alcoholism is not a clear or fixed one and varies from person to person. Many people stay on the borderline of alcoholism for years and never cross over; others become frank alcoholics early in their lives and never make it back. It is clear, however, that with the support of management, the occupational physician, and the local union leadership, the drinking employee has a reasonable chance to be rescued from the pitfalls of "alcoholism" and is able again to become a productive member of the local community.

The Labor-Management Agreement and the Occupational Physician The company-union collective bargaining agreement is the document that sets the tone of management-labor relations for the duration of the

union contract. The occupational physician (whether he be full-time or part-time) must also live by the spirit and the letter of the collective bargaining agreement. Unless the physician understands the contents and meanings of the union contract, avoidable misunderstandings will occur.

Most of the details of the collective bargaining agreement do not involve the occupational physician. In the past, the union contract was looked upon as something that "the doctor did not get mixed-up in." Labor's growing interest in health and safety has resulted in increased activities by unions in areas where they interface with occupational health and safety and has highlighted the importance of a basic understanding of labor relations by all physicians who are active in occupational medicine. "Bumping rights" (ability of an employee to replace another employee with less seniority in a job) are basic to all collective bargaining agreements. How a union contract spells out "bumps" will make a big difference in an employee's reaction to a medical restriction. It is thus important that the occupational physician has some basic understanding of the union contract.

Whenever there is a dispute between the occupational physician and the union over medical absenteeism, group insurance, or workers' compensation matters, the union contract is looked to in an effort to find common ground for a just solution. If the occupational physician is not knowledgeable of the union contract, he will be at a severe disadvantage in dealing with labor and management on matters affecting occupational medicine. Even in matters traditionally reserved to labor and management, such as length of work breaks, the occupational physician may be asked for an opinion, and he must therefore be cognizant of the basic fundamentals of labor relations.

The advent of OSHA and NIOSH has resulted in the occupational physician being consulted when the union contract is negotiated. The expertise of the occupational physician can be invaluable in preventing a clause from being inserted in the union contract that both labor and management would have cause to regret in the future.

The Ethics of the Occupational Physician Occupational medicine is one of the broadest, least understood, and most complex medical specialties. It probably even exceeds family practice and internal medicine in its scope, depth, and complexity. An occupational physician must be well versed in traditional clinical medicine. He must have a thorough background and understanding of industrial hygiene, toxicology, water pollution, safety, preventive medicine, administration, labor and industrial relations, legal medicine, workers' compensation, government regulations, and familiarity with OSHA and NIOSH. The occupational physician must be able to interact with his colleagues in the private practice sector and with the business and labor community.

Most occupational physicians are employed full- or part-time by industry, though there are specialists in occupational medicine who work for hospitals, educational institutions, agriculture, civil service, and labor organizations. The number of occupational physicians employed by unions in full-time or part-time positions has been increasing recently. In addition, there are occupational physicians who are self-employed and who do consulting work in industry.

Recent developments in toxicology have led a few critics to question the ethics of the occupational physician. Doctor William E. Morton, Professor of Environmental Medicine at the University of Oregon Medical School, accused occupational physicians of unethical practices in a "Letter to the Editor" published in *The Journal of Occupational Medicine*. Occupational physicians were accused of withholding medical information from publication in order to protect their employers. Doctor Morton wrote that "most industrial physicians identify strongly with management for sociological and financial reasons, and some may forget that the ethical guidelines for the medical profession are more restrictive than for businessmen."[4]

While every profession and group has some

"bad eggs." Doctor Morton's doubts have not been substantiated. Occupational physicians, like their colleagues in private practice, are physicians first and take the ethics of their profession seriously. What charge could be more important than "to help make the work place safe and healthy for all employees"? Unfortunately, the unfavorable publicity has led some labor leaders to question the ethics of the occupational physician. This has resulted in a "confidence gap" between some occupational physicians and labor.

Part of the misunderstanding that exists may be traced to an unrealistic viewpoint on the potentials of preventive medicine. There is a good deal of evidence to show that medicine has over-sold the capabilities of preventive medicine in the health care field. Most of the illnesses seen today are not preventable, as we do not know the cause of most illnesses. There are many theories concerning the etiology of vascular disease, heart attacks, strokes, and cancer; but the exact causes of these diseases are not known. Risk factors have been identified that predispose to heart attacks, strokes, and cancer; but at the present state of knowledge, prevention cannot be guaranteed. The same can be said for arthritis, diabetes mellitus, neurological disorders, inflammatory diseases, degenerative diseases, and the common cold to mention only a few.

Not only cannot the diseases alluded to above be prevented, but we are often unable to detect subclinical conditions predisposing to disease states. If it is not possible to prevent disease entities in the general population, can we expect industry to do for its employees what the personal physician is unable to do for his patients?

If the occupational physician, labor leader, and businessman are to work together, then it is important that "emotionalism" be deleted from the occupational health environment. Occupational physicians have a moral and ethical obligation to disclose any medical documentation of human occupational health impairment. Like their colleagues in private practice, the occupational physician is primarily interested in the welfare of the individual. Whether the individual is called a patient or an employee, he is still a human being; and in the medical profession, the physician is here to serve him.

REFERENCES

1. Rowe, M.L. "Low Back Disability in Industry: Updated Position." JOM 13:10 pp. 476-478, October 1971.

2. Strasser, A.L. "Occupational Health and Safety." Family Practice, W.B. Saunders Company, Philadelphia, 1973.

3. Pell, S. and C.A. D'Alonzo. "A Five-Year Mortality Study of Alcoholics." JOM 15:2 pp. 120-125, February 1973.

4. Morton, W.E. "Are Medical Ethical Practices Sufficient in Industrial Medicine?" JOM 15:11 pp. 860-861, November 1973.

ADDITIONAL REFERENCES

1. Strasser, A.L. "Low Back Pain in Industry, A Position Paper." JOM 11:4 pp. 161-169, April 1969.

2. Strasser A.L. "The Foreman: At the Job Health and Safety Firing Line." The International Journal of Occupational Health and Safety 43:3 pp. 25-26, May/June 1974.

3. Strasser, A.L. "How the Occupational Physician Works with the Safety Professional." The International Journal of Occupational Health and Safety pp. 32-34, May/April 1975.

4. Strasser, A.L. "Put the Once-Sick or Injured Worker Back on the Job." The International Journal of Occupational Health and Safety 43:2 pp. 18-19 March/April 1974

5. The following series of articles by A.L. Strasser, M.D. published in The Bulletin of the Monroe County Medical Society.

"Acute Myocardial Infarction, ??? Return to Work Date." 30:6 pp. 202-213 June 1972.

"Alcoholism." 30:4 pp. 138-139 April 1973.

"Are Federal Guidelines Needed?" 30:1 January 1973.

"Chronic Illness." 30:11 pp. 494-495 November 1972.

"HMO's First Returns." 32:9 pp. 351-352 September 1974.

"Industry's Role in Claims Control" 30:7 pp. 246-247 July 1972.

"Medical Absenteeism." 30:4 p. 147 April 1972.

"Minor Illnesses." 30:5 pp. 170-171 May 1972.

"Neurological Disorders." 31:3 pp. 98-99 March 1973.

"Pregnancy—Is it a Disability?" 30:10 pp. 54-55 October 1972.

"Psychiatric Illnesses." 30:12 pp. 534-535 December 1972.

"Small Industry." 30:2 pp. 52-53 February 1973.

"Surgical Sick Leaves." 30:9 pp. 412-413 September 1972.

"What We Can Learn From—"The Energy Crisis" 32:2 pp. 51-52 February 1974.

"The Work Syndrome." 31:5 pp. 181-182 May 1973.

"Workmen's Compensation." 31:9 pp. 394-396 September 1973.

WHEN WORKERS FLY

PROBLEMS OF FLIGHT PHYSIOLOGY

C. Craig Wright, M.D.

As it has evolved, the human body functions well at the bottom of an ocean of mixed gases held and compressed toward the earth by gravity. This gaseous atmosphere surrounds the earth and exerts pressure upon it. As atmospheric pressure decreases at upper altitudes attained by aerial flight, changes occur in the body's physiological processes. I will discuss briefly some of the physical characteristics of the earth's atmosphere and human physiological processes related to them.

I have borrowed freely from the manuals and other publications listed as reference documents. I have, in many cases, rounded the values presented by the graphs, charts and tables they contain. Since several of these sources present similar but slightly different data, I have not made specific attribution in my text. In no sense, then, is this presentation my creation. If the information given is helpful, all credit is due those who performed and reported the basic research. To be more easily understood, I shall be retrogressive in my use of units expressed in degrees Fahrenheit, feet, pounds per square inch, and miles per hour instead of the more rational metric units. As an admission of my recidivism, some values will also be expressed in metric units in parenthesis.

Exclusive of water vapor in various forms, salt particles, dust and the complex microgarbage created by natural forces and civilization, earth's atmosphere contains by volume 78% nitrogen, 21% oxygen, 0.03% carbon dioxide, and 0.97% other gases. The three named gases are those that interest us physiologically. Due to the mixing action of thermal currents and other weather factors, these percentages hold constant into the high stratosphere. The atmosphere we are concerned with is divided into the troposphere extending upward from the earth's surface to an altitude which may vary from 28,000 to 55,000 feet, a narrow intermediate tropopause layer which usually is

not wider than 5,000 feet and the stratosphere which continues outward from the edge of the tropopause to approximately 250,000 feet.

The trophosphere exists from the earth's surface to an average height of 35,000 feet and is characterized by a varying moisture content, most of our weather phenomena, turbulent air, a nearly constant rate of temperature decrease with altitude, and prevailing west to east winds. The troposphere contains within it roughly 75% of the total number of gas molecules which make up the earth's atmosphere.

The tropopause is the narrow transition zone between the troposphere and the stratosphere and has some of the characteristics of each. Its lower border is higher above the earth in summer than it is in winter and higher at the equator than over the poles. The stratosphere is characterized by an almost total lack of moisture and weather phenomena, temperatures which are nearly constant at -67°F, and high velocity west to east winds often called jet streams. Similar high speed winds flowing roughly from west to east are also found in the upper tropopause.

From a physiological standpoint, it's of little importance; but as a matter of interest, the speed of sound through air, being directly proportional to the square root of the absolute temperature, decreases from 760 miles per hour at the United States Standard Atmosphere Sea Level temperature of 59°F (15°C) to 662 miles per hour constant temperature of -67°F (-55°C).

In the troposphere and tropopause, temperature decreases at a rather constant rate with increases in altitude. While local air masses and geography influence the temperature lapse rate, it can be generally stated that for every 1,000 feet increase in altitude there is a temperature loss of 3-4°F (2°C). Thus the following average ambient temperatures can be expected at these altitudes:

Altitude	Temperature
Sea Level	59°F 15°C
5,000 ft.	41°F 5°C
10,000 ft.	23°F -5°C
15,000 ft.	5°F -15°C
20,000 ft.	-12°F -25°C
25,000 ft.	-30°F -34°C
30,000 ft.	-48°F -44°C
35,000 ft.	-67°F -55°C

Pressure also decreases with altitude but logarithmically rather than arithmetically as does temperature. Sea level pressure is usually considered to be 14.7 pounds per square inch or, in units which will be more useful to us, 760 millimeters of mercury. At approximately every 53,000-foot increase in altitude, the decimal point in the pressure value moves left one digit.

Altitude	Pressure
Sea Level	760 mm Hg
53,000 ft.	76 mm Hg
106,000 ft.	7 mm Hg

A more useful table showing this altitude - pressure relationship is given below:

Altitude	Pressure	Ratio
Sea Level	760 mm Hg 14.7 psi	1 atmosphere
5,000 ft.	633 mm Hg 12.1 psi	
10,000 ft.	522 mm Hg 10.1 psi	
15,000 ft.	429 mm Hg 8.3 psi	
18,000 ft.	380 mm Hg 7.3 psi	1/2 atmosphere
20,000 ft.	350 mm Hg 6.7 psi	
25,000 ft.	282 mm Hg 5.5 psi	
27,500 ft.	252 mm Hg 4.9 psi	1/3 atmosphere
30,000 ft.	226 mm Hg 4.4 psi	
33,700 ft.	190 mm Hg 3.8 psi	1/4 atmosphere
35,000 ft.	179 mm Hg 3.5 psi	
40,000 ft.	141 mm Hg 2.7 psi	

Quantities of gas at various altitudes expressed in percentages of the atmosphere have little significance, for percentage represents the volume of a gas and not its molecular concentration. Since molecular concentration determines the availability of the gas to the body, the actual concentration of any gas can be expressed better in terms of its partial pressure.

A quantity of gas mixed with other gases exerts the same pressure that it would if the other gases were not present. The total pressure of a mixture of gases is the sum of the *partial* pressure of the individual gases comprising the mixture. Although water vapor is not a true gas, it can be considered as such in stating the total pressure—partial pressure relationship of moist air in the formula

$$B = pO_2 + pN_2 + pCO_2 + pH_2O$$

where B is the total barometric pressure and pO_2, pN_2, pCO_2 and pH_2O are the partial pressures of oxygen, nitrogen, carbon dioxide and water vapor respectively. At normal body temperature of 98.6°F (37°C) the partial pressure of water vapor is 47 mm Hg.

As previously stated, dry atmospheric air contains roughly 21% oxygen. When we multiply the sea level total pressure of 760 mm Hg by this percentage, we show sea level oxygen partial pressure to be 160 mm Hg.

Gas	Partial Pressure	Per Cent of Atmosphere
Nitrogen	593 mm Hg	78%
Oxygen	160 mm Hg	21%
Other gases	7 mm Hg	1%
Total atmosphere	760 mm Hg	100%

From the physiological standpoint it is the partial pressure of each gas that governs its effect in the body, not the percentage of the gas in the total mixture.

During respiration the lung may be thought of as a thin diffusion membrane across which oxygen and carbon dioxide enter and leave the blood. The nitrogen previously mentioned does not cross the lung membrane in any appreciable amount so long as its partial pressure remains unchanged. This will be discussed later under dysbarisms. All gases tend to move from high to low pressure areas and in so doing are able to pass through thin membranes. The blood entering the lung is relatively poor in oxygen (therefore low oxygen partial pressure) and rich in carbon dioxide (high carbon dioxide partial pressure). Since the inspired air has a high oxygen pressure relative to the blood, oxygen crosses the lung and enters the blood. The reverse situation causes carbon dioxide to pass into the gas mixture in the lung where it is subsequently exhaled.

The rate of respiration is normally regulated by small sensing organs in the brain which respond to carbon dioxide partial pressure in the circulating blood. If the carbon dioxide partial pressure is higher than normal, the respiratory rate and volume are increased. This causes more carbon dioxide to be lost in the exhaled gas mixture. If the carbon dioxide partial pressure is lower than normal in the blood, the rate of breathing is slowed to allow CO_2 to build up to normal level.

A second regulatory system includes small receptors located in the large arteries close to the heart and sensitive to oxygen partial pressure. If the body needs more oxygen than that supplied by the carbon dioxide sensitive system, this back-up system can and does establish a new rate and volume of lung ventilation. The body thus defends the partial pressure of oxygen in the blood. If the partial pressure of oxygen is adequate under the carbon dioxide regulating system, well and good; if not, the oxygen sensitive system assumes control.

This is an appropriate time to comment on hyperventilation which is one of the most common physiological disturbances observed in individuals in flight. Hyperventilation is defined as an over ventilation of the lung with resulting loss of an excessive amount of carbon dioxide from the body.

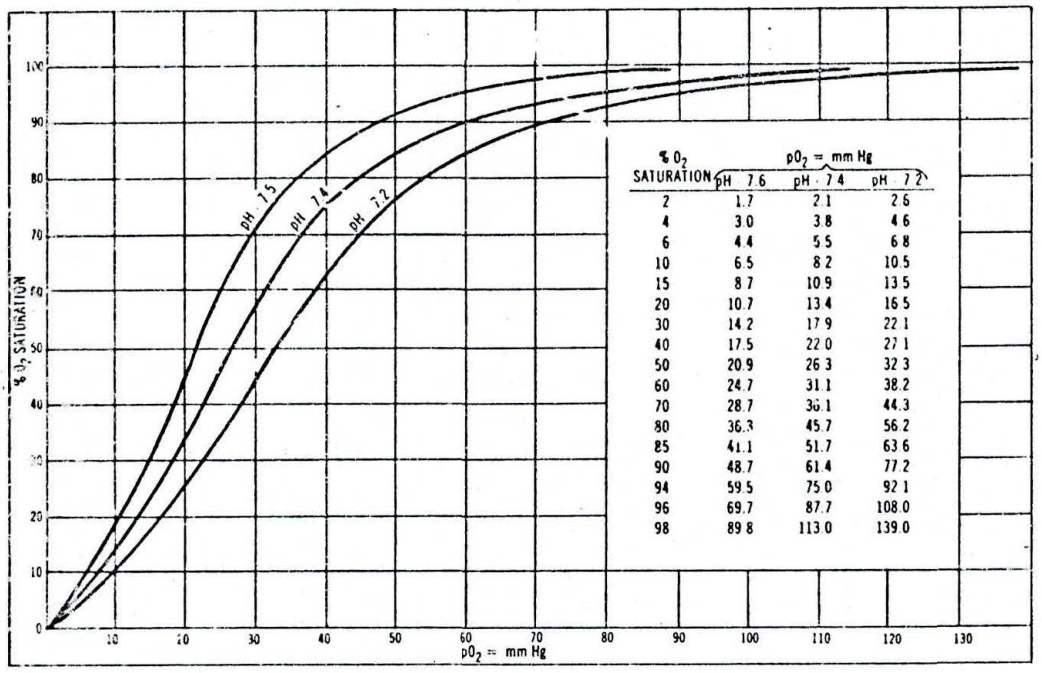
This over ventilation is due to breathing too rapidly, too deeply or a combination of both and is usually secondary to (or caused by) fear, claustrophobia, or some other stress which produces anxiety or apprehension. The loss of excessive carbon dioxide produces a respiratory alkalosis which may give symptoms of light headedness, dizziness, tingling of the fingers and toes, increased sensation of body heat, blurring of vision, perspiration, nausea, tachycardia, muscle spasm, and eventual loss of consciousness. Symptoms may be relieved by voluntarily decreasing the rate and depth of respiration to permit the body to reestablish a normal carbon dioxide level in the blood. In extreme cases, rebreathing from a paper bag will speed up the return to normal through the carbon dioxide present in the previously expired air.

Atmospheric air which is drawn through the nasal passages and trachea into the lungs becomes saturated with water vapor which, at normal body temperature of 37°C, has a partial pressure of 47 mm Hg.

In addition, the usual partial pressure of carbon dioxide in lung air will be in the range of 35-40 mm Hg. As the total pressure of the inhaled gas mixture decreases at increasing altitudes, these two gases occupy a greater percentage of the total lung volume and act to diminish the available oxygen partial pressure. The higher the altitude, the greater the influence produced by this water vapor and carbon dioxide within the lung. The net result of these factors is that the sea level atmosphere oxygen partial pressure of 160 mm Hg is reduced to an alveolar oxygen partial pressure just slightly in excess of 100 mm Hg. In the normal body this alveolar pO_2 of 100 mm Hg will produce an arterial blood oxygen saturation in the range 95-97%.

In moving from the alveoli into the blood, oxygen does not stay in simple solution. If this were the case, only a relatively small amount of oxygen could diffuse before the oxygen partial pressures on the two sides of the lung membrane equalized. Each red blood cell contains a complex iron and protein pigment, hemoglobin. Hemoglobin has a strong affinity for oxygen and removes it from simple solution through the formation of a strong chemical union creating oxyhemoglobin; this reversible chemical union lowers the pO_2 in the blood, permitting more and more oxygen to diffuse across the lung membrane. Thus a large volume of oxygen can be transferred from the inhaled air to the blood with only a small pressure differential. Hemoglobin has a relatively high affinity for oxygen at high partial pressures, as normally exist in the lungs, and a relatively low affinity at lower partial pressures as are found in the tissues. This favors a rapid loading of the blood with oxygen in the lungs and a rapid unloading in the tissues.

Figure 1



% O_2 SATURATION	pO_2 = mm Hg pH 7.6	pH 7.4	pH 7.2
2	1.7	2.1	2.6
4	3.0	3.8	4.6
6	4.4	5.5	6.8
10	6.5	8.2	10.5
15	8.7	10.9	13.5
20	10.7	13.4	16.5
30	14.2	17.9	22.1
40	17.5	22.0	27.1
50	20.9	26.3	32.3
60	24.7	31.1	38.2
70	28.7	36.1	44.3
80	36.3	45.7	56.2
85	41.1	51.7	63.6
90	48.7	61.4	77.2
94	59.5	75.0	92.1
96	69.7	87.7	108.0
98	89.8	113.0	139.0

Oxygen Dissociation Curves for Human Blood

As shown by the oxygen dissociation curve, the uptake and release of oxygen by hemoglobin is not a simple matter of pressure differentials. Notice that the right side of the curve is nearly flat. For rather large increases in oxygen partial pressure above 65 mm Hg, the blood oxygen saturation increases only slightly. This is the situation at the lung membrane and explains why the normal person is nearly as well oxygenated at 10,000 feet (90% saturation) as at sea level (97% saturation) although the total pressure drops from 760 mm Hg to 522 mm Hg and the alveolar oxygen partial pressure drops from 100 mm Hg to 65 mm Hg.

On the left side, however, the oxygen dissociation curve drops sharply. This indicates that for small additional decreases in oxygen partial pressures, such as exist between the blood and the tissues, large volumes of oxygen are released by the oxyhemoglobin and are available for absorption and use by the body tissue cells.

Altitude	Alveolar Oxygen Partial Pressure	Blood Oxygen Saturation
Sea Level	100 mm Hg	97%
5,000 ft.	82 mm Hg	95%
10,000 ft.	65 mm Hg	90%
15,000 ft.	60 mm Hg	87%
20,000 ft.	45 mm Hg	80%
25,000 ft.	35 mm Hg	75%
30,000 ft.	24 mm Hg	47%
35,000 ft.	14 mm Hg	25%
40,000 ft.	8 mm Hg	15%

At sea level the alveolar oxygen partial pressure of 100 mm Hg normally produces a blood oxygen saturation of 95-97%. At 10,000 feet, breathing air, the alveolar oxygen partial of 65 mm Hg produces a blood oxygen saturation of 90% which is usually considered the lowest saturation percentage compatible with normal physiological functions. No flights above 10,000 feet should be made without supplementary oxygen or cabin pressurization.

The breathing of pure oxygen at 34,000 feet produces the same alveolar pO_2 as does breathing air at sea level. Breathing pure oxygen at 40,000 feet is equivalent to breathing air at 10,600 feet. As shown in the oxygen dissociation curve, the oxygen carrying capacity of the hemoglobin is very sensitive to changes in pH of the blood away from the usual pH of 7.4.

There are four conditions, corresponding to the four phases of respiration, which must be satisfied if hypoxia is to be prevented. Adequate oxygen partial pressure must be available for diffusion to occur across the lung membrane. The blood must contain sufficient hemoglobin to chemically unite with the oxygen for transport. The circulation system must be able to carry the chemically bound oxygen to the tissues. Finally, the tissue cells must be capable of absorbing and using the oxygen made available to them.

In flight, most cases of hypoxia which occur are due to insufficient oxygen partial pressure in the alveoli. This type of physiological embarrassment is called Hypoxic Hypoxia and can be corrected either by compressing the gas mixture prior to inspiration (through cabin pressurization) or through enriching the inhaled gas by adding oxygen to it. Most oxygen masks make use of this latter approach.

The other three conditions involving available hemoglobin, adequate blood circulation, and tissue cells capable of using oxygen must be satisfied if Hypoxia is to be prevented. Anemic Hypoxia, Stagnant Hypoxia, and Histotoxic Hypoxia are, however, beyond the scope of this presentation.

The symptoms and effects of Hypoxia depend upon the degree to which it is present and upon the individual responses of the Hypoxic individual. The table below summarizes the most common symptoms of Hypoxia by time of exposure to various altitudes:

SYMPTOMS OF HYPOXIA

Altitude	Time of Exposure	Symptoms
10,000 to 14,000 feet	Hours	Headache, fatigue, listlessness, non-specific deterioration of physical and mental performance
15,000 to 18,000 feet	30 minutes	Impairment of judgment and vision, high self-confidence, euphoria, disregard for sensory perceptions, poor coordination, sleepiness, dizziness, personality changes as if intoxicated, cyanosis.
20,000 to 35,000 feet	5 minutes	Same symptoms as 15,000 to 18,000 feet only more pronounced with eventual unconsciousness.
35,000 to 40,000 feet	15 to 45 seconds	Immediate unconsciousness (with little or no warning!)

The most outstanding characteristic feature of hypoxia is its gradual and insidious onset. The hypoxic individual commonly believes that things are getting progressively better as he nears total decompensation. While not all of the symptoms mentioned occur in each individual, any given person will develop the same symptoms and in the same order each time he becomes hypoxic. For this reason, any individual, having once experienced hypoxia under careful supervision, is better prepared to recognize his condition if hypoxia occurs again. Usually, as observed by an oxygenated observer, the hypoxic individual will manifest a decrease in mental and physical activity, a loss in judgment and coordination, and a clouding of thought and memory. He may show tremors of hands and fingers, and personality changes similar to those of intoxication. The hypoxic individual may be completely unaware of the above changes, particularly if his hypoxia is rapidly progressing. If hypoxia continues, unconsciousness, convulsions, and death may ensue.

Not all individuals are equally susceptible to the development of hypoxia. Each person's susceptibility may vary from day to day depending upon numerous factors. Fatigue, infection, overindulgence in alcohol and tobacco, fever, low blood sugar following inadequate food intake, emotional disturbances, certain drugs, poor physical condition, and many other factors may increase an individual's susceptibility.

One aspect of hypoxia requires further discussion. Although the hypoxic individual may remain conscious for a longer period, he has only a limited time in which he is capable of performing useful acts. The time of useful consciousness at any altitude is the maximum length of time the exposed individual has to perform the useful tasks necessary for his survival, such as the immediate donning of an oxygen mask.

Time of Useful Consciousness

22,000 feet	5 minutes
25,000 feet	2 minutes
28,000 feet	1 minute
30,000 feet	45 seconds
35,000 feet	30 seconds
40,000 feet	18 seconds
65,000 feet	12 seconds

The shortest times, 12 to 15 seconds, depend upon the circulation time of the last oxygen carrying blood from the lung to the brain.

The treatment for hypoxia is the re-establishment of an adequate oxygen partial pressure in the lung. This may be accomplished through the use of an oxygen mask, pressurization, or descent to a lower altitude. Recovery from hypoxia is usually rapid, occurring within 15 seconds after oxygen is administered. Transient dizziness may occur during the recovery. The severely hypoxic individual will usually have no memory of having lost consciousness. Artificial respiration has been necessary in some cases. However, to be effective it must be given very shortly after the cessation of breathing. Permanent brain damage following a short period of hypoxia is extremely rare.

Although recovery is rapid following the administration of oxygen, a word of caution is necessary. The individual recovering from a moderate to severe hypoxia incident is usually quite fatigued and may suffer a measurable deficiency in mental and physical performance for hours.

Normally there is gas present in various body cavities including the stomach, intestine, middle ears and nasal sinuses. If, under conditions of low total pressure, this trapped gas expands and is unable to pass out of the containing cavity, severe pain may result. The following graph presents the ex-

pansion ratio of this trapped gas at various altitudes:

Altitude	Approximate Volume Ratio
Sea level	1.0
10,000 feet	1.5
18,000 feet	2.0
20,600 feet	2.4
25,000 feet	3.0
30,000 feet	4.0
35,000 feet	5.4
40,000 feet	7.6
50,000 feet	17.0

In addition to these trapped gases, there is a considerable volume of gas, primarily nitrogen, dissolved in the blood and other body fluids. When the ambient pressure falls, these gases tend to come out of solution with the formation of gas bubbles. This phenomenon is similar to the bubble formation in carbonated beverages when the bottle cap is removed, lowering the internal bottle pressure. When these bubbles form in the body, severe pain may result, as well as bizarre neurological symptoms. Pain caused by bubble formation in and around joints is called the "bends." The same bubble formation in the lungs causes a burning sub-sternal discomfort called the "chokes." The neurological symptoms including skin itching or mottling, tremors, paralysis, or convulsions result from bubble formation in nerve or brain tissue, or from bubbles carried to these tissues by the circulation. All of these conditions may cause generalized body collapse with the low blood pressure and rapid pulse of clinical shock. Symptoms referable to trapped gas expansion and gas bubble evolution are called dysbarisms.

While the symptoms of trapped gas expansion develop fairly rapidly, the symptoms due to bubble formation do not occur for a considerable period of time. At 35,000 to 40,000 feet it takes approximately twenty minutes for the average individual to develop severe or incapacitating symptoms. Evolved bubble symptoms (bends, chokes) rarely occur below 20,000 feet. Their frequency and severity are dependent upon the rate of pressure loss, the total ambient pressure, the elapsed time at altitude, and the ambient temperature.

Exercise increases both the frequency and severity of symptoms. Due to the high solubility of nitrogen in body fat, obese individuals are considerably more prone to develop bends than the average person. Both the prevention and the treatment of dysbarisms consist of descending to a lower altitude (higher total pressure) as rapidly as possible.

Some persons have trouble clearing their ears following flight, particularly flights made in unpressurized aircraft. Almost everyone who flies regularly will encounter this problem at some time or other.

The ear canal is constantly at the same pressure as the atmosphere surrounding the head. The middle ear, containing the three bones, is a small air-filled cavity situated within the bone of the skull, separated from the ear canal by the tympanic membrane and connected to the nasal cavity by the Eustachian tube. As ascent to altitude is made, the ambient pressure decreases, thus lowering pressure in the ear canal. The initial result is that the pressure in the middle ear exceeds the canal pressure and the eardrum bulges outward somewhat. In the middle ear, however, only a slight excess of pressure opens the Eustachian tube and the gas passes outward, equalizing the pressure on the two sides of the eardrum. The individual may be aware of this pressure change only through recurrent mild sensations of fullness in his ears. It is rather rare for ear pain to develop during ascent since middle ear over-pressure is so easily relieved.

During descent, the reverse occurs. As the surrounding air pressure increases, a relative negative pressure or vacuum develops within the middle ear and the eardrum bulges inward. This condition is more difficult to relieve since the problem now is to introduce air back up the Eustachian tube to relieve the vacuum.

For a moment imagine the Eustachian tube

as a soggy, limp, drinking straw. It is fairly easy t blow air out through the straw but attempts at sucking air in through it occasionally collapse the straw completely. The more gentle the attempt to suck the air in, the more successful it will be, so long as the walls of the straw are not completely in apposition.

During descent the individual is usually aware of this negative pressure in the middle ear by a sense of eardrum tension, a significant loss in ability to hear, and a vague discomfort turning into an actual pain if the condition worsens. Chewing, yawning, and swallowing will cause small muscles around the nasal end of the Eustachian tube to contract, holding open the mouth of the tube. These motions are usually followed by reinflation of the middle ear, giving complete relief of symptoms. If these actions are not followed by reinflation, additional measures are necessary.

The most efficient method of reinflating your middle ear calls for you to squeeze your nostrils together between your thumb and forefinger. You should then imagine that the upper portion of your nose is a balloon. Holding your nostrils to form an air-tight seal, you should SLOWLY AND GENTLY build up pressure in your nose as though you were blowing up the balloon. At some point during this procedure you should hear or feel air enter your middle ear. If the vacuum has been present for only a short period you will immediately notice a marked improvement in your ability to hear, and a disappearance of the sense of fullness and discomfort.

If this balloon inflation maneuver is unsuccessful, you should use nosedrops, an inhaler, or nasal spray. After waiting a short time for constriction of the tissue around the mouth of the Eustachian tube, repeat the balloon blowing maneuver. You will find it easier to keep your ears pressurized during descent if you GENTLY inflate your nose balloon every minute or so during letdown. If you have frequent ear trouble on descent you should routinely use one of the shrinking preparations mentioned above, 15 minutes before the descent is started.

If you have an upper respiratory infection, the tissue around the nasal end of the Eustachian tube will probably be thickened, and you can expect to have more ear trouble during descent than you normally would. When flying with a cold, you should routinely use a vasoconstricting agent before the letdown is started.

Occasionally, you may notice the same condition involving your nasal sinuses. These sinuses, like the middle ear, are air filled cavities which vent into the nasal cavity. The reinflation methods previously described are also effective in relieving any partial vacuum which may develop in these sinuses.

Toothache brought about by decreased barometric pressure at high altitudes seldom occurs in flight. Nevertheless, persons who have defective fillings, caries, and periapical abscess may be particularly predisposed to this discomfort. Occasionally, aerodontalgia may have a basis in pain referred from maxillary barosinusitis.

REFERENCES

1. Physiological Training. Air Force Pamphlet 160-5. Department of the Air Force, 1976.

2. Flight Surgeon's Guide. Air Force Pamphlet 161-18. Department of the Air Force, 1968.

3. Medical Factors in Flight. Aircraft Division, United States Steel Corporation, Pittsburgh, Pennsylvania, 1965.

4. Medical Aspects of Business Aviation. A Joint Committee Report of the Aerospace Medical Association and the Industrial Medical Association. JOM 28:338-352, 1964; also Aerospace Medicine 8:785-794, 1964.

5. "Medical Criteria for Passenger Flying." Arch Environ Health 2:124-138, 1961.

6. Medical Aspects of High Altitude Flight. Pan-American World Airways, JFK International Airport, New York, N.Y., 1959.

7. Instructors Manual for Physiological Training. Air Force Manual 52-13. Department of the Air Force, 1953.

8. Physiology of Flight. Air Force Manual 160-30, 1953.

9. Wright CC. "Factors Influencing Air Transportation of Sick and Injured." JOM 12:732-736, 1962.

COMMERCIAL AIR LINES

Ludwig G. Lederer, M.D., Ph.D.

Travel by air carriers has become one of the safest, most efficient ways to travel for the worker and his family, be he white or blue collar worker. Deaths during air travel, not due to accidents, average world-wide only 0.4 passengers per million passengers carried.

It is estimated that 70% of a physician's patients travel by air. Fitness for air travel can easily be assessed by the physician in simple terms. If your patient can climb one flight of stairs without resting, or walk one city block, in all probability, he can safety take a trip by air without difficulty. Many patients can travel with little or no problems if they are properly assessed by the physician. Table 1 shows the Civil Aeronautics Board criteria of lay and professional acceptance of certain disabilities.

On American Airlines, we now carry 25 million passengers per year. Each day we dispatch 1,000 flights. A passenger with a clinical condition which was stable at the beginning of a flight may deteriorate as the flight progresses. These instances are few and far between, necessitating an unscheduled landing for medical reasons. Note we do not call these "emergency" landings; emergency landings are only those involving an unsafe condition of an aircraft or its components. We average 50 such unscheduled landings per year. In the past few years, physicians traveling as passengers, who have been called upon to act as Good Samaritans to help our flight attendants and crew, have requested more medical equipment on board for professional use. The governmental agencies, the C.A.B., and the Federal Aviation Administration are aware of these requests. We do carry onboard first aid equipment and some drugs, but these are in the category of a "home medicine cabinet."

	LAY ACCEPTANCE	PROFESSIONAL ACCEPTANCE	EXAMPLE
Stable, Ambulatory	X		4-6 Weeks Post Myocardial Infarction
Stable, Non-Ambulatory	X		Paraplegic
Non-Stable, Ambulatory	X	X	Infectious Mono Viral Hepatitis
Non-Stable, Non-Ambulatory		X	Advanced Emphysema

Table 1

Civil Aeronautics Board criteria of lay and professional acceptance of certain disabilities.

The Airline Medical Directors in the U.S. have repeatedly voted not to carry "doctor-type" medications. In this day of malpractice dilemmas, it is easy to see why an ophthalmologist being the only physician on board would be reluctant to use cardiac or pulmonary emergency drugs. Instead, the trend is to make sure that all airlines adequately train and give refresher courses to the crew and flight attendants in cardiopulmonary resuscitation techniques including mouth-to-mouth, mouth-to-nose, and closed cardiac massage. The teaching of the Heimlich Maneuver for the "cafe coronary" victim has paid good dividends in our airline.

Recently the FAA has recognized the needs and problems of the disabled. Table 2 shows the number of persons handicapped by various diseases and conditions. Table 3 shows the geographic distribution of handicapped persons in various regions of the United States.

HANDICAPS OF WORK FORCE AGE AMERICANS

Handicap	No. of People
Paralysis (Muscular-Skeletal)	5,400,000
Mentally retarded	3,500,000
Mentally restored	250,000
Hearing loss (not total)	2,000,000
Total deafness	250,000
Epilepsy	2,000,000
Blindness	700,000
Kidney failure	450,000
Amputee	200,000

Table 2

Statistical source: 1970 U.S. Census, the President's Committee on Employment of the Handicapped, National Easter Seals and Lawrence Berkley Laboratory

GEOGRAPHIC DISTRIBUTION OF THE HANDICAPPED

Region	In Labor Force	Not in Labor Force (able to work)	Total Handicapped
1. (R.I., Conn., Mass., N.H., Vt., Maine)	313,536	76,452	389,988
2. (N.J., N.Y., Canal Zone, P.R., V.I.)	622,733	173,430	796,163
3. (Va., W. Va., D.C., Md., Del., Pa.)	600,497	177,704	778,201
4. (Ala., Miss., Fla., Ga., S.C., N.C., Ky., Tenn.)	917,775	288,036	1,205,811
5. (Ill., Ind., Mich., Minn., Ohio, Wis.)	1,212,603	363,876	1,576,479
6. (La., Ark., Okla., Tex., N.M.)	576,646	174,541	751,187
7. (Iowa, Kansas, Mo., Neb.)	324,176	86,871	411,047
8. (Mont., N.D., S.D., Colo., Wyo., Utah)	158,061	44,241	202,302
9. (Ariz., Nev., Calif., Hawaii)	661,770	216,551	878,321
10. (Alaska, Wash., Ore., Idaho)	207,673	67,459	275,132
TOTALS	5,585,470	1,669,161	7,264,631

Table 3

Statistical source: 1970 U.S. Census, the President's Committee on Employment of the Handicapped, National Easter Seals and Lawrence Berkley Laboratory.

It has only been in the past two years that we have developed equipment and care for the passenger who needs oxygen "all the way." This embraces primarily the area of emphysema. All of these cases in our airline are assessed for travel by having a consultation often by telephone between the patient's personal physician and one of our full-time flight surgeons. We use only our own oxygen equipment which is solid state. However, the rate of flow is often a problem in that the treating physician overemphasizes the need. In many instances, if we mention to the physician what the physical capability of the passenger is, namely, climbing a flight of stairs or walking one city block, no added oxygen is really needed. For passengers who cannot be handled by us, air ambulance service is now available.

There are two other areas of concern in air travel, one is that of smoking or non-smoking in passenger and crew areas, and the other is the over-indulgence of alcohol which is a real problem. Let us take the smoking issue first. The non-smokers, especially those who have given up the habit and become converts to a new way of life, are most vociferous in their demands for an all "no-smoking" rule. We find these people are becoming the majority, and we are gradually reducing the "smoking area" in our aircraft seating configuration. When there is a transgression, the arguments become violent and, if aided and abetted by alcohol intake, we have had instances occur of assault and battery.

We have our own problems in this area with reference to cabin and cockpit crew and smoking habits. Medically, we have told our people that "smoking (cigarettes) is bad for their health." We have some who will not heed our warning. However, there is no area on the aircraft except buffet areas where, with curtains drawn, a flight attendant can "sneak" a smoke. The lavatories are "off limits," and so is the cockpit area where we have a rule that there will be no cigarette smoking by flight attendants without the expressed approval of the captain. The reason for that ruling was the occurrence of unap-

proved cigarette smoking by flight attendants during the last half hour of descent in transcontinental flights. This is a period during which, on the recommendation of the Medical Department we ask our cockpit crew to go on 100% oxygen voluntarily to overcome the subclinical hypoxia induced by a four hour plus period of operating at a cabin altitude of 7,500 feet.

We have not solved the problem of cigarette smoking in our cockpit crew members, and there is much activity going on in this area, but it is a complex subject. However, because we use timed velocity of pulmonary function as part of our Pilot Health Maintenance Program, we have had success in stopping cigarette smoking in those individuals who are showing a decrement in pulmonary function. At one pilot base, we have stopped cigarette smoking in 30% of our cockpit crews!

There are other factors that affect the comfort and well-being of the traveling worker. One of these is the health habits during long periods of air travel. A good rule to follow is to give the traveler adequate time to accomplish his journey. Adequate time to get to the airport (overseas flights require a one hour pre-flight check in) is important. Carrying of heavy baggage by the elderly over long distances is to be avoided. We lost more passengers from heart attacks prior to and after the flight than during the flights.

Comfort factors with respect to eating and drinking on board aircraft are important. Overeating and overindulgence in alcoholic beverages should be avoided. We have a problem here with the wife accompanying the passenger. She wants to treat this trip as a "night on the town" and wants to be dined and wined accordingly.

Another factor to cope with in travel by air carrier is the distinctly low humidity of the cabin and cockpit area. Fluid balance should be maintained by adequate fluid intake preferably by non-alcoholic and non-diuretic beverages. We give the same advice on fluid intake to our cabin and cockpit crew. Of course, alcoholic beverages are forbidden to aircraft crew members for twenty-four hours before flight time.

Also, because of the low humidity referred to, wearers of contact lenses should have wetting solution available to use at frequent intervals while in flight. We give the same advice to our flight attendants who wear contact lenses. In this same vein, passengers who are on timed medications like insulin or insulin-like oral medication should be sure to have the medication available on board and not packed in their luggage which is not immediately available to them.

With reference to immunizations for foreign travel, the requirements are becoming much more liberal. As an example, smallpox requirements are no longer necessary for European and Mexican travel. The ineffectiveness of cholera immunization is recognized by the World Health Organization. Yellow Fever immunization, good for ten years, and anti-malarial medication are still prime requisites when traveling to infested countries. A good anti-diarrheal medication is a real asset because the two greatest fears of the international air traveler are still "travelers' diarrhea" and the fear of flying.

In conclusion, air travel is still a very safe way to traverse long distances for everyone, the young and the old, the weak and the strong, the healthy and the infirm.

PREPARING WORKERS FOR INTERNATIONAL TRAVEL

Nicholas A. Pace, M.D.

The General Motors Overseas Division known as the General Motors Overseas Operations is headquartered in the General Motors Building in New York City. It is the responsibility of the New York and Detroit G.M. medical departments to prepare medically each General Motors Overseas Operations employee as well as each accompanying member of his or her immediate family before proceeding on a foreign assignment or an extended international business trip. Approval of an overseas assignment or continuing thereon is contingent on obtaining medical clearance for the International Service Personnel (ISP) as well as for members of the immediate family who accompany him. Therefore, the medical examination must be completed before the assignment or continuation thereon is finalized. This policy is an attempt to reduce the possibility of medical problems that could affect the ISP's performance necessitating his premature return to his home country or that could result in continuing medical problems after his return.

Scheduling of the medical examinations is done as early as possible. This allows time for additional consultation or treatment if necessary. The ISP medical examination is scheduled for three or four days before his home leave begins, allowing time for additional consultation if necessary. In other words, his home leave begins only after the examination has been completed.

The Personnel Department of the Overseas Operations has advised all of our overseas plants that the International Service Personnel as well as their immediate families are required to maintain their inoculations and vaccinations up to date. All of our overseas plants are referred to use our *General Motors Medical Guidebook for Foreign Travel and Service.*

Any General Motors employee or member of his immediate family who experiences an

illness or an injury while on foreign assignment or on an authorized business trip is advised to report this problem to the Medical Department immediately upon returning from the trip. The company will pay for any diagnostic, medical, surgical, or hospital expenses incurred by employees and their immediate families as a result of an environmental illness contracted in the line of duty abroad to the extent that such expenses are not covered under our insurance program. However, the company will not pay for any medical expenses due to an illness other than an environmental illness. Our definition of an environmental illness is a disease or illness that is endemic in the foreign location and which probably would not be encountered if the employee and his immediate family had remained in his own home country. Conversely, the non-environmental illness is that illness for which risk of exposure is the same as that incurred while working in one's own home country. Should an ISP or member of his immediate family develop a serious medical problem at the assignment point, which in the opinion of the local management requires a higher quality of care than is available locally, the company will assume the expense of moving the patient to a location where proper medical or surgical care can be obtained whether the illness is classified environmental or non-environmental.

Prior to the time of the examination, the Personnel Department provides the employee and the family members with the following: date and time of examination, letter of instructions for medical examination, a medical questionnaire, also a stool specimen kit with its instructions. On the day of the examination the family arrives in a fasting state to the medical department with their completed questionnaire and stool specimen. The nurse interviewer reviews the patient's home leave itinerary containing addresses and phone numbers so that the patient can be reached if necessary for further medical follow-up. The nurse discusses family adjustment to environment, housing, food, sanitation and so forth, and records this on a confidential sheet. Special health problems such as availability of medical facilities, hospitals, physicians, and medications are also reviewed by the nurse. The nurse also reviews all medical systems and questions the use of drugs, tobacco, and alcohol. She has been instructed to underline and alert the examining physician to any medical problem areas, and in this way the physician can concentrate on these problem areas during the course of the examination. The immunization schedule is then reviewed and the necessary immunizations are recorded and scheduled on a special immunization schedule form. The family then proceeds to have a standard series of laboratory tests which include a chest X-ray, a resting electrocardiogram for all adults over the age of 30 and/or anyone with a history of heart disease, a hemogram which includes a complete blood count and routine blood chemistries, a complete urinalysis, and a stool examination for blood, ova and parasites.

Following the laboratory procedures the examinee is then brought to the examining room where the physician reviews the history form, giving special attention to the nurse interview notes. The family is examined thoroughly by the physician who fills out the General Motors Foreign Assignment Medical Examination Report. At the bottom of this report the diagnoses are listed as well as the recommendations for treatment or further consultation. He then fills out a qualification form indicating that in the physician's opinion the examinee is or is not physically capable of performing the duties of an overseas employee as well as any medical limitation to foreign travel or assignment that the employee may have. This form is then submitted to the Personnel Department. Following the physical examination, appointments for any necessary referrals are scheduled. All females are referred to the gynecologist for pelvic examination and pap smear. The pediatrician in turn submits a standard G.M. Pediatric form to the company clearing the children for foreign station.

The International Service Personnel is told to call or return to the medical department one week later for a comprehensive review of the results of the physical examination, laboratory procedures, and medical recom-

mendations. In addition to this review, either in person or on the phone, a complete set of records are sent to the patient at his overseas assignment. The Personnel Department is notified of the medical status of the employee and his family.

At the end of the examination, the nurse reviews the physician's recommendations with the family via an exit interview. It is during that interview that a list of travel tips are supplied to the traveler as well as an international medical travel kit which includes drugs and instructions for use of the medications while overseas. If the family is traveling to a malarious area, malaria prophylactic medication is supplied. If the worker is going to a tropical area, a supplementary tropical medical kit is added to the international travel kit.

Our International Service Personnel are examined once every two years when they return from home or from ordinary assignments. If they are in a hardship area, for example, an underdeveloped country, they return home and are examined on an annual basis, since it is usually in these areas that disease exposure is greater and medical care is poorer.

The post travel interview is performed by the nurse on ISP's who return to home office on a trip of less than six months of international travel or assignment. The employee is told to report to the medical department for an interview which would include having: 1. a review of any illnesses or symptoms that have occurred over the last six months. The doctor may decide, at this point, to examine the patient for the system involved in the illness or symptoms; 2. the travel kit replenished; 3. immunizations updated, and 4. stool examinations if indicated. (Indications for stool examination would be: returning from an undeveloped area, a tropical country, or having an episode of diarrhea during the last six months or since the previous examinations.) 5. any other medical laboratory procedures that the physician might deem as necessary.

The schedule for preparation of the international traveler's immunization was devised by our committee, in accordance with U.S. Public Health Service schedule. We also took into account such problems as immunizations to satisfy local health authorities, as well as what immunizations should be given in order to provide maximum protection to our people. Please note that our definition of Northern Europe includes England, Scandinavia, West Germany, Switzerland, Belgium, and Holland.

All our International Service Personnel while on foreign assignment throughout the world are expected to maintain their immunization program outlined below. If certain vaccines are not available locally, every effort is made to obtain them from other sources including the home medical office. We also realize that dosages are often changed, and, therefore, the manufacturer's recommendations listed on the package should supersede any of our manual's directions.

Smallpox Initial dose—one revaccination every three years for all international trips except for Canada and Northern Europe. If a person is traveling to an area where smallpox has been reported recently, then revaccination should only be given when vaccination was given more than a year earlier. Note, all revaccinations must have a take.

Typhoid Initial series number of doses 2—each dose is 0.5 ml. subcutaneously, at least four weeks apart. Booster, one dose 0.5 ml. subcutaneously, to be given every three years for all international trips except Canada and Northern Europe. Note, all those actively involved in travel to high risk areas should have a booster annually. Most typhoid strains no longer respond to ordinary antibiotic therapy; therefore, immunization is important.

Tetanus toxoid The initial series for tetanus toxoid requires three doses, each dose being 0.5 ml., subcutaneously, at least four weeks apart, for the first two doses, and the third dose being given one year later. A booster is required every ten years for all in-

ternational trips except Canada and Northern Europe. If the patient is exposed to a penetrating dirty wound, the immunization will protect providing a toxoid injection is repeated after exposure. Therefore, a booster should be given upon the occurrence of penetrating wounds or burns as directed by a physician.

Typhus The typhus immunization initial series is a number of two doses. Each dose is one milliliter subcutaneously. There is an optional interval between initial doses of four weeks. Booster doses of typhus should be once a year. The use of typhus vaccine is optional. It is not mandatory, because typhus is a treatable disease; nevertheless, it is recommended in the presence of danger of epidemic lice or lice-borne typhus. It is not necessary in Canada or Northern Europe. It should be considered for travelers to rural or remote areas of Ethiopia, Rwanda, Burundi, Mexico, Ecuador, Bolivia, Peru, and other mountainous areas.

Cholera Has an initial series of two doses, the first dose being 0.5 ml., the second dose being 1 ml. subcutaneously, at least seven days apart. Boosters of cholera are required every six months. Cholera can be given for all international travel except Canada, Northern Europe, and Latin America. Cholera is given mainly to meet the requirements of the country. Exceptions will be made if there is no cholera in the area and the country to be visited does not require this immunization.

Polio-Sabin The initial series of polio is a number of three doses—the second dose at least six weeks apart from the first dose and the third dose being 8 to 12 months after the second. A booster is required every four to five years. Polio vaccine is given for all international travel except for Canada and Northern Europe and it is optional after the age of 50.

Influenza The U.S. Public Health Service recommends that those over the age of 50 should receive the flu vaccine. All travelers with cardiac or respiratory diseases should receive the flu vaccine. The flu vaccine is now in a single dose of 0.5 ml. subcutaneously and it is much less toxic and has fewer reactions than the flu vaccine of years ago.

Yellow Fever Initial dose—one. It is valid for ten years beginning ten days after the primary vaccination. A booster is given every ten years mainly to meet the requirements of the country to be visited. It should be given for all international travel except Canada and all of Europe.

Plague (Follow manufacturers instructions for dosage and the amount.) A booster is given at six months interval and only in the presence of the danger of plague or for those traveling to remote interior areas of Viet Nam and Cambodia.

BCG Vaccine This especially for children. BCG vaccine should be reviewed by a pediatrician on an individual basis for those scheduled for an extended stay in the tropics.

Gamma Globulin Gamma globulin should be given just prior to departure and every six months in a dose of 5.0 cc for all international travelers except those going to Canada and Northern Europe. Gamma globulin should be given to those persons stationed overseas in areas other than Canada and Northern Europe on a six months basis. If there is a high incidence of hepatitis reported in any particular area, this schedule should be modified so that gamma globulin be given every four months instead of every six months. When possible, patients going overseas should be given gamma globulin as their last inoculation just two or three days prior to departure.

The simultaneous administration of certain vaccines, according to the U.S. Public Health Service, is both safe and effective. This is important for the traveler who has imminent exposure to several infectious diseases and limited time access to call for vaccinations with multiple antigens. According to the U.S. Public Health Service, "inactive vaccines and large attenuated viral vaccines can be administered simultaneously at separate

sites keeping in mind the precautions that apply to single antigens or a combination product. Smallpox and Yellow Fever vaccines (once thought to be unsuitable for simultaneous administration because of virus interference) can now be given at the same time at separate sites with an effectiveness and safety equal to that following an individual administration. Furthermore, since the reactigenicity and the antigenicity of the smallpox and yellow fever vaccines are unaffected by the interval between inoculations, it is not necessary to separate the injections by two to four weeks if they cannot be given simultaneously."

Malaria prophylaxis This is advised for employees traveling through Africa, Southwest Pacific, Far East, Southeast Asia, Middle East, and specific areas of South America. The dosage schedule is as follows:

1. Chloroquine (aralene) 500 mg. weekly beginning one week prior to departure and six weeks following return.

2. If traveler is to remain in the malarious area on a continuous basis, then suppressive treatment is to be continued in excess of six months, chloroquine is to be alternated with pyrimetamine (daraprim) 25 mg. weekly for three months alternating with chloroquine for six months.

The employees' children are advised to have individual doses of medication, per pound not kilo. Infants should be checked by a pediatrician; drug therapy is probably not necessary, but they should be protected by anti-mosquito means, i.e., nets.

Precautions Since chloroquine can cause serious eye problems, persons taking these drugs should have annual eye examinations regardless of whether any eye problems are experienced. Examination is at company expense by an ophthalmologist during home leave or locally by an ophthalmologist during the intervening years. If any eye complaints occur during the years of chloroquine use, the drug should be stopped and an ophthalmologist consulted. It should be noted that most of the cases of malaria that occur now are in the businessman who foolheartedly believes that he is immune to malaria.

THE GENERAL MOTORS INTERNATIONAL TRAVEL KIT

The traveler is given a General Motors International Travel Kit. In the kit there are vials labelled with the various medications and an instruction sheet which cautions the traveler to read the labels carefully and avoid alcohol use with any of the medications since alcohol with medications may cause undersirable interreactions which may be severe. The traveler is also cautioned that if symptoms persist, competent medical assistance should be sought out either through our nearest local General Motors facility, the American Consulate, the International Association for Medical Assistance to Travelers directory, or by calling the Company Medical Director in New York long distance. The kit includes medications to take care of most common medical problems. The company realizes that the cost is tremendous to send a traveler on a business trip. Should the business traveler become ill while overseas, not only is it detrimental to his health but also to the business purpose of the trip. The medications that the International Travel Kit includes are listed with their doses and directions.

For those going to a tropical area, a tropical kit is supplied in addition to the international kit. In the tropical kit there are medications to treat severe allergic reactions or hives due to an insect bite, or food or drug allergy. There is also medication for prophylactic use for diarrhea prone travelers. Also included in the kit are medications for sunburn prevention, itchiness, fungus infection, protection against malaria, water purification tablets, sodium chloride and dextrose tablets to avoid heat prostration, an insect repellent and finally a snake bite kit.

SUPPLEMENTARY ITEMS TO BUY

We also give the traveler a supplementary list of items he should take with him. The

supplementary list includes an adequate supply of any medications that his own physician may have prescribed; an extra pair of glasses and a prescription for his glasses; a bar of soap for cleaning the skin and preventing infection; a box of Kleenex, one soft pack per week for toilet use; an aerosol insect killer spray, such as Raid for use in hotel rooms; a thermometer; a tweezer to remove foreign bodies; a small pair of scissors; a triangular bandage; a small immersion water heater, and an electrical adapter for continental outlets. In addition to the travel kits the traveler is provided with a list of medical travel tips on how to stay well during international travel and assignment.

We suggest that the traveler drink bottled water which is carbonated and perhaps even carry his own bottled water which now comes in convenient quart plastic bottles. If one uses bottled water that is purchased locally, one should make sure that the bottle is opened in front of the traveler and that the bottle fizzes when it is opened. We suggest the use of bottled water to brush the teeth. Ice should be avoided. We also suggest that all uncarbonated soft drinks be avoided, since the sugar in them makes an excellent media for bacteria. One should check that the glass he uses is clean. If one cannot boil the water, we suggest the use of an immersion water heater in a cup. This inexpensive instrument can boil a glass of water in less than a minute. The traveler is cautioned in the undeveloped parts of the world to avoid milk, cheeses, and ice cream unless he is certain that it has been made safe by pasteurization. If milk is required, one can use bottled water and powdered milk. Tea and coffee are safe if the water has been boiled for three minutes. Beer and bottled wine can be taken safely, but fruit juices should be avoided.

As for food, we advise the traveler to be sure that both meats and vegetables are well cooked. In undeveloped countries we advise the traveler to ask to see the meat before it is cooked, checking it for freshness, and if possible, have it cooked in front of the traveler. In these areas meat should always be cooked very well done and never eaten rare. Bread is usually safe anywhere but if in doubt it can be heated. Raw salads, fruits, and vegetables should always be avoided. Any fruit which has a thick skin intact is safe if it is peeled by you with a clean knife and the skin is washed with bottled water first.

Should the traveler become sick on a trip, we advise the following:

For Diarrhea For the treatment of the common diarrhea of the tourist we suggest Lomotil, Kaopectate, rest, and a diet of light tea, rice, and applesauce. We caution the traveler that, if diarrhea persists for more than two days or if accompanied by fever or bleeding, a physician should be consulted.

To find a competent physician overseas, we suggest:

1. Checking with the company's nearest foreign office,
2. The nearest U.S. Consulate or British Consulate,
3. The nearest medical school or university hospital, and
4. The International Association for Medical Assistance To Travelers, Empire State Building, 350 Fifth Avenue, Suite 5620, New York, New York.

In general, we suggest that one should avoid foreign physicians on short trips; visits can be a waste of time and money and in some of the undeveloped countries they can even be dangerous. For example, the use of a dirty hypodermic needle spreading disease like hepatitis is not uncommon.

Circadian Desynchronization This is a new medical entity in which people who travel across time zones desynchronize or unbalance their biological clock which regulates their normal cycle of sleeping, waking, eating as well as other biological processes. This unbalance can cause a person to be fatigued and irritable or to have insomnia, headaches, and loss of appetite. It may even cause disturbed thinking facilities and decision making. These symptoms disappear after one or two days in the new time

zone. It is important when scheduling travel to allow enough time for recuperation when passing through a number of time zones. Most people can only manage three time zone changes. On any transoceanic flight, it is well to allow one day for recuperation and rest before scheduling activities. We suggest breaking a long trip into several portions. Schedule flights to arrive at your destination before nightfall in order to get a good night's sleep.

Drugs for Intestinal Parasites In the *General Motors Overseas Procedure Manual* we have included a reprint of Chapter 22 of the book *Drugs of Choice 1976-77* by Dr. Benjamin H. Kean and Dr. Donald W. Hoskins from the Mosby Company. We included this chapter entitled "Drugs for Intestinal Parasitism" because it gave our company physicians a concise outline for the standard treatment for intestinal parasitism such as amebiasis, trichinosis, giardiasis, hookworm, ascariasis, tapeworm, schistosomiasis, to name just a few. I recommend this book heartily, especially Chapter 22.

General Medical Advice The following general advice is given to the traveler:

1. Wash and wear clothes do poorly in the tropics. Cotton clothes are cooler since they absorb moisture better.
2. In remote hotels use insect spray in the room. Spray under the bed and around the room for a minute or two, and leave the room for an hour or two. Leave the room closed with the lights out. Open the windows for the night.
3. Have a dental and eye check-up before you go abroad.
4. Take sun glasses, an extra pair of regular glasses, and your eye prescription with you.
5. Break in new shoes before you depart.
6. Take a supply of hand cleaning "Wash Ups" packages.
7. If you experience ear pains while flying or are flying with a cold, take one tablet of Actifed one half hour before you board the plane and use Afrin Nasal Spray (see directions).
8. Stay out of fresh water bathing areas unless you can be sure that they are free of snails. Schistosomiasis, a snail borne parasitic disease, is second only to malaria as a serious parasitic infection. The most casual contact with infected water can transmit this disease.
9. Avoid flying with any symptoms of infection, i.e., temperature elevation, inner ear infection.
10. If there is a history of varicose veins or phlebitis, we advise travelers not to cross their legs on the flight, and advise getting up and walking around the plane frequently to increase circulation.
11. If there is a history of digestive disorder, travelers should be cautioned to eat and drink very sparingly or not at all during the flight.

Mental Status Evaluation One of the problems that I have encountered is the traveler who fears flying. The following list of recommendations can be made to such a traveler:

1. We suggest that the patient read the following two books. *Hope and Help for Your Nerves* by Dr. Claire Wiekes and *Fear of Flying* by Marvin Essons.
2. We also explain to the patient the pathophysiology of the fear, the "flight or fight" syndrome. Included in this is the concept of sensitization of the nervous system that fear produces. This sensitization causes excess adrenalin to be produced which is responsible for the physical symptoms that the patient experiences, i.e., symptoms and signs of hyperventilation (i.e., paresthesias of the extremities, light-headedness, syncope, or tachycardia), abdominal bloating, eructation, and so forth.
3. We also attempt to reduce anxiety by: (A) Education, reviewing: cost of airplane, mechanical checks, personnel competence, turbulence, sounds of landing gear lowering, slowing of motors driving; (B) Picking the right flight: daytime — good visibility landing, good weather, large plane, i.e., 747; (C) Tranquilizers; (D) Relaxation exercises and techniques, i.e., TIM; (E) Organized occupations such as conversation, puzzles, reading, and so forth.

A very careful mental status evaluation of the employee and his family who are being

sent on foreign assignment should be made. The executive whose wife and he are not getting along usually do not do well on a trip or on a new assignment. One does not run away from marital problems by changing geographic locations, nor does the geographic location change the problem that exists between a couple. Heavy drinking can become alcoholic drinking in a setting of a new geographic location. There is a high percentage of alcoholism that develops in Americans based overseas, probably because there is a great deal of socializing around alcohol in the American community overseas and very few physical and emotional outlets.

A careful evaluation of the social aspects of the family should be taken into consideration prior to sending the employee on an overseas assignment. Interviewing of the family members that will be going with the employee is important. If the wife is not happy about moving to a new country, chances are she is not going to do well at the new location, and second thoughts should be given about giving medical clearance to that particular family for an overseas assignment. there are no community facilities for counseling, no mental health counselors, marriage counselors or even drug or alcoholism counselors.

Drugs among the adolescent children should be watched for. We do a screening test on all adolescents. I might mention that adolescents, in general, do not do well overseas. If a youngster is picked up as having a drug problem in an overseas community, the laws are very stringent; in the Middle East, for example, the punishment is death or life imprisonment. The son of the American executive of another company, in Iran, age 17 1/2, almost went to prison for life because he had some narcotics in his possession. Narcotics are very plentiful and easily obtained overseas; however, the penalty is so great that it is unwise for a company to send a youngster overseas who has had a history of trouble with drugs; hence, it is important to screen the medical history and the urines of adolescents for drugs during the examination.

Alcoholism among the wives of some Americans on foreign assignment seems to be somewhat prevalent. We would caution the examiner to be especially attuned to the possibility of alcoholism among the wives of the overseas assigned employees. Many times a subtle alcohol problem can be discovered when the patient gives a history of severe nervousness, insomnia, frequent headaches, and the constant use of alcohol and/or tranquilizers to reduce these symptoms.

Wives appear especially vulnerable since many of them are discouraged because of local customs or mores from working outside or inside their own homes, and they do not have the usual outlets of outside community activities that can keep them busy. To this is added the fact that the few social activities foreign-based Americans do have usually revolve around activities when alcohol is used in great abundance, i.e., the cocktail party. We have had to evacuate several families when the wife of an employee became an alcoholic. In these cases, we used the General Motors Alcoholism Recovery Program as a basis for treatment since the threat of loss of the husband's job was used as a lever to motivate the wife into treatment.

It should be noted that when we send a family overseas, the Corporation feels responsible for the health of that entire family as opposed to a domestic employee whose personal life becomes his own after his working hours are over. In other words, when the company hires a man and sends his family along with him, they are, in reality, hiring the whole family. Since it has been estimated that it costs the Corporation three times the employee's salary to maintain him and his family overseas, the company has a great investment in the good health of its overseas families. It is, therefore, important that a careful evaluation of the family's health be performed prior to the assignment being made. The evaluation should include not only a careful mental status but also an evaluation of the social inter-reaction of the family, since there is a great deal of cultural shock that an

overseas employee and his family will be subjected to on a foreign assignment. By doing this, the company has a better chance of guaranteeing a happy, healthy American employee and family working and living on an overseas assignment.

SUMMARY

We have tried to include in our discussion preparation of individuals for international travel — the physical evaluation, immunizations, medications for foreign travel, and how to obtain physicians's care in foreign countries. We also included travel tips in general. We have touched on the time zone changes that affect the traveler over long flight distances, and we have outlined for you what our corporation policies are concerning our International Service Personnel based overseas.

GENERAL AND BUSINESS AVIATION

Robert L. Wick, Jr., M.D.

The scheduled and supplemental U.S. airlines are a reasonably well-defined area of civil aviation. This is not so with respect to business aviation and the air taxi industry. The reasons for this will be apparent in a moment, but it is worthwhile to define something of the corporate and air taxi aircraft operations for clarity.

In general, aviation activity in the United States is classified in terms of three entities. These are: military aviation, airline activities, and general aviation. While the first two are reasonably self-explanatory, the third category is a very amorphous one and in effect, is a classification by exclusion. That is, anything which cannot be identified as military or airline is therefore classified as general aviation. It is a large area. There are approximately three quarters of a million pilots within the United States, and more than 150,000 aircraft. Less than 3,000 of these are airliners, and less than 30,000 of the pilots are employed in scheduled airline services.

Government regulations require very careful documentation of airline operations, but require almost no recordkeeping in the general aviation sphere. Consequently, we must estimate the size and degree of activity in this area. We do know that almost a quarter of a million individuals are licensed as commercial pilots. That is, they may fly professionally in almost every phase of aviation except as captains of scheduled airliners. They can and do serve as the copilots for major air carriers. Records are not required of these commercial pilots, and in fact, they are known to drift in and out of commercial aviation as their fortune, and the economy, waxes and wanes. Estimates vary, but a conservative guess is that about 90,000 pilots earn their living in aviation exclusive of air carrier work. Examples of jobs these people might hold run from pilots of airline type aircraft operated for private corporations to test pilots, crop dusters, air am-

bulance pilots, banner towers at resort areas, flight instructors, fish spotters, power line and pipe line patrol pilots, air show pilots and even the pilots of the well known Goodyear blimps.

The area in which they fly is also one of the factors complicating the problem of determining the actual size of aviation operations in the United States. There are at present between 11,000 and 12,000 registered aircraft landing areas in the United States. A mere three hundred and fifty of these have a Federal Aviation Administration control tower in operation. No records are required or kept concerning operations at the remaining airports. Any statements concerning aviation activity, therefore, are at best rather tenuous estimates. As a matter of interest, it should be noted that the airlines serve only about 500 airports in the United States.

The figures just mentioned are rationale for the existence of general aviation. It is not always possible to travel to any given destination by airliner. Major metropolitan areas are often served by several airports, only one or two of which will host the scheduled airlines. The remaining airports may well be located somewhat nearer to the business center of the area, or to other attractions for the traveler. Examples include: Chicago's Meigs Field, just five minutes from the Loop compared with almost an hour from busy O'Hare Airport; Detroit City Airport; Toronto Island Airport; Seattle's Boeing Field; Kansas City Municipal Airport; Downtown Airpark in Oklahoma City; Lakefront Airport in New Orleans; Burke Lakefront in Cleveland, and many others. The list is almost endless. Los Angeles is a special case in point. While the airlines serve a number of airports in the L.A. basin, there are many more serving general aviation located all through the basin. These include several of the busiest in the world. Unless one's business is almost at the airline airport, there is usually one of the smaller general aviation airports located more conveniently to industry, tourist attractions, or sports areas.

Airline flight schedules are not always convenient either. At some of the less busy terminals, airline flights are quite infrequent, and may be as few as two or three a day. Inconvenient schedules sometimes require more than a full day to travel from one point to another in the United States. These pressures and the value of a busy executive's time, have led to the development of extensive air taxi and corporate flight department networks. It is common for a large corporation with highly compensated management officials to own and operate several jet powered aircraft to more efficiently utilize their executive manhours. Others use air taxi operators for the same purpose.

Air taxi services used in this manner are likely to be jet aircraft themselves, approximating the speed and range capability of many airliners. They have the additional advantage of being able to use many more airports than are served by airliners. And they arrive and depart at the schedule required by their passengers rather than somewhat arbitrary and perhaps inconvenient times. Of course, all this costs considerably more than the price of an airline ticket, but some executives are worth enough to their companies to easily justify the additional added expense.

These same aircraft are sometimes used for relatively small freight shipments. Consider the case of a large and expensive automobile production line. As a result of some minor miscalculation in ordering; imagine the costs if the line is shut down for hours with all the workers sitting and drawing their wages because of a shortage of 40 left front windows. It may well justify shipping those missing parts by a special jet charter flight, as expensive as it is, to avoid stopping the production line.

It is obvious from the foregoing discussion that the size of corporate and air taxi operations cannot be clearly identified, but we can consider some of the problems facing both the pilots and their passengers. Let us consider the passengers first. Let us further consider those most likely found in the executive category who will be carried on board sophisticated jet aircraft whether corporate or air taxi operated.

There are now more turbojet airplanes operated in this category than are operated by the airlines. However, they tend to be much smaller. Typically, they are crewed by two pilots, and may carry from four to twelve passengers. All are pressurized, and provide the same emergency oxygen systems as well as creature comforts found on their larger airline cousins. Indeed, a number of former jet airliners are also operated in corporate service, but these comprise only a relative handful compared with the typical small jet just described.

There is one important difference, however, which is of vital concern. These airplanes are almost exclusively twin engined models, and they do not have quite the same reliability as their larger three and four engined relatives. At times windshields do crack and door seals do fail. An airliner with a large cabin volume plus three or four engine-driven cabin compressors is not subjected to a rapid decompression under these circumstances. Unfortunately, the small jet is occasionally thus subjected, and with great rapidity. Further, the most popular of the small jets, the Lear, cruises at 41,000 feet frequently, an altitude considerably above the cruising altitude of most airliners. A cabin decompression is therefore very serious indeed.

The passengers seldom if ever receive an emergency briefing from the crew. Nor is there any hostess on board to provide one, or assist the passenger in the case of such an event. The crew is busy with the aircraft problem which caused the loss of cabin pressure. The passenger is on his own. The time of useful consciousness at these altitudes may be as little as twelve seconds. If the passenger does not recognize the emergency, don the mask, and secure the retaining strap within the alloted time, he is not likely to at all until the aircraft reaches altitudes below 20,000 feet. This in turn may take vital minutes, and at the very least hypoxic convulsions may be expected. Brain damage is also possible, but is, happily, apparently extremely rare. At best, however, the passenger is in for an unpleasant experience and possible injury.

Leaving the high flying world of the jet, and returning to somewhat more mundane propeller driven aircraft, we find several different categories of airplanes. Some are prop jets, that is, a jet engine is hooked to a propeller. While these are not as fast as pure jet airplanes, they may have as long or longer a range, and most important, they are generally able to operate from much smaller airports, thus opening up to them the possibility of using the great majority of the nation's landing areas. The prop jets tend to be pressurized, and therefore provide the same comfort of the pure jets. However, they tend to operate at considerably lower altitudes, 20,000 feet and below, so their passengers are not exposed to the same decompression risks as those riding in the pure jets. A complete loss of cabin pressure at 20,000 feet, for example, would not be expected to cause unconsciousness in any normal individual. Ample time is available for the aircraft to descend to lower altitudes before the degree of hypoxia becomes more than uncomfortable for those riding in the cabin.

Propeller driven and piston engined planes tend to be unpressurized. Only a few "top of the line" piston powered aircraft have pressurized cabins, and these can be classed with the jet props with respect to their loss of cabin pressure hazards. However, any propeller driven airplane has another problem which is a significant hazard to the occupants. That hazard is noise.

There are three major sources of noise within an aircraft cabin. These are engine noise; aerodynamic noise, i.e., noise generated by airflow around the outside of the fuselage; and propeller noise. Pure jet engines obviously do not have propellers, and thus we may disregard this source of noise when considering the corporate or air taxi jet airplane.

These smaller jet aircraft have noise levels within the cabin which approximate 85 dBA or less while the airplane is at the cruise configuration. It tends to be somewhat similar to white noise, and is largely the result of aerodynamic generation. Jet engine noise is

a major hazard to those working outside on the ground around the jet efflux, but it does not play any significant part in the noise picture within the cabin.

The propeller driven airplane is an entirely different story. One design limiting factor is propeller tip speed. It must not be allowed to become supersonic, but it does reach high subsonic airspeeds. It generates the majority of the noise permeating the aircraft cabin. Surprisingly enough, engine noise is a minor part of the noise environment found in most cabins and cockpits. Aerodynamic noise is similarly a small part of the ambient noise, in part because airspeeds tend to be relatively low compared with jet airplanes.

Several surveys of propeller driven aircraft common in the general aviation world indicate that cabin and cockpit noise levels of 100 dBA are common in the overwhelming majority of propeller aircraft. The noise hazard is obvious. While the casual or occasional passenger may not suffer permanent damage, the busy and frequently traveling executive takes a significant risk. It is well known, and has been for more than 40 years, that the professional pilot usually has a significant noise-induced hearing loss. Data do not exist which document this for the frequently flying executive, but it certainly would not be an unexpected finding.

Thus far, we have considered only universal hazards for the traveling executive passenger. There are other lesser problems facing him as well. For example, flights in smaller and slower aircraft tend to be confining. Small piston powered aircraft tend to have seating arrangements similar to that found in passenger automobiles. It is impossible to get up and walk around or stretch one's legs. Even medium sized and so called "cabin class" executive aircraft have little headroom, and will not permit an individual of average height to stand upright although they may have comfortable chairs. Several of the multi million dollar corporate jets also will not permit a six footer to stand erect. The older executive with circulatory problems, therefore, is restricted in his movement, and is more prone to dependent edema and other complications during his air travel.

The smaller aircraft also normally do not have any sanitary facilities. Unlike the case with automobile, train, or airliner, toilet facilities may not be available in any form for a period which may exceed four hours. The average flight duration capability in hours of even the smallest single engine airplane is usually this period at a minimum. It can easily exceed eight to ten hours in some higher performance small aircraft.

A word about helicopters is in order. They are presently used in very small but slowly increasing numbers for executive transport. They are most useful for areas where airports are scarce or non-existent, but range requirements are not great. Problems of hypoxia virtually do not occur because the operational altitudes of helicopters tend to be less than 10,000 feet above sea level, and hypoxia is not considered a significant factor at these levels.

Noise levels tend to be extremely high, however, and hearing protection is essential for all crew members, and for all but the most occasional passenger. However, flight durations are short, and coupled with the ability to land in very small areas almost anywhere, the lack of sanitary facilities on board presents no problem to the traveling executive.

There are two other aspects of the traveling executive which should be considered. We have assumed that the traveler is in good health. The individual with respiratory problems, or with metabolic problems, e.g., diabetes, may require some additional considerations. Respiratory disease may impose some cabin altitude restrictions for comfort, and in some cases necessitate the use of supplemental oxygen. However, this is in no way different from the case of the same individual carried on board a scheduled airliner.

The executive with a medical problem, diabetes for example, must be aware that at times he will be isolated from ground assis-

tance for a significant period of time. Aircraft en route through areas of bad weather may not be able to divert and make an emergency landing. Therefore, such an individual must be prepared for emergency actions should difficulty arise while airborne.

The problem of flight within smaller aircraft also must be considered. Some individuals are afraid to fly under any circumstances and in any aircraft. Others are comfortable in larger airplanes, but may be quite apprehensive about flight in smaller cabins or in very light aircraft with automobile type interior configurations. Still others with some degree of claustrophobia become quite upset at the closed in tube-like effect found in the cabins of many modern airliners. This last problem is usually alleviated by flight in corporate aircraft. These smaller aircraft tend to have proportionately larger windows, and because each seat is next to a window, claustrophobia becomes a relatively insignificant problem. The fear of flight syndrome usually can be relieved as the flight progresses when the passenger sees the actions of the pilot.

Corporate and air taxi flight crews have no significant medical problems not also affecting airline crews. However, crews of propeller aircraft do have the aforementioned noise problems, and in addition, the flight durations make the lack of sanitary facilities in the smaller airplanes a somewhat more serious problem. It has been said that "Hemorrhoids and a hearing loss are the mark of the professional pilot." There is more than a grain of truth in this statement.

Airplane accidents are also a hazard for the flying individual. From a statistical standpoint, they are quite rare. At the same time, the problems and data concerning occupant protection in crashes constitute one of the most voluminous aspects of the aeromedical literature. A detailed discussion should reasonably be a separate subject. However, there is one aspect worth mentioning. That is the subject of passenger restraint in the case of a light aircraft accident.

At one time, aircraft tended to be more advanced than automobiles with respect to passenger protection and restraint. At the present time, the situation has been reversed. Seat belts have been required for aircraft occupants for many decades. Today, a seat belt is still the only restraint required of any pilot or passenger. Automobiles have rapidly passed through the stage of seat belts only, and are today equipped not only with seat belts, but with shoulder harnesses, in some cases inertia reels, and in many cases with interlock devices assuring their use. Development work is also under way with air bag passive protection systems.

Similarly, aircraft panels and instruments have changed little since World War II, but automobiles now feature recessed instruments, flush door handles, padded dash boards and so forth. There is some evidence to indicate that up to 37% of light aircraft (defined as airplanes with takeoff weights of less than 12,500 lbs, a class which includes almost everything smaller than the current corporate jets) fatalities could be prevented by using the state-of-the-art techniques available for passenger protection.

The remaining problems for workers who fly are found in the more specialized types of aviation. Perhaps the largest of these is the field of agricultural aviation. "Crop dusting" is a major economic part of general aviation. It is also a highly technical business and is carried out by professionals far removed from the "barnstormer" operation common after WW II. The aircraft used are highly-developed, expensive machines. Prices for a well-equipped airplane and agricultural application equipment necessary for it can easily exceed $100,000. In addition to insect control with respect to crops, aircraft are today used for vegetation control of all types, mosquito control, seeding, fertilization, and insect control with respect to animal husbandry.

Hazards include those of crashes. Unlike the corporate transportation area, crashes are common in agricultural work. The aircraft are designed to provide maximum protection in the event of a crash, and are also

designed to minimize the effects of striking unseen wires, and the crushing effects of the payloads they may have on board.

A far more serious problem is that of the chemicals applied. They tend to be toxic particularly when they are used for insect control. The flight and ground crews working with these chemicals must know the hazards of the individual material they are applying, and must also apply strict discipline in their use. Protective clothing of the proper type is absolutely essential. And in the untoward event of an accident, specific first aid materials must be readily at hand. Further, nearby medical facilities must be alerted to the possibility of a problem with these chemicals, and should take steps to have necessary drugs available for treatment.

It does little good for a pilot or ground crewman to be brought in to an emergency department of a local hospital if the hospital staff members are totally unaware that the patient, in addition to any trauma he might have, may also be suffering from an acute overdose of an organic phosphorous compound. Nor is it any more helpful if the correct diagnosis is made but the nearest supply of Protopam^{R} is a hundred miles away in a drug supply house storage facility.

These then are some of the problems facing workers who fly. The list is by no means exhaustive, but the interested and concerned physician can begin with a study of these problems and proceed as his interest leads.

GENERAL REFERENCES

1. Aerospace Medicine. (ed.) Hugh W. Randel. Williams and Wilkins Company. Baltimore. 1971.

2. FAA Statistical Handbook of Aviation. U.S. Government Printing Office. Washington. D.C.. 1975.

3. McFarland. RA Human Factors in Air Transportation. McGraw Hill Company. New York. 1953.

4. Annual Report to Congress. National Transportation Safety Board. Washington. D.C.. 1975.

5. Ryan. RP "Crash Injury Survival. A Report of 26 Cases." Aerospace Medical Association. Miami. May 1976.

6. U.S. Naval Flight Surgeons Manual. U.S. Government Printing Office. Washington. D.C.. 1968.

HOW TO DO A WALK-THROUGH SURVEY

THE INDUSTRIAL HYGIENIST'S VIEWPOINT

Marshall E. LaNier

From the industrial hygiene point of view, it is important that the desired result is taken into consideration prior to selection of the walk-through site. In addition, it is important to consider the various personnel involved. The establishment's on-site industrial hygienist often has more familiarity with the process than does its corporate industrial hygienist. In those states with approved OSHA plans, the approach of the State industrial hygienist may not be the same as a Federal industrial hygienist, whether this individual is from OSHA nor NIOSH. Similarly, an industrial hygienist serving as an outside consultant from a university may not have the same approach as one from a private consulting agency.

The question of certification is of current interest. Just as physicians have specialties, industrial hygienists often have special areas of expertise. As a result of the examination given at the 1976 Industrial Hygiene Conference in Atlanta, the number of board certified industrial hygienists in the United States is about 1,025. This compares with the approximately 600 board certified occupational physicians.

Just as a note of interest, when NIOSH conducts an evaluation of a work site, these results are not used by OSHA in citation for an over-exposure. OSHA develops its own information as it relates to worker exposure. This gives me an excellent opportunity to say a few words about the NIOSH Health Hazard Evaluation Program. As many of you know, the Act provides that any employer or representative of employees can request an evaluation of his worksite for adverse health effects. This formal mechanism provides for an on-site evaluation generally of a specific process, rather than a plant-wide walk-through. The number of requests received, and those which we are capable of providing an immediate response to, is presently stretching our capability. It is, therefore, advantageous to the field of oc-

cupational safety and health that manpower be developed through individuals such as yourselves to provide assistance in this area.

What does the industrial hygienist look for when requested to evaluate a particular establishment? He must consider several areas. He will first divide the plant according to types of operations conducted. Then it will be necessary to look at the complete plant layout, checking which operations are located near other operations that may pose a potential problem when the contaminants from one are mixed with the contaminants from the other. In order to do this, he must be familiar with the material flow and procedure throughout the plant. This cannot be done without a detailed familiarity with the chemicals at every given step.

This raises a point that probably should be touched upon, and that is the flexibility of purchasing given the procurement department. On a number of occasions that I have personally witnessed, the purchasing agent has changed a given chemical because he could get the quantity required at a lower price without consideration as to the compatibility of that chemical with others in the plant. I would strongly urge that prior to changing chemicals in a given process, the compatibility and toxicity of new chemicals with others being used be considered.

Compatibility has not been taken into consideration in the development of either Section 1910 OSHA standards or the American Conference of Governmental Industrial Hygienists Threshold Limit Values. In each of these lists, the permissible exposure level is considered as a pure substance. There are few occasions where the substances listed will not be present with other chemicals. Much will have to be done to establish standards for work environments containing mixtures. Although the 1910 standards list approximately 500 chemicals, and the present Threshold Limit Value list has 611, NIOSH's Registry of Toxic Effects of Chemical Substances now has some 21,729 different chemicals for which there are documented human data. Also there are more than 61,000 cross references. Depending upon the information source, there are between 100,000 and 500,000 different chemicals used in the various work environments across this nation today. The task of developing standards for each of these substances is almost insurmountable, particularly at the speed we are going today.

The initial walk-through provides the industrial hygienist with an opportunity to observe the various processes in operation that might be a source of contamination. His trained eye can often spot areas of concern. For example, the respirable particles from a crushing or grinding operation that are most harmful to man are those that are invisible to the eye. Fumes are generated from an operation that involves heat (such as welding or brazing), where particles are generally less than one micrometer in size.

The type and location of local exhaust ventilation; the air disturbance near the point of entry which can affect the capture velocity; the pipe sizing, shape, and corners which can affect the air flow or serve as collection points for contaminants—all of these must be observed. What type of filter or air cleaning equipment is used? Where is outside exhaust in relationship to the clean air inlet? Is the building under negative pressure because exhausted air is not replaced with make-up air? The evaporation of a solvent at a dipping operation may not create a unique odor for its detection; however, the industrial hygienist will flag suspicious areas for later sampling.

Sampling for work environment contaminants is still an art. In our Standards Completion Program, more than 100 sampling and analytical procedures for those substances listed in the 1910 OSHA standards were inadequate. Laboratory experience has demonstrated that one must carefully consider not only the type of operation, but the possible interferences present when sampling, and that the provision of your chemist with a bulk sample does not necessarily provide him with the sample he needs of the airborne situation. Industrial hygiene chemistry is becoming a specialized field within itself.

A method of control most often relied upon is personal protective equipment. Your people problems will start here, not stop. The law suggests that protective equipment be used only as a last resort while engineering controls are being designed, purchased, or installed. I saw a sign that said something like "walk a mile in a man's shoes before you condemn him." Well, you should wear a respirator yourself for the time period suggested, and you will understand why they are often worn as a necklace. Are gloves needed and worn? What kind are provided? Observe how they take them off—one with the gloved hand, the other with the bare hand—then put them back on. Note how the inside of the glove can be contaminated.

In summary, the industrial hygienist starts his walk-through with the need to evaluate a particular site against the criteria based on his knowledge of good practice and the requirements of the law. His intent is to locate potential hazards and prevent their occurrence so that the worker is protected.

THE PHYSICIAN'S VIEWPOINT

Donald J. Billmaier, M.D.

Industrial hygienists are specifically trained to evaluate the work environment. Unfortunately, many of you probably do not have an industrial hygienist to call upon to help you, at least on a routine basis. Therefore, the job of identifying potential problem areas, which will need more intensive evaluation by a professional industrial hygienist, may be up to you.

This paper cannot present or teach all aspects of industrial hygiene, occupational medicine and nursing, or safety. To do a walk-through survey you ought to have some basic grounding in at least some aspects of those disciplines. Performing a walk-through survey is not a natural, inborn function. However there is a lot you can accomplish simply by using your senses, being inquisitive, and keeping some basic principles in mind.

This is not a talk on how to do a safety inspection. I admit to a lack of expertise in the safety area, and leave such walk-through inspections to those who do have safety expertise. I am sure, however, that some of the things I will mention will also pertain to safety inspections.

What is a walk-through survey? Basically, it is comparable to an office history and physical examination. No complicated laboratory procedures are done, but you take an all around look at the workplace to identify trouble spots or potential trouble spots. A well done history and physical can probably identify ninety to ninety-five percent of the health problems an individual may have. Likewise, a well done walk-through survey probably will uncover ninety to ninety-five percent of the areas or operations where health problems may be encountered in the workplace.

A walk-through survey is not a definitive study. By history you may suspect anemia

and a look at the conjunctiva may give you further indication of low hemoglobin. A history of mid-epigasteric pain will alert you to look for upper G-I bleeding, but only by further studies will you be able to get to the cause of the problem. A walk-through survey, likewise, will help to point out a problem; but further definitive studies, such as industrial hygiene sampling, or physical examination of the workers may be necessary.

On the other hand, a history and physical examination may provide enough information to make a definitive diagnosis and start treatment. If you discover that your patient is having typical ulcer symptoms, you may institute treatment with no further studies. If you smell ammonia and the workers have definite complaints of eye and nasal irritation, you can probably say there is too much ammonia and something needs to be done, even if you do want to get further studies for documentation.

Some patients will come to you with minor complaints, or if the least little thing is wrong. Employee complaints may let you know of areas where health problems exist. Some employee complaints, just as some patient complaints, may have nothing to do with health problems or might be within the range of normal. Some employees or patients may know that problems exist, but for one reason or another do not mention them unless asked, or unless you discover them by looking. Some employees and patients may be unaware that they have a problem and only by doing a thorough and systematic history and physical examination, or in this case a walk-through survey, will you discover any abnormalities.

The title of this section is "How To Do a Walk-Through Survey." It will also help to address the other adverbs of the journalistic trade, namely "who, what, when, where, and why." We have already talked a little about why you want to do a walk-through survey.

There are many potential health hazards in industry, and we need to keep an eye on them to make sure they do not get out of control. A walk-through survey is one way to define and help you learn what is normal in the workplace and to detect actual or potential work hazards. A walk-through survey will help you learn of existing health hazards so that corrective action may be taken. It will establish a baseline so that you can more effectively evaluate future problems. Surveys will also help you to get to know the operations and types of jobs, so that if a worker comes to you for treatment of an injury or illness, you will know from first hand what kind of work he was doing.

Besides getting to know the jobs and production operations you will get to know the people. Seeing workers on the job may help you to know them better and in a different way than seeing them in the medical department or across the table at a meeting. Also, a walk-through survey can be good public relations. Workers may tend to question the credibility, qualifications, or intentions of a physician, especially if he is paid by a company, and is a member of management, no matter how competent he is or how fairly he acts. By getting to know the workers and the workplace so that you can act in an unbiased way to protect the workers' health, you can gain the confidence of management and employees.

One of the main points I would like to get across is that **YOU** must **DO** the walk-through survey. There is no substitute for either the you or the do. If someone comes to you for a physical examination, you certainly want to be sure that they receive a thorough examination, and you will want to perform the examination yourself. You will not rely on others to listen to the heart and lungs, or palpate the abdomen. In examining the workplace you will want to use the observations and expertise of others, but you cannot get away from the fact that it is something you yourself must do. To belabor the point, **you** is the most important answer to **who** should conduct the walk-through survey. Conducting a walk-through survey by yourself can be very worthwhile. Also worthwhile is a walk-through survey conducted as a member of a group. In many

locations, walk-through surveys are done as part of a plant safety committee function. The plant physician, nurse, safety man, industrial hygienist (if there is one), supervisors, and union representatives will participate. This has the advantage of providing several areas or levels of expertise and points of view. At least initially you will want to enlist whatever expertise you can. The plant engineer, chemist, or process or quality control personnel can be very helpful in explaining processes or defining what chemicals are used or produced.

When do you do a walk-through survey? First of all, you have to do it when you have time. But if you say "I'll do it when I have the time," you will probably never have the time. As a professional with occupational health responsibilities, walk-through surveys should be a basic part of your activities, and you should make sure that your schedule contains time to conduct them. While it may be difficult to take the time or adjust your schedule, it will be very worthwhile to have yourself included in plant health and safety committee activities, including the walk-through surveys. After you have learned the workplace and met the workers, doing a walk-through survey by yourself will allow you to give more attention or time to specific workers, areas, or operations.

A walk-through survey generally implies that you look at, or walk through, all areas of the location. However, you can look at specific problem areas when the need arises. If you see a worker from a certain area with a minor problem, you could use the opportunity to go take a look at his workplace. Perhaps you could take a different route through the plant when you go to the medical department. If you provide medical services in your private office, rather than at a plant location, you will have to make a more concerted effort to get your walk-through accomplished.

Plant management may not agree or understand that plant visits and walk-throughs are a necessary and integral part of providing occupational health services. Besides selling yourself on the idea, you may also have to sell plant management that surveying the workplace is an important and integral part of your job. Putting a time for conducting a walk-through survey on your own schedule is one thing, but announcing your plans ahead of time is another. Oftentimes you will need to make plans for a walk-through survey in advance, so that you do not waste your time and are able to see the production operations which you need to see. If you conduct the survey as part of a committee, it will be difficult to make an unannounced survey. When doing your walk-through, you ought to see things as they normally are.

In considering when to conduct a walk-through survey you need to take into account the nature of the production operation. A survey at 6:00 p.m. may fit into your schedule just fine. If workers are only in the factory from 7:30 to 4:30, however, that is obviously not a good time. Many production operations are intermittent in nature, so you would like to schedule your walk-through survey when the greatest number of processes are in operation. It may take several visits to complete a survey and cover all the operations, but an attempt should be made to do this. Processes which are run only intermittently may present some of the greatest potential hazards. If there is work at night or on weekends, it may be good to make an occasional visit at these times to see if there are any differences from normal daytime operations. The type of operations or the type or amount of supervision may be significantly different on nights and weekends. If there are fixed shifts, rather than rotating shifts, you will get to know a wider range of employees.

There is no general rule on how often you should do a walk-through survey. If the factory or plant has relatively stable amounts and kinds of operations or processes, it may be all right to perform a walk-through survey relatively infrequently. But if the processes, people, or level of activity are constantly changing, you will want to do a walk-through more often.

Where do you do a walk-through survey? The only place to do a walk-through survey is at the worksite. You may be able to learn a lot about production and manufacturing operations by talking to employees and supervisors, on the phone or sitting in your office. The only way you can learn what normal operations are, or observe problems or potential problems for yourself, is to actually visit the work place. You cannot do this by telephone or sitting behind your desk. There are probably many areas where people are working and where OSHA regulations are being complied with. The tendency might be to write "deferred" or "not done" for these portions of the walk-through. However, it is important to do a survey of those areas, possibly more important than surveying the less desirable areas.

Sometimes security precautions will make it difficult to arrange a walk-through in certain areas. Health and safety professionals, however, have a legitimate right and need to know what work people are doing and the things they are working with. The time and effort must be taken to make arrangements to visit those special security areas. Initially, and periodically thereafter, all areas should be visited. This means walking around the grounds, and looking outside as well as inside. It means looking at storage areas, maintenance areas, locker facilities, washrooms, bathrooms, office areas, and even the medical facility.

In doing a walk-through, it is best to start at the beginning and follow the process flow to the end. At some locations this may be very simple with one process or line which has a discrete beginning and end. At other locations, it may be difficult because of many separate lines or processes, or smaller lines or processes which lead into larger lines. In addition, most locations will have work areas not connected with the main processes of the work place. Maintenance, building, and grounds are examples. After you have conducted a few walk-through surveys of a site, it will be less necessary to start at the beginning and go to the end. You can concentrate on areas that you know are likely to be the trouble spots. It would be well, however, to do formal periodic walk-throughs which follow a plan, so that you are able to observe all areas and workers on a periodic basis. Most plants or facilities have some sort of layout or map. You do not normally need an extremely detailed map, but you should have one that shows the major operations and process flow. If a site is exceptionally large, or has many varied operations, a map will be essential. If you have a limited number of locations to survey, you may want or may be able to develop a checklist, by areas, process, or potential hazards. Make sure that you give attention everywhere that needs it.

I don't think Amy Vanderbilt has written a chapter on the etiquette of performing a walk-through survey. However, there are certain rules which you ought to follow. Letting a supervisor know you are in his area is helpful. Many supervisors are very protective of their turf and resent intrusion. If you explain what you are doing, and why you are there, you will probably get more cooperation. You may also keep yourself from walking into unexpected hazards. Another etiquette type question is "what do I wear?" You wouldn't normally rent a tuxedo to do a walk-through survey. In most cases your usual clothes will suffice. But if wearing a good suit will inhibit you from climbing, crawling, or poking your nose in certain areas, you should give less consideration to your sartorial splendor, and more to what you need to wear for a proper walk-through survey. (I am not suggesting that you carry coveralls in your black bag.) Also, you will want to wear proper safety and protective equipment for your own good, not only for your own benefit but to serve as a good example or reinforcement for supervisors and employees. While many workplaces have loaner-type protective equipment, it may be worthwhile to invest in some of your own equipment such as safety glasses, shoes, and a hard hat.

Having discussed why, who, when and where to do a walk-through survey, we are left with what and how. You can go to the Federal Register and find the many standards that OSHA has written, and which

form the basis for a safety survey. There are relatively few standards, however, on which you could base a health or hygiene survey, at least of the walk-through type.

The following books can be included in an occupational health library and will help you in performing a walk-through survey, as well as dealing with other occupational health problems.

Industrial Hygiene and Toxicology: Patty, FA (Editor). Interscience Publishers, Inc., New York, 1958. (Although many years old, this is still a standard text. Volume I discusses basic methods of industrial hygiene, while Volume II covers toxicology.)

Occupational Diseases. Gafafer, WM (Editor) Public Health Service Publication No. 1097. (This book has been in the process of revision for four or five years, and the new edition hopefully will be available sometime in the future.)

The Industrial Environment - Its Evaluation and Control. NIOSH, 1973. (This is a good, basic text.)

Documentation of Threshold Limit Values. American Conference of Governmental Industrial Hygienists, 1971 (Supplement published in 1975.)

Fundamentals of Industrial Hygiene. Olishifski, JB and FE McElroy (Editors), National Safety Council, 1971.

Survey Manual, National Occupational Hazard Survey, Volume I. HEW publication No. (NIOSH) 74-127, 1974. (This book describes the manner in which NIOSH personnel are conducting detailed walk-through surveys of industry.)

If you do some homework, you will find that your walk-through will be simplified as well as more productive. We have already talked about getting a map or plant layout. You should get as much information as you can ahead of time about processes and operations. It may help to do some reading on various types of processes, and many companies will have technical or sales literature which will help give you some background. If they do not, the public library will usually have some good basic references for almost any type of industry.

One of the basic parts of an occupational health program, and one of the things that will help you enormously in conducting a walk-through survey is an inventory of chemicals and materials used and produced in the manufacturing process. In compiling the list, you should not overlook chemicals used in cleaning and maintenance activities. Compiling such an inventory is easier said than done. It is a difficult and time-consuming endeavor at best. Hopefully, with more and more people becoming aware of the need, it will become easier in the future. More and more companies, as well as employees and health professionals are becoming aware of the need to know what chemicals people are working with, so that proper precautions can be taken.

You can go to the purchasing department to get a list of chemicals and their suppliers. The purchasing department can also tell you the quantities of the various chemicals used. You may want to look more intently at operations which use large quantities of chemicals.

Perhaps more important than the amount used, however, is the toxicity of the chemical and information on how it is actually handled. For this you will need some basic toxicological information on the chemicals. The material safety data sheets may be helpful, as well as the references mentioned previously. The manufacturer can supply you with these. There is a lot of unevenness in material safety data sheets: the good ones will tell you what is in a product, and how much, as well as giving good toxicity and handling information; the poorer ones will tell you very little and even give misleading information. Armed with your knowledge of the processes and chemicals, wearing the proper clothes and protective equipment, and perhaps with a guide, you are ready to set out on your walk-through.

What do you do on a walk-through? Basically, you use all your senses, including your sixth sense, to determine whether there are any actual or potential hazards for the people who are working. As you walk around the worksite, look at what workers

are doing, where they are working. Look at the general housekeeping. This can give you a clue as to how well the plant is supervised or managed. If housekeeping is sloppy, other controls to prevent occupational injuries or illness may also be sloppy. Look at the labels on bags, drums, and cans. In most cases, these may be as uninformative as the material safety data sheets. In some cases, however, you may discover chemicals which somehow sneak in, that you did not know about. You can talk to supervisors and employees about what they are doing. You can carefully inquire about any health problems related to work. You can observe work practices. You can observe dusts or mists. You can observe whether protective equipment is used, and you may be able to observe whether engineering controls are effective, or if they are not working or have been sidetracked. You can listen for noise, and also listen to the comments of employees and supervisors. You can smell the various chemicals used.

In all probability, you will want to take notes during your walk-through. You may find, especially initially, that you have more questions than answers. What is the chemical you saw the workers dipping their hands into? What was it you smelled where the employees complained of eye and nose irritation? Is the dust the employees are breathing where they empty the bags any problem? How hot was it back by the furnaces? Should those employees by the press be wearing hearing protection? Doing a walk-through survey is only the beginning. It will raise questions that you must answer. As you do more and more walk-throughs, you will be better able to spot hazards or potential health hazards. When you note hazards, you need to follow up and recommend corrective measures. You may need to arrange for industrial hygiene sampling. You may want to examine employees or do some biological monitoring. Basically you want to do whatever is necessary to prevent occupational illness in employees.

ROLE OF THE OCCUPATIONAL HEALTH NURSE

Helen P. Onyett, R.N., B.S.

Doctor Billmaier has just presented not only the "how," but also the "who, what, when, where, and why" in performing walk-through surveys of industrial workplaces. While insisting to this physician audience that **YOU** (the physician) must **DO** the walk-through survey, Doctor Billmaier also recommends the procedure as a group activity as "part of a plant safety committee function," and adds: "The plant physician, nurse, safety man, industrial hygienist (if there is one), supervisors, and union representatives will participate." This echoes recommendations already made yesterday afternoon at this Congress on the "Interdisciplinary Teamwork in the Health/Safety Professions" symposium by both the Eastman staff and Mr. MacCollum of the Society of Safety Engineers. We nurses welcome these evidences of an era of cooperation and good feeling among the health and safety professions!

The occupational health nurse is often the grass roots "den-mother" of the plant health team. The nurse is often the only full-time health worker, especially in the smaller plants, working to support a cluster of part-time safety and medical people, and consultant industrial hygienists, toxicologists, and other specialists. Because she/he writes most of the accident reports, operates the plant dispensary, checks up on use of personal protective equipment, and follows up on correction of hazards, the nurse is often the essential coordinator of the plant's safety/health program in all except job title. Those worker injuries or illnesses that may result from safety or health rule violations most commonly first appear in the medical department, and the nurse being in general charge of that listening post, has the best opportunity to alert other appropriate members of the safety/health team to needed studies and corrective measures.

In such organized preventive programs as safety committee meetings, walk-through

surveys, and health and safety education campaigns for workers, the nurse often finds herself and her medical department at the center for both planning and implementation of these activities. In addition, her daily professional contacts with workers and their supervisors keep her in constant touch with current administrative problems in each department that affect injury and disease control on the job. She/he is usually the primary portal of entry, not only into medical care, but also into primary prevention of hazardous exposures. She/he frequently is consulted spontaneously by workers on a wide range of health matters, and, in the field, often knows which workers and supervisors can be asked to cooperate with the professional team on constructive preventive programs.

The occupational health nurse is employed for the purpose of prevention of disease and injury of employed workers at and through their places of employment; she also reduces incidence and severity of illness and injury to the minimum. This can be accomplished by her responsibility for making first level diagnosis (or nursing diagnosis) of injury and illness and referring the employee to the physician for early treatment. In order to determine causation of the injury and illness, an accident report must be promptly submitted to be incorporated in the OSHA 101 report or on the employer's report of injury for workers' compensation insurance. The supervisor's accident report often is late or even non-existent; this necessitates questioning of the employee. A walk-through survey of the plant periodically will assist the nurse in identifying hazardous conditions which may be responsible for accident or illness.

In order to apply principles and procedures for promotion, restoration, and maintenance of optimum health of the employees, the nurse emphasizes basic areas of professional knowledge and skills. These subjects are most directly concerned in planning a plant survey. An effective occupational health program involves the physician, the nurse, the safety director, the industrial hygienist, and medical specialists. The scope of occupational health services is dependent on the nature of occupational safety and health hazards, accident experience, number, age, and sex of the work force, rates of labor turnover, absenteeism, availability of community medical and health resources, and requirements of local, state, and federal legislation. The safety director and the industrial hygienist can counsel the nurse on identification and control of environmental hazards.

A planned walk-through survey is based on a self-analysis by the plant professionals. Preliminary preparation is mandatory to provide a systematic procedure for the walk-through survey. Environmental health hazards should be identified:

1. Determine raw materials, processes, and equipment, by-products, and products.
2. Review material properties, effects, process flows, pressure, and temperature conditions.
3. Develop references, safety data, and Threshold Limit Values information for all items in 1 and 2. These can be secured through the National Safety Council, American Industrial Hygiene Association, American Mutual Insurance Alliance, Manufacturing Chemists' Association, the American Medical Association, and so forth.
4. Establish cooperative relationships with: a. the safety specialist—he can teach the nurse how to recognize the process or hazard and how to investigate accidents; b. the industrial hygienist—he can teach her to identify potentially hazardous materials and environmental conditions and can recommend engineering and medical controls.
5. Collaborate with the physician and management to develop a medical surveillance system for control of occupational disease or injury.
6. Develop a list of industrial processes itemizing operations hazardous to safety and health.

A WALK-THROUGH PLANT SURVEY—THE NURSE'S ROLE

1. Plan plant tour with plant supervisor and, if available, the physician, safety specialist, and industrial hygienist.
2. Observe safety rules. Obey the signs

posted for protective equipment, also instructions.

3. Be guided by your five senses to detect hazards and harmful activities which may affect the workers' health and welfare. I use **E E N T T O** as my rule of thumb.

"E"—"Eye" Are the workers following proper operative procedures? Are safety rules obeyed? Are machine guards in place? Is the worker wearing protective equipment properly? Is housekeeping good? Is carbon monoxide produced in the manufacturing process? An employee was found unconscious Monday morning. What are those dusts and fumes in the plant? Employees claim they are carcinogenic. Is lead being heated or used in ways to produce inhalable fumes or dust? Does the worker in the laser department have a pre-placement retinal photograph?

"E" for "Ear" Do plant operations cause excessive noise exposure? Has a noise survey been done? Are the permissible hours of noise exposure documented and complied with? Are there signs posted for ear protection to be worn in this department? Is ear protection worn properly? Are there baseline and periodic audiograms recorded? How did the welding spark get into the worker's ear?

"N" for "Nose" Do plant odors irritate the worker? Are vapors, gases, liquids, or solids in harmful concentration? Is protection (masks, respirators) indicated? Are they approved by the Occupational Safety and Health Administration, the National Institute for Occupational Safety and Health, the Medical Emergency Service Associates, and so forth? What is the air concentration of the hazardous material? Is there a medical surveillance procedure for this hazard? Are the environmental controls effective? What about the sulfuric acid fumes?

"T" for "Touch" Did the worker handle equipment properly? Is he wearing protective equipment such as gloves or protective cream? Is he clean? Has the worker been instructed as to the hazard and what he should do in case of accidental spill of the hazardous material? Are there showers and water fountains in the near vicinity of the hazardous material? Has the clean-up procedure been explained to the worker? What are the hand washing and shower facilities? Is the temperature excessive? How does the extreme pressure affect the worker? Is this area marked "off limits"?

"T" for "Taste" Is the worker eating, smoking, chewing, or drinking at the worksite? (Lead and mercury workers must be instructed to refrain from eating in the department.) Are there warnings or instructions regarding the hazard? Is there a lunchroom or cafeteria where employees can eat during break and scheduled mealtime? Is the worker washing hands or showering before meals or departure from the plant? What are the sanitary standards? What about food handling facilities? Where do the employees keep their lunch? Is the food safe to eat?

"O" for "Other Physiological Effects" Check the chart "Hazards of Plant Operations." Is the worker instructed on the nature of the hazard? Does the sandblaster wear protective equipment? Is the abrasive blasting agent silica? Did the mix room attendant get his backache from the job? Is this job automated? What about the employee wearing a pacemaker? Is there a microwave oven on the premises? Is that cardiovascular patient on specific medications which may affect his efficiency and work production? How about the worker on the "pill" who is complaining of dermatitis? Has the diabetic patient been instructed on prompt first aid attention for all injuries no matter how minor? An employee with severe kidney disease is assigned to the mercury or solvent operations. What do you do about this? How about the ex-coal miner working in the molding department? Will he put in a claim for silicosis?

Reporting results of the survey to management for correction of the hazardous environment and to the physician for medical controls and treatment of injured or ill employees will increase the occupational health nurse's capability in functioning as an occupational health nurse.

WOMEN AT WORK

PREGNANCY

Vilma R. Hunt, A.M.

Fifty years ago we could read in a publication of the Women's Bureau[1] that "although legislation on the subject shows that some attention has been given to special hazards to which women are exposed in industry, it also shows that there has been little, if any real attempt to discover what the special hazards are for women." Twenty-five years ago, Anna M. Baetjer in her book *Women in Industry — Their Health and Efficiency*[2] stated that the section on mortality and fertility of women in relation to occupation was included not so much in the hope of presenting any information on the subject but rather to point out the need for investigation in this field and to serve as a word of caution in interpreting the data available at that time. It would seem that the warnings of the past fifty years have come to haunt us when we attempt to define working women as a particular population-at-risk to hazards of the work place. Can we justify the study of a particular population-at-risk — in the context of this discussion — women workers?

As we consider other characteristics of the work force, e.g., age, race, smoking history, we have little difficulty in considering them all as appropriate subgroups for epidemiologic investigation. The application of such studies to the practical problems of safety in the work place present demographic, legal, and biological complexities. These complexities reach their extreme when regulatory agencies, industry, and unions attempt to focus on the female work force. And yet an examination of epidemiologic studies, regulations, and industry practices relating to this particular population, women workers, gives little indication that such complexities exist. From the biologist's vantage point, the somatic and genetic integrity of the total population must be considered when there is environmental, including occupational, exposure to physical, chemical, and biological hazards; and examination of all groups in that population becomes essential. Somatic effects resulting

from exposure to occupational hazards are likely to be observed differentially in populations designated by age, race, smoking history, sex, and so forth; and epidemiologic studies are frequently directed to the identification of the most vulnerable group in the identified population-at-risk. It is surprising, then, to note that frequently sex as a designation is not mentioned in many studies. A review of the past five years of journals which publish occupational health studies gives the subjective impression that the woman worker does not appear to be a part of the work force (in all its variety) that is being described.[3]

It is at this stage that we can identify a roadblock in the development of an adequate information base concerning the occupational health status of women in the United States. Currently we do not know if there are occupations where women are the most, or the least vulnerable, or whether somatic effects stem from their particular female characteristics. To claim that women can be ignored as a separate group epidemiologically because we have equal employment opportunity laws or because standards for permissible exposures to hazardous substances will be stringent enough in the dim future to protect the most vulnerable, begs the question. Women have been too frequently excluded as a group for study, whatever their age, their race, or smoking habits.

One of the exceptions to such a broad generalization concerns those occupations with radiation exposure. The extensive studies[4] of the radium dial painters (mostly women) presented the problem of locating women who had married, moved, remarried, and so forth in order to identify as accurately as possible the population-at-risk and to compile as detailed data as possible on each person in that population. But all the sociologic and economic problems of this complex study were solved in order to provide critical information for the setting of radiation exposure limits during the rapid development of the country's nuclear capability in wartime and subsequently for the growing nuclear industry. The extent of that study has not been matched since for a female working population. It is useful to examine the process of risk estimation for ionizing radiation and other hazards to which the general population and specific groups of workers are exposed. It is the estimation of risk which in part influences the setting of standards for allowable exposure to hazardous conditions. As we look at radiation exposure and protection today, particularly in the work place, the practices and constraints are quite different from those we find associated with other hazards. It would be interesting to know how historians would explain these differences. If the philosophy of protection of the worker from industrial hazards is far from being a unitary concept, can futurists predict with any accuracy the eventual impact of this relatively new phenomenon of radiation on the environment, including the work environment? Will the impact be much different from that of the old familiar dangers and the newer suspected ones?

To my knowledge, the men and women who were exposed to excessive polonium contamination in the forties under the Manhattan Project were never followed up, although estimates of body burden were made and the health physics experience contributed to subsequent radiation protection reports in the early fifties. But in the sixties came the realization that the human and experimental animal data upon which standards for public protection might be based applied primarily to high exposure doses, i.e., 100 rads and above, when information was really needed on exposures of 0.1 to 0.5 rads. A working assumption developed among organizations concerned with radiation protection that there is a proportional relation between radiation dose and the biological effect, and that the effect would be considered to be independent of the dose rate in the lower ranges of exposure. The implication is that there is no threshold, i.e., any radiation exposure may have a finite possibility of being causally associated with carcinogenic, developmental, and/or genetic effects. The evidence is quite clear from observations on both human and animal populations that genetic and developmental

effects and several kinds of cancer can be produced by high doses of ionizing radiation. As the dose diminishes, the number of individuals affected also decreases. And in both epidemiologic studies and laboratory experiments we find that the dose reaches a point below which there are so few identifiable cases that they cannot be differentiated from the background noise.[5]

The National Council on Radiation Protection and Measurements (a non-profit corporation chartered by Congress) recently published a report, "Review of the Current State of Radiation Protection Philosophy," which analyzed the reports published since 1970 by the International Commission on Radiological Protection and the National Academy of Sciences of the United States.[6] This is the continuation of a process of re-evaluation which has gone on for more than 30 years. Whatever one's judgment of the particular standards set and the efficiency and vigor of enforcement of the standards, the process of standard setting during the 80 odd years since the introduction of ionizing radiation into the work place bears comparison with the standard setting procedures for other physical and chemical agents. The current guiding principle of the National Council on Radiation Protection (NCRP), which undergoes continual review and which has most strongly influenced the setting of numerical radiation protection guides or dose limits for occupational exposure, is that the "lowest practicable radiation level" is the concept basic to the establishment of radiation standards. In addition, the assumption is made that radiation health hazards do not have a dose threshold. In other words, numerical radiation protection guides or dose limits for the exposure of radiation workers are provided only as upper limits, with the expectation that all exposures will be kept to a practicable minimum, far below what is allowable.

As a working philosophy how does that apply to the fertile woman? Although the larger proportion of fertile women who work in a radiation environment are hospital workers, more women are entering the nuclear industry, and we have new occupations appearing, e.g., airline baggage inspection. The appendix to the National Radiation Commission Regulatory Guide 8.13[7] applies to workers employed in facilities licensed under the U.S. Atomic Energy Act, and stems from a proposed amendment to Section 19.12, 10CFR Part 19 that would require NRC licensees to include instructions to all workers, information about the biological risks to embryos or fetuses exposed to ionizing radiation, and in addition to advise women employed in jobs involving radiation exposure that the intent is to minimize exposure to and possible adverse effects on embryos or fetuses. The proposed amendment also states that licensees should make particular efforts to keep the radiation exposure of an embryo or fetus to the very lowest practicable level during the entire gestation period. This recent concern arises from a recommendation made several years ago by the National Council on Radiation Protection[8] that during the entire gestation period the maximum permissible dose equivalent to the fetus from occupational exposure of the expectant mother should not exceed 0.5 REM, i.e., one tenth the maximum permissible dose allowed the worker, 5 REM. The comment that went with the recommendation was that, "The need to minimize exposure of the embryo and fetus is paramount. It becomes the controlling factor in the occupational exposure of fertile women. In effect, this implies that such women should be employed only in situations where the annual dose accumulation is unlikely to exceed 2 or 3 REMS and is acquired at a more or less steady rate. In such cases, the probability of the dose to a fetus exceeding 0.5 REM before a pregnancy is recognized is negligible. Once a pregnancy is known, the actual approximate dose can be reviewed to see if work can be continued within the framework of the limit set above. The method of application (of the recommendation) is speculative and needs to be tested for practicality in a wide range of occupational circumstances. For conceptual purposes the chosen dose limit essentially functions to treat the unborn child as a member of the public involuntarily brought into controlled areas. The NCRP recommends vigorous efforts to keep exposure of an embryo or fetus to the very lowest practicable level."

Rather than pursue the pros and cons of this approach to protection of the fetus, I want to pick up the thread of discourse with which I began, namely that the extent of the danger which can result from radiation exposure is acknowledged, and that practical means of avoiding exposure to the fetus are being developed. In addition, the central principle of keeping exposure as low as practicable is being emphasized, even if that exposure is already well below the maximum permissible dose. Is it possible to identify some aspects of the radiation experience which might be useful in other occupational settings? What are the current deficiencies in practice and knowledge?

Although individual monitoring for radiation exposure has been a regular procedure for many years, it is only very recently that hospitals have started to become more responsible in their checking of exposure records. They are still irresponsible in their lack of instructional programs for employees regarding occupational hazards. The National Institute for Occuaptional Safety and Health (NIOSH) study on hospital occupational health services showed that in the hospitals reporting, 64% of the small hospitals, 40% of the medium hospitals, and 30% of large hospitals had no routine in-service training programs for the control of radiation exposure.[9] Many of these institutions are not NRC licensees, but are now under the jurisdiction of the Occupational Safety and Health Act (OSHA). Less than 2% of the more than 5,000 hospitals queried replied that pregnancy received any emphasis in their safety and health education programs. Better work practices are going to have to be demanded of health professionals as is currently expected of NRC licensees. It is ironic that epidemiologic studies of the longevity, morbidity, and mortality of radiologists (usually excluding the few who were female) have been going on for 20 years; but there are no U.S. studies of X-ray technicians, nuclear medicine technologists, or nurses dealing with radiation therapy. Who knows what their reproductive experience has been these last 30 or 40 years? And how much more efficiently and expeditiously improved exposure standards could have been introduced if these studies had been available?

The futurist view is that we will move toward a biological and epidemiological understanding of cancer susceptibility, including particular sub-groups in the workplace. The influences that make for differences in susceptibility in humans are little known, though the evidence for a relationship with impairment of immune reactions is strong, stronger perhaps than the evidence relating childhood leukemia to radiation exposure in utero at low doses of a few rads.[5] The real practical usefulness of "low as practicable" should become apparent more quickly and directly as more hazardous substances for which "zero exposure" is necessary come to be identified. In addition to considerations of potential carcinogenicity, hazardous substances are now being tested for mutagenicity. The experience with ionizing radiation goes back to Herman Muller's drosophila experiments of fifty years ago.[10] But estimates of genetic risks in human populations are still based primarily on experimental animal data and the assumptions of the linear hypothesis I mentioned earlier. The genetically significant impact on subsequent generations which can result from exposure of a population to mutagenic agents is affected by the contribution to the gene pool of both men and women who procreate. But we are a long way from knowing whether there is a differential genetic effect on developing and mature ova and sperm as a result of old familiar hazards, least of all the multitude of new chemical, biological, and physical agents now in the workplace.[11]

Today the number of women in the work force (and in many specific industries) is not a limiting factor for adequate epidemiologic study. Indeed only a few industrialized countries have a total work force of men and women which exceeds that of working women in the United States.[12] For example, it has been found feasible in England to make a cohort study of female asbestos workers.[13] A population-at-risk which has been virtually ignored for 50 years is made up of the children of workers. The National Center for Health Statistics[14] reported that in 1963 for legiti-

nate live births almost one-third of the mothers were employed at some time during pregnancy. Among those for whom this was the first live birth, 59% were employed, and among those who had had previous live births, 22% were employed. It is somewhat surprising to note that for the sample of 4,000 mothers from which these estimates were made, specific information on their occupation was not solicited, although that on their husband's was. It may well be that Harriet Presser's comment[15] that the working woman, and most particularly the working mother has been, "one of America's best kept secrets" is even more applicable to the 60% of primiparae and 22% of multiparae who work at some time during their pregnancy. We do not know their distribution by occupation or industry. Any specific question we ask today concerning a particular occupation, e.g., X-ray or nuclear medicine technologist, laboratory worker, pharmaceutical processor, textile worker cannot be answered. The recent studies on operating room personnel and their pregnancy outcome have now been extended to the unexposed wives.[16] We are learning the hard way of the inadequacy of monitoring procedures appropriate for the identification of an additional population-at-risk — the children of workers.

During healthy pregnancy different reference standards of normality are essential. At the same time, we know that the normal can merge gradually into a pathologic condition with the boundary being difficult to diagnose clinically.[17] A complicating factor is that many of the physiological changes found in pregnancy simulate pathology in the non-pregnant state, (e.g., edema — swelling of ankles, and so forth). Many of the metabolic adjustments of pregnancy are established—often completely—during the early weeks and months of pregnancy, when the product of conception is still too small to make significant demands on maternal reserves. It is useful to note that physiologists no longer consider maternal changes as reactions to "stress" or to depletion of reserve by the fetus. This is not to say that these known modifications of maternal body function from conception to the birth of the infant can be ignored when conditions in the work place directly impinge on the pregnant woman. For example, respiratory function undergoes some changes in pregnancy. Although vital capacity probably does not change, there is a marked rise in tidal volume throughout pregnancy. The increase in tidal volume in pregnancy can increase 39% over post-partum levels.[18] Cugell found the mean tidal volume at term to be 678 ml compared to 487 ml post-partum. The respiratory rate, however, rises very little, if at all in pregnancy. The minute ventilation, because of the tidal volume increase, shows a rise in pregnancy of over 3 liters, about 42%. These observations show that the pregnant woman increases ventilation by breathing more deeply and not more frequently, and minute alveolar ventilation at term will be 8.6 liters, an increase of 65% over the 5.2 liters postpartum. If the vital capacity is unchanged by pregnancy, there must be a rearrangement of respiratory compartments; the inspiratory capacity increases at the expense of the expiratory reserve, so that the lung is relatively more collapsed at the end of a normal expiration. The residual volume is reduced. Moya *et al* [19] point out that the alveolar tension of each inspired breath of gas depends on the degree of dilution by the functional residual air volume. This volume usually acts as a buffer to changes in normal respiratory gas tension as well as gas tension of an anesthetic or noxious gas. The larger the residual volume, the more slowly the change in concentration occurs. Conversely, the pregnant woman with her smaller functional residual capacity, will more readily and rapidly fill her lungs with an adventitious gas at a certain tension than the non-pregnant. In other words, a decreased functional residual volume accelerates the rise of alveolar concentration of the contaminant by reducing lung washout time. The effect on alveolar concentration is thought to be greatest with the less soluble gases, and least with the highly soluble gases.

The rise in alveolar concentration production by ventilation is opposed by uptake of the gas into the pulmonary blood. The greater the loss the lower is the ensuing alveolar concentration. There are several

factors which determine the extent of uptake:

The solubility of a gas is primarily dependent upon the nature of the solvent and any variation in composition of the solvent alters solubility. Total lipids are increased 40% during pregnancy, with an elevation of over 100% in neutral fat and about 25% in phosopholipids and cholesterol. However, little is known about the solubility of gases in the blood of pregnant women, including those commonly used as anesthetic agents such as chloroform, methoxyfluorane, halothane and trichloroethylene.

Cardiac output governs pulmonary blood flow which can remove gas from the alveoli. Therefore, the greater the cardiac output the more rapid the absorption of the gas from the alveoli. With soluble gases such as ether and halothane, an increase in cardiac output results in a considerable reduction in alveolar tension and increased absorption of the gas. And during pregnancy the significant and progressive increase in cardiac output reaches a maximum of about 40% by the 25th and 27th week. These factors of (1) altered blood volumes and composition and (2) altered lung function must affect the maternal and fetal response to contaminants. There does appear to be a theoretical possibility that the absorption of contaminants, particularly those which follow the inhalation route, may be increased over that experienced in the non-pregnant state for the same exposure level.

During pregnancy, the concentration of red cells in the blood and therefore of hemoglobin, falls because the increase of plasma volume is relatively greater than the increase of red cell volume. A common description is the "**physiological anemia of pregnancy**," which is a contradiction in terms because these changes in red cell volume and plasma volume are entirely appropriate to the changed circumstances of pregnancy, and probably the margin of safety for oxygen carriage is raised. However, it is difficult to extrapolate to conditions where the pregnant woman is exposed to carbon monoxide or methylene chloride, for example on the basis of theoretical considerations. Similarly, we are aware that the fat content of blood is raised during pregnancy, and increases have been reported from between 650 to 700 mg/100 ml serum at 16 weeks to over 1000 mg/100 ml at the end of pregnancy. The total lipid is measured as that soluble in solvents such as petroleum ether. In addition, the accumulation of maternal body fat during pregnancy, particularly during the first half of pregnancy can make up 25% of the total weight gain associated with the development of the fetus. The purpose of maternal fat storage is important to consider — particularly in relation to fat soluble solvents. The fat store at 30 weeks gestation is about 3 1/2 kg, which is almost half the total energy requirement specific to pregnancy. In our American society the healthy pregnant woman enters the last third of pregnancy with a very considerable buffer against food deprivation. She probably needs no such safety measure; but many, possibly the majority of the world's pregnant women, do manual labor until the day they deliver. A further use for the store which remains at the end of pregnancy is as a subsidy for lactation, where energy requirements are considerably greater than those of pregnancy. The biological significance of labile stores of body fat is not known, at least in the context of industrial exposure. Hardy[20] concludes that toxic chemicals stored in fat are probably largely inactive. These physiologic considerations raise more questions for the toxicologist and industrial hygienist than they answer.

How do we answer the question, "is the pregnant woman herself more vulnerable to some conditions in the workplace than she might be — if not pregnant?" The comparison is not with other workers — such as the highly vulnerable middle-aged, slightly over obese male, or the individual with occupationally and/or tobacco-induced respiratory impairment. The integrity of the placenta can seemingly be affected by a variety of circumstances — most, if not all, quite inadequately understood. Maternal blood coagulation characteristics are a case in point. But it is not known whether fibrin formation in pregnant women is continuous, possibly at the placental inter-

villous surface or intermittent — associated with episodes of bleeding from the placenta. The prevention of micro-circulatory blockade depends, in part, on the ability of the woman to generate further supplies of plasminogen activator. There is at least one study[21] which shows that in the context of work, a significant proportion of normal pregnant women in the third trimester appear to lose their ability to release systemic plasminogen activator following simple physical exercise. Such women may therefore be at risk to episodes of severe intravascular coagulation. But we have little further to go on and no linkage information until we reach the clinical sector and epidemiologic observations of pathologic conditions such as premature rupture of membranes, placenta abruption, and placenta previa. There is no doubt that many detrimental substances in the maternal bloodstream can readily reach the embryo and fetus via the placenta.[22] However, we know little of the factors that determine rates of transport of different types of chemicals at different times in gestation. Probably the placenta transmits to the conceptus some fraction of almost all substances in the maternal blood plasma, but the rates must vary widely. Molecules of large size or that bear high electrical charge are likely to be excluded by the placenta. Some foreign substances may be excluded or their passage impeded; for others the placenta may facilitate their transfer. Research in the area of transfer rates for the placenta is limited and has been concerned with advanced fetal development, whereas the greatest teratogenic risk is during embryonic stages. We do not know what concentration of a teratogenic agent the embryo or fetus can tolerate before damage occurs.

The effect of maternal work on the fetus has been examined by Pokorny and Rous.[23] Fluctuation of the heart sounds of the fetus in 12 pregnant women was measured in the last four weeks of a physiological pregnancy. It appeared that the sounds of the fetus during "dosed" physical work of the mother increased to a maximum in the third minute when a steady state was reached. In the restitution period it gradually returned to the value at rest. However, all the pregnant women did not react uniformly to the work effort, and three types of reaction were described:

1. Fetal heart rates were practically unaffected by physical effort. Pokorny presumes that these women were well adapted to the work, which was confirmed by the slight heart rate change in the women.
2. Fetal heart rates gradually increased with a maximum at the beginning of the steady state. Yet towards the end of the effort the fetal heart rate decreased to the starting value.
3. There was acceleration of the fetal heart rate with a maximum toward the end of the effort, but with a marked decrease below the starting value at the beginning of the restitution period. A similar pattern is often found in the mother's heart rate.

Pokorny *et al* considered the possibility that these examples represent three qualitative types, or perhaps only variable deviation, and that the greater the reaction of the pregnant women to work, the greater its influence on the fetal heart rate. Under the conditions of physical work, the fetus would have an advantage in those women who are physically fit. In examining pathological pregnancies (toxemia of pregnancy and diabetes), the change in fetal heart rate was in marked contrast to those in normal pregnancies. There was conspicuous increase in the fetal heart rate even in the first phases of the effort (exceeding the limits of 2 standard deviations for physiological pregnancies) and it continued to increase until the end of the work without reaching a steady state. During the restitution period the fetal heart rate fell below the initial value with a slow return to the initial value within 5 minutes. Pokorny concluded, "In muscular work, we must consider the possibility of a diminution of the oxygenated blood supply to the uterus because of the redistribution of blood from inactive tissues to the active muscles. The influence of this change in the blood supply on the fetus may be different according to whether the pregnancy is physiological or pathological or according to the maternal adaptation to physical work. Moreover, an increased physical effort may disclose a pathological state which is compensated at rest."

This evaluation of the range of variability in pregnancy should be of prime concern to those who are responsible for the physical well-being of women and to those who monitor their workplaces. On the one hand we can see the continuing need for improved physical conditioning of women. With the obvious increase in exercise and sports participation by young women there should be further research interest in exercise and stress physiology directed to women. Physiologists dealing with exercise testing are well aware that the poor performance of an exercise test, by itself, does not tell whether the subject is sick or is simply unfit, i.e., a poor aptitude for exercise/work during pregnancy may be due to the lack of physical training in association with the additional physiologic demands of that pregnancy. I am proposing that the information we derive from exercise testing and sports medicine can be considered in light of the European view of recent times. "Pregnancy, far from being an illness, should be considered an intensive day and night, 9-month period of physical conditioning because of the increased demands upon metabolism and the entire cardiovascular system."[24]

CONCLUSION

The evaluation of the health of women workers as part of the total work force is necessary for the identification and comparison of their response to occupational hazards. Currently it is not possible to identify those industries where women workers are more or less likely to be affected adversely, when compared to men. In the future, the result can be on the one hand, extreme protective measures directed to women workers which may be quite unjustified or, on the other hand, inadequate consideration of their particular characteristics when criteria for standard setting are being developed. The occupational exposure of the pregnant mother to hazards potentially dangerous to the embryo has not been examined in sufficient detail to allow any reliable decisions. The critical decisions concerning job opportunity and security for women can only be made when there is considered judgment of the advantages and disadvantages of her work participation. Particular occupational conditions dangerous to women are both real and imagined. Due to inadequate monitoring and evaluation of this group of workers, the difference is scarcely known. Safety in the workplace is far from absolute and we know that over a million of the babies born this year will have been in the work place at some time during gestation.[3] And, their mothers and their fathers probably may have had the same experience. For contrary to popular opinions, we are not observing a new social phenomenon. Women have always worked. Indeed reproduction and work are women's lot.

REFERENCES

1. "The Employment of Women in Hazardous Industries in the United States." Women's Bureau. U.S. Department of Labor. 1919.

2. Baetjer, AM Women in Industry — Their Health and Efficiency. W. B. Saunders Co., Philadelphia. 1946.

3. Hunt, VR "Reproduction and Work." SIGNS. J Women in Culture and Society. 1:543-552. 1975.

4. Maletskos, CJ et al. "Quantitative Evaluation of Dose-Response Relationships in Human Beings with Skeletal Burdens of Radium 226 and Radium 228." Assessment of Radioactivity in Man. Vol. II. 225-252. Proceedings Symposium. Heidelberg IAEA. Vienna. 1964.

5. Warren S "Effects of Low Levels of Radiation on Rodents and Potential Effects in Man." Health Physics 29:251-255. 1975.

6. Review of the Current State of Radiation Protection Philosophy. National Council on Radiation Protection and Measurement Report No. 43. 1975.

7. Appendix to Regulatory Guide 813. U.S. Nuclear Regulatory Commission Title 10, Part 19 and 20 of Code of Federal Regulations.

8. Basic Radiation Protection Criteria. National Council on Radiation Protection and Measurements Report No. 39. 1971.

9. Hospital Occupational Health Services Study. 1. Environmental Health and Safety Control. U.S. Department of HEW. PHS-CDC-NIOSH. 1974.

10. Muller HF "Artificial Transmutation of the Gene." Science 66:84. 1927.

11. Report of the Advisory Committee on the Biological Effects of Ionizing Radiation. The Effects on Populations of Exposure to Low Levels of Ionizing Radiation. National Academy of Sciences. National Research Council. Washington, D.C. 1972.

12. 1975 Handbook on Women Workers. U.S. Department of Labor. Employment Standards Admin-

istration. Women's Bureau Bulletin 297. Washington, D.C. 1975.

13. Newhouse, ML et al. "A Study of the Mortality of Female Asbestos Workers" Brit J Ind Med 29:134-141. 1972.

14. Employment During Pregnancy. Legiti nate Live Births. U.S. 1963. National Center for Health Statistics. Vital and Health Statistics. PHS Publ. No. 1000. Series 22. No. 7. 1968

15. Presser, HB "Perfect Fertility Control: Consequences for Women and Family." (ed) C.E. Westoff and others. Toward the End of Growth: Population in America. Prentice Hall, Inc., Englewood Cliffs, N.J., 1973.

16. Knill-Jones RP, BJ Newman and AA Spence "Anesthetic Practice and Pregnancy-Controlled Survey of Male Anesthetists in the United Kingdom." Lancet 2:7-9. 1975.

17. Hytten, FE and I Leitch The Physiology of Human Pregnancy. 2nd Ed. Blackwell, Oxford. 1971.

18. Cugell, DH et al. "Pulmonary Function in Pregnancy: Serial Observations in Normal Women." Am Rev Tuberc 67:568-597. 1953.

19. Moya, F et al. "Uptake, Distribution and Placental Transport of Drugs and Anesthetics." Anesthesiology 26:465-476. 1965.

20. Hamilton, A and HL Hardy Industrial Toxicology. 3rd Ed p 362. Publishing Sciences Group, Inc., Acton, MA. 1974.

21. Woodfield, DG et al. "Serum Fibrin Degradation Products Throughout Normal Pregnancy." Brit Med J 4:665-668. 1968.

22. Wilson, JG "Environmental Effects on Developmental Teratology." (ed) N.S. Assali Pathophysiology of Gestation. Vol. 2. Academic, N.Y., 1972.

23. Pokorny, J and J Rous "The Effect of Mother's Work on Fetal Heart Sounds." Proc Internl Symp "Intra-Uterine Dangers of the Fetus" Exerpta Med., 1967.

24. Klaus, EJ and H Noack Frau und Sport. Stuttgart: George Thieme Verlag. 1961.

MAKING THE WORKPLACE SAFE FOR WHOM?

Kathleen M. Lucas, J.D.

The views I am about to state are my own. They do not necessarily represent the views of the Solicitor of Labor or other Department of Labor officials.

The problem of assuring adequate protection to women of child-bearing capacity while at the same time providing women with equal employment opportunity is, from all points of view, a complex problem.

A national debate has emerged over the significance and consequences of the development of scientific evidence suggesting that embryos during the first six to eight weeks of life are highly susceptible to the toxicity of particular substances; that the offspring of women who are exposed to particular substances suffer a higher incidence of birth defects and deaths than do the offspring of men who are similarly exposed, but that the offspring of such men suffer a higher incidence than do those in the general population; that the dangers associated with some substances are not eliminated when exposure ceases because such substances are cumulative in the body; and, that some toxic substances are transplacental.

In general, researchers and employers have focused their attention onto the health of the fetus within the working environment of women, the childbearing sex. For good reasons, women workers of childbearing age and capacity fear that the increased concern in protecting fetuses may lead to their removal from jobs involving exposure to substances which are known or are suspected to cause injury to the fetus.

Many women's groups maintain that the focus should not be on women workers because many substances are suspected of causing damage to the reproductive systems and the offspring of both sexes. These groups also assert that the pattern of conducting research primarily on the offspring

of women workers is, in itself, discriminatory treatment. The defenders of the research respond by saying that because the offspring of women suffer the higher incidence of birth defects and deaths, studying the offspring of women workers is the first priority. Representatives of women's groups are also questioning whether an employer's failure to eliminate the likelihood of exposure or to reduce exposure to a level which is safe for fetuses as well as adults constitutes a violation of the Occupational Safety and Health Act.

Before I explore the OSHA aspects, I want to point out the third concern raised by the representatives of women workers which is perhaps the most difficult. It is whether the removal of women workers from jobs involving exposure to toxic substances known or suspected of causing injury to a female's future offspring is prohibited discriminatory treatment.

Returning to the Occupationaly Safety and Health Act, I believe that it is too simplistic to say that OSHA should always set the standards at the lowest level, the level which is safe for fetuses because not all workplaces can be made safe for fetuses. Based on the following three reasons I believe that it is naive to say that the total burden is on OSHA to require employers to make workplaces safe for employees and for fetuses.

First, at this time, we do not know the range and scope of the dangers to employees and their future offspring resulting from different levels of exposure to various toxic substances. We do not know how the reproductive systems of men and women are affected much less how they can be adequately protected. We cannot define the classes of women or of men whose reproductive systems or offspring are endangered if they are exposed to individual substances and the variance in effects at particular levels of exposure. We have little data on those substances which affect male sterility or other aspects of the male reproductive system.

Second, I am not convinced that without knowing the dangers, the safety levels, and the feasibility of protecting employees and fetuses that OSHA could ever promulgate standards which would make all workplaces safe for employees and fetuses. I believe that after the scientists establish the facts, OSHA might be able to formulate workable standards which would adequately protect the reproductive systems of males and females but that due to the high susceptibility of fetuses, there are some work places which simply can never be made safe for fetuses.

Third, at the bottom line, the hazards exist regardless of OSHA, and an employer's liability exists independent of OSHA. Given the present state of the law, an employer would generally be held liable to a child for prenatal injury which resulted from either the employer's negligence which has not yet been defined within this context or from an inherently dangerous object, a classification which could conceivably include toxic substances.

In order to understand the extent of an employer's liability, let us look at the principles established by the lines of cases related to an employer's liability for fetal injury. It should be noted here that the Workmen's Compensation Acts control an employee's causes of action against an employer. So, the question is an employer's liability to the fetus, which is not considered an employee within the meaning of those Acts. The facts are: a women knowingly accepts a job which involves exposure to a toxic substance known to cause serious damage to embryos and fetuses. She becomes pregnant while on the job. She decides not to have an abortion and to bear the child.

First, as to the rights of the parent. If the child is born alive, an action may be brought by him or by the parents for damages to compensate for the consequences of the prenatal injury. If the child dies, a wrongful death action may be brought by the parents. The parent's own contributory negligence or assumption of risk, however, may in some jurisdictions defeat his recovery for the

resulting injury to the child, but will not interfere with the child's right to recovery. Thus, it appears that a parent's consent may not preclude the child's recovery.

Second, as to the rights of the fetus. Historically, most jurisdictions have allowed the recovery of damages for injuries inflicted upon an unborn child even though the injury occurred during the early weeks of the mother's pregnancy.

Let us add a new factor to the hypothetical. the employee signed a waiver of the right to sue for herself and her offspring. What is the result? In most states, a parent may waive her right to recover for injuries to the child but may not defeat the child's right to recover for its own physical injury resulting from the wrongful conduct of another. In those states, a parent is not viewed as the agent of the child for the purpose of waiving tort liability resulting from the actions of another. It should be noted that courts have generally held that right-to-sue waivers should be strictly construed.

Further, it is not clear whether an employer in a suit brought by a fetus or its next of kin on its behalf would be considered negligent, as a matter of law, in assigning, or indeed allowing, a potential mother or father to work at a job in which the employee is exposed to toxic substances which are suspected to cause damage to the employee's offspring.

In another area of tort law, courts have held that a person, company, or manufacturer is liable for the damage resulting from an inherently dangerous object, a classification which may include some toxic substances. The fetus might win on this argument. Thus, a suit by the fetus against an employer for damages resulting from exposure to a toxic substance could be brought as a tort action outside of the Workmen's Compensation Acts, based upon a negligence or an absolute liability theory. The amount of the recovery could be an enormous sum of money, to say nothing of the unhappy social impact of propagating a group of malformed children. Thus, the issues are broader than OSHA and the problems cannot be simply and finally resolved through legal determinations. The law does not provide adequate answers because this area of the law is unique and undeveloped. The moral and social aspects of the health of future generations cannot be ignored.

At the same time, the counterbalancing thrust is that women themselves have a right to employment. Given an employer's potential tort liability to a fetus, knowing the possibility of a danger is not enough to eliminate its potential liability for discrimination. To satisfy Equal Employment Opportunity principles, an employer must at least define the excluded class as narrowly as possible.

But what does that mean? Would the following category be acceptable: all persons whose reproductive organs will be damaged by exposure to a substance and who are of an age or inclination to father or bear children? Must it apply to men and women? What if a woman accidentally gets pregnant and decides not to abort even though prior to her pregnancy she had agreed to have an abortion? Is her assurance enough to protect an employer from liability to the fetus? Probably not. What if both she and her husband signed a waiver for themselves and the child? Would it insulate the employer from liability? Should fertility tests be required? Will the right to privacy permit an employer to inquire into the state of the reproductive organs as well as the fertility and the intentions of the employee?

Could an employer refuse to hire a woman who had a child every year for the past five years but who says she intends to stop? How far can an employer inquire into the reproductive history of employees in light of the right of privacy? I don't know the answers to these questions, and I dare say no one does.

There is no doubt that not hiring or not placing women into jobs involving exposure to toxic substances is discriminatory because it is a denial of equal employment opportunity. But, that is not the question. This

issue is whether such an exclusion is *prohibited* discriminatory treatment under the equal employment laws. Because there is no precedent on this issue, I cannot say how a court would rule. However, one thing the analysis does tell us is that the issues cannot be finally resolved in the courts unless the courts reject the traditional and well-settled concepts of tort liability. If the courts were to abandon the existing principles in favor of a new set of laws, they would be deciding very difficult moral and social questions.

To me, the more appropriate forum for such decision-making is the legislative forum. In light of the problems outlined above, one can envision special compensatory programs such as a new category under workers' compensation which compensates those women who are denied employment opportunity because of their potential role as a mother. While this approach remedies one aspect of the problem, it is not entirely satisfactory because women are not assured of full employment opportunity. They would not be in positions to improve their jobs because they would not be part of the system. In addition, the exclusion of women from particular jobs would cost a great deal of money and would result in a loss of skilled workers from the workplace.

In conclusion, looking at the options given above, the following alternatives are available:

First, the existing body of law could be applied, and the test for discrimination would be whether the excluded class was defined as narrowly as possible. It should be noted that the Title VII Guideline requiring that pregnancy be treated as a temporary disability is presently being tested in the Supreme Court case of *General Electric* v. *Gilbert** So the treatment of pregnancy as a sex classification may be affected by the court's ruling in that case, but the employer's tort liability would not be affected.

Second, the body of law could be changed by judicial or legislative action. For example, women could be allowed to waive the rights of the fetus within the employment context. This change could be analogized to the abortion decision which prevented a state from regulating abortions in the earlier months of pregnancy. However, such a change would be dramatic and it must be weighed against the possibilities of bringing deformed children into the world.

Finally, society could recognize the risks involved in exposure to toxic substances and could establish a system for compensating women, and maybe eventually men, who are denied employment opportunity. This alternative, which accepts the first alternative, provides relief to victims, and creates a mode to define the affected class, requires legislation.

I believe that the legislative forum is the proper place for addressing the issues. However, there appears to be no question which can be adequately or finally resolved until the scientists establish the facts on the dangers present in the workplace. Then hopefully, scientists will develop and employers will adopt the technology necessary for assuring adequate protection for potential offspring.

The task before us is to work toward assuring men and women of their rightful place in the workplace while at the same time protecting the health of future generations. It is not an easy one, but we must begin to take some steps. Conferences like this help to inform us of the problems, but we can make few decisions until we know the facts about the hazards, and that information must come from the scientists, not the lawyers.

* The Supreme Court has issued an opinion in the Gilbert case, but the question of whether pregnancy is a sex classification has not yet been resolved.

SPEAKERS AND MODERATORS

Marvin L. Amdur, M.D., Director
Buffalo Industrial Med. Ctr.
Buffalo, N.Y.

Donald J. Billmaier, M.D.
Asst. Medical Dir.
Owens-Corning Fiberglass Corp.
Toledo, OH

J. Howard Bunn, Jr., Chairman
Interdepartmental Task Force
on Workers' Compensation
U.S. Department of Labor
Washington, D.C.

Ernest M. Dixon, M.D.
Corp. Medical Dir.
Celanese Corp.
New York, N.Y.

Thomas S. Ely, M.D.
Asst. Dir., Health, Safety, and
Human Factors Lab.
Eastman Kodak Co.
Rochester, N.Y.

Barbara Healy, R.N.
Supervisor, Nursing Service
Kodak Park
Eastman Kodak Co.
Rochester, N.Y.

William D. Hoskin, M.D.
Med. Dir., Kodak Park Div.
Eastman Kodak Co.
Rochester, N.Y.

Vilma R. Hunt, A.M., Assoc. Prof.
Environmental Health
Penn. State Univ.
University Park, PA

Harold R. Imbus, M.D., Sc.D.
Medical Director
Burlington Industries, Inc.
Greensboro, N.C.

Marcus M. Key, M.D., Prof.
Occupational Health
Univ. of Texas
Houston, TX

Marshall E. LaNier, Director
Div. of Technical Services
NIOSH
Cincinnati, OH

Ludwig G. Lederer, M.D., Ph.D.
Corp. Medical Dir.
American Airlines
New York, N.Y.

John H. Lewis, J.D.
Attorney at Law
Coconut Grove, FL

Kathleen M. Lucas, J.D.
Off. of Solicitor, Div. of Labor
Relations and Civil Rights
U.S. Department of Labor
Washington, D.C.

David V. MacCollum, P.E., C.S.P.
Pres., Amer. Society of
Safety Engineers
Sierra Vista, AZ

Sol M. Michaelson, D.V.M.
Dept. of Radiation Biology
& Biophysics
University of Rochester
Rochester, N.Y.

Franklin A. Miller, Supervisor
Ind. Hygiene Sec., Health, Safety,
and Human Factors Lab.
Eastman Kodak Co.
Rochester, N.Y.

Helen P. Onyett, R.N., B.S.
Occ. Health Consultant
Employers Ins. of Wausau
Indianapolis, IN

Nicholas A. Pace, M.D.
Medical Dir. of New York
Executive Offices
General Motors Corp.
New York, N.Y.

J. Newell Stannard, M.S., Ph.D.
Prof. Emeritus, Radiation Biology
and Biophysics
University of Rochester
Rochester, N.Y.

S. D. Steiner, M.D.
Former Medical Dir.
General Motors Corp.
Detroit, MI

Alexander L. Strasser, M.D.
Medical Dir.
Stromberg-Carlson Corp.
Rochester, N.Y.

Robert L. Wick, Jr., M.D., Prof.
Department of Preventive Medicine
The Ohio State University
Columbus, OH

C. Craig Wright, M.D.
Mgr./Med. & Health Services
Xerox Corp.
Rochester, N.Y.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1977— 757-057/6724

END

DATE

FILMED

1-26-78

NTIS