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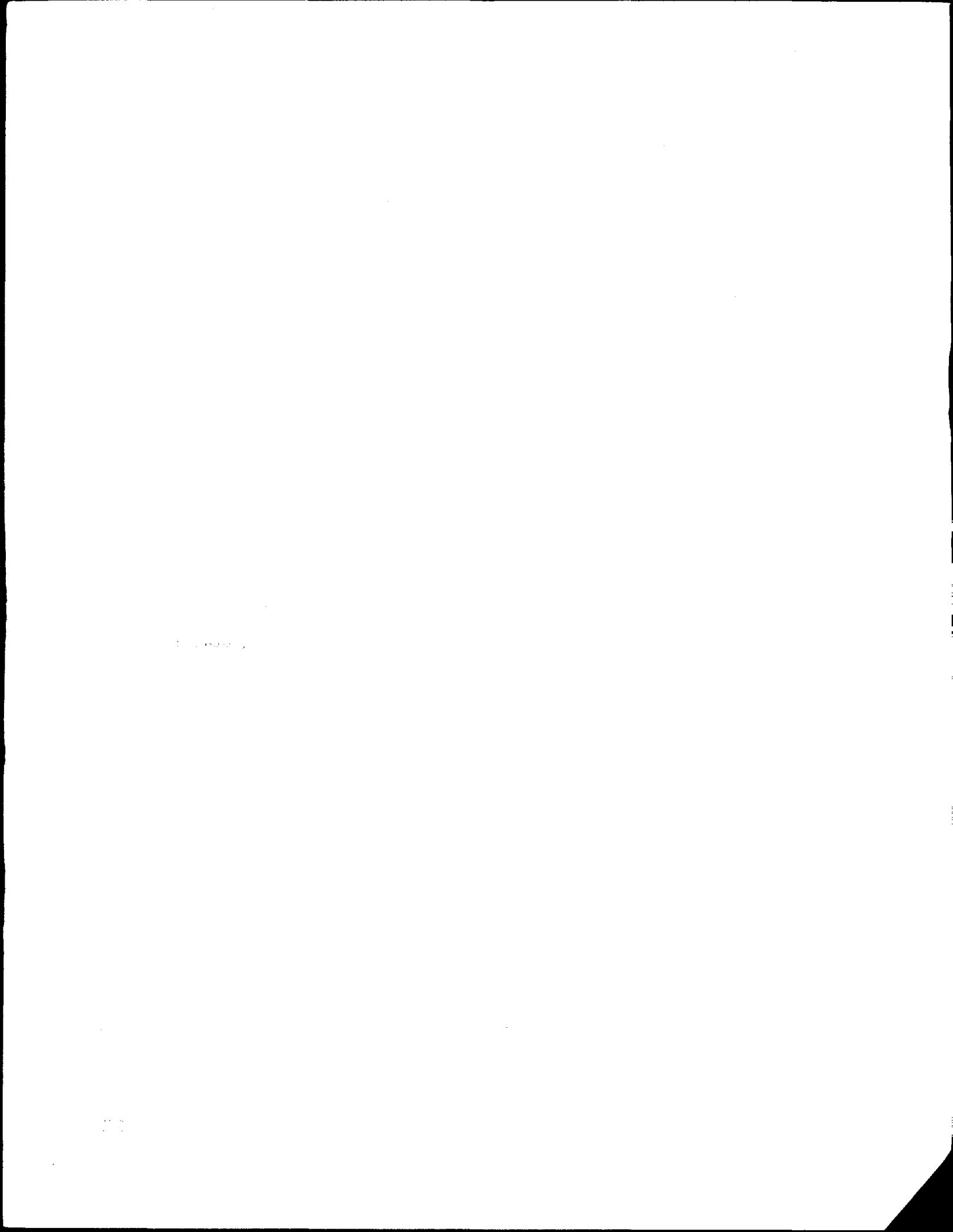
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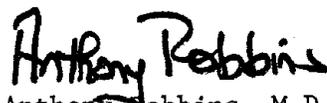
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FOREWORD

For the past 38 years, the American Medical Association has held an Annual Congress on Occupational Health. The National Institute for Occupational Safety and Health has published the proceedings of the Congress since 1974. This year, for the first time, the Congress was held at a NIOSH-funded Educational Resource Center--the one at the University of Arizona, Tucson.

These congresses have provided a continuing education resource to the physicians, nurses, and industrial hygiene and safety professionals attending. The speakers, selected on the basis of their expertise, now bring to the readers of this reference publication the most recent research issues in areas of particular concern to the safety and health profession.



Anthony Robbins, M.D.
Director, National Institute for
Occupational Safety and Health

PREFACE

This Occupational Safety and Health Symposium is the sixth such meeting that the National Institute for Occupational Safety and Health (NIOSH) has held in a continuing program of cooperation with the American Medical Association; however, NIOSH has published the proceedings only since 1974. These symposia provide a continuum on the state-of-the-art in the rapidly expanding field of occupational safety and health in the United States.

The audience has expanded from the original group of primarily part-time occupational physicians to include full-time occupational physicians, nurses, industrial hygienists, safety professionals, technicians, and students in these respective fields. Publication of the proceedings makes the current information available to students and professionals unable to attend the Congress and provides a relevant text for students in occupational and worksite environment studies at various colleges, universities, and conferences.

These proceedings do not necessarily represent the views of NIOSH; they do, however, represent the concern NIOSH has for improving the delivery of occupational safety and health services to an ever broader segment of working men and women

Suggestions for agenda and items for future symposia are requested, as well as comments to improve the services of NIOSH to providers of occupational safety and health care.

Loren L. Hatch, Project Officer

ABSTRACT

These Proceedings, the fifth in a series of NIOSH Occupational Safety and Health Symposia, are a compilation of papers presented during the 38th AMA Annual Congress on Occupational Health at the University of Arizona Health Sciences Center, Tucson, Arizona from September 14-16, 1978. While adhering to its tradition of bringing to the practising physician--and especially the part-time occupational physician--the latest developments in the field of occupational health and safety, this Congress was somewhat unique: not only did the meeting take place within a university environment, but this particular site was one of the newly formed Educational Resource Centers which had been established by NIOSH. Thus, as evidenced by the content of the papers in this volume, the conference should have appealed to the broadest possible spectrum of occupational health professionals--academicians, practitioners, and students. Topics ranged from legal issues (such as the confidentiality of medical records) to some of the more pressing health problems of the day (i.e., reproductive disorders of both the male and female workers, injuries to the extremities, pesticide problems, non-pneumoconiotic diseases of the lung, cancer, and arthritides).

Inasmuch as the meeting was staged at a medical school, it was appropriate that a forum assemble to discuss the direction such schools should be taking to train physicians or medical residents in the speciality of occupational medicine. On the other hand, both students and residents also had an opportunity to speak their minds on training in this important field of medicine when they told of their experiences in various clerkships in which they were engaged while in school.

R. H. Wheeler (AMA)
Principal Investigator
and Editor

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A special note of thanks is awarded to Dr. Herbert K. Abrams and his staff at the University of Arizona--namely, Herschella Horton, RN and John Repko, PhD--who assisted in putting the program together and to the University administration who made their facilities available for the conference.

Further appreciation is due the individual authors who presented papers and to all who took part in the interesting and informative discussions.

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In Memorium

Not too long after supervising NIOSH editorial work on these proceedings, Lorice Ede, J.D., passed away October 20, 1979.

She will be long remembered by those in the field of occupational health for her unstinting help and cooperation.

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OSHA LOOKS TO THE FUTURE

Eula Bingham, PhD

This morning I'd like to tell you how I envision things must go if we are to accomplish the purposes of the OSHA Act. When I came to the Agency, health standards were uppermost in my mind; that's what my association and background brought to me. Very quickly I realized that the best standard, the most scientifically predicated standard, is nothing without fair and knowledgeable enforcement of that standard. Along the way, I also discovered that though some people thought we had a lot of safety standards, we probably had a lot of the wrong kinds of safety standards and we needed additional ones. Above all, it is clear to me that we are never going to be able to inspect and enforce all the standards adequately. We must turn to other means--additional means, not alternatives--to bring about the intent of the Act. As I make my comments, I hope you will see how we are progressing toward that end.

As many of you know, we have recently proposed rules that will allow workers and their physicians (or other designated representatives and appropriate health officials) access to the workers' medical and environmental monitoring records. We believe this policy will be very valuable; I think it's a necessary policy for the purpose of identifying problem areas in the work environment. Clearly this proposal has raised a number of controversial issues; we knew it would at the time. We hope that these issues will receive comments from each of you in the medical community as well as from other interested groups; and we shall certainly consider thoroughly all such comments. For example, I am sure that there is a genuine concern about whether employees who cannot understand certain findings will be unduly alarmed. Certainly there is a broad range of opinion on what and how much to tell a patient under any circumstances. For example:

What constitutes disclosure in tests where the evaluation of data is very complex?

At what point is data disclosed?

How should we differentiate between raw data and interpretation of the data?

These are just a few of the concerns that will be raised and I hope addressed. I would also like to explain some of the concerns that have led to the proposed new rules. Too often in the history of occupational medicine, and even very recently, we have seen cases in which corporations and physicians have kept their suspicions and knowledge of work-related exposures leading to disease and death from workers. Not long ago, a consulting physician to a pesticide manufacturer advised against informing Texas workers about the effects of Phosvil and the nature of their diseases. Some of these workers had been diagnosed earlier by their private physicians as suffering from multiple sclerosis and encephalitis or encephalomyelitis. And recently, we discovered evidence that top corporate officials of two major asbestos producers actively

discouraged (as early as 1935) the publication of information about asbestosis. Physicians in private practice are often ill-trained to correctly associate disease with toxic exposures. Most often this is because occupational diseases may present the same symptoms as many non-occupational illnesses. Chronic lead poisoning, for example, has been diagnosed as hypertension, anemia or ulcers without association with the causative agent. Carbon disulfide poisonings have been diagnosed as schizophrenia, while lung diseases in the dusty trades have been diagnosed as allergies or asthmas that have nothing to do with work.

Quite a bit more needs to be done and I would urge you to try to find the ways and means. I would urge you here at this Educational Resource Center to attempt to reach private physicians and urge them to give more attention to their training and continuing education in occupational diseases. This really means asking primary health care physicians to engage in a new way of thinking about disease. Some of us in the government are pressuring for required courses in environmental and occupational medicine at federally funded medical schools.

Recently, a number of workers at a plastics manufacturing plant developed a number of symptoms--distended bladders, anuresis, and impotence, along with weakness and a tingling sensation in the legs. After talking to one another, the workers realized or suspected that these symptoms were work-related. Their private physicians had diagnosed the symptoms as simply prostate trouble, bladder infections or other non-work-related diseases; they did not relate any of these difficulties to toxic exposures. Some of the workers had had surgical intervention. Frustrated, eleven of the workers at one plant got together and went to a local hospital emergency room where they demanded treatment and consideration of the problem as an occupational one. OSHA and NIOSH quickly became involved; it was soon discovered that the most probable agent was a chemical catalyst, ESN, which had been introduced into this plant, as well as several others. That problem was solved, but long after the fact.

In some instances, private practice physicians have suspected a connection between a toxic exposure and disease, but they have been denied information which might have aided them in identifying the cause of the problem. As an example: An Ohio hematologist became suspicious after he recognized a series of leukemia cases from a single factory. When he called the company and asked the plant physician about a substance referred to as Urbine--a company code name for the chemical which the workers were using--he was reportedly told that the chemical had been tested thoroughly and was absolutely anoxic. That supposedly "safe" chemical was later discovered to be benzene, long considered to be a carcinogen.

In the area of research, there is an unresolved question of whether and when you inform workers of adverse health affects from materials to which they are exposed. A physician from a major chemical company recently said that he did not advise workers about a company research project on benzene because he thought it would "place an undefined albatross on the backs of the worker."

I'd like to borrow a remark of a National Cancer Institute scientist who deals in assessment of risks; he said, "When we talk about the acceptable risks that we can live with, we must also be reminded that there is the risk that others must die from this particular material." I think it is long past the time when we must "demystify" science and medicine; we must tell working men and women what we as researchers and physicians know and, just as importantly, what we don't know. Workers need this knowledge so they can make informed judgements about their own lives. Inasmuch as

we can't say what the risks from certain toxic agents may be, the workers should be able to decide for themselves what action to take. I also think it is a mistake to underestimate most employees' abilities to comprehend and constructively assimilate this information. Last year, for example, workers at a California plant were the first to spot a serious health problem, which was eventually found to be caused by the insecticide DBCP. These workers, through their union, had been provided with enough information about an occupational hazard so they were able to spot a common difficulty among the workers who had been attempting to sire children.

Time and time again, the astute observations of workers have led to their own discoveries of job-related health problems. It was a worker's signs of lung cancer that first brought attention to the high death rate from cancer among workers exposed to bischloromethyl ether. A Japanese kimono painter was the first to relate bladder cancer to benzidine dyes after that chemical was substituted for the traditional vegetable dyes used in kimono painting.

Let me point out that one of the major themes of the Act is the right of a worker to know. We think that allowing access to medical records will greatly facilitate the discovery of relationships between disease and toxic exposure. We recognize that this proposal raises a wide range of moral, legal and ethical issues as well as practical considerations; all will deserve a great deal of thought. Clearly, information disclosure of this kind must be considered judiciously. It should neither instill panic or unreasonable fear, nor overwhelm a worker with an indecipherable list of chemical agents. There must be ways to explain risks clearly and rationally.

We have additionally proposed--to become effective immediately--that medical records cannot be destroyed pending the outcome of the rule making procedure.

Other actions over the past year reflect our intentions at OSHA. We have issued a federal regulation notice defining hours worked; thus, walkaround pay will be available to men and women who are designated to accompany the OSHA inspectors. We have issued another regulation that allows workers access to the log of illnesses and injuries. These attempts will, I hope, provide employees with the tools for taking informed action, so they might regain a sense of control of their own destinies.

Another very great effort which I think is absolutely necessary is a new directions program providing funds to educate workers and employers, particularly small employers, about the hazards of the workplace. This year we'll have \$2.8 million and \$5 million more in the 1979 budget if God and the Senate are willing. We will be able to fund research proposals that have been submitted by trade associations, unions, university labor centers and universities such as this one.

In closing, I think our nation has an epidemic of workplace disease and injury. Millions of men and women are being exposed to substances and hazards that may turn them into respiratory cripples, amputees, or cancer victims. There are no vaccines available at CDC and none are on the horizon; neither is there real therapy nor progress in therapy to turn around these irreversible diseases. This week a new study was announced which indicated at least 20% of the future cases of cancer will come from workplace exposure. As someone who has been involved in chemical carcinogenesis for a very long time, the figures come as no surprise to me. This is actually a conservative estimate, the figures may actually be as high as 38%; you only have to look at the cases of asbestos-induced cancer to judge that these figures cannot be far off the mark. You know as well as I that we cannot even make good estimates for the other

occupationally-induced diseases.

We don't have to accept these very grim figures. Go into action so we can reduce these injuries and illnesses. This is the challenge that faces OSHA and I hope that you will accept and go forward with the challenge as well. We don't have enough compliance officers and we are never going to have enough standards on the books. We are going to see that workers know the hazards of the workplace; we are going to teach them the hazards of the workplace and then encourage each worker to control his own destiny.

MEETING PERCEIVED MANPOWER NEEDS IN OCCUPATIONAL SAFETY AND HEALTH

Alan D. Stevens, DVM

During survey visits to several thousand workplaces in 1972, the National Occupational Hazards Survey (NOHS) found that most workplaces lack even the most basic occupational safety and health services. The workplaces were in standard metropolitan statistical areas where, in general, places of employment would be more likely to have access to occupational safety and health services than businesses located in smaller towns or rural areas. Thus, the lack of basic services shown by NOHS understates the problem of the country as a whole. In general, larger concerns (over 500 employees) are more likely to provide some services than those with less than 250 workers. Even so, fewer than half of even the larger concerns provide a full range of basic safety and health services.

Currently, medical and environmental surveillance requirements in the standards being promulgated by the Department of Labor utilizing NIOSH criteria will increase the demand for occupational physicians, nurses, industrial hygienists, safety personnel, and other allied health professionals. At present, many businesses covered by these standards have no medical or environmental monitoring programs; they must rely on consultants or private physicians and nurses who have no special training in occupational health.

While there was unanimity of opinion as to the existence of the shortages, there was anything but unanimity as to the extent of the shortages, both in individual categories and for the population as a whole. Thus NIOSH, through the Division of Training and Manpower Development, began a feasibility study in 1974 for an accurate census or inventory of health professionals in occupational safety and health. This census, under a contract to John Short and Associates of Salt Lake City, forms the basis for this presentation.

CURRENT WORK FORCE

The survey drew on a sample from a universe of all firms with 100 or more employees in mining, construction, manufacturing and transportation, communication and utilities, plus all firms employing 500 or more in the trades and services industries and in non-occupational safety and health-related state and local industries. Loss prevention insurance carriers and safety and health-related state and federal government agencies were dealt with separately from the universe; usable replies came from approximately 3,300 industries of various types. Analyses of the data shows that this was a statistically valid sample and the results--there are currently about 84,000 individuals employed more than 50% of their time in occupational safety and health activities--are accurate to within 7% at the 95% confidence level.

The study also made assessments of the current demands for additional personnel by asking about current vacancies for the classes of personnel that were reported and the

kinds of personnel that were being recruited to fill those vacancies. The results are at variance with previously estimated needs in these job categories.

The performance of a study such as this is not of particular value to the manpower development groups unless future demands can be forecasted. Several factors must be taken into account in developing these forecasts. Assumptions must be made, for example, about expected retirement or death of the individuals in current positions. Thus the average age of currently employed individuals is important, as is the average age at entry into the field (the latter adds the factor of prospective duration of activity in the field) and the ratio of safety and health professionals to the total work force. The ratio may remain the same, while the size of the work force increases as the Bureau of Labor Statistics has predicted; or there may be increases in the ratios of occupational safety and health professionals to the total work force. These changes might be due to increased demands of personnel as required by legal or regulatory mandates. For example, if the number of required physical examinations is markedly increased, more physicians and nurses will be needed. National health insurance might have some effect on how health services are delivered in the occupational setting, which could in turn cause the demand for physicians to alter accordingly. In any case, there is going to be a demand for physicians who have training in occupational medicine, the only difference being the particular setting in which the individual physician is utilized.

Based on the number of physicians in the sample and assuming the same distribution in the rest of the universe of workplaces, approximately 1,000 are employed more than 50% of their time in occupational health; of these, approximately 62% are full-time. This figure may seem low until it is remembered that the survey does not include those in occupational medicine who spend most of their time in educational institutions; neither does it include physicians in group practice or clinics who provide occupational health services to industry but who are not employed directly by industry. No one knows how many of these physicians were not counted and there is no easy way of acquiring such information. Regardless of the actual number, it is obvious that there are not enough to meet the current demand, since the study data indicates that at least 100 employers would hire a physician today if there was one available.

We also have other descriptors of the group. Their average age is 50.3 years. I suspect this is somewhat above the average age of all physicians in the United States. We also learn that the average physician in occupational medicine has been employed for just under 9.5 years. This indicates that they probably have been engaged in something other than occupational medicine for several years before entering the field; in other words, many physicians enter occupational medicine in mid-career rather than directly out of training. No effort was made to determine how much training they may have had beyond the MD degree, so we don't know the kinds of preparation they may have had in occupational medicine. Considering the numbers of available residencies over the past 10 years, it is obvious that most of those presently employed do not have any formal training in the field, or they have had insufficient training to establish eligibility for board certification in occupational medicine.

Looking beyond the present, this study tells us that there will be a continuing demand for occupational physicians. Between 1977 and 1980, it is estimated that we will need 100 new physicians per year. Between 1981 and 1985 the demand is expected to be 60-70 per year and 50 per year between 1986 and 1990. There is an assumption here which may not be valid: that anyone who enters the field of occupational medicine is going to remain until either retirement or death. We know that this is not realistic, but

there is no satisfactory way to factor in the other variables that will influence these figures. Probably there will continue to be at least as much demand for physicians as there is at present; that is, about 100 new hires per year.

SOURCES

We know from the study that prospective employers would prefer physicians who have had at least 4 years of training or experience beyond medical school. This might be interpreted to mean that they want physicians who are either board certified or board eligible (or nearly so). Immediately, it is obvious that the supply is not meeting the demand. The AMA Directory of Accredited Residencies (1977-78) lists 24 positions at 6 schools; if all these residencies were filled, we would still be supplying only about 1/4 of the need. All physicians trained in occupational medicine are not going into practice. Some will be teachers, others will do research, still others will go into activities that are outside the study universe. There will still be a certain percentage who will come from other sources (e.g., other training programs or mid-career shifts). But as the opportunities for formal training in occupational medicine increase--as through the Educational Resource Centers--so will the supply increase.

NIOSH'S EDUCATIONAL RESOURCE CENTER PROGRAM

In order to provide a more comprehensive approach to meeting the needs for occupational safety and health manpower education and training, NIOSH developed an initiative in 1976 for support of occupational safety and health Education Resource Centers. These Centers were intended to augment and partially supplant the individual single-discipline training grant support to universities and colleges. During the course of development, discussions were held with ADAMHA, the Bureau of Health Manpower, HRA, NIH, and NIEHS so as to coordinate this program with other related health manpower development activities and research and service programs in HEW.

The first nine grants were made at the end of FY 77, awarded under the Institute's basic training grant authority of the OSHA Act of 1970. The awards were designed to assist nonprofit educational institutions in establishing, strengthening, or expanding their training of persons in occupational safety and health so as to provide an adequate supply of qualified personnel necessary to fulfill the purposes of the Act. The Centers must develop cooperative arrangements between medical schools, schools of nursing and public health and schools of engineering. Each Center should have a board of advisors, including representatives from labor and management. These Centers will provide full- and part-time, long-term training for occupational physicians, occupational health nurses, industrial hygienists, industrial engineers, and safety personnel. Training programs also may offer industrial toxicology, biostatistics, epidemiology and ergonomics, and will include field experience among public health and safety agencies and labor-management health and safety activities. Both short-term training and continuing education courses are intended to upgrade the competence of practicing occupational safety and health professionals. In addition, an "outreach" program will assist intra-regional institutions or agencies to develop their own occupational safety and health training activities by providing them with curriculum materials and consultation.

In addition to being a base resource for training and education, the Center programs (by providing training opportunities for students) will be a focus for research and service activities in occupational safety and health and related Federal and state programs. For example, ADAMHA has indicated that with their support, alcohol and drug abuse

problems in the workplace could be attacked through ERC student/faculty research and field training. Programs for the nurse practitioner to supply basic skills in physical assessment has been a major thrust of the Division of Nursing of the Bureau of Health Manpower; these can be implemented with the cadre of industry nurses who are identified through the ERC outreach and field training activities.

Other examples of work-related problems that can be addressed through ERC activities and programs include health hazard evaluations of work environments, studies of latency and possible carcinogenesis or mutagenesis, and behavioral and attitudinal factors involved in work accidents.

Based on a number of demographic factors (i.e., numbers of workers, industry concentration and diversity, and special problems) it appears that there need be no more than 20 Centers to effectively provide basic and continuing education, with at least one in each HEW region. At present 11 institutions have been awarded grants; as future Centers are funded, primary consideration will be given to those with the best potential and greatest need for training and education services.

If all goes according to plan, the output from these programs will almost meet the forecasted demand for new occupational physicians. Undoubtedly, some of the forecasts for increasing the numbers of accredited residencies represent wishful thinking, but it would be a mistake to set one's sights too low. Increased awareness of the place of occupational medicine in maintaining the well-being of our nation's work force is going to demand more adequately trained occupational physicians. The challenge of assuring safe and healthful working conditions for the men and women of tomorrow will be met.

CONFIDENTIALITY OF MEDICAL RECORDS

Alan F. Westin, PhD, LLB

Almost every poll by Harris, Yankolovich, Gallup, and others in the last six years has shown that the issue of privacy--personal privacy and group privacy--is of increasingly paramount concern to Americans. Two out of three people believe that too much information is being collected about them as individuals by governmental and private organizations. Two out of three also feel that there are inadequate safeguards on the transmission and circulation of such information. The general field of health and medical records is caught up in this issue just as the information systems of the FBI and CIA, and the welfare and other social agencies, etc. were involved earlier.

More and more, our medical data are being used for many purposes other than for care and treatment of the ill and injured. The average American has simply lost control over the outward circulation of his medical records. It used to be that our records were kept by a local physician. There was a one-to-one relationship in some type of primary care facility, whether a doctor's office, a clinic, or some kind of local, county, or municipal hospital system. Patients' records and their problems remained inside the facility. In the last several decades, the information about our medical conditions has moved outside the health care facility and into third-party mechanisms: to insurance carriers for life, accident, and health insurance; in various employment situations where government licensing requires certification of a worker's health; in civil litigations involving workers' compensation and negligence claims in which health conditions are considered; a large number of law enforcement uses where the medical conditions of people are relevant to various kinds of investigations.

If the physician could make a promise that only he and the patient would be involved in the storage and use of the very sensitive personal information that is collected from the tests and the doctor-patient consultation--if the physician could only promise a kind of desert island situation for the bond between the health professional and the patient--we wouldn't have this current dilemma. But health professionals simply cannot promise to control a patient's medical data, because it must be reported for so many other purposes: for payment of services, quality care assurance, and a myriad of social uses.

In the broad sense, we are working on the problem. We have new privacy legislation; such as the Federal Privacy Act of 1974, which sets regulations on the collection and use of medical data by Federal agencies when they are health-care providers or health insurers. We have had important new state legislation to tighten the confidentiality of health records and to give patients the right-of-access to their own records in health-care institutions. These broad considerations about protecting people's rights are still under development; by no means have all of the mechanisms been set in place to resolve the kinds of conflicts that are involved.

It seems to me that in the next decade or two we shall create what may be one of the largest, most important, most sensitive medical record systems that any country has produced. It will cover most of the working force, about 80-90 million adult

Americans. It will be an extremely long-term record system--from the time a person enters the work force, through retirement. Records should be kept beyond a worker's retirement if there are to be meaningful studies on what happens after people leave the work force--a longitudinal record period from 40-75 years. The record will have to include extraordinarily intimate and sensitive personal information.

One thing that is clear from recent studies is the linkage between dangerous substances and sexual dysfunctions, such as loss of libido, impotence, abortion and miscarriage--the kinds of things that are most sensitive in terms of people's feelings about privacy. Moreover, intrusion into one's personal life reaches beyond the individual worker to include his spouse, children, relationships with parents, etc. Yet this is the kind of information that must be systematically collected if the linkages between dangerous substances and health are to be discovered.

Finally, more and more of these records are going to be a part of a large computerized or automated data system, which in turn becomes an inviting target for government regulatory agencies, courts, law enforcement officials, and endless people who view such easily retrieved and extensive data as a resource for their own selfish interests. There is an extraordinarily important duty for those who build, manage, and safeguard that system. The basic question at the very beginning is what rules should apply to the creation and maintenance of such a system.

Before I give you my impressions of what those rules should be, I want to make sure that we all agree on who the players are. Unless we start with an idea of whose interests are involved, we may very well miss some of the important nuances of defining protections and problems.

The individual worker has a stake in what the employer's personnel department knows about his medical condition, which in turn may affect his work assignments and promotions within that company. On the other hand, what a subsequent employer will learn about an individual's health, prior work exposures, etc. is bound to affect the mobility and transferability of all workers. The publicity that has been generated already about dangerous substances and their effects on workers is going to change a fairly passive labor force into an increasingly militant one. Even where there are no unions, there will be individual workers, groups of workers, workers' committees, and the like demanding a different relationship between them and their employers. And what affects the worker affects his family, spouse, and children.

The personal physician and the local community health facility are certainly a part of the game. Unless the physician in the community knows many of the things that have previously never been divulged by the employer to those who provide community health, that physician, nurse, clinic, or hospital simply cannot do its job properly. Therefore, access to some of this information clearly must include people who are primarily responsible for the community's health.

The third group with a stake is the union. The Oil, Chemical and Atomic Workers International Union has been active and interested in this matter because their members work in one of the most hazardous industries. Another half a dozen or so unions are also concerned and active. Unions will increasingly see access to health records as a primary service for their membership, and treat the issue with as much militancy as they have with working conditions and pensions.

Another player in this game, of course, is the employer. An employer generally is

caught in a dilemma and whipsawed between two forces. On the one hand, he may have a desire for the earliest research and the best scientific effort to discover possible dangers and conditions in the industry. The Occupational Safety and Health Administration, along with other Federal and state agencies, helps keep the pressure on employers for the kinds of studies that might detect adverse conditions. On the other hand, employers are subject to tort liability under which the courts and juries decide at what point in time an employer received due notice of a dangerous situation; thus, the company can be charged with money damages if it does not thereafter take protective steps. Any employer these days has to sweat out the serious problem of balancing early detection against the alarm the courts will use to measure tort liability. This suggests that in a society as litigious and lawyer-driven as ours, we may have to change the tort liability system, perhaps to reward employers who subscribe to early detection and elaborate systems of detection.

Government health and safety agencies feel that they too should have the broadest possible access to individual medical data in order to perform the kinds of inspection and detection functions which they are charged by law to conduct.

Health insurers want the data so that they may discern trends that affect insurance rates and costs for health programs. And last, but not the least, public interest groups--many of these operate in the public health field--make insistent demands for data which oftentimes have to be personally identifiable.

I believe OSHA deserves the broadest possible praise for its position on worker access. There is absolutely no substitute for the right of workers and their designated representatives--physicians, unions or anyone the individual worker chooses--to have access to his medical records. The worker should have a right to identify hazardous conditions, to have some control over his own health destiny, to make his own job decisions, and be able to bargain for and demand hazard pay in hazardous situations. I think OSHA's position in this is extraordinarily correct and commendable and ought to get the broadest possible support.

On the other hand, I have the deepest reservations about their other proposed rules, the ones that define a medical record and consent procedures by which individuals would be allowed to release those data for other purposes. I know these proposed rules are not final; OSHA is probably simply staking out a potentially broad position, which it will not insist upon after the hearings. These rules would provide that all medical information pertaining to an employee, including the occupational physician's personal notes, shall be open to inspection by various government agencies (i.e., NIOSH and OSHA). No employee consent is required before the records may be examined by NIOSH for the purposes of occupational health and regulation. There is no effort to inform the worker that his records are to be examined. There are no safeguards in the regulations to insure that the records, which once in Federal hands, will not be shared with any other parties, or will not be used to make any adverse decisions about the individual. It is not enough in my judgment for any Federal agency to say, "Of course, we will only use it for our purposes." The problem is whether there is the proper legal regulation to forbid disclosure of that information for other purposes. If one is not careful, employers will limit what is put into their medical records, believing that it will be most prudent to either keep or record less data.

The regulations ought to include many of the safeguards that were recommended by the Federal Privacy Protection Study Commission: that various kinds of consent, release, and data protection safeguards ought to be used whenever inspection or research

functions are performed on primary medical records. I believe the proposed regulations will provide us an opportunity to look at what could be done, to decide whether or not the safeguards are adequate, and to make sure that we don't end up with either "exceptionally good occupational health surveillance," or "complete privacy." We want to have both protection of individual rights and a safe, healthy, and efficient work force.

There is an organization called the National Commission on the Confidentiality of Health Records, an umbrella organization which intends to testify on these proposed OSHA regulations and to voice many of the above concerns; I think it represents one of the best efforts to bring together the interests of the health professionals and related groups on these kinds of problems. The Commission is a voluntary organization in Washington* made up of about 21 organizations, including the American Hospital Association and the American Occupational Medical Association. Its purpose is to coordinate the various issues and to create an information clearinghouse for hospitals, physicians, and health organizations. They will also collect and distribute news about Federal and state legislation and monitor court cases that relate to these kinds of health issues.

I've never assumed that the record systems in occupational health be a "big brother" enterprise that will take away many of our most precious liberties. One of the hallmarks of a democratic society is that we don't accept an either/or resolution of colliding values. Ever since the days of Jefferson, we have believed that a part of the creativity of the American legal and political social system is to find the techniques for both personal liberties and an effective society. The challenges in the next two to three years will set in place the parameters of these new occupational health systems. At the same time, we should have in place the regulations, safeguards, legal rules, and all other things through which we can achieve the protection of individual rights.

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REPRODUCTIVE DISORDERS OF THE MALE/FEMALE WORKER

Introductory Remarks

Jacqueline Messite, MD

The whole area of reproductive toxicology is one of great concern and interest for the entire occupational health community. Within the past quarter of a century, the sex composition of the civil labor force in the United States has undergone a marked change. The proportion of the labor force made up of women 16 years of age and over has risen from 29% in 1950 to 40% in 1975, a percentage increase almost equal to that of the entire 60 years previously. By 1975, there were 37-million women workers; the projected number for 1990 is 48.6-million. It is noteworthy that the percentage increase by sex in the civilian labor force projected to 1990 is 31.4% for women as compared to 17.3% for men.

During the past 25 years and particularly in the past 10 to 15 years, there has been a significant change in attitudes and expectations of women at work. A high proportion of women currently expect gainful employment outside the home to be a major part of their life's activity and they wish to increase the variety and importance of women's roles in our society. Included is the desire, by some women at least, to obtain and achieve success in jobs that are traditionally held by men. In addition, there have been two major pieces of legislation enacted to focus attention on the subject of women at work; mainly, the Occupational Safety and Health Act and Title VII of the Civil Rights Act, with the guidelines adopted thereunder by the Equal Employment Opportunity Commission. The need to provide a safe and healthful workplace for every worker, male or female, is explicit in the OSHA Act; its further purpose, the preservation of our human resources, in my judgement, has implication for the protection of a fetus before conception and while exposed in utero to occupational chemicals or physical stresses of the working mother. The EEOC guidelines clearly affect the employment of women whether pregnant or not, and their implementation signals the potential for substantial increases in employment of women in traditionally male jobs.

To date, women are still primarily entering those fields in which they have always been employed. Women are largely employed in service industries, in the health field, in clerical jobs, and as semi-skilled operators in the manufacturing industries. In the trades, they are primarily found in the retail industry, whereas men predominate in the wholesale field. Women in education are primarily pre-college teachers, while men predominate in the faculties of colleges and universities, particularly at the higher level. Manufacturing employs the largest share of the male force. Nevertheless, inroads are being made in such typically masculine jobs as bartending and bus driving; yet most women bus drivers still only work part-time. There has been some progress in the professions: Women doctors of medicine comprised 10% in 1974 vs 6% in 1962, and in law their numbers of lawyers and judges rose from 3 to 7% in those same years. A few women are now represented among our nation's mine workers, a significant change from the past. As a personal note, I was intimately engaged in doing epidemiological

studies of miners and millers in northern New York State in the late 50's and early 60's, and it was perfectly acceptable for me to perform all of the physical examinations and to take part in the entire study. However, I was not allowed to enter the mine because there was a superstition about women entering mines. We are delighted to know that this superstition may have been dispelled. Given opportunities for training at all levels, from apprenticeship in industry to education in the higher professions, it can be anticipated that women will continue to move into areas that previously have been closed to them. With the expansion of child-care facilities and flexible work schedules, there will be an increasing participation by women of childbearing age in the labor force.

In addition to the changing trends in employment, however, there are newer attitudes that have emerged toward pregnancy. More and more women are exercising the prerogative to determine the frequency and timing of their pregnancies, and those who wish to remain employed during pregnancy want more information about the health effects of their work on themselves and their unborn. It is primarily the obstetrician or the practicing physician to whom the worker poses these questions. But because of his limited knowledge and perhaps some lack of concern, he often does not provide answers that will satisfactorily decide whether or not to continue employment. Only a limited number of workers have access to trained occupational health personnel with whom they can confer about occupational health problems. Even where such consultation is available, there may be serious gaps in what is known about the reproductive toxicology of occupational exposures. In other words, sound advice is very difficult to obtain.

Spurred by the implications of these events, a small group of occupational physicians and obstetricians explored the possibility of developing needed information for the attending physicians. A formal contract was awarded by the National Institute for Occupational Safety and Health in July 1976 to the American College of Obstetricians and Gynecologists (ACOG). The primary objective of the project was the publication of a monograph entitled, "Guidelines on Pregnancy and Work"; this is available from ACOG.

The document is not meant to supply all the answers; such a feat would be impossible anyway with the limited knowledge that is available. It does, however, offer a structural framework for the application of sound clinical judgement; a system of logic for analyzing the information about the woman's work and her pregnancy. A basic premise of the guideline is that:

"The normal woman with an uncomplicated pregnancy and a normal fetus, in a job that presents no greater potential hazard than those encountered in her normal daily life, may continue to work without interruption, even until the onset of labor, and may resume working several weeks after an uncomplicated delivery."

Each case shall be assessed individually. A simple algorithm in the form of a questionnaire elicits information pertinent to the task and work environment, medical history, sexual history, and occupational or other environmental history, in addition to the clinical examination for the health status of the woman.

The primary question to be resolved is whether there is any severe medical or obstetrical condition that might threaten the mother or the fetus; if so, can that condition be controlled by medical therapy. If it cannot be controlled, one may conclude that the woman cannot continue to work; this situation would probably occur

in only a small number of cases. The occupational query delves into the work background of the woman, as well as that of her male partner. As our recent experiences with Kepone and DBCP have shown, the male reproductive problem is one that cannot be taken lightly. Once it has been determined that the woman has no medical problems, or that they can be controlled, the next step is to define the task and its environment. To assist the obstetrician at this point, there is a list of those occupations in which women generally are employed and the types of exposures they are likely to encounter. Another list presents those reproductive toxins for which there is either animal or human data. As expected, the number of known suspected toxins is very limited (i.e., about 20 compounds). Presumably, this list will enlarge continuously as we put more effort into studying and researching this problem.

Also included in the guidelines are pertinent questions that both the physician and the worker might ask of the occupational health team where she works, plus a directory of the governmental agencies by region, including universities and the ERC's to be used as information resources.

The authors often emphasize the tremendous paucity of information about the reproductive effects of occupational toxins and other stresses, and they urge more research and clinical studies of both male and female workers. Most current standards for occupational exposures have been based largely on the studies of male workers, and little or no consideration has been given to reproductive effects. Inasmuch as the physician should always endeavor to get the most current, relevant scientific data, it is most fitting that this Congress has devoted a session to the subject of reproductive toxicology.

REPRODUCTIVE DISORDERS OF THE MALE/FEMALE WORKER

The Effects of Toxic Agents on Reproduction

Jeanne M. Stellman, PhD

INTRODUCTION

Although the incidence of birth defects, spontaneous abortions and stillbirths among humans is quite high (1)--about 7% of all newborns in the US have birth defects--the cause of the vast majority of these defects (as many as 70%) is not known (2). While hundreds of agents capable of causing reproductive failure or of inducing germinal and/or somatic mutation have been recognized, the actual magnitude of their effect on human reproductive health has not been quantified.

It should be noted at the outset that reproductive failure in the form of stillbirth, spontaneous abortion, or birth defects alone is not an adequate measure of the extent of reproductive hazard from toxic agents among humans. Toxic agents can adversely affect both the male and female reproductive cycles leading to infertility, insufficient or defective sperm production, unsuccessful implantation of fertilized ova, or inducing functional defects that are not readily observed at birth and hence not associated with reproductive failure.

I shall review briefly some of the aspects of human reproduction with a particular emphasis on the effects of those toxic agents that may be encountered in the modern workplace.

MODES OF REPRODUCTIVE DYSFUNCTION

Some of the modes of reproductive dysfunction are given in Table I to show which parent, male or female, may be at risk.

Table I
 MODES OF REPRODUCTIVE DYSFUNCTION

Mode:	Parent at Risk:

Organ Dysfunction:	
insufficient/defective sperm	male & female
an ovulation-defective ovum	male & female
implantation defects	female
spontaneous abortion	male & female
Genetic Defects	male & female
Gestational Toxicants:	
pre-embryonic	male (sperm) & female
embryonic	female
fetal	female
Post-Partum Toxicants:	
via lactation	male & female
via inhalation	male & female

Examples of toxic agents capable of inducing each mode of dysfunction are readily available. However, it should be apparent that not all agents can be easily classified and some will fall into more than one category.

For example, diethylstilbesterol (DES) (3,4) is capable of inducing organ dysfunction in the adult male and female, and is a gestational toxicant as well, since it is a transplacental carcinogen (5). Adult male workers who have been occupationally exposed to DES were found to develop gynecomastia, decreased libido, and infertility. Female workers with similar exposures experienced intermenstrual bleeding. DES has induced carcinoma of the vagina in young human females who had been exposed in utero; a corollary effect has been observed experimentally in the mouse and hamster (6).

Organ Dysfunction

Paternal Factors

Manson (7) has recently reviewed the influence of environmental agents on male reproductive failure. Several modes of action are possible: direct damage to the male germ cells causing mutations and/or infertility; anatomical lesions in spermatogenic tissue; loss of libido and impotence.

The majority of evidence to date points to infertility in the male and spontaneous abortion in the sexual partner; far less likely are birth defects, stillbirths, or childhood diseases as a result of paternal exposure. There is evidence, however, that toxic agents

may penetrate the blood-testis barrier to enter the testicular fluid. As reviewed by Manson, the mutagen alpha-chlorohydrin and its metabolites have been found to enter the testicular fluid from the blood (8). A wide variety of other pharmacologic agents do likewise. It has been hypothesized that such penetration of the blood-testis barrier is the reason for false-negative results in the dominant lethal testing of environmental mutagens (9).

Congenital defects, low-birth weight, and poor survival in the offspring of male rabbits exposed to thalidomide have been observed by Lutwak-Mann (10); adverse drug effects in human and animal sexual partners of treated males have also been observed (8). Epidemiological evidence also implicates paternal exposure to toxic agents in adverse reproductive outcomes. Anesthetic gases, vinyl chloride, chloroprene, and other hydrocarbons have all come to be associated with an increased spontaneous abortion rate among unexposed wives (11). Similarly, exposure to non-ionizing electromagnetic radiation among fathers has led to an increased incidence of clubfoot (12) and Down's syndrome (13); this latter study apparently has not been confirmed in follow-up investigation.

Dibromochloropropane (DBCP) is a recent, highly publicized example of a substance that is capable of inducing infertility and decreased sperm count in occupationally exposed adult males (14). The original exposed population consisted only of males; no second generation effects or effects on females have been noted as yet. Some of these data are summarized in Table 2.

Table 2

OCCUPATIONAL TOXICANTS OF THE MALE REPRODUCTIVE SYSTEM

Toxicant:	Species Effect:	Indigenous Occupation:
alkylating agents	a,h	chem. & drug mfrs.
anesthetic gases (nitrous oxide)	a,h	med., dental, & vetny.
cadmium	a,h	ore smelters, battery workers
carbon disulfide	a,h	viscose rayon mfrs., soil fumigators
carbon tetrachloride	a	chemical workers
diethylstilbesterol	a,h	DES mfrs.
chloroprene	a,h	rubber workers
ethanol	h	(a social hazard)
ethylene oxide	a	hospital sterilizers
hair dyes	a	cosmeticians, etc.
lead	a,h	ore smelters, battery mfrs., police
manganese	h	ore smelters, welders
nickel	a	ore smelters, welders
organomercurials	a	pesticide workers
TRIS (flame retardant)	a	textile workers
pesticides	a	farmers, mfrs., formulators, applicators, migrant workers
vinyl chloride	h	VC/PVC mfrs. and processors
elevated CO ₂	a	brewers, chem. mfrs.
high temperatures	a,h	bakers, glassblowers, foundry & oven workers
microwave radiation	a,h	radar operators & repairmen, air crew- men
x-ray radiation	a,h	x-ray technicians & nuclear specialists

a = animal
h = human

Maternal Factors

Successful reproductive outcomes are contingent upon successful fertilization and implantation. Thus, ovulation must occur and the produced ovum must not be defective. It is the function of the ovaries to produce the correct balance of hormones to which the endometrium must respond before the blastocyst is properly implanted. Even a shift in the menstrual cycle, despite an otherwise normal endometrium, can alter the attraction of the endometrial tissue for the blastocyst (15). Implantation occurs at the height of the secretory phase of the menstrual cycle, and both the fertilized ovum and the endometrium must be in equivalent states of maturation, which is hormonally dependent. There is some evidence that a mother's exposure to certain "foreign" chemicals may interfere with the normal reproductive organ function.

Organochlorine compounds, for example, stimulate uterine growth and interfere with fertility and conception in rats and mice (16). Ware has hypothesized that the many reproductive studies of DDT on animals illustrate the estrogenic and uterotrophic properties of this pesticide which are responsible for the resorption of the implanted conceptus. Although there is no direct human evidence of this effect, it can be theorized that the high incidence of adverse reproductive outcomes associated with hospital operating room personnel (17) is related to a similar response from trichloroethylene exposure.

Foreign substances absorbed from the mother's bloodstream into the uterine fluid are another aspect of maternal organ dysfunction that should be considered. The uterine fluid serves as the environment for the fertilized ovum as the ovum passes through the uterine tubes to the uterus. The fertilized ovum initially divides into the blastocyst, which is heavily coated with endometrial secretions. It takes about 96 hours for the blastocyst to reach the uterus where it resides for a period of 2-6 days. During this time the blastocyst is metabolizing actively, drawing its nutrients from tubal and uterine secretions.

Fabro has identified a variety of substances in the uterine fluid of treated experimental animals (18):

caffeine	salicylate
nicotine	barbital
cotinine	thiopental
isoniazid	DDT

Since cotinine is the metabolite of nicotine, Fabro concludes that active metabolism of nicotine may be occurring; however, the penetration of cotinine from the maternal bloodstream has not been ruled out.

Trace metals also have been shown to be present in uterine secretions. Women wearing the copper intrauterine device were observed to have copper-secretion concentrations that were five times greater than the controls without such implants (19). Lead in female Rhesus monkeys has resulted in an end to their menstruation. After cessation of lead exposure, gonadal function appeared to completely recover (20). It is difficult to extrapolate the meaning of such evidence to women workers, since there is virtually no data on the biological effects of measured contaminants on gonadal function.

Genetic Defects

Examples of environmentally-induced mutations are even more sparse. While a great number of environmental agents clearly change the genetic structure of somatic and germinal cells (21), the impact of these agents on birth defects and other adverse reproductive outcomes is not yet quantified; although, it has been suggested that an increased mutation rate will have an immediate and substantial impact on the frequency of dominant mutational effects and will result in an increased morbidity rate (22).

While Wilson states that mutation is a firmly established mechanism of teratogenesis arising from chemical mutagens and ionizing radiation (2), it is difficult to extrapolate the actual impact of occupational exposure to chemical mutagens and radiation on reproduction. For example, a recent report on chromosomal aberrations and sister-chromatid exchange in chemical laboratory and rototyping factory workers and the children of women laboratory workers discloses similar aberrations in the mothers and their offspring; however, the cause and biological significance of the findings were not clear to the author (23).

In general, it is acknowledged that there is a good correlation between mutagenesis, carcinogenesis and teratogenesis, but generalizations on the correlations cannot be drawn as yet. Table 3 presents some substances in the occupational setting that have been implicated as mutagens or as substances that interfere with normal DNA repair mechanisms.

Table 3

SELECTED OCCUPATIONAL AGENTS CAPABLE OF
CHROMOSOMAL ABERRATIONS AND/OR MUTATIONS

alkylating agents	halogenated
arsenic	anesthetic gases
benzene	ionizing radiation
benzidine	lead
chlorinated hydrocarbons	beta-naphthylamine
bis-chloromethyl ether	nitrosamines
chloroprene	polycyclic aromatic
dioxin	hydrocarbons
ethylene oxide	TRIS (flame retardant)
hair dyes	vinyl chloride

Gestational Toxicants

Table 4 lists some potential gestational toxicants that occur in the workplace.

Table 4

AGENTS OBSERVED TO INDUCE ADVERSE REPRODUCTIVE OUTCOMES
FROM OCCUPATIONAL EXPOSURE DURING PREGNANCY*

Agent:	Type of Occupational Exposure:
alkylating agents	drug workers
anesthetic gases	operating room personnel
arsenic	agricultural workers
benzene	chemical workers, gas station attendants
carbon monoxide	toll booth operators, policemen
chlorinated hydrocarbons	labty. & craft workers, dry cleaners
diethylstilbesterol	drug workers
dimethyl sulfoxide	laboratory workers
dioxin	agricultural workers
infectious agents:	health care & social
rubella virus, cyto-	workers, teachers, meat
megalovirus, herpes	cutters & inspectors,
virus hominis, toxo-	animal handlers, laun-
plasma, syphilis	dry workers
ionizing radiation	x-ray technicians, nuclear specialists
organophosphates	pesticide handlers
polychlorinated biphenyls	electrical workers, microscopists

*Adapted from Wilson (2)

The toxic effect of an environmental agent during gestation is dependent on the dose of the agent and the stage of the gestation at which the agent is encountered. It is not correct to assume that an agent interacts with the conceptus uniformly throughout the gestational period, nor can the observations (either experimental or clinical) during one trimester of pregnancy be extrapolated to another trimester. A good illustration of this is found in a study of dose and gestational age in placental transfer of cadmium in rats (24). It was observed that cadmium crossed the placenta at all gestational ages tested, but the percentage of cadmium in the fetus did not increase as a function of dose; instead, it was a function of gestational age. Another interesting observation was the large concentration gradient between maternal and fetal tissues. Such a gradient demonstrates the impracticality of extrapolating from maternal dose to fetal dose.

In addition to this problem of extrapolation, interspecies differences must also be taken into account. For example, Ferm et al (25) observed, in contrast to Sonawane et al (24), that placental permeability of the hamster to cadmium may decrease markedly as gestation progresses. Their results indicated that as the placental membranes mature and become more differentiated, they may in fact block the transfer of cadmium.

It is also necessary to note that toxicants must not be judged solely on their ability to permeate the placental tissues. In human beings, the placenta does not become fully functional until the second trimester of pregnancy. During embryonic development,

there is a relative quiescent phase of human placentation in which much of the nutrition of the developing embryo is histiotrophic (derived from endometrial secretions) rather than hemotrophic (derived from maternal blood flow) (26).

Since it is clear that the first trimester in humans is the period of organogenesis and is the most susceptible to toxic agents, the significance of placental transfer of toxic agents is questionable. What may be of greater significance during the embryogenic stage is the presence (or absence) of agents in tissues which supply the histiotrophic nutrition.

In order to classify and quantify the toxic effects of various agents during gestation on reproductive outcome, it is essential that the differences in the physiology of pregnancy be elucidated. Placental transfer effects will largely affect the second and third trimester; there is good evidence to believe that the effect will not be uniform, but will be a function of gestational age. Further, it is necessary to appreciate the difficulties of extrapolating from maternal to fetal dosages. And finally, the effects of toxic agents on successful implantation and embryonic development must be considered apart from the ability of the agent to permeate the placental tissues.

In essence, great caution must be used in making generalizations about gestational effects of toxic agents, particularly when such generalizations are drawn from animal experiments in which interspecies differences may be very great.

Post-Partum Toxicants

The last group of reproductive toxicants to be discussed are those encountered post-partum by the neonate. The source of the toxicants can be directly related to a prior occupational exposure of the parent: e.g., asbestos or heavy metals such as lead, (28, 29) can be brought into the home on contaminated clothes and shoes (27-29); then too, the mammary glands readily absorb and sometimes concentrate many foreign substances from the blood, particularly those like the polychlorinated biphenyls (PCBs) which are lipid-soluble (30). The magnitude of this potential health problem for persons who are indirectly exposed to the dangers of the workplace is not presently known, since there is no good estimate of the numbers of women or neonates at risk. Also, the health effects of toxic agents when ingested via breast feeding have not been identified or quantified.

SUMMARY

Of the variety of toxicants (both chemical and physical) that may affect successful reproductive outcomes, some are of more relevance than others. This is not necessarily because of the relative toxicity of the agent, but rather because of the large numbers of workers who are potentially exposed at the workplace.

Infectious agents are an example: A number of viruses and other infectious agents have been associated with adverse reproductive outcomes and there is clear evidence that health care workers are at a significantly increased risk of infection. There are more than three million women employed in the health care industries (31), representing more than 70% of the total health care workforce. But though there are some data available on the incidence of nosocomial infection (32) among hospital patients, the extent to which health care workers are affected is not known; and it is difficult to extrapolate. Infectious agents are also prevalent in many other occupations, such as social work, teaching, animal handling, and meat inspecting.

Examination of the available literature and data indicates a wide range of occupational agents that can adversely affect reproductive outcomes. The hazards are not limited to pregnant females; they include males and non-pregnant females, as well as neonates in familial contact with persons who have had exposure.

In light of such evidence, it is imperative that the current scope of inquiry and the current perceptions of occupational health problems as they relate to reproductive outcomes be widened. For example, international policies currently recommend that no women be exposed to lead in the workplace. Such a recommendation cannot assure that there will be no adverse reproductive effects from lead since the reproductive behavior of males is also in jeopardy. Lead is but one example. It is also necessary to increase our general awareness of the potential for adverse reproductive outcomes. Recent professional-governmental committees have attempted to address the occupational health problems that pregnant women face (33) and recommendations have been made (34). It is likely that similar efforts will continue in the future. Such efforts must involve systematic methods for detecting, reporting, and analyzing the effects of toxic agents on reproduction. In this way, the true potential effect of working conditions on reproduction can be recognized and appreciated. Until then, only crude estimates, extrapolations, and hypotheses will be made.

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REPRODUCTIVE DISORDERS OF THE MALE/FEMALE WORKER

Occupational Placement of Women of Reproductive Capacity --Views of the Medical Community

Ernest M. Dixon, MD

For many years, physicians did not become too involved with the occupational problems of pregnant females, though they were aware of the vulnerability of the unborn. They were essentially oblivious to male concerns except when confronted with an occasional question about impact on sexual potency. However, the explosion of information on toxic substances, carcinogens, etc., has brought forth a complex health and social dilemma. In the past, a suitable policy of not permitting the more susceptible or vulnerable individuals to work in areas that were potentially hazardous provided a simple solution; that policy is no longer tenable. A once seemingly minor subject has now blown into a raging controversy, generating far more heat than light, I might add.

Each of the participants has acquired a degree of tunnel vision, allowing him to see only those areas of importance that meet his own wishes and needs. On the one hand, the workers want to know about the hazards of exposure as well as the alternative work opportunities or pay. The primary concern thus far has been for the female--the pregnant female and the fetus; now we are becoming concerned about the male. Physicians and other health personnel want to avoid adverse health effects. Management wants the problem to go away. The Equal Opportunity Commission insists on sustained job opportunity and wages at all costs. And OSHA is perplexed--as are all the rest of us--about its proper role. Unions are in a similarly awkward situation.

I first encountered this dilemma a year and a half ago during a company executive meeting; it was suggested that I should write a medical policy to address the issue. And very grudgingly I said, "Of course, I'll be glad to do it. I'll be back home in a couple of weeks and I'll write it up over the weekend." Well, that was a very unpleasant weekend. I found myself scratching my head but the old brain didn't seem to work. In the course of discussions with other people in the field, I became aware of all the perplexities; that the problems are not purely medical or health-directed. I made the terrible mistake of suggesting to the American Academy of Occupational Medicine that they form a committee to address the problem. I was immediately appointed to the committee, which subsequently developed into a joint committee of the American Academy of Occupational Medicine and American Occupational Medical Association. Our original charge was to draw up a set of principles that members might use as a guideline. We were about to throw in the sponge when we finally decided to draw up a statement that might serve as a representative approach.

With the exception of a few known or suspected chemicals, our knowledge is very limited about human mutagens, teratogens, fetal or embryo toxins, and carcinogens. Testing methods are developing very rapidly, but for the moment the answers are totally unclear--especially from the physician's standpoint. For one thing, we are unable to extrapolate much of the animal data to humans. Certainly, there is need for

greater protection of persons who are vulnerable reproduction-wise; however, what are the "safe" levels of exposure? We finally concluded that no purely medical policy could solve the problems of today nor be sufficiently flexible to cope with the future. Our one hope was that research and clarification of the issues involved in identifying hazardous materials will be forthcoming. Our statement will be presented to the Boards in the next several weeks for possible adoption.

Recent concern over male reproductive function is essentially a new issue from a medical perspective and it is also without scientifically valid information. As a social issue, it embraces an even more vulnerable sector of the population--one that should not be deprived of equal job opportunities. Again, the committee has not been able to delineate a statement of purely medical policy to resolve the dilemma. There are many ways to deal with the problems, which vary from industry to industry. Some of the better features of each have been incorporated into a tentative policy titled,

"Interim Guidelines for Safe Handling of Substances Which Pose Potential Hazards Specifically Peculiar to Either Sex or Offspring"

and is directed to neither males nor females.

As a first measure, all plant operations should be surveyed to identify materials that are mutagens, teratogens, or otherwise adversely affect human reproduction. These substances are then classified as follows:

RESTRICTED--no safe limit of exposure can be assured. Vulnerable individuals will not be permitted to incur exposure. Degree of vulnerability shall be determined by the medical department.

CONTROLLED MATERIALS--hazard information is adequately established and engineering or administrative controls can keep exposure at or below acceptable levels. These levels will be established by the industrial hygiene division of the medical department.

When it has been determined that a substance is a potential hazard, the following actions are recommended:

For controlled materials, employees shall be informed about the consequences of exposure and the appropriate safe handling procedures. Engineering controls shall be used to maintain exposure at or below acceptable levels, augmented by administrative controls where appropriate. Whenever engineering or administrative controls are impractical and personal protective equipment is appropriate and required, training in the proper use and care of such equipment shall be provided. Persons of the vulnerable sex should be removed from work areas whenever an acceptable exposure level cannot be set, or whenever engineering and administrative controls are inadequate.

REPRODUCTIVE DISORDERS OF THE MALE/FEMALE WORKER

Occupational Placement of Women of Reproductive Capacity --OSHA's View

Peter F. Infante, DDS, PhD

At the present time, OSHA has not completed an official policy on this extremely complex issue. However, we have observed several inconsistencies in the practice of worker placement by sex, and I'd like to talk about some of these.

In the past decade, there has been a dramatic surge of women in the labor force. In 1976, the female labor force increased by 1.6 million for a total of over 39 million. This is twice the number of new male workers over the same period of time. Two-fifths of the entire work force is female and nearly half of the adult female population is employed or seeking work. NIOSH has estimated that in 1977, one million infants were born to women who were employed during their pregnancy. Because increasing numbers of women in the US are seeking employment outside the home, the attention of government, industry, and labor has become focused on the effects of occupational exposures to toxic agents on women, and especially on the fetus and embryo.

In lieu of adequate industrial engineering controls, women of child-bearing age in the US are being transferred from jobs where they are continually exposed to toxic agents because of the concern about adverse effects on the unborn. In some companies the alternative to a job transfer is the requirement for medical evidence that a woman cannot bear children. But such a policy will demand a critical assessment of the adverse effects of the contraceptives. To adequately assess this risk, we must be concerned first with the general mechanisms that pose potential harm to the unborn. Germ cell damage as well as transplacental effects must be considered.

The traditional approach to determining adverse effects on the unborn from female exposure entirely ignores the occupational exposure of the male parent--i.e., effects that may be attributable to the sperm. Although a limited number of studies have demonstrated transplacental effects from environmental toxins, it is difficult to determine potentially transmissible mutagenic effects. Some chemicals in widespread use are mutagenic in subhuman test systems; thus, there is a possibility that they may be a genetic hazard to humans as well. If so, there could be serious consequences both to the current generation (through decreased fertility due to grossly abnormal germ tissue) and to future generations through the production of transmissible gene mutations and changes in chromosome structures and numbers.

Vinyl chloride, for example, has been shown to be carcinogenic and mutagenic in animals as well as microbial, insect, and plant systems; chromosomal aberrations have been noted in exposed male workers and excessive miscarriages have occurred in the wives of these male workers. Obviously, neither sex should be unduly exposed to this compound. In 1975, two transplacentally-induced cancers in experimental animals were observed and it was, therefore, recommended that women not be exposed to vinyl

chloride. Pregnancy outcome studies among female operating room personnel have repeatedly shown a significant excess of miscarriages and birth defects; the same results are reflected in the animal data. Moreover, the wives of anesthesiologists and dentists also have demonstrated an excess of birth defects and spontaneous abortion.

Chloroprene is now associated with sterility and dominant lethality in mice and rats; sperm effects, testicular atrophy and chromosomal aberrations in rats; mutagenesis in microbial systems; and recessive lethality in *Drosophila*. Epidemiological studies on humans show chromosomal aberrations and decreased sperm motility in males and a three-fold excess of miscarriages in the wives of male workers exposed to chloroprene.

Numerous studies have indicated that five glycidyl ethers induce testicular atrophy in experimental animals. Epidemiologic studies on the potential reproductive hazards of these compounds have not been reported.

In 1961, dibromochloropropane (DBCP) was first revealed to cause sterility in several species of experimental animals. It was not until 1977 that infertility and low sperm counts were observed in workers exposed to this nematocide. Then in 1978, adverse chromosomal effects (non-disjunction) were reported in the sperm of DBCP workers. It is worth noting at this point that 0.5% of all live births contain chromosomal errors; 80% of this burden is a result of errors in chromosome number and is associated with mental retardation.

Until recently, little attention had been focused on occupationally-related reproductive hazards. As a result, our knowledge about the occupational setting as a factor in the etiology of these problems is extremely limited. The significance of effects at each stage of the reproductive cycle needs to be evaluated, utilizing available techniques along with newly developed methodology for assessing etiologic factors. We at OSHA are looking to the scientific and medical communities for help in this area. We are dedicated--and it is our legal responsibility--to insure the safe and healthful workplace for all American workers, women and men, including protection of all their functional capacities. Although OSHA has not completed a formal policy for dealing with reproductive hazards in the workplace, we are beginning to address comprehensively the scientific issues and policy alternatives. Meanwhile, we hope that medical policy decisions by industry will be based on firm scientific data instead of economic or social bias.

REPRODUCTIVE DISORDERS OF THE MALE/FEMALE WORKER

Short-Term Bioassays as Indicators for Potential Mutagens and Carcinogens--Current Status

Gordon W. Newell, PhD

It is appropriate that new and rapid methods for the detection of potential carcinogens and mutagens be considered at this symposium, which is concerned with the effects of the work environment on the reproductive health of the worker. The increasing realization that any chemical in the environment may have an adverse effect on human health has further emphasized the need to assess a substance's safety. However, there are finite limitations that preclude the evaluation of any or all compounds by the usual long-term animal testing schemes (i.e., the 2-3 year studies with the rat or the 1 1/2-2 year studies with the mouse): the shortage of test facilities, insufficient numbers of qualified professional personnel, and the costs for testing all compounds would be in the millions of dollars--a staggering figure. Consequently, over the past 30 years increased attention has been given to the need for the development of short, rapid, and inexpensive toxicity tests, particularly those that might assess the potential carcinogenicity of a material.

During this period, various procedures have been proposed and put to use. Only within the last 5 years has there been a new era, with Ames and associates from the University of California, Berkeley reporting on work which has been evolving over the past twenty years (1,2). Various mutant strains of Salmonella typhimurium have been developed which are sensitive to point mutations. Genetic alterations of these strains have been characterized as base-pair substitutions and frame-shift mutations, enabling detections of reversion to prototrophy. The test systems are capable of recognizing not only direct-acting mutagens but also indirect mutagens. The latter is accomplished by the introduction of enzymes and co-factors from postmitochondrial fractions of mammalian liver into the growth medium; these fractions can generate electrophilic metabolites (commonly referred to as the S-9 fraction) (3). The source of this metabolic activation system is the liver of animals who have been treated with PCB's or phenobarbital. More recently, the whole animal as a modified host-mediated assay system has been found useful for the detection of chemical mutagens in the urine. Usefulness of the Ames Salmonella assay prompted interest in other systems; thus, other prokaryotic assays also have found use in the identification of potential mutagens. The repair-deficient assays using Bacillus subtilis as well as Escherichia coli are well-known (4-5).

Eukaryotic systems such as Saccharomyces cerevisiae (i.e., baker's yeast) contain a nucleus cytoplasm with chromosomal material comparable to that of mammalian cells. Several of these yeast strains have been used extensively to identify deleterious genetic properties of chemicals (6). Mammalian cells in culture also are used in addition to microbial systems for detecting gene mutations (7). Detection of such events are made with Chinese hamster ovary cells using drug-resistance markers (such as ouabain-resistance and 8-azaguanine-resistance mutants) (8). A similar approach uses Syrian

hamster embryo cells in a point mutation assay (9).

Other systems useful for measuring mutational events are the plant system Tradescantia (10) or the insect Drosophila melanogaster (11), wherein sex-linked recessive lethals can be identified; unscheduled DNA synthesis using either human or animal cells in culture (12); measurement of sister-chromatid exchange (13); as well as in vivo chromosomal aberrations which can be measured with leucocytes or developing bone marrow cells (14).

While heritable mutagenicity is an important toxic endpoint, evidence has been accumulating since Ames first reported on his system to indicate that there is an association between mutagenesis and carcinogenesis (15). Consequently, the relationship offers a possibility of screening for carcinogenic events with simple and low-cost test systems.

Generally, it is considered necessary that there be multi-test evidence to demonstrate the mutagenicity of a test substance (16,17). It is well recognized that a single system is not yet able to assess all types of genetic change with sufficient sensitivity and yet incorporate the concerns relevant to mammalian physiology and metabolism. The following discussion identifies the types of genetic changes that may be induced by chemicals and considerations that should be included in test parameters when evaluating the mutagenicity of a compound. These genetic end-points include gene mutations (such as point or small multilocus mutations), chromosomal aberrations, and indicators of primary genetic damage. The latter signs include stimulation of recombination (through gene conversion or mitotic crossover) as well as stimulation or inhibition of DNA repair, or examination for the incidence of sister chromatid exchange.

Mutation is a universal mechanism underlying genetic change in all life systems. Furthermore, the usual target molecule, DNA, is chemically the same in all cellular organisms. Therefore, test results from a wide variety of cells and organisms are relevant to the assessment of the mutagenic potential of a chemical in humans as well as other forms of life. If a compound is found to be mutagenic in either non-mammalian organisms or in mammalian cells in culture, procedures and practices should be developed to protect intact mammals.

Because of the relative simplicity of the Ames Salmonella test, it has attracted many converts. Unfortunately, it frequently has been used by both industrial and governmental organizations as the only mutagenicity test. Its limitations have been shown in a number of review studies. A retrospective study of 66 carcinogens and 29 non-carcinogens (wherein several short-term test procedures were used by investigators in the US and Japan) showed that mutant strains of yeast and E. coli gave correct responses with about 50% of the carcinogens but only 25% of the non-carcinogens. However, the Salmonella strains developed by Ames showed a correlation of 75% with carcinogens; on the other hand, only 11% of the non-carcinogens were identified as mutagenic. Later, after Ames added a metabolic activation step, the correlations of mutagenic activity with known carcinogenic response in animals were increased to levels of 86-90% (18).

More recently, Purchase et al summarized the study of 10 short-term test procedures that were candidates for evaluating toxicity-mutagenicity-carcinogenicity of a compound (19). Initially, 4 of the tests were quite non-sensitive and were eliminated early. The remaining 6 were then used to study some 120 compounds, half of which

were known to be carcinogenic from long-term animal studies and half were known to be non-carcinogenic. Here the Ames test as well as a cell transformation system (using Syrian hamster kidney fibroblast and human diploid lung fibroblast cells) showed correlations of mutagenic response with carcinogenicity at a 91% level of agreement with known carcinogens and 93-97% agreement with non-carcinogens.

The results of the Purchase investigation stimulated the initiation of a new collaborative international program to assess the validity and reliability of various short-term test systems (20,21). The exciting aspect of this program is that it is the first controlled prospective collaborative mutagenesis testing program to examine the many short-term tests now under evaluation in various laboratories. Financially supported by the Medical Research Council of the United Kingdom, the Imperial Chemical Industries Ltd. of Great Britain, the National Institute of Environmental Health Sciences, and the US Environmental Protection Agency, it includes an assessment of some 25 different short-term assays for their sensitivity to 42 known carcinogens and non-carcinogens. The 21 pairs of compounds are unique because each pair is closely related structurally; one compound of a pair is known to be carcinogenic from long-term animal studies while the other half of the pair is a closely related congener which has been shown to be a non-carcinogen in the mouse and/or rat. Japanese investigators also will participate in this effort. All the compounds will be tested blind; an independent panel will review all of the data and also will carefully assess the animal carcinogenicity data to assure that the "carcinogenic" compounds do indeed meet the defined criteria. Many of the short-term systems identified earlier will be used in this study.

A second ongoing program is evaluating the reliability and inherent problems of the Ames assay through a contract with the National Cancer Institute (22). Four laboratories are testing a wide variety of compound structures under code, using a carefully delineated protocol. Each compound is being examined both with and without the addition of the S-9 metabolic activation system and in the *E. coli* W-p₂ prokaryotic system. Initial results have shown the importance of following a carefully identified protocol. In reviewing the results of the initial group of compounds, two of the four laboratories had mutagenic responses different from the known carcinogenic responses in animals. It was finally determined that the prescribed procedure was not being followed.

Inasmuch as the Ames system has gained prominence as a short-term test for carcinogenic potential, the major efforts of these two programs will concentrate on this system. Twelve separate evaluations of the Ames system will be made; allowing time for accumulation and evaluation of the data, definitive information may not be available for 1-2 years.

Collaborators in the international mutagen program presented data in Washington, DC in August 1978, to show that the composition of the S-9 metabolic activation preparation (as developed and reported by Bruce Ames) was as optimal as could be expected; i.e., variations in composition and tissue source, as well as method of preparation, were no more effective than the system developed by Ames. On the other hand, the host-mediated assay (wherein a culture of micro-organisms is injected intraperitoneally into a treated animal and then withdrawn later for mutagenic evaluation) has, for the most part, been dropped. Its sensitivity to known mutagens is consistently less than that of other systems. Also, the *in vitro* transformation assays have elicited much enthusiastic support--these systems use mammalian cells as the tester endpoint; the results are considered to have a closer relationship to man and may

be more meaningful. However, these systems have yet to prove their value as short-term, inexpensive, and reliable procedures. The several systems now under development can require several weeks or months to complete and only a few laboratories have been able to successfully conduct them on a routine basis. They seem to be particularly sensitive to contamination and require more complicated test facilities and more sophisticated staffing than the simpler in vitro mutagenesis test systems. Also, the cell culture/transformation systems have been studied with only a few compounds; thus, there are only limited data for validation and support of the systems.

Although US regulatory bodies have been reluctant to adopt any in vitro mutagenesis system, their research and development divisions, as well as many industrial organizations, are using these procedures in a variety of applications.

Today we can test for mutagens and carcinogens in industrial and environmental air and water, as well as municipal waste treatment systems.

NCI is now using the Ames procedure to assist in setting priorities for long-term animal bioassays.

In conclusion, I wish to emphasize that:

Short-term in vitro mutagenesis bioassays are finding increasing acceptance and use by industry and government. There are limitations in the use of any one assay, but through judicious consideration of several assays, the mutagenic and carcinogenic potentials of a compound can be assessed.

Many of these systems, however, need validation before their widespread and routine use can be justified. Fortunately, several collaborative testing programs are being conducted, which should provide valuable information for choosing the most consistently reliable procedures. Since in vitro assay for mutagenesis is a new and developing research area, one should be cautious in his choice of a contract laboratory for such services. Time spent in developing assurance, through the submission of blind samples to candidate laboratories, will be well rewarded.

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CASE STUDIES IN OCCUPATIONAL HEALTH PROGRAMS

Industrial Conception--Birth of a Plant

Richard W. Repert, MD

Although the title of this paper suggests a meeting of the Arizona Obstetric Society or a botanical trend in industry, it was chosen deliberately because Tucson has recently become a birthplace of a brand new baby IBM manufacturing plant.

The Tucson plant, in an early state of development at this time, is experiencing the typical, rapid newborn growth pattern--requiring much high calorie nourishment in the way of staffing and brainpower from its foster parents in San Jose, California and Boulder, Colorado. I was selected to make this presentation because of my involvement in the development of the medical program in IBM's Austin, Texas plant. Since the Tucson plant is still in an immature stage and therefore cannot be used as a complete model for this subject, I would like to use the Austin plant--which celebrated its tenth anniversary in April of 1977--for that purpose.

The development and coordination of Austin's occupational medical program within a complex, dynamic manufacturing process was a challenge that was not easily met. This was true not only in the hectic embryonic and childhood phases of plant development, but also in the more controlled, adolescent growth phase.

When a new plant is born, healthy, energetic, skilled and unskilled employees must be located, interviewed, selectively placed, trained, and then protected from potential environmental hazards. This requires the coordinated efforts of industrial hygiene, safety, and medical personnel. Since people are industry's most valuable resource, it is necessary that every precaution be taken to preserve their health by providing an environment free of hazards. This is especially true in the very early phases of plant growth, since many inexperienced workers are being hired, many new manufacturing processes are being initiated, and safety and chemical procedures may not have been perfected. To illustrate, statistics show that the Austin plant, with a population of 1,700 in 1969, recorded nearly 1,300 industrial injuries; while in 1977, with about 3,800 employees, we had only 1,600 injuries. The Tucson site plans to have the industrial hygienist and safety technician on board during the construction of the new plant site to make environmental assessments in advance. IBM, as well as many other corporations, has been dedicated to the philosophy of preventive medicine--long before the advent of OSHA in 1970.

The original plan for the Austin plant was conceived in 1966 in Lexington, Kentucky because the Lexington plant had grown beyond its optimum size. This could have been called industrial planned parenthood. Also, new technology had been developed in the field of equipment linking the typewriter with programming technology. The final product was to be called the Selectric Composer. Ground breaking ceremonies took place in January of 1967, with the delivery date set for July. Experienced assembly and engineering personnel were selected from the Lexington work force for transfer to

Austin at a later date. A training area called "Little Texas" was set up within the Lexington plant, identical to the proposed assembly operation in Austin; and to gain special attention, a Texas flag was displayed in the area.

Following the selection of a plant manager and personnel manager, an experienced occupational health nurse was picked from the medical staff in Lexington. The personnel manager and a small staff of recruiters came to Austin in March 1967, and set up a temporary employment office several miles from the plant site. A divisional medical director from New York came to Austin and, after many interviews, compiled a list of Austin doctors who were willing to do preemployment physical examinations and care for industrial injuries and illnesses. Approximately 150 people were hired in Austin, including a safety technician. All were sent to Lexington in April to train for assembly operations in the "Little Texas" area.

The newly-appointed supervising nurse, (still located in Lexington) was given a floor plan for the proposed temporary medical area to be constructed in the first Austin building. She ordered the clinic's furniture, equipment, and supplies. The medical department budget was estimated for the remainder of the year, based upon employee population projections.

Records of employees transferring from Lexington, plus those in training from Austin, were delivered to the nurse; confidential handling of these records was assured from the outset. She also became qualified as a Red Cross first-aid instructor in order to carry out the first-aider program.

On July 31, 1967, the first IBM Selectric Composer was delivered from the assembly line. It was a natural birth following a busy, but uneventful, gestation period. The safety department, which included chemical control and industrial hygiene, had been established in temporary off-site quarters prior to completion of the first building and had begun the process of safety inspections before the new plant was occupied; these included noise, ventilation, light, and heat evaluations. Chemical controls were handled through a chemical engineer assigned temporarily as a chemical coordinator. Since Austin was an assembly plant at this time, the chemical hazards were minimal.

By 1968, the plant population had reached 1,000 and plant size had grown irregularly to 300,000 square feet. Engineering support areas and business and personnel offices were now well-established, and another nurse was hired at this time. A formal hearing conservation program was set up to perform an audiogram on every employee. An audio booth and equipment were purchased, and the nurses were given training in audiometrics at Southern Methodist University in Dallas. A part-time physician was engaged to supervise the hearing conservation program and to perform preemployment and periodic examinations. Over 10,000 visits to the medical department were recorded for 1969, including personal illnesses, industrial injuries, physical assessments, and over 1,000 audiograms.

Part-time industrial hygiene services were shared with Lexington. The first-aider training program came into full operation, shared by medical and safety instructors, with the objective of having at least one first-aider for every 50 employees. Internal trucking licensure was handled by safety personnel with medical department examination and approval. Personnel problems having medical overtones were handled by the management team with our counsel. By the end of 1968, recruiting and hiring were accelerating and medical needs were increasing; therefore, a full-time occupational physician was hired. The baby was ready to enter childhood.

A new medical area of almost 2,000 sq ft was completed in 1969, with chest X ray and minimal laboratory facilities. CPR training was now included with first-aid, even though the American Heart Association had not yet approved the training for lay people. This training was considered mandatory for plant protection officers, emergency squads and medical personnel. The medical department purchased a battery-operated "crash cart" with defibrillator, ECG monitoring, and an automated heart-massage unit. Also included were tracheal intubation equipment, IV fluids, and medications. Since we had no emergency medical service in Austin at that time, we wanted to have the capability of keeping an employee with cardiac or pulmonary arrest alive until he could reach the nearest coronary care or emergency center.

In 1968, plant adolescence had just begun when IBM initiated its corporate Voluntary Health Screening Examination Program (VHSEP). This examination is now performed at 5-year intervals by the nursing staff and supervised by the physician. It was originally limited to employees 41 years of age or older; the age limit was later dropped to 35. This program, in my opinion, was a very significant step for preventive medicine at IBM. Time and a careful statistical analysis will determine the true value, but the opportunity for health education on a one-to-one basis with participating employees is a major advantage. Also, the program provides direct clinical interface with the medical community through letters and personal conversations, and it brings occupational medicine out of the industrial environment into community health. Recent analysis of the data after 85,000 first-time examinations indicates that as many as 30% of the participants were found to have a health defect of potential importance, of which they were unaware.

Seeking to comply with the regulations of the newly implemented OSHA Act soon became a full-time task for each plant. Recordkeeping fell to the medical department; the added emphasis of the Act on health, especially in regard to noise and chemical exposure control, created the need for an on-site industrial hygienist. In recent years, the need for medical surveillance has increased the number and complexity of examinations aided by the sampling and monitoring by the industrial hygienist. The site has now matured into young adulthood.

IBM considers health education to be a very important part of its preventive medicine program. Done on a one-to-one basis by nurses and doctors, the periodic exams, chemical surveillance, and screening programs provide exceptional opportunities for health counseling. Also, medical department personnel are accessible at no cost to every employee. Audiovisual programs on such subjects as diet, exercise, hypertension, breast examinations, and Pap smears have been developed for groups and individuals. Tuberculosis skin testing has been done at 2-3 year intervals to identify positive reactors. Diabetic screening has also been performed on several occasions. The safety department has contributed much to the health education effort with movies on safety, and pamphlets dealing with environmental, home, and recreational hazards.

Participation in the medical community of Austin was started in 1968, involving the plant physician in hospital staff duties and education programs, medical society affairs, and community health organizations. Over the years, this had led to compatible medical relationships between our medical department and most private practitioners. I believe this is crucial to the overall success of any industrial preventive medicine program. Many local physicians have been my guests for a brief plant tour to see the working conditions and to learn about our occupational medical program.

The Tucson plant medical program, on the other hand, is already underway with an

experienced occupational nurse from Boulder, Colorado. A medical department with its records system, community physician contact, health education, first-aid program, and information regarding emergency treatment facilities have been organized. Meanwhile, new employees are being hired, many are transferring in from other areas of the country, but all are being screened by the nurse for any unusual medical conditions which might be influenced by job exposure. In anticipation of OSHA's emphasis on chemical exposure, particularly carcinogens, an industrial hygienist will be hired in advance of the full-time physician.

In summary, the establishment of an occupational medical program in a new plant is an exercise in preventive medicine progressively integrated into the plant as it and the working force continue to grow. In order of importance, I feel that:

- A well-equipped, well-staffed and strategically placed medical facility for treatment of industrial injuries, illnesses, and emergencies should be organized;

- environmental controls planned and implemented with the cooperation and guidance of safety, industrial hygiene, and engineering personnel;

- preplacement and periodic health surveillance examinations scheduled and performed;

- counsel with management and personnel staff on employee medical problems;

- first-aid and CPR education instituted;

- a medical recordkeeping system organized to satisfy corporate, state, and federal needs;

- personal medical care provided to accommodate minor problems;

- interface with the local medical community.

And finally,

- A health education program should be developed in order to maintain both a healthy work force and community through the practice of preventive medicine.

CASE STUDIES IN OCCUPATIONAL HEALTH PROGRAMS

US-Mexico Border Industrialization Program

Herbert K. Abrams, MD

INTRODUCTION

The US-Mexico border is in some ways the most unique international border in the world. It joins two great nations which are in different stages of economic and social development. One is a world power with an Anglo-Saxon cultural background enriched with immigrants from everywhere in the world; its second largest ethnic group is the Latino people of whom Mexican-Americans are the most numerous. The other is one of the leaders of Latin-America with a Hispanic-Indian heritage. From Brownsville and Matamoros on the Gulf of Mexico to San Diego and Tijuana on the Pacific Coast, the border stretches 3,200 kilometers, two-thirds of which is river. The estimated population of these areas--four states on the US side and six on the Mexican side--is about 20 million people, almost equally distributed on both sides but with most of the Mexican urban communities larger than their US counterparts.

The social and economic differences of the two countries are reflected in their disease patterns. For example, enteritis and other diarrheal diseases are 1st among the ten leading causes of death for young children (ages 1-4) in Mexico but 8th in rank in the United States (1). While it is easy to stress the differences of the cultures which face each other at this border, there is one common overriding factor that underlies and aggravates the health problems on both sides: poverty. Health of Mexican-Americans is generally poorer than that of the Anglo, but it is somewhat better than that of the black. Chicanos still have higher age-standardized death rates than the Anglo, lower life expectancy, higher infant and maternal mortality and higher percentages of the population with dental and nutritional deficiencies. Chicanos also have higher mortality rates from diabetes, tuberculosis, and other infectious diseases and from cardiovascular diseases (2). The Mexican scholar Ricardo Loewe says: "There is an underlying but clear, huge and definite stratification among the population which, when it comes to health, allows to a small minority the luxury of dying of cancer or heart disease, while the majority are forced to die of cheaper diseases such as bronchial pneumonia and enteritis" (3).

The ecologic differences at the border are lessening as industrialization takes place on both sides. For example, air pollution usually progresses from north to south, water pollution in both directions, while housing and occupational health problems are prevalent on both sides. Cancer researchers tell us now that at least 80% of the human cancer cases stem from the environment; recent studies of the National Cancer Institute and the National Institute of Environmental Health Sciences indicate that about 20% of these are occupational (4). All available data also suggest that most of the major diseases originate in the environment. Numerous studies throughout the world demonstrate that the lowest socioeconomic groups have the highest mortality rates. Thus, we can say that both sides of the border generate an excessive amount of

social disease, including occupational diseases.

THE MIGRANT FARM WORKER

The condition of seasonal and migrant farm workers today in the US is an integral part of the story of the US-Mexico border; it is perhaps more nearly like that of industrial workers in England in the 19th century than any other occupational group. Life expectancy for migrant farm workers in the US is reported to be 49 years, about 20 years less than the national average (5-7). Compared to the population as a whole, infant and maternal mortality rates are 125% higher, influenza and pneumonia death rates are 200% higher. Moreover, farm workers are deprived of many of the occupational health and safety protections that are available to other workers. The National Safety Council rates agriculture as our third most dangerous industry behind mining and construction; figures for migrant farm workers per se must be even more dramatic since the NSC data include all types of US farmers. In addition, the US Department of Agriculture estimates that there are 800,000 children under age 16 still working in the fields of the United States.

In California the mortality rate from respiratory disease in the farm labor group is triple the rate in the farm management group; accidental deaths are also much greater in the farm labor group (8). With respect to pesticides, there are many more suspected cases of poisoning than are reported. One study showed that the rate of illnesses due to pesticides in California was three times greater than that which was officially reported (9). When one considers the multiplicity of factors--poor housing, poor nutrition, preventable diseases, pesticide exposure, and lack of adequate medical care--it is understandable that the life expectancy for migrant farm workers is 20 years less than that of the general population.

Recently, I was asked for help with a group of "undocumented" farm workers. "Undocumented" is the euphemistic term for illegal immigrants; there are hundreds of thousands of them, but because they are undocumented they can't reveal themselves or they will be deported. This particular group was living on the ground in an orange grove near Phoenix; they were accidentally sprayed with pesticide in the dim light of early morning. What to do? My first response was to send them to the county hospital; however, they feared they would be revealed and deported. So, we had to work out a way of having a local doctor examine them informally.

THE BORDER INDUSTRIALIZATION PROGRAM

This program, also known as the "twin plants" program, represents the latest in a series of efforts by American employers over the past half-century to utilize the large pool of unemployed workers in Mexico. Thousands of Mexican workers were imported into the southwest United States during and after World War I, followed by massive deportations during the Depression. Much the same import-deport cycle has occurred many times since. Our biggest effort was the "bracero" program from 1942-1964; during one year of this period, more than one million braceros were brought into the US for agricultural work. When the bracero program was terminated in 1964, hundreds of thousands of Mexican workers found themselves stranded near the border. Border cities were meanwhile suffering from their own population growth, caused in part by industrialization. Social unrest was on the increase. Campos Salas, then Mexico's Secretary of Commerce and Industry, is credited with the idea for the border industrialization program after he had visited the Far East and observed American-owned assembly plants staffed with low-paid foreign workers.

Under the twin plants concept, two plants--one on each side of the border--operate under a single management. The major products assembled are electronic components, clothing, furniture and wood products, musical instruments, toys and novelties, and a variety of other products; included are at least two asbestos textile plants. At the end of 1977, there were 395 such plants on the Mexican side, all owned by US corporations and employing approximately 70,000 workers.

What has the twin plants program accomplished? For Mexico, it has brought many jobs to her border areas. Whether it has helped to reduce massive Mexican unemployment resulting from the end of the male bracero program is doubtful, since it has added an estimated 70,000 women to the work force who were previously not part of it. Most of these plants are assembly operations and employ predominantly women. Also, the development of these industries has attracted many thousands of Mexicans from the interior countryside to the border. Only a very few of them are able to obtain jobs; thus, many live in squatter's settlements, in wretched conditions that breed disease and social pathology. Unfortunately, the program is dependent on the uncertainties of the American economic cycle; or as one American report puts it, "The employment and economic well-being of perhaps 100,000 Mexican workers and their families are at the mercy of US firms who make decisions on the basis of profits first, rather than what is best for Mexico" (10).

From the American point of view, the development has opened up a new source of cheap labor for American industry. Many of these industries claim that they have been able to stay in business; whereas, they would be unable to operate using American workers. On the other hand, the American labor movement claims that it deprives American workers of jobs. Doubtless some communities have benefited and others have suffered precipitous dislocations. For example, in 1975, the Matell Company (which manufactures Barbie dolls) had 3,000 employees in Mexicali. Suddenly they decided to close down; overnight 3,000 people were unemployed. Dr. Jorge Bustamante, a professor at El Collejo de Mexico said, "The bracero program, and those like it, are escape valves that postpone the more realistic solutions; sooner or later, the problems return to Mexico, either as deported workers or overcrowded conditions in the border cities" (11).

In terms of specific occupational health problems, there is as yet little hard data available; however, it is not difficult to see problems developing. Some of them are quite obvious; in Nogales, a border community 65 miles south of here, the sewage system is inadequate. Some of the twin plants on the Mexican side are new and attractive buildings built in the past 8-10 years; yet some of them discharge their wastes onto the open ground. We already know of at least one asbestos textile plant that was reported to have gross exposures not only to workers in the plant but also to those living in the neighborhood (12). Since 80% of the workers in the assembly plants are women, there are possibly special effects on women which must be studied. The Mexican writer Carlos Monsirais complains, "Job insecurity is constant, and labor and sexual abuse are oppressive for women in the maquiladoras i.e., twin plants" (13). My own observations in several plants were that most of the workers are young women, working at a rapid pace to fulfill quotas of production set by the company. As in Charlie Chaplin's famous movie, "Modern Times", each worker was trying very rapidly to keep up the pace of the assembly line, putting in place a single component of a product which would be finished elsewhere. Each had to work carefully as well as rapidly, since many of the machines were stamping machines which could easily amputate fingers. There was an atmosphere of great tension to make the quotas so that they would not lose their jobs. Studies have shown that this kind of work creates

fatigue, boredom, accidents, and a lack of work satisfaction with corresponding mental and emotional consequences. I have also heard of a number of pulmonary problems in some of the textile plants, but these have not been investigated. Incidentally, these workers typically put in a 48-hour week and earn the minimum wage, which is equivalent to about \$5.00 (US) a day.

AIR POLLUTION

Most air pollution along the border emanates from US industry. The many copper and lead smelters discharge sulfur oxides, particulates and heavy metals. A Mexican engineer named Alberto Villasana views pollution on the Mexican side a little differently; he says, "Pollution due to the dumping of industrial waste in the rivers and streams hardly exists in Mexico, our pollution comes from poverty" (14).

Several reports have documented heavy metal absorption as the result of air pollution from primary copper, lead and zinc smelters on the US side of the border. For example, in El Paso, Texas there were excessive blood lead levels in 53% of the children 1-9 years old who lived within 1.5 kilometers of the smelter. Particulate lead and dust accounted for most of the lead absorption in the El Paso children, and the smelter was the principal source. It was projected that over 2,700 children 1-19 years of age in the area surveyed may have had blood levels of at least 40 micrograms per 100 ml. at the time (15). Other studies have shown anemia, and neurologic and psychologic dysfunction in children living near this and other smelters (16,17). In a nationwide and statewide study of primary copper, lead and zinc smelters--most of these located in US communities near the Mexican border--there was excessive absorption of arsenic in children, elevated blood lead levels and also elevated levels of lead and cadmium in hair. Subsequent studies on both sides of the border reported, "an estimated 10,000 children in two counties with lead poisoning or excessive lead absorption. More children seem to be affected on the Mexican side. El Paso continues to have one of the highest air/lead concentrations in the United States and, as of about a year ago, it was on the increase" (18-20).

What can be done? The Pan American health organization, the US-Mexico border health association and the US Boundary and Water Commission have established many cooperative activities, ranging from conferences such as this to the establishment of air and water quality monitoring programs and programs for the disposal of sewage and solid waste. There have also been some limited attempts at developing joint water supplies. However, these organizations can do little more than make recommendations to the authorities in power. Yet, I continue to believe that as long as both countries are democracies and both subscribe to the wisdom of the people, something will be done.

A recent California report on the twin plants program called my attention to an interesting development: "The most innovative and least known effort to find a way to help solve Mexico's critical economic problems may well be the Association for Social Solidarit permitted under Mexican law. At least eight of these associations are in operation. A cross between a commune and a cooperative, these associations produce everything from toys to work clothing, from food products to simple homes, with the worker/members receiving living expenses for their work contributions. Either through this money or through barter, these basic consumer goods then become available for the poor peasants who otherwise gain nothing in goods or work from such programs as the Border Industrialization Program. They differ from the cooperatives permitted under Mexican law because they are not government controlled and because, unlike the co-ops, they have not become enmeshed in government red tape" (21). Mexican engineer

Villasana says, "In the US, ecology means the improvement of the standard of living; south of the border, it means life itself. If Mexico and the US were to agree on a community of purpose, solutions beneficial to both countries could be promptly and effectively provided" (22).

California's report said, "In the past, Mexico has usually ended up with the lion's share of the profits. Only future efforts planned with regional input and cross-border cooperation can determine whether this can be altered for equal benefits on both sides of the border" (23). There is great potential in this area, in cooperative bi-national effort for immunizing the large numbers of unprotected children and adults, cooperative bi-national programs for maternal and child health and family planning, primary health care centers with reciprocal arrangements for care, frequent scientific exchanges and conferences among the professional workers, and occupational health protection which presently is in its embryonic stage. Think of the potential for youthful employment of the unemployed and for benefit to the entire community of a bi-national effort by industry and government to construct safe water supplies and low-cost, pleasant housing for the thousands living in wretched hovels.

Finally, consider the benefit of combining forces for protection of the environment: in the factory, in the field and in the community. "Maquiladora" and "bracero", these words would take on heroic meaning if human ingenuity were put to work for these purposes.

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SHIFT WORK--The Incidence of Medication Use and Physical Complaints as a Function of Shift

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Adjusting to shift work has become a routine practice for many working Americans and their families. According to one recent report (1), approximately 26% of the American work force is involved in some form of shift work, and there is reason to expect that this percentage may climb in the coming years (2).

Despite the prevalence of shift work practices in US industry, little is presently known about the potential health consequences of working during periods that may be contrary to one's physiological circadian rhythm and his customary social patterns. Conclusions regarding the effects of shift work on general physical health are in disagreement (3-6). While some investigators report no detrimental effects, there is evidence that certain types of problems are related to shift work.

Thiis-Evensen (7) found, for example, that 30% of a group of workers who had changed from non-day shift work to day work complained of gastritis. The majority of complaints came from workers who had been on shift work only a short time. Bjerner et al (8) found little difference between night shift workers and day shift workers in complaints of gastritis and medical attention to gastritis. When these investigators, however, compared their data for day shift workers who had never worked shifts with those who had, an interesting pattern emerged: Day shift workers who had never worked other shifts had the least medical attention and hospitalization, current non-day shift workers had a slightly higher frequency, and day shift workers with previous experience on other shifts had the greatest number of problems.

Long-term studies of disease incidence in shift workers are rare. Those who have attempted to estimate long-term effects (e.g., Aaonsonen (9)) by including former shift workers in their samples have found that individuals who leave shift work have the highest incidence of disease. Some investigators, noting that about 20% of the workers are not able to continue shift work, feel that there is a definite health risk to this group (10,11).

There appears to be a connection between shift work and gastroduodenal ulcers, but the exact nature of the relationship is not clear. Studies have shown that the frequency of reported ulcers is from 2-8 times greater among rotating shift workers than among day shift workers (7,10,12). Wyatt and Marriott (13) hypothesized that the disruption in meal times "may be an important factor in the etiology of peptic ulcer," while Andlauer's study supports the view that gastroduodenal ulcers are more common among shift workers due to their eating, drinking, and smoking habits (14). Although many other studies have shown higher frequencies of ulcers under shift work conditions (8,15-18), Mott *et al* present data that are inconsistent (19); they found a higher incidence of ulcers among workers on fixed day and afternoon shifts than among

those working nights and rotating. Although their experimental design did not specifically test this hypothesis, the authors suggested that the day and afternoon shift workers with ulcers may possibly have developed the lesions during their prior night or rotating shifts.

One recent study (20) of the number of absent days vs causes for a sample of fixed day and non-day shift workers (matched by age, sex, job title, etc.) concluded that non-day fixed shift workers were absent for health reasons more often than day shift workers. Complaints were primarily respiratory and digestive disorders.

Although ulcers and some other gastric-related problems appear to co-vary with shift work, there is little information about the relationship between shift work and other bodily ailments. The available research suggests that the general physical health of most workers is not detrimentally affected by shift work *per se* (21,22). Taylor later found that fixed night shift workers were healthier than rotating shift workers (23). On the other hand, Pocock *et al* determined that changing from a conventional 7-day shift schedule to a rapidly rotating schedule produced a 36% increase in certified illness and a 29% increase in uncertified sick leave (24). Thus, rotation appears to pose a greater health threat than do fixed shift systems; unfortunately, no investigators to date have provided enough follow-up data to determine the health effects of adaption to new schedules.

As these studies indicate, the relationship between shift work and health is complex, and much additional research will be required before any consistent patterns emerge. Furthermore, most of the studies have been made in Europe where there are significant differences in work practices, cultural standards, dietary habits, etc. from their US counterparts. Consequently, correlations from the European studies to the American work force are limited.

NIOSH has recently undertaken a major investigation (NIOSH Contract No. 210-75-0072 with the Stanford Research Inst., Palo Alto, Calif.) of the health consequences of shift work to compare the incidence of physical complaints with medication usage. A total of 1200 food processors were selected randomly from eight plants located throughout the US and were contacted for their participation in a questionnaire survey. Of those contacted, 886 (74%) completed and returned the form.

Table I presents a summary of the gathered information. The sites varied by size of worker population, turnover rates, use of fixed vs. rotating shift system, and sick leave policy.

Table 1

QUESTIONNAIRE SUMMARY: FOOD PROCESSORS

Respondents:	Sites:							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Predominant system	R	P&R	P&R	P	P	R	P&R	P&R
Turnover	5*	?	18%	20%	?	?	18%	20%
Shift type:								
day	4	63	69	9	62	7	17	7
afternoon	0	42	51	3	68	0	13	4
night	0	42	46	6	75	1	4	8
rotating	142	59	24	3	2	16	17	22
Plant population	553	725	666	1100	455	484	980	1100
Clinic facilities	no	yes	yes	yes	yes	yes	yes	yes
Sick leave								
(see note below):	a,b	a	a,c	d	a	e	d	d

Note: Distribution of respondents over shifts is roughly proportional to the original plant population.

Legend:

- P = permanent, R = rotating
- * = 5 days during the last year
- a = no sick days
- b = disability program
- c = compensatory program
- d = 1 wk leave/each yr of employment
- e = 40 hrs leave/yr

All sites had three 8-hour shifts per 24 hours. Workers could either be assigned to a particular shift on a permanent basis or rotate according to some prearranged schedule; thus, there were four groups in the study: permanent day workers, permanent afternoon workers, permanent night workers, and rotating shift workers.

From the plant employee list, potential respondents (stratified by shift) were selected randomly and mailed the questionnaire, which was specifically designed to assess the physical health, psychological adjustment, and social adaptation factors thought to be most sensitive to shift regime. The frequency and incidence of physical complaints and medication usage were measured by means of a self-report checklist using a Likert-type response format.

Variables, besides shift, were sex, age, and self-reported measures of medication usage and physical complaints. Table 2 presents the sex distribution of the respondents over the four shift categories. Using a chi-square test, the distribution was found to differ

between sexes. 42% of all male workers were on rotating schedules vs 15.3% of the female workers. Female fixed shift workers were evenly distributed across the day, afternoon, and evening categories, whereas male fixed shift workers were concentrated on the day schedule.

Age was significantly related to shift. A Duncan's multiple range test indicated that the fixed day workers (mean age = 41.24) were significantly older than workers on all other shifts. Rotators (mean age = 36.32) and fixed night shift workers (mean age = 33.94) were significantly older than those on fixed afternoon shifts (mean age = 33.83); but these statistical significances (36.23 vs 34.94 and 34.94 vs 33.83) are probably due to the large sample size.

To provide an overview, a discriminant analysis of the data was performed using shift status to define the groups. Discriminant analysis weighs and linearly combines the response variables so that groups (shifts) are forced to be as statistically distinct as possible. The purpose to this approach was to identify those health-related variables (i.e., physical complaints and medication usage) that clearly differed.

Table 2
SEX DISTRIBUTION BY SHIFT
(n = 885*)

Gender:	Day:	Afternoon:	Night:	Rotating:
Males	143	95	86	235
Females	95	86	95	50

* Note: 3 respondents did not indicate their sex and are omitted from the analysis.

The discriminant analysis confirms the previous chi-square analyses with regards to sex and age. The first function in Table 3 shows sex to be most closely associated with shift differences, while age is most closely associated with shift in the second function. Thus, sex and age bear the strongest relationship to current work shift; these two variables would have to be "controlled" by using partial correlation techniques in order to assess the independent effects of shift on medication usage and physical health. After adjusting for age and sex, only four of the health variables were found to be related to shift status with partial correlation coefficients all less than 0.20:

nausea and vomiting (see Fig. 1),
constipation (Fig. 2),
tearing/itching eyes (Fig. 3), and
the use of aids for stomach or digestion problems (Fig. 4).

The most dramatic findings deal with the frequency of constipation and the use of stomach and digestion aids. Females in general and females on fixed night and rotating shift schedules in particular have more frequent constipation than males (this effect appears to be independent of age).

Sex differences are reversed with respect to the use of stomach and digestion medication; males report more frequent usage than females, especially on the night and

rotating shifts. This effect is most pronounced for those males on rotating shifts who are over 50 years of age. These results strongly suggest that future research be aimed at sex-specific health problems, for it appears that the impact of shift work on worker health is a function of age and sex of the individual employee.

Table 3

STANDARDIZED DISCRIMINATE FUNCTION
COEFFICIENTS AND GROUP CENTROIDS

Variable:	Coefficients (function):		
	(1)	(2)	(3)
Sex	0.50	0.10	0.49
Age	0.09	-0.54	0.07
Marital status	-0.04	0.25	0.15
Difficulty with feet & legs after long standing	-0.09	-0.24	-0.16
Persistent numbness or tingling anywhere in body	0.01	-0.24	-0.12
Aspirin or headache medicine	-0.00	0.13	0.24
Aids for stomach or digestion	-0.31	0.14	0.13
Laxatives	0.04	-0.21	-0.21
Cough, cold, or sinus medicine	-0.03	-0.22	-0.15
"Pep pills"	-0.15	-0.07	0.14
Shortness of breath or breathing difficulty	-0.14	-0.28	-0.14
Persistent cough and expectoration	-0.07	0.20	0.00
Expectorating blood	0.17	0.04	-0.12
Hay fever or sinus trouble	0.01	-0.06	0.27
Tearing or itching of the eyes	-0.27	0.21	-0.01
ringing or buzzing in the ears	-0.06	0.20	-0.16
Fainting spells or dizziness	0.35	0.10	-0.31
Sweaty or trembly feeling	0.02	-0.17	0.36
Bloody urine	0.10	0.14	-0.17
Alarming pain or pressure in the chest	-0.16	0.27	0.20
"Racing" or pounding heart	0.27	0.25	-0.16
Severe fatigue or exhaustion	0.04	-0.10	0.27
Nausea or vomiting	0.39	-0.26	-0.22
Bloody bowel movement	-0.02	-0.12	-0.34
Constipation	-0.32	0.09	0.14
Tight feeling in stomach	0.14	0.24	-0.39
Feeling of pressure in neck	-0.20	0.06	-0.06
Dryness in the mouth	0.11	0.16	-0.23
Variable:	Centroids:		
Shift--day	0.26	-0.61	-0.04
--afternoon	0.47	0.45	-0.29
--night	0.10	0.21	0.54
--rotating	-0.56	0.05	-0.11

Figure 1

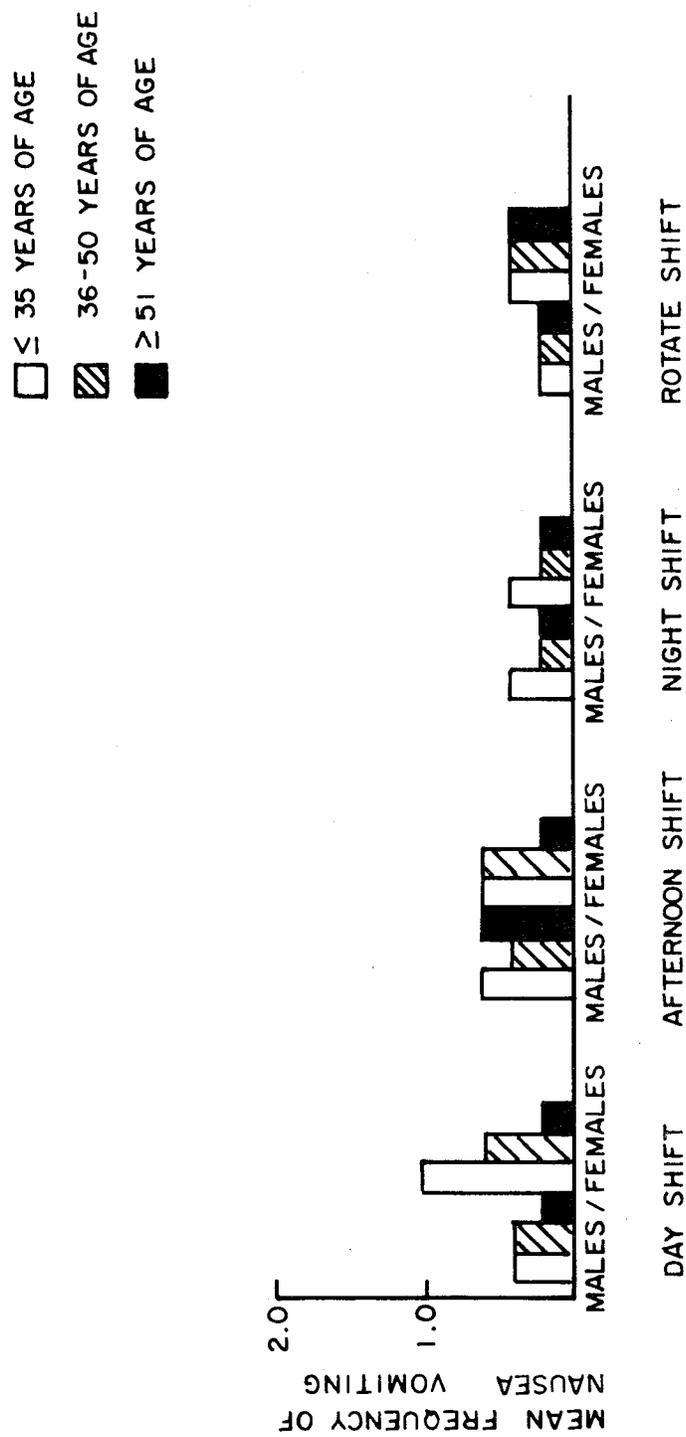


Fig. 1. Mean frequency of nausea/vomiting as a function of sex, age, and shift

Figure 2

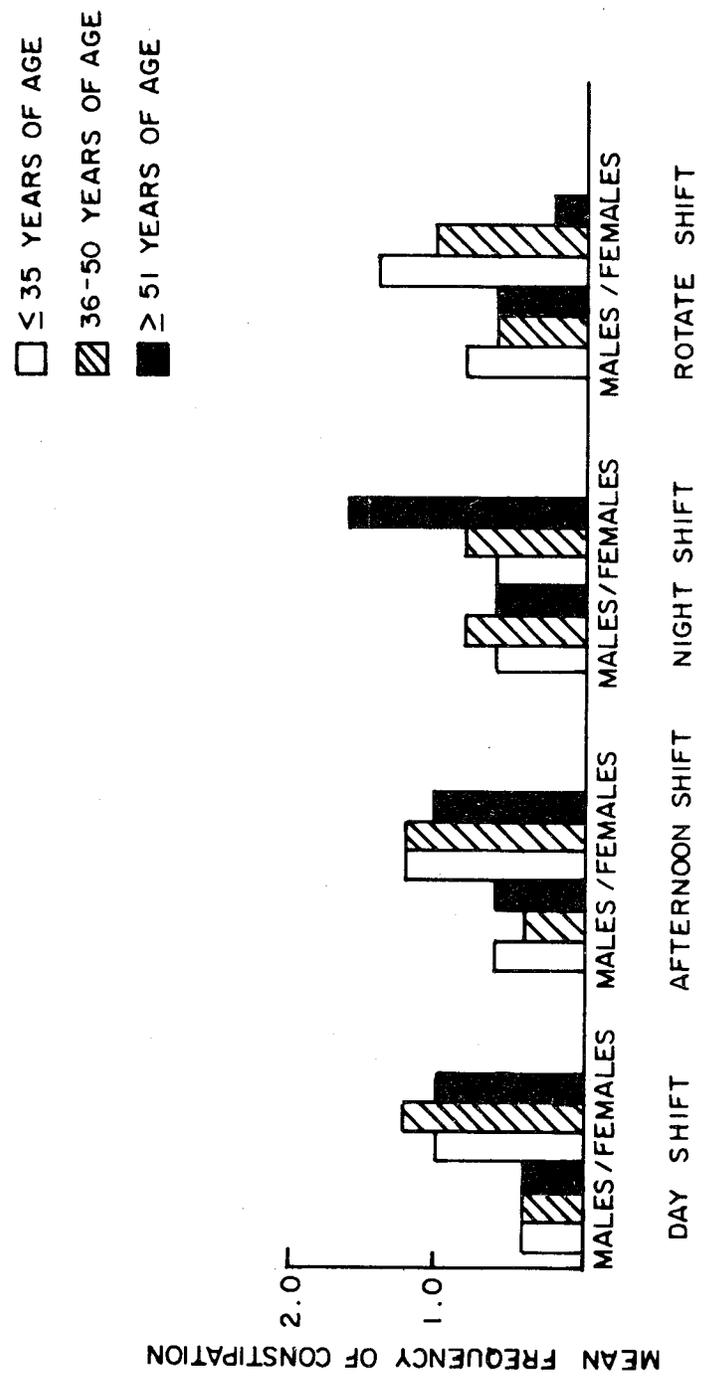


Fig . 2. Mean frequency of constipation as a function of sex, age, and shift .

- ≤ 35 YEARS OF AGE
- ▨ 36-50 YEARS OF AGE
- ≥ 51 YEARS OF AGE

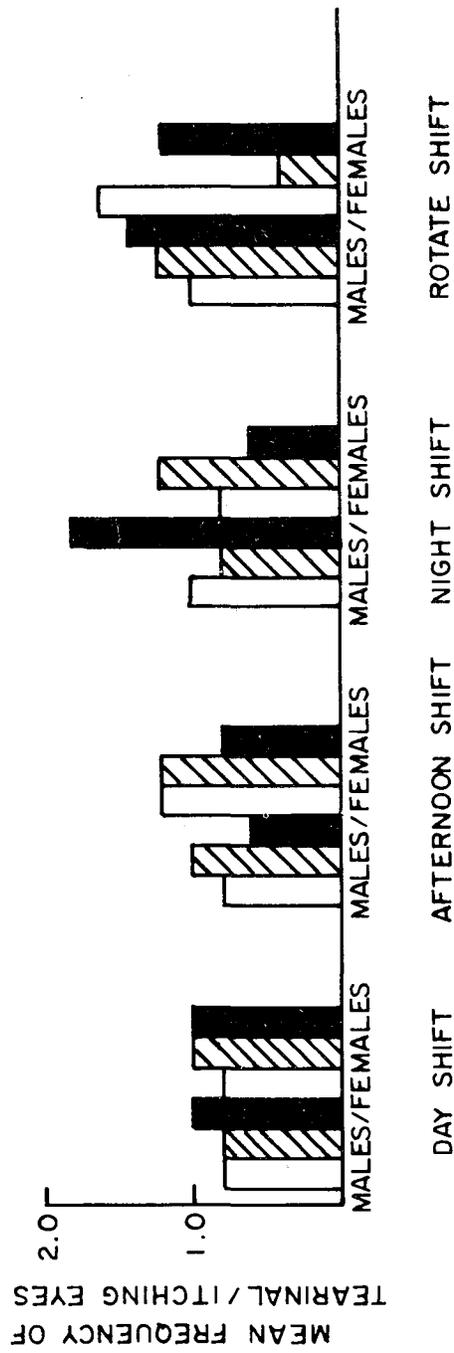


Figure 3

Fig. 3. Mean frequency of tearing / itching eyes as a function of sex, age, and shift.

Figure 4

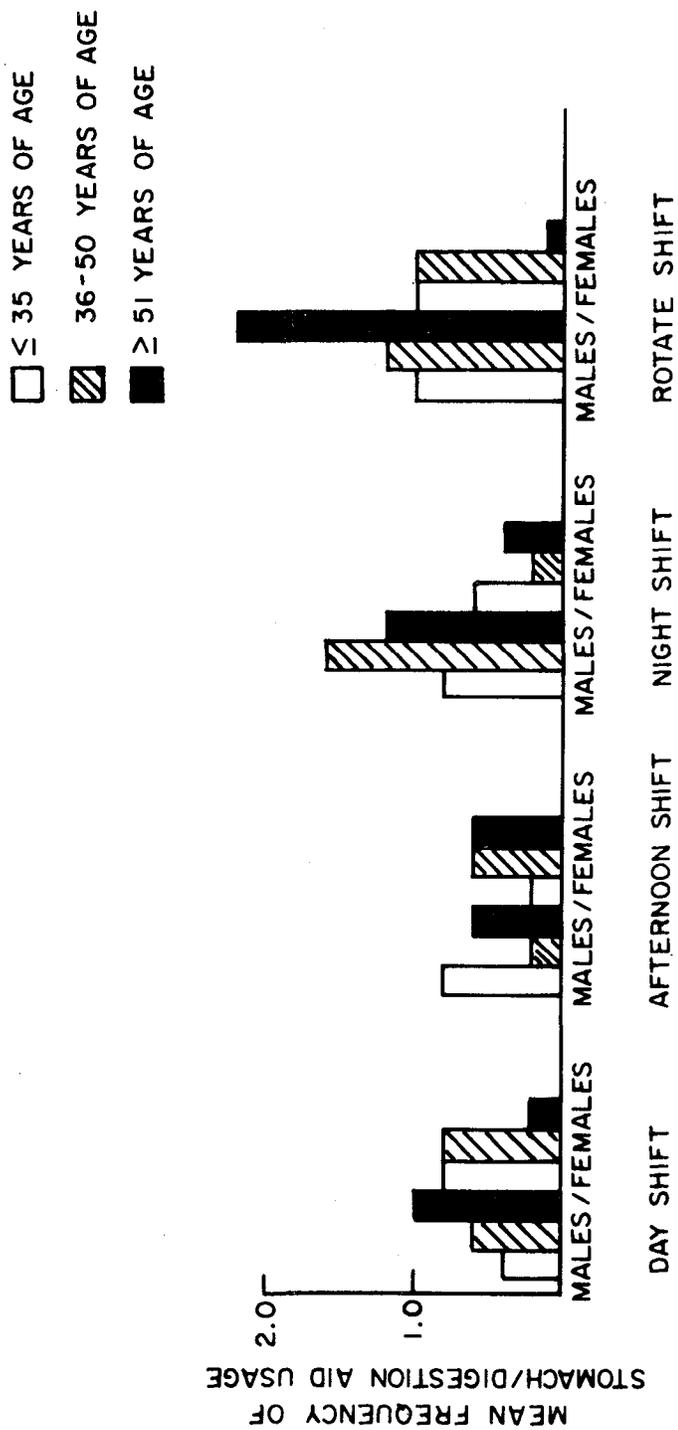


Fig. 4. Mean frequency of stomach or digestion aid usage as a function of sex, age, and shift.

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INJURIES TO THE EXTREMITIES

Infectious Injuries

C. George Ray, MD

I want to avoid talking about the commonplace infectious diseases of the extremities, like streptococcal and occasional clostridial contamination of wounds by soil and feces, and devote the time instead to several situations which I think are very interesting. Interesting by virtue of the fact that one can look at the situation and predict what organism is most likely to be present. On some occasions, one may even be able to prevent the injury.

Veterinarians and other animal handlers--there are a number of other professions where persons come in contact with animals--are subjected largely to the canine or feline bite; this can be a simple dog or cat bite, but it can also be that of a panther, coyote, etc. The organism is usually the same basic flora, usually Pasteurella multocida, a nice little gram-negative rod that's common in oral/pharyngeal flora. Once in awhile, there will be a staphylococcal or streptococcal infection in these cases, but it is Pasteurella multocida that concerns us most. All respond very well to penicillin or erythromycin and either drug is advised even where the wound is particularly severe and where primary closure is required.

A little more rare is the rat bite infection. I see this most frequently in research workers; here we are dealing less with the local wound infection and more with a systemic disease of either streptobacillus or spirillum, which can be very severe. Mortality rates from streptobacillus infection can be as high as 10% if the patient is inappropriately diagnosed and not treated in time. The treatment of choice for both infections is penicillin, with tetracycline and streptomycin together if needed.

I am not sure how many of you encounter alligator trainers in occupational health, but there are claims that the most common infection related to the alligator bite is Aeromonas hydrophila.

Patients who step on nails or other sharp foreign objects and suffer penetrating wounds of the foot can present a very vexing problem in infectious disease. Many of us treat these patients with cloxacillin or some drug designed to cover both staphylococcal and streptococcal infection after a good debridement and cleansing. However, one of the more common organisms I've seen with the penetrating foot wound has been Pseudomonas aeruginosa. There is often a delay in the onset of infection; in these cases, the patient may come back to you days, or even weeks, later complaining of foot pain, together with low-grade fever and local tenderness. The only way I've been able to handle these cases effectively is with a very thorough open debridement of the affected area, covering the patient through the operation and the next few days of "post-op" with very potent anti-pseudomonas therapy; carbencillin and gentamicin is the general choice. Only 2-3 days of medication is necessary if it is coupled with good surgical debridement. Attempts to treat it solely by medication or local aspiration will

end up with a prolonged hospital stay for the patient and what I'd consider a less than optimal outcome.

We run into a few situations that are indigneous to this area; especially, due to thorny flora, such as the cacti and pyracantha. One of the injuries that is seen both occupationally and recreationally is nocardial infection from spiny wounds. Thus, if you have a history of cactus thorn intrusion, consider the possibility of Nocardia. The treatment of choice is a sulfonamide; if you wish, you may also use the trimethylbrom/sulpha combination, though it is usually reserved for the more severe systemic nocardial infections.

Some others that I have been very concerned with from the virological point of view include herpes simplex infection. On a number of occasions, dentists or dental hygienists who have local herpes infections on their extremities (so-called herpes whitlow) will transmit the infection to their patients. I had a dentist in Seattle who effectively inoculated nine of his patients before he realized what he had. This problem is encountered in other health-related professions as well, particularly among intensive care nurses who don't bother to glove-up when they aspirate tracheal secretions from comatose patients. People tend to forget that a chronically debilitated or acutely ill patient can be excreting herpes simplex virus from his respiratory tract. It takes just a little recreational abrasion on the finger and direct contact with the herpes to get a severe infection, one that is severe enough to put an employee out of commission for up to 2 1/2 weeks. Herpes is often mistaken for a felon; one case may look almost like a deep-seated abscess, progressing through the usual acute duration of up to 9-11 days after which they slowly resolve. It's an extremely painful disease; the extremity may blacken and the distal end of the digit may become quite black. Patients are often treated with incision and drainage and antibiotics, but none of these measures is effective. Most of the difficulty is simply a matter of not recognizing the risk and taking adequate precautions.

There are also variations on this theme: In one instance, a medical technician with an abrasion on the small finger was sampling a herpes patient in order to get viral cultures. The technician has herpes in the past; however,--and this is an important point--a past history of herpes does not impart an immunity. There is no acquired protection from herpes whitlow. Anyway, within a few days an erythematous area of the abrasion became very purulent, with radicular pain going up the ulnar nerve; an axillary node was large and very tender, and there was fever as well. I happen to be very familiar with this case because it was mine; I learned a very good lesson from it.

There are some rather rare infections that still occur from time to time. Tularemia among trappers and hunters, for example; this may begin with a little nodular lesion that becomes purulent, the patient later becoming quite systemically ill. The occupational clue in such an instance is of great benefit to making an accurate diagnosis.

Another zoonosis that used to be of immense occupational concern is anthrax. During the first few days the site of infection takes on a papular appearance. By the third day there is a necrotic ulcer which becomes black in color (anthracnose, or coal-like, is thus a good name for this particular bacterium). The later stages take on an exuberant secondary nodular appearance. This is a very slowly healing wound which may take 50-60 days to resolve; secondarily, these patients can develop septicemia, meningitis, or pneumonia. If they get pneumonia, they are most apt to disseminate pneumonic anthrax by way of a respiratory aerosol to others in their immediate area. Imported wools

from Afghanistan, improperly tanned hides from Haiti and like articles are an ever present risk, particularly for those who deal with leathers and woolen goods. The ability to recognize the infectious organism is of great importance in order that you might determine its source and eliminate that source as quickly as possible.

A teenage girl came to me one summer with a little lesion in a web space; it looked like the beginning of a staphylococcal abscess. Her physician had treated her with antistaphylococcal therapy as an outpatient, but there was no response so he incised and drained the wound and took a culture. Though nothing grew in the medium, he continued the cloxacillin. Another lesion presently appeared, which became very inflamed but not very painful. The patient was not systemically ill; however, the lesion grew larger and larger, and appeared along her lymphatic drainage distribution. By the time I saw her she had similar nodular lesions near, but not including, the axilla. A biopsy suggested a rheumatoid nodule. We really didn't know for sure. We were anxious to get going on a diagnosis, so we aspirated and cultured this on a variety of media, then questioned her a little more closely as to her occupational and recreational activities.

Allow me to emphasize this latter point, especially to physicians outside the occupational health field; they forget that you can get a number of diagnostic clues from what the patient does for fun or living. In this situation, the girl had been taking an academic course in marine biology--this was our first clue! Our skin tests (which can be done on atypical mycobacterial infection) gave a response to Microbacterium marinum. This is a common occupational infection in individuals who work in the field of marine biology. The infection took a long time to clear--over a year--using antimicrobial therapy. Meanwhile, we did a little detective work among pet shops in the Seattle area and found that every shop with tropical fish had Microbacterium marinum as the normal flora in their aquaria. We also found that several former pet shop owners had sold out their businesses because they had had smoldering lesions of the same type. Their physicians didn't know the cause of the infection, but they related the problem to occupation.

Individuals in the fishing industry (especially Gulf Coast fishermen) are often exposed to this organism, and it is also the most common infectious agent encountered in dolphin bites among dolphin trainers.

In conclusion, should you encounter a nodular lesion that looks infectious, broken down in the center and quite chronically ulcerated, you may not know the cause but you can often make a very good educated guess by knowing the patient's occupation--or recreation. If he is a trapper, it could be a case of tularemia; a hide or wool worker might possibly have anthrax; if he works in an abattoir, think of cutaneous brucellosis; a jungle missionary or Peace Corps worker could have cutaneous leishmaniasis; rose gardeners, foresters, or anybody who works with spaghnum moss may pick up sporotrichosis, and finally, a sheep herder is most likely to have orf, a classic disease caused by a pox virus of sheep which is transmissible to humans via cuts and scratches on the extremities.

INJURIES TO THE EXTREMITIES

Recreation Injuries in Industry

Edward C. Percy, MD

With the increasing demands of labor for a shorter workweek, it is estimated that by 1984 the average laborer and office worker will be putting in a 24-hr week. With ever increasing "free-time", the working person will use more and more of it for leisure activities, hopefully, in some form of health-promoting activity. No one can dispute the assertion that supervised and organized physical activity that is directed towards improving health will minimize cardiac and respiratory disease, and will improve not only the quantity but also the quality of life. Indeed, some of the leading causes of death in today's society may be diseases of affluence; as such, they may be largely preventable. However, the level of physical fitness in North America is frighteningly low, as demonstrated by the Framingham study: 21% of the adult female population and 15% of the adult male population did little more in a day than if they had spent that time in bed--separately! With improved health, a direct dividend must certainly be less time off work and increased productivity.

Sport is now an industry in itself and those in this particular occupation do sustain injuries. Our concern at this meeting, however, is not for the professional athlete who usually has excellent medical care, but rather for the common and less serious injuries of the recreational athlete.

Since a large number of recreational athletes are in industry, it follows that injuries incurred while "off work" may directly or indirectly interfere with an employee's performance and productivity on the job. The majority of these injuries involve the soft tissues, generally as a result of the "overuse syndrome," but they may derive also from acute trauma. One should select his recreational activity according to his own age and general health; hopefully, the six D's of old age will be delayed by a sensible physical activity. Anyone beyond age 40 should be assessed by a physician before embarking on a physical fitness program.

One of the most distressing musculoskeletal afflictions in today's society is low-back pain. This painful and disabling condition probably leads to more loss of work than any other condition. It has been estimated that at least 75% of the population has complained of back pain at one time or another by the age of 50. The common cause is an acute strain while lifting or bending--the so-called "sprung back." The most important factor in its management is to make an accurate initial diagnosis. The main differentiation should lie between the acute ligamentous or muscular strain and the potentially more disabling disc protrusion. A standard history and complete physical examination should accurately solve this diagnostic problem. Standard X rays of the lumbosacral spine should be taken of all patients with back pain. The basic approach to acute back pain is rest, both mental and physical. If there is an area of acute, pinpoint tenderness--the so-called "trigger area"--it can be injected with a few cc's of local anesthetic and hydrocortisone. If the trigger area is in the interspace between the

spinous processes, the injection is safe and gives dramatic relief. Sometimes the tender area may lie under a so-called "olive lesion" (a small, painful subcutaneous nodule of fat). Combined, deep injections into these lesions usually give relief. If the pain is quite severe with marked spasm, epidural blocks of local anesthetic and hydrocortisone are successful. For success, however, injections must be given as soon as possible after the onset of symptoms so that the cycle of pain and muscle spasm does not become irreversible.

The shoulder is also a very common site of pain and subsequent loss of work from recreational injuries, especially from throwing and swimming; more particularly, in swimmers who use the freestyle and butterfly strokes. With abduction of the arm from the body, the greater tuberosity impinges upon the coracoacromial ligament; because of the leverage action, the arm is forced to externally rotate. Anything that interferes with this smooth, synchronized action leads to limited shoulder movement. Indeed, without full external rotation of the shoulder, the arm cannot be abducted completely.

In examining the shoulder, do not forget the acromioclavicular joint (directly above the subdeltoid bursa) for local tenderness. The patient will almost invariably be relieved of pain with an injection of hydrocortisone and local anesthetic into the joint using a small gauge needle. This joint is very injury-prone and quite commonly develops into early post-traumatic arthritis. If no relief is obtained after several injections, the outer inch of the clavicle may have to be excised. Any of the above shoulder disorders may progress to a frozen shoulder if they are not recognized and treated early. A frozen shoulder may require manipulation under general anesthetic before the patient can regain function and return to work. Indeed, physical therapy should play a role in the treatment of all of these conditions so as to prevent the development of a frozen shoulder.

A common cause for arm pain is in the supraspinatous tendon. In man, the arm is held at the side while in the upright posture; consequently, the blood supply to this tendon is diminished, which leads to a progressive breakdown of tissue and occasionally the deposition of calcium. Tissue breakdown and/or calcium deposition in turn leads to a local inflammatory response. The overlying deltoid bursa soon becomes involved and is subject to inflammatory changes. A fall or strain may start the entire complex, the wear and tear process going on to rupture if there is partial or complete tearing of the rotator cuff. The calcium deposit which may develop causes a local painful mass that impinges on the coracoacromial ligament with abduction. The mass may actually rupture in the subdeltoid bursa and set up a chemical bursitis. A lesion in the area of the subdeltoid bursa leads to the "painful arc syndrome." Pain with abduction of the upper extremity at the shoulder passes through the range from 80-130°. Local application of ice to this painful area at ten minute intervals, four times a day, is most helpful. Anti-inflammatory drugs may also help. Cortisone has probably given the most beneficial relief of pain in this particular area; however, do not inject large amounts. I usually use about 0.5 cc of local anesthetic with about 0.5 cc of hydrocortisone. If any resistance to the injection is noted, the needle should be withdrawn a short distance, as the injection is probably going into the tendon rather than into the bursa, which may lead to more pain. For the acute calcium deposit, one may be able to aspirate calcium with an 18-gauge needle; normally, however, the calcium is in a solid amorphous state. Occasionally, it can be aspirated by syringing the deposit with local anesthetic, even where it has ruptured into the bursa itself. Indeed, the deposit may become acutely painful and require surgical excision.

With rupture of the supraspinatous tendon, there may be audible or palpable crepitus as

the torn portion swings over the head of the humerus. Generally speaking, these do not need to be repaired in individuals over 50 years of age. These persons will often retain good function in spite of the tear. A younger individual with a complete tear who is unable to abduct his arm should have repair. If you cannot be certain that the supraspinatus is ruptured because of local pain upon abduction, inject local anesthetic to allay the pain. If the pain was the limiting factor, active abduction should take place with ease. Another method is to perform an arthrogram of the shoulder to see if the dye escapes from the joint into the bursa. Normally, this bursa does not communicate with the shoulder joint; thus, escape of dye will indicate a rotator cuff tear.

The long head of the biceps is commonly involved in an abuse syndrome complex because it lies deep with respect to the rotator cuff. This condition is referred to as "bicipital tendonitis." It may rupture spontaneously, giving a characteristic bulging in the muscle belly distally. Undoubtedly, it should be repaired in the young individual by excising the intra-articular portion and suturing the tendon to the humerus. In the less active or older person over 50, the ruptured tendon can often be left unsutured and treated conservatively, with no significant residual disability.

Probably the most disabling elbow condition in athletics is "tennis elbow." Although this is fairly common in racquet sports, the vast majority of these patients have never played tennis. This is really a tendonitis involving the common extensor origin of the lateral aspect of the elbow and involves, in general, the extensor carpi radialis brevis and the extensor digitorum communis tendons; it too is a typical overuse syndrome and is a common occupational injury due to repetitive forearm or wrist movements as well as direct blows to the area. The site may also be the common flexor origin on the medial aspect of the elbow. A variety of treatments are satisfactory. Locally applied ice offers great relief in addition to the anti-inflammatory drugs. Immobilizing the area for about four weeks is more than most patients will tolerate; hence, a local tensor arm band allows some people to continue playing tennis (presumably some of the involved muscles are deactivated to a certain degree). I prefer 2-3 repeated injections of hydrocortisone plus local anesthetic with a 25-gauge needle into the tender area and joint. The elbow should be flexed as far as possible and the point of maximum tenderness marked with a ballpoint pen. The skin area should be swabbed with iodine. Do not inject superficially or lipodystrophy will result. If the patient is a tennis player, he should be advised to switch to a metal racquet, which offers more resiliency. Also, less string tension and perhaps a thicker handle may help. The tennis player could have developed poor playing habits, which might be corrected by a lesson or two from a pro. If all these measures fail, I recommend a simple lateral release of the extensor muscles under a local anesthetic. This outpatient procedure takes about 15 minutes and leaves no serious disability.

One of the most common bursa involved in sport trauma is the olecranon bursa at the elbow. It is commonly traumatized either acutely or chronically. Repeated aspirations may be necessary, but injections with cortisone have little effect. In addition, this particular bursa is very likely to develop infection. If so, it is extremely troublesome and must be drained, left packed open, and immobilized. Aspiration of the bursa simply removes the mass; and it may recur. If there is chronic swelling and local discomfort, it may be necessary to excise the bursa.

A common complaint at the wrist is tenosynovitis involving the short extensor and long abductors of the thumb as these tendons pass over the radial styloid. This is called "De Quervain's disease," represented by local tenderness and swelling, local pain upon forced flexion of the thumb, and ulnar deviation of the wrist. This condition usually responds

to a small injection of hydrocortisone and local anesthetic from a small bore needle. If there is no response, it is best to surgically decompress the tendon sheath under a local anesthetic.

Be careful of the diagnosis for so-called "sprained wrist." If the wrist is painful and the X rays are negative, immobilize the wrist in a cast and take another X ray in two weeks. Fractures of the scaphoid may not be revealed by X rays until several weeks following trauma. Unfortunately, this condition is often not diagnosed until it is too late to do anything but a major surgical procedure, such as a wrist fusion. Be aware of rotary subluxation of the scaphoid where, because of the twisting injury to the wrist, some of the surrounding ligaments are torn and a slight subluxation of the scaphoid results. The X ray will show a widening of the gap between the lunate and scaphoid (this is often referred to as the "Terry-Thomas" or "gap-tooth" sign). If the gap is small, four weeks of immobilization in a cast usually suffices; if it is major, it may require operative repair of the ligaments. When unrecognized, it can lead to future instability and pain in the wrist. The proper X ray uses an AP view with full supination of the wrist.

Don't forget the "trigger finger," which is a stenosing tenosynovitis in the flexor sheath at the metacarpal head region in the palm of the hand. It is identified clinically by a clicking or snapping of the finger as it unlocks from the flexed position. Once again, small injections of hydrocortisone may give relief, but generally, decompression surgery is required.

Other common sites of post-traumatic arthritis that may be aided by a single injection of hydrocortisone are the carpometacarpal joints of the thumb, knee, ankle, and great toe.

Baseball finger is still a common entity. It can be treated usually with a small splint on either the dorsum or palmar aspect of the DIP joint for a period of about six weeks. If there is a displaced fragment of bone, it will have to be treated surgically. Be on the lookout for occult torn tendons (e.g., the insertion of the profundus).

A common cause of hip pain is trochanteric bursitis, often misdiagnosed as a protruded lumbar disc with sciatica. The patient will have local tenderness when he lies on the involved side. There may be pain on that side when the involved leg is crossed over the normal leg, or there may be a limp and local tenderness. This condition arises from friction of the tensor fascia lata over the trochanteric bursa, which lies between that muscle and the greater trochanter. There is a local area of tenderness which the injection of cortisone and local anesthetic will relieve.

Of the many and varied bursae about the knee the infrapatellar has a superficial and deep bursa in relation to the patellar ligament. An anserine bursa additionally lies in the medial aspect of the proximal tibia just below the joint line. These structures can be simply aspirated to remove the fluid; cortisone should only be used if pain is a factor in the symptomatology.

Cortisone is basically an anti-inflammatory drug with an analgesic effect. Injecting it into an area where there is blood may seed an infection. Nor would I consider injecting it where there is a suspected infection or if the person has a history of TB. The suprapatellar bursa is really an extension of the joint cavity and swelling in this area points to disease in the knee. Generally, I favor aspirating the joints because it relieves the discomfort and pain and permits a greater range of motion. More importantly, the

examination of that joint is facilitated and the aspirate may provide additional clues.

There are usually three sites in the calf that are commonly injured. These soft tissue injuries may be acute or chronic. There may be an acute rupture of the plantaris muscle as a result of a sudden, sharp turning movement (as in a racquet sport); a sudden, very sharp acute pain will be felt, like the impact of a squash ball on the back of the leg. The pain will be located just below the joint line on the posteromedial aspect of the calf and the area will be quite tender. An elastic bandage from the metatarsal heads to below the knee is an effective treatment. In addition, a one-inch lift worn for three to four weeks in the heels of both shoes will take the strain off the calf muscles. The medial head of the gastrocnemius occasionally ruptures to cause what is referred to as "tennis leg." In this case, the tendons will be more distal than the plantaris structure at the site of the insertion of the medial gastrocnemius to the soleus tendon. Treat the same as a ruptured plantaris.

Another overuse syndrome is Achilles tendonitis, representing a simple local tendonitis to a partial rupture of the tendon. Most authorities now feel that Achilles tendonitis is really a form of tendon rupture, involving some tearing of the fibers. There may be a tender nodule in the tendon, which represents a tearing of a larger number of fibers. Degenerative changes may lead to calcification or even the formation of bone. Steroid injections have been the commonly accepted treatment in the past; however, there have been so many cases of subsequent tendon ruptures following injections of cortisone that this procedure is now considered unsafe. Research work neither proves nor disproves the argument; in any event, the analgesic effect of the cortisone and local anesthetic diminishes the pain so that the patient may increase his activities, placing additional stress on the tendon and leading to rupture. In view of the numerous reports in the literature that condemn the tendon injections, it is legally unwise to continue this form of treatment. The heel lift together with anti-inflammatory drugs and ice usually solve the problem. On the other hand, surgery may be necessary to explore and repair minor tears that do not respond to conservative measures. Be certain that the powerful toe flexors will allow the patient to stand on his toes even with a complete rupture of the tendoachilles.

One common condition in the foot is plantar fasciitis. In my opinion, this is an overuse syndrome involving the stretching of the long plantar fascia where it is attached to the medial tubercle of the os calcis. The constant stretching of the fascia with the weight of the body stressing the longitudinal arch ultimately causes a small spur of bone to form on the os calcis.

Be certain to exclude generalized metabolic conditions such as gout, pseudogout, diabetes, and a rheumatoid-like condition. It is not uncommon for these particular conditions to manifest themselves first in the foot. A heel pad of sponge rubber or felt, anti-inflammatory drugs, and local injections of steroids into the tender area through the sole of the foot eventually will give relief. Surgery is rarely necessary but it is occasionally demanded by the patients.

INJURIES TO THE EXTREMITIES

Bone and Joint Problems

Lawrence M. Haas, MD

The orthopedic surgeon in active practice sees numerous patients daily, at least half of whom have problems related to their occupations. Thus, the orthopedic surgeon and occupational medicine specialist not only have a number of patients in common, but they also share a similar goal: the patient's early return to full work capability. To achieve that goal, a prompt diagnosis must be made and aggressive management begun; vigorous rehabilitation must then follow. The surgeon's goal is to maintain the reduction of the fracture, control swelling, and start early protected motion when possible. It has been our experience in observing at least 15,000 patients in the past eight years that it is best if a patient can be returned to work within three months after his initial injury; although, there are some injuries that make this goal impossible. A patient who is off the job for six months or longer often never successfully returns to work, since he has adjusted to his altered socioeconomic state and has less motivation to work. It would be ideal if all companies had some types of light duty available so that "work therapy" could be started at the earliest possible opportunity.

There are so many orthopedic problems confronting the busy practitioner that I cannot discuss all of them. Some of the major and more common injuries--such as fractures and joint injuries of the lower extremities--will be discussed and hand injuries of all types will be mentioned.

Fractures are common occupational injuries. The primary treatment of an extremity injury involves adequately splinting the affected limb--on the scene, if possible. An arm should not be manipulated to see if there is a fracture. For that matter, any moderately traumatized extremity is presumed to be a fracture until an X ray is taken. The first examination must determine whether the injury is an open or closed one. An open fracture has a wound that communicates with the fracture. Open fractures are more serious than closed ones, since infection can result in permanent disability. All open fractures should be cared for as an emergency. Wounds should be covered with sterile gauze or a Betadine dressing, the limb adequately splinted, and the patient sent to the emergency room immediately. Fractured femurs and tibias are best transported in specially designed splints; an air splint for the tibia and a Hare traction splint for the femur is quite satisfactory. Upper extremity fractures, depending on the type, can be treated either with a short- or long-arm splint, or a sling. It is best to immobilize the joint below and above the fracture site.

When conditions are optimum, fractures of the forearm, femur, and tibia can be treated by application of internal fixation to allow early motion. In special cases, this provides early rehabilitation and return to work, and less long-term disability. There is a slight risk in operative surgery, but in certain patients it is justified because of the potential benefits.

In the lower extremity, phalangeal fractures are often treated by taping; the patient usually can return to work within three weeks. Metatarsal fractures often require a walking cast for three weeks, then three additional weeks of rehabilitation before resuming work. Fractures about the ankle that are undisplaced require either a walking or non-weight-bearing cast. Displaced fractures call for open surgery. Usually eight weeks in a plaster cast is required after ankle surgery, followed by six weeks of exercises. Tibia fractures are nearly always treated without surgery; either non-weight-bearing, weight-bearing, or patellar tendon-bearing casts are applied. In unusual cases, open reduction is indicated; if rigid fixation is obtained using plates and screws, then external casting is unnecessary. This has the advantage of allowing early motion of the knee and ankle. Fractures of the femur can be treated in traction with modified balanced skeletal suspension. Early motion of joints can be started even when the patient is in bed. Fractures of the mid-shaft of the femur can be treated with a femoral nail; and with early motion of the hip and knee, the patient often can return to work within three months. Hip fractures can be repaired with a device called the compression hip screw; ambulation is started within five to seven days using protected weight-bearing with crutches (the patient can return to work within three to four months).

In the upper extremity, fractures of the shoulder and humerus are often treated with a hanging cast; surgery is seldom necessary. Displaced fractures of the forearm are often treated with plates and screws, and external fixation is seldom needed after four weeks; the patient can usually return to full-time work in three months. Fractures of the carpal bones or metatarsals are often treated by casting. Fractures about the metacarpals need only about three weeks of immobilization before early motion is begun. Newer methods of orthopedic surgery provide improved fixation and earlier return to a functional state.

The most common joint injuries on-the-job occur to the knee and are more prevalent with workers who perform bending, stooping or twisting motions. The initial examiner must determine if there is a minimal strain, an internal derangement, or major knee trauma.

A minimal strain is characterized by very mild pain and a history of little trauma; the worker is able to walk easily on the leg and is most likely free of pain in 24 hours.

An internal derangement signifies a possible abnormality inside the knee. A physician who is trained in knee problems should make the examination within 24-72 hours of injury. Primary internal derangements are tears of the medial or lateral meniscus and possible strain of internal ligaments. There also may be loose bodies within the knee or subluxing of the patellofemoral joint.

Minor conditions can be treated with exercises and without surgery. However, if the worker is in sufficient pain that he cannot work, then an early physical examination by an orthopedic surgeon is indicated. There are two tests that are used to make an accurate diagnosis. One is arthrography: Radiopaque dye and air are injected into the knee joint; the double contrast image can define the knee cartilages, which are not seen on plain roentgenograms. Also, medial meniscus can be seen easily and other structures are often apparent. Another diagnostic procedure is arthroscopy: An instrument resembling a cystoscope is introduced into the

knee joint through a small puncture. The orthopedic surgeon can look inside the knee and observe the pathology. Thus the combination of early examination, arthrography, and arthroscopy can provide an accurate diagnosis in over 95% of the knee problems.

When major knee trauma is encountered, the victim should be sent immediately to the hospital or an orthopedic surgeon's office. Early examination, early diagnosis, and early surgery are most likely to be essential. Fractures, dislocations, or major ligamentous disruptions may be present, and it is important that surgical repair of major disrupted structures be performed within the first week of injury. If diagnosis and treatment are delayed, the final result will be less favorable.

The most important factor in returning the patient to work after knee surgery is the quality of rehabilitation. If vigorous and enthusiastic rehabilitation is instituted, a patient can return to full-time work within six weeks following a simple medial meniscectomy; inadequate rehabilitation often takes months. Much has been learned from rehabilitation techniques used in athletic training.

Other occupational injuries to the joints involve the hip, which often is affected by strain or synovitis. This can be treated by temporary rest, anti-inflammatory medication, and occasional injections. In the upper extremity, the most commonly injured joint is the shoulder. Bursitis or inflammation about the shoulder joint often requires injection or immobilization. Also, shoulder joint dislocation occurs in heavy laborers with external rotational trauma. The elbow joint can be affected either by tendonitis or lateral epicondylitis. This is often called "tennis elbow" and responds to either physical therapy or injection.

The majority of job-related bone and joint injuries occur to the wrist and hand. A very common injury is the so-called "wrist sprain." It is well known among orthopedic surgeons--though not necessarily among other physicians--that a wrist injury can produce a fracture of the scaphoid (navicular) that is not visible on X rays in the early weeks. Hence, a wrist sprain that is accompanied by pain over the radial aspect should be placed in a plaster splint for a minimum of 10 to 14 days. At the end of that time, the X ray evaluation should be repeated with particular attention to the carpal scaphoid (navicular). If there is no fracture and the patient is pain-free, immobilization can be discontinued. If a fracture is evident, immobilization should continue.

Another common occupational condition is DeQuervain's disease. This is stenosing tenosynovitis on the radial aspect of the wrist, involving the tendon sheaths of the abductor pollicis longus and extensor pollicis brevis. The disease is easily diagnosed and treated by either immobilization or injection, or surgery if the other two methods are unsuccessful. This condition is often found among workers who have frequent repetitive motions of the wrist. Carpal tunnel syndrome is another disorder that is aggravated by prolonged and frequent flexion of the wrist and heavy lifting. Anything that increases the volume of the carpal tunnel, such as edema or synovitis from heavy lifting, can compress the median nerve and produce aching in the hand and forearm along with numbness in the thumb, index, and long fingers. It is easily treated by injection or surgery.

Dupuytren's contracture is an acquired condition that is often genetically derived. It is aggravated by certain types of work and physical trauma.

Fractures of the hand are very common. The most important principle in treatment is to prevent swelling by elevation of the hand and dressings for the first few days, and to begin early motion of all joints. If early finger motion cannot be started by merely placing the hand in a splint, then fixation of the fracture with small Kirschner wires is indicated. More than 90% of fractures of the digits require no longer than three weeks of immobilization. Although healing is not solid at three weeks, early joint motion can begin (if immobilization is continued until there is solid healing, the joints may develop some permanent immobility). Dislocations in the wrist and hand often accompany tendon and ligament injuries, and these dislocations need to be treated either by adequate splinting or early surgery; early reduction of these dislocations is important.

Tendon injuries of the hand occur both by lacerations and by blunt trauma. The flexor or extension tendons can be avulsed from their insertion even without a wound. The closed tendon injuries are most often missed by examining personnel. It is critical that all closed tendon injuries be diagnosed within the first few days after injury. My personal experience of 15 "missed" tendon injuries was compared with 30 "early-diagnosed" tendon injuries: only 2 of the 15 "missed" had excellent results, while 20 of the 30 "early-diagnosed" had excellent results following surgical treatment. The most common closed flexor tendon injury is avulsion of the flexor digitorum profundus and requires early surgical repair. Avulsion of the extensor tendon due to a blunt injury is called "mallet finger" or "baseball finger"; this should be treated by splinting of the distal joint in full extension. It is not necessary to splint the proximal interphalangeal joints as this would only further stiffen the proximal interphalangeal joint. If the patient is unable to wear a splint, a small Kirschner wire can be placed across the distal joint to hold it in extension while the tendon is healing. If flexor and extensor tendons are not diagnosed early, the results may be unsatisfactory and even surgical reconstruction may not be beneficial. On occasion there may be a need to delay the repair of flexor and extensor tendon injuries; if the accident is at a moderate distance from an adequate medical facility, it may be best to repair only the skin locally and then send the patient to a hand surgeon. As long as the delayed primary repair can be performed within the first five days after injury, the final result will still be as good as a primary repair; for a delay that is longer than one week, final results will most likely fall into the "missed" category.

Nerve injuries of the hand are very common. Consequently, any small laceration of the hand should be examined carefully for nerve damage. The median, radial, and ulnar nerves can be checked easily by a trained physician; all skin areas distal to a laceration should be examined for changes in sensation. It is also possible to perform delayed primary repairs in digital nerve lacerations when the nerve cannot be repaired immediately. Microsurgical repair of nerves using a loupe or microscope produces the best results; microsurgical techniques can also restore circulation that has been lost to vascular injuries of the hand. It is also possible to replant digits and hands that are amputated, though it is very important that any amputated part be transported to a replantation center in the proper fashion. The part should never be frozen; it should be wrapped in a sealed plastic bag to prevent water or ice from contacting the tissue. The sealed bag is then placed in a cooler with wet ice.

REHABILITATION

The major factor in hand rehabilitation is to encourage the patient to move his fingers and use his hand as soon as possible. Early motion can be accomplished in many ways. In a minor hand injury, the patient is instructed to elevate the hand and fully flex and extend the fingers several times daily. Where there is mild stiffness of an involved

finger joint, the affected finger is taped to an adjacent finger; the patient is instructed to actively flex and extend both fingers. If the very conservative program is not successful, a carefully supervised hand rehabilitation therapy is indicated; preferably at a hand rehabilitation center where both occupational and physical therapists are available to assist in restoring hand function. One positive aspect of such a setting is that the patient sees other patients with hand disabilities and may become aware that he is not as severely disabled as he believes. Seeing others with greater problems prepares him to accept his degree of impairment and to make the most of his remaining function. Also, he can begin to practice those activities that he is likely to do when he returns to work. The patient is evaluated at intervals to determine when he is ready to resume his occupation. This type of rehabilitation is not always indicated for those with initiative, but it is absolutely necessary for those who are reluctant to restore their function. Any hand that is kept entirely immobile for three or more weeks may have a permanent limitation of motion unless some type of rehabilitation is practiced.

INJURIES TO THE EXTREMITIES

Common Biomechanical Foot Injuries

Gerald A. Gorecki, DPM, MPH

The foot is an organ of locomotion and stance and functions as an adaptable lever; as such it is subjected to a variety of deforming forces. Unfortunately, minor and almost undetectable variations in foot structure and function can pose a major threat to the integrity of the foot. Then too, occupational stresses of this nature (however minimal), if continued for a long period of time, can lead to physical or emotional disability and result in decreased worker productivity and possible injury. Disabilities and deformities interfere with normal motion, resulting in a disequilibrium of the musculature; disequilibrium in turn produces fatigue, strain, pain, and poor posture. These factors may accumulate to reduce a worker's attentiveness and cause injury to the foot or the superstructure. Utilizing the natural history of pressure keratosis as a model, I shall discuss the ramifications of common occupational foot injuries resulting from multiple, minimal, biomechanical trauma.

Under appropriate host, environmental, and agent factors, a simple pressure keratosis may lead to inflammation and infection; potentially, ulceration, osteomyelitis, and/or gangrene can result (Fig. 1). Gangrene is the most extreme of any callous problem and is frequently seen.

Figure 1

FACTORS LEADING TO PATHOLOGICAL CONSEQUENCES IN THE FOOT

<u>Host:</u>	<u>Environment:</u>	<u>Infectious Agent:</u>
		*
Foot structure variants:	Shoe gear	*
--fixed forefoot inversion	Walking surface	*
--first plantarflexed metatarsal	Occupation	*
--acquired deformities	Poor personal hygiene	*
Arterial disease	*	*
Musculoskeletal disease	*	*
Metabolic disease	*	*
Nutritional disorders	*	*
*	*	*
*	*	*
*	*	*
* * * * *	* * * * *	* * * * *
	*	
	*	
	<u>Pathological Sequelae</u>	
	--callus	
	--ulceration	
	--infection	
	--amputation	
	--death	

Most problems are biomechanical in origin as evidenced by a retrospective study of 137 patients who were referred to a podiatrist by a physician over a three-month period (Table 1). Diagnoses were based on ICDA code categories. Foot deformities and pressure hyperkeratoses go hand-in-hand; therefore, a combination of the two constitutes about 35% of all patients seen. Twenty-eight of the 137 patients had deformities (about 20% of the total problems). Orthopedic deformity is actually a general diagnostic category and includes many other disorders, such as flat foot, cavus foot, plantarflex metatarsals, etc. Digital deformities are symptoms of biomechanical foot problems. Pressure keratoses are a symptom complex of an underlying biomechanical foot problem occurring in the subtalar midtarsal joints. Infection and related conditions account for 23% of all the problems, most of these were paronychia—i.e., infected ingrown nail. Gangrene, osteomyelitis, cellulitis, and diabetic ulcer were seen mostly in the diabetic patient. Almost all of these patients had underlying biomechanical deformities or imbalances. Rheumatological and related disorders accounted for approximately 17% of all the patients. The periostitis and fibrositis of the heel, with or without spur, is a category referred to as the "heel spur syndrome" and the most common of all the categorical problems seen.

Table 1

PRIMARY DIAGNOSES OF PHYSICIAN REFERRALS TO PODIATRISTS

Primary Diagnosis (ICDA*):	No. of Patients:	% of Total:
Infections and related conditions		
Gangrene (100.1)	2	
Osteomyelitis (720.1)	1	
Cellulitis (682.5)	2	
Diabetic ulcer (250.9)	6	
Paronychia (681.0)	9	
Dermatophytosis (110.1)	5	
Verruca (079.1)	6	
	total=31	23
Trauma		
Fracture (825.0, 826)	7	
Ankle sprain (854.0)	2	
Foreign body (733.6)	9	
Strained foot (845.1)	1	
	total=19	14
Deformities		
Orthopedic, congenital (755.9)	18	
Orthopedic, acquired (738.8)	3	
Of toes, acquired (738.6)	1	
Hallux valgus/varus, bunion (737.0)	6	
	total=28	20
Rheumatological and related disorders		
Periostitis-fibrositis of heel (with or without spur) (720.3)	13	
Tenosynovitis, bursitis, ganglion, etc. (731.8)	4	
Arthritis, gouty (274)	3	
Periarticular fibrositis, myositis, etc. (717.9)	2	
Plantar fasciitis, stress (732.0)	1	
	total=23	17
Pressure hyperkeratosis		
Clavus, callositas (700.0)	13	
IPK, porokeratosis, hyperkeratosis (701.0)	8	
	total=21	15
Nail conditions		
Ungus incarnatus (703.0)	6	
Injury (928.0)	4	
Dystrophy (703.9)	2	
	total=12	9
Other		
Perineural fibrosis (neuroma) (357.9)	3	2
	Total=137	100

*Inter. Classification of Diseases Adapted for Use in the US

We are currently studying heel pain problems and have approximately 250 patients in this project. These patients are divided into three categories--those with heel pain and spurs; those with heel pain and no spurs; and those with heel spurs and no pain ("silent heels"). Our control group consists of randomly selected patients who were scheduled for a routine, annual physical examination; X rays were taken of their feet. We have not evaluated our data sufficiently to make any statistical predictions, but it appears that we are encountering more occupationally-related cases, especially in those people who are working on hard surfaces (e.g., concrete, hard tile, etc.). There seems to be no difference whether the floor is covered with carpeting or not.

Other problems--in which we find tenosynovitis, bursitis, and ganglion--are somewhat traumatic in nature and account for approximately 14% of all cases seen. Plantar fasciitis and stress is another problem; it is common and most likely related to the pronated foot or the pes planus foot. The most common trauma is fracture, especially of the metatarsals. Ankle sprain is next, followed by foreign bodies and then strained foot. Strained foot is virtually a catch-all diagnosis for something that we couldn't label at the time. It is interesting to note from a study by Greenberg (J. Amer. Podiatry Assn. (February 1977)) that nine times as many soft tissue complaints and three times as many static foot deformities were treated by podiatrists as were treated by physicians and osteopaths, but only about 17% of the foot injuries were treated by podiatrists. This correlates roughly with the 14% trauma cases that were referred to us.

The next diagnostic category, nail conditions, accounts for approximately 9% of all conditions. Dystrophy of the nail can be the result of anything from a mycotic nail to an earlier injury. Many times the ingrown nail can be related to a foot that is pronated; for instance, the foot of a patient with a bunion deformity will continually roll over on the side. Over a period of time, the nail will appear to grow into the skin; actually, the skin rolls around the nail to form a "relatively" ingrown nail.

The last category, consisting of three cases, included perineural fibrosis or neuroma (also called Morton's neuroma or neurofibroma). In many instances this disorder is related to a pronated foot or the pes planus foot, in which there is considerable stretching of the plantar nerve between the medial and lateral nerves. This is also associated with mechanical imbalances of the body.

There are a number of factors (i.e., host, agent, and environment) that can lead to a callous, infection of the skin or bone, and ultimately amputation of a limb (Fig. 1). Environmental factors may consist of such items as shoe gear, walking surfaces, one's occupation, and poor personal hygiene. The agent can be any number of infectious agents. As for host factors, it is in the biomechanical area where the podiatrist can give significant input to the medical profession. Some of these problems are often not noticeable, while others are very grossly apparent and can be easily recognized by the physician. Forefoot inversion, for example, is one that is often missed. If it is very mild, there can be a severe turning in of the front part of the foot; the rear part of the foot, meanwhile, may compensate. If so, anything from a callous to an ankle injury or ankle sprain can develop. The plantarflexed metatarsal, forefoot equinus (or a turning down of the foot), exostosis-growth on the bone (whatever the reason), and the shape and length of the metatarsal can lead to various callous formations. Also, fusion of the phalanges may be related to mechanical difficulties and can be troublesome.

The improperly fitted shoe along with heel height are often precipitating factors in digital deformity, callous formation, and other bursitis problems of the foot.

Metatarsal toe protectors, or safety shoes, have reduced the numbers of injuries to the foot; however, there is often some difficulty in getting the patient's foot to fit into the shoe properly. Usually the crease where the steel toe ends does not correspond with the metatarsal-phalangeal joint (the place where the foot bends). In some instances, workers will try to avoid wearing them as much as possible. The shoe, therefore, is a precipitating factor of pathology, especially if the foot cannot go through its normal range of motion. Likewise, protruding nails and improperly fitted stockings are to be avoided. The ambient air temperature and relative humidity influence the retention of moisture within the shoe, which moisture serves to encourage fungal infections both of the skin and of the nail.

The environmental or walking surface is largely responsible for a number of foot disorders. Again, because of the non-bearing or non-yielding nature of the surface, the foot cannot adapt and, therefore, will degenerate by formation of callous, arthritic changes, etc. In regard to flooring surfaces, there has been a study on the development of a "variable terrain" flooring surface. This is an attempt to cushion the floor as well as to give the foot an opportunity to function through its ranges of motion. The rubber mat has strategically placed ribs on the bottom side, causing very slight (hardly noticeable) changes in its horizontal plane. In effect, the mat causes the peripheral venous pump in the musculature of the leg to pump the venous blood back to the heart. Demonstrations using intravenous catheter transducers show that the amount of hydrostatic pressure in the extremity can be reduced by 14cm of water pressure (1).

What can the average industrial nurse or physician do about the promotion of good foot health? Health education is a key factor, but you can talk until you are blue in the face and very little will change. I don't know what real effect you can get by educating people about their feet, inasmuch as the foot is generally considered to be a very innocuous part of the body. During the periodic examination, the industrial physician or nurse in many instances does not request the patient to remove his socks or shoes. Certainly, a proper examination of the foot at this point could help to identify a number of problems that might need treatment or correction. There are six common and preventable occupational foot injuries that arise from biomechanical stress:

- pain and disability caused by corns and calluses (possibly leading to ulceration, infection, and gangrene);

- periostitis and fibrositis, with or without heel spur (heel pain syndrome);

- fatigue fractures of metatarsals;

- ankle sprains;

- bursitis and tenosynovitis (from overuse syndrome);

- sequelae of bunion deformities (e.g., hallux valgus).

We cannot alter the shape of a foot except through surgical procedures; in most instances, surgery is not recommended. Orthotics (i.e., foot braces, arch supports, etc.) are based upon the structure and function of the foot and can be constructed specifically for the individual. Improved flooring materials and surfaces can be installed. Also, don't overlook patients with metabolic and musculoskeletal disease; they should be periodically examined and referred to a diagnostic and treatment clinic. Disability limitation through adequate treatment, the recognition of the

complications of pressure hyperkeratoses, biomechanical corrections (i.e., orthotics), and surgery can prevent ulceration, infection, amputation, and/or loss of life.

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INJURIES TO THE EXTREMITIES

Load and Capacity:
Behavioral Aspects of Safety

William R. Ferrell, PhD

A MODEL FOR ACCIDENTS

A simple but useful conceptual model for accident causation states that initiating incidents produce causal chains that lead to an event, socially defined as an accident, that has a number of outcomes. Several initiating incidents are often involved which may or may not result in an accident; if the accident does result, it may either be that certain things happened or failed to happen. There are, then, three means of accident intervention:

Outcomes can be mitigated by a wide range of measures, from protective equipment to insurance;

Causal chains can be blocked by prophylactic means, such as fireproofing, guarding, antislip coatings, etc.;

Initiating incidents can be prevented from the start; this is potentially the most optimal means of intervention.

INITIATING INCIDENTS

A large proportion of accidents stem from one or more initiating incidents involving human action or inaction; these are sometimes referred to as "human errors." The factors that lead to such incidents in organizational settings have been well discussed by Turner (1). Those attributable to individuals result principally from one of three factors: 1. improper activities and procedures, 2. incompatibility, and 3. overload.

Improper activities and procedures are simply unsafe practices conducted without knowledge or awareness of the potential consequences. Job training and safety education can combat bad habits and ignorance, but exhortation to "act safely" is of little value when risk-taking favors the risky alternatives, as they very often do. A large body of evidence supports the view that people have a limited ability to make rational choices under uncertainty (2).

It is well-recognized that incompatibility between human and equipment or task characteristics frequently causes initiating incidents. The classic studies by Fitts and Jones (3,4) about aircraft accidents and near-misses document the subtle role that improperly designed equipment can play.

Although it may properly be classed with incompatibility, overload--the dynamic mismatch between human resources and task demands--is sufficiently important to be

separately classified; the remainder of this paper will consider it in more detail.

Overload

Both load (imposed by a situation) and the capacity of a person to meet the demand are multidimensional, so that a single measure of them may not suffice. Load varies with time because of task definition and random events. Ordinarily, one's capacity to deal with a situation is more than adequate, but occasionally the load may exceed the capacity; and an initiating incident for a potential accident may be the result. Capacity also varies with time, declining as the person becomes fatigued; overload thereafter becomes progressively more likely.

It is overwhelmingly evident that there are definite limits to human information processing capacity just as there are limits to human capacities for muscular work (5). Short-term memory span is limited to about eight items, while information transmission rate (depending on the perceptual coding and training) is generally limited to a few bits/second. If decisions are required, people are unable to attend to more than one thing at a time and must switch attention from one task to another--a time-consuming process.

When task load is momentarily or chronically greater than capacity, there are only a limited number of possible compensating behaviors:

store--remember an input and act on it later;

parallel--make two responses at once (but two decisions cannot be made at once);

recode--respond to several inputs as a unit;

compromise--give the right response but with less accuracy;

err--attempt a response but with a greater probability of its being the wrong one;

filter--attend selectively to only part of the situation;

omit--unselectively fail to respond to an input.

Only the last two are common under heavy overload, yet all of these coping behaviors compromise performance and create initiating incidents.

Sources of Load

Task Load--

the imposed load may have a number of sources and it is important to recognize them. The most obvious source for physical tasks is the task design itself and how it imposes stress on the muscular-skeletal and cardiovascular systems. Physical overload can cause direct damage to the body or it may incite an initiating incident either through failure to maintain the load or through interference with information processing and sensory-motor skills. Chronic overload is obvious but peak overload is often ignored. The information processing load imposed by the task is

harder to measure: It increases with the rate, complexity, and unpredictability of both stimuli and required responses; it also increases according to the required precision of observation and response--the amount to be retained in short-term memory and the extent to which anticipation or prediction is necessary.

Environmental Load--

The nature of the environment may require one to work harder to perform a given task. There are those elements that cause discomfort and annoyance (thermal stress), those that distract (sudden noises), and those that interfere with the task (poor lighting or vibration). When these elements tend to degrade task performance, they are usually remedied; but when they only decrease spare capacity without causing overload, they are frequently ignored. Nevertheless, they still have an effect.

Internal Load--

Those tasks and distractions in the worker's mind (e.g., worry, personal problems, emotional stress, and doubts about one's adequacy and worth) that are not directly related to the work at hand constitute an internal load; though unobservable, they are nonetheless real. Another source of internal load is pain. Also, people daydream about other matters while on the job; this is especially true when there is a large amount of spare capacity. The idea has been advanced frequently that there is an optimal load; i.e., when the task or environmental load is sufficiently low, it is augmented by the internal load. Because of the difficulty of controlling or measuring internal load, this theory is only plausible speculation (7,8).

Situational Load--

There are certain other aspects of a job environment that contribute to the difficulty of the task and impose an additional load on the worker; e.g., uncertainty about goals, criteria, or instructions, as well as deadlines or unusual expectations of any sort. For the most part, however, such a load is not recognized as such.

Influences on Capacity

The principal influences that determine an individual's capacity to sustain load are:

Natural endowment; individual differences in information processing capacity are at least as great as those in stature and strength.

Physical condition, health, fitness, and nutritional status.

Fatigue.

Drugs, pollutants, and environmental stresses (anoxia, hypoxia, nitrogen narcosis, etc.) reduce capacity substantially even when performance is not reduced.

Training on the task reduces the effective load in information processing tasks and increases strength, stamina, and skill in physical tasks. From a safety standpoint, training under overload conditions--if the conditions can be identified and simulated--is especially important in determining whether or not the failure will be an initiating incident for an accident.

Motivation--a disposition to perform well--does not actually increase

capacity, but it does direct attention away from internal and environmental load toward task load.

Arousal—the general level of activity of the organism—appears to have an optimal level which permits deployment of one's available capacity.

Implications for Industrial Safety Practice

Recognition that overload is virtually certain and a possible cause of initiating incidents leads to a number of specific guidelines for industrial practice; it is also a useful heuristic tool for evaluation and design.

An employer should select people who have sufficient capacity for peak task loads—not for the average load.

Workers should be trained to acquire spare capacity and, especially, how to fail or how to "shed load" without causing initiating incidents.

Environmental load should be minimized even if performance is unaffected, especially if peak loads may be at or near capacity.

Some environmental load is desirable to maintain adequate arousal.

People with high internal loads should not be given high task loads or critical jobs, particularly if their motivation is low.

The task should be designed to "fail safe," or at least to "fail soft," so that:

unacceptable alternatives are impossible; failure to act will have acceptable consequences; what is to be done is predictable; the pace is determined by the worker; the criteria for good performance and the standards for judgments made by the worker are clear and well understood.

* * *

In summary, the cheapest and most effective safety precautions are tasks, equipment, and procedures that prevent initiating incidents or accidents from occurring.

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PESTICIDES

Pesticides in Perspective

Ephraim Kahn, MD, MPH

It is important to realize that pesticides are distinguished from other toxic chemicals only by the manner in which they are used. Clinically and toxicologically, there is no such thing as pesticide poisoning. One might just as well speak of chemical poisoning. Pesticides consist of some 1,400 different compounds formulated into over 30,000 products; the annual US production of pesticides is 1 1/2-billion pounds. Pesticides include numerous different chemical classes as shown in Table I.

Table I

THE MORE COMMON CHEMICAL CLASSES OF PESTICIDES	
Organophosphates	parathion, mevinphos, dimethoate
Carbamates	carbaryl, methomyl, aldicarb
Chlorinated hydrocarbons	DDT, chlordane, toxaphene
Halogenated short-chain hydrocarbon fumigants	DBCP, EDB, methyl bromide
Chlorinated phenols	pentachlorophenol
Nitrophenols	dinitrophenol
Thiocarbamate fungicides	Thiram, Ziram
Bipyridyls	Paraquat, diquat
Chlorinated phenoxy herbicides	2,4-D, 2,4,5-T
Aminotriazines	Amitrole, Atrazine
Metallo-toxins	mercurials, arsenicals, copper salts
Pyrethroids	natural and synthetic

The toxicity of these compounds is not an inadvertent phenomenon; that is, they are designed to kill unwanted pests--whether insects, rodents, fungi, or weeds. Furthermore, these compounds are purposely applied to the environment. They do not get there by accident or lack of planning.

The era of modern pesticides began near the close of World War II. With the advent of potent insecticides like DDT and parathion, there developed what one might call a chemical engineering approach to agricultural pest control--a simplistic approach of spraying widely and frequently in the belief that this would take care of all pest infestation. Unfortunately, agricultural pest control is not an engineering process. It is a complex biological system in which crops, pests, and natural insect predators coexist

in intricately inter-related ecosystems. The many problems created by pesticides can be attributed, by and large, to the fact that these compounds have been developed and utilized without adequate research or understanding of their potential effects on the environment or on human health.

Thirty years ago no one was familiar with the word ecology and no one spoke about the environment. Excessive and unscientific use of pesticides became the rule of the day, fostered by the chemical companies; marketing and use was virtually uncontrolled by any public or governmental authority. DDT was applied by the thousands of tons over the surface of the globe, with no realization or thought that it would find its way into the lipoid tissues of all mammalian organisms. I consider it one of the greatest strokes of luck in human history that DDT has so little chronic toxicity for man. And luck is the only word for it, because no one gave the matter any thought when the biosphere was being flooded with this persistent material.

Besides environmental contamination, there were numerous other problems caused by excessive and inappropriate use of pesticides. Natural predators were killed off while the pests began to develop a genetic resistance to the pesticides, resulting in a resurgence of the pest population and the appearance of entirely new pest species. In addition, medical problems of human exposure arose, including many large-scale and tragic episodes of human poisoning.

Some of the various ways that human beings can be exposed to pesticides are shown in Table 2.

Table 2

HUMAN EXPOSURE TO PESTICIDES

OCCUPATIONAL

Agricultural:	Non-Agricultural:
Applicators	Manufacturers
Mixers-Loaders	Formulators
Spraymen	Applicators
Pilots	(industrial,
Flaggers	highways, parks,
Fumigators	etc.)
Field-workers (to	Structural pest control
foliar residues)	

NON-OCCUPATIONAL

Home and garden use	Food residues
Environmental contamination (air and water)	
Commercial (residential, office and workplace)	

It should be noted that a far greater degree of protection is afforded the general public than the occupationally exposed. With regard to residues on food, for example, no pesticide can be registered for use on a food crop until a tolerance has been set by state and/or federal regulatory agencies. Establishing a tolerance requires the acquisition of a great deal of specific toxicological and other data and, hopefully, allows for very

large margins of safety to humans. Occupational exposure is an entirely different matter, especially in agriculture where standards for pesticide safety are covered by the Environmental Protection Agency, not OSHA; the former is notoriously weak in the regulation of environmental health effects and totally deficient with regard to occupational health.

We also find different levels of standards and control within the groups of agriculturally exposed. The pesticide applicators handle the toxic materials directly, often in concentrated form. These persons number in the thousands, whereas field workers number in the hundreds of thousands.

While applicators are not covered by OSHA, their work exposures are amenable to control by other governmental agencies. In California, for example, the State Department of Food and Agriculture is responsible. Field workers also present another set of problems: Their work is largely migratory or semi-migratory; they tend to be sociologically distinct from other parts of the work force in culture, language, ethnic background, etc. Partly because they are such a disparate group, there is a great deal of uncertainty about how much they are affected by pesticide exposure--an uncertainty that has led to considerable controversy. Our first speaker will undoubtedly touch on this subject in his presentation.

PESTICIDES

Epidemiologic Monitoring of Pesticides and Its Implications for Occupational Health

John E. Davies, MD, MPH and
Henry F. Enos, PhD

I was both delighted and honored to have been asked by Doctor Kahn to participate in this session of the Congress. As I am a member of the newly formed Federal Insecticide, Fungicide, and Rodenticide Act Science Advisory Panel, he has requested that I say something about the responsibilities of the Panel in relation to pesticide regulations. I indicated to him that my comments would not necessarily reflect their viewpoints, but I was confident that they would welcome having their responsibilities explained and their interest in the monitoring of human health effects of pesticides emphasized.

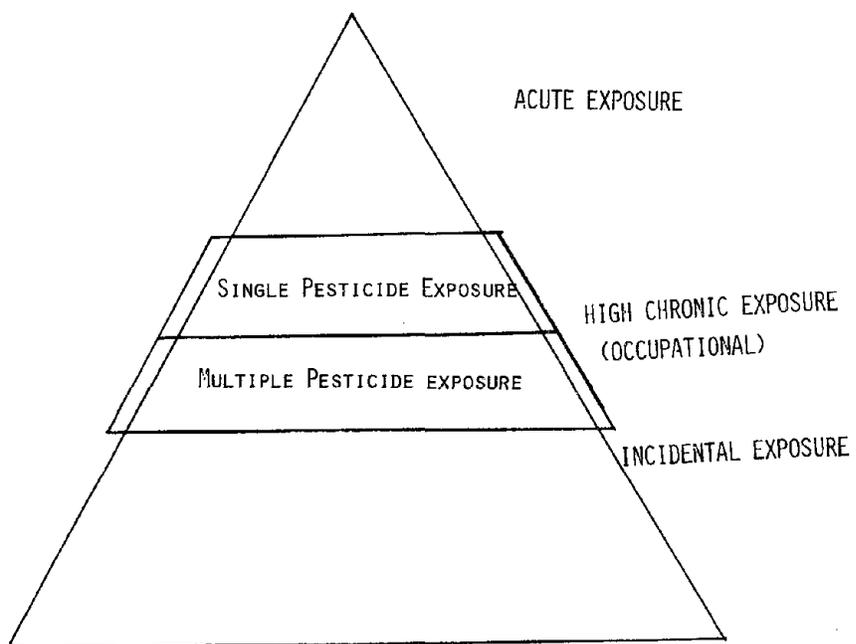
It should be explained that the Science Advisory Panel, which is mandated by Congress under FIFRA Amended, is required to review health and environmental effects of the decisions that the EPA is making, both in terms of their regulatory requirements and their specific decisions to cancel particular pesticides. One of their prime missions is to provide a risk assessment of the regulations (1).

It is not easy to make judgments about risk based on animal toxicity data alone; and to extrapolate these to man is always speculative. When human health data are available, the process is so much simpler; thus, the Panel has, on several occasions, stressed the urgent need for more human monitoring data to assist them in their mission.

First, to clarify two terms used in this discussion: "Monitoring" covers the quantitation of all human health effects of pesticides, not just the measurement of the pesticide residue; "occupational health" is used somewhat loosely to describe the members of a health team who understand human health exposure in contrast to specific health professionals who work in various Federal agencies such as OSHA, EPA, or FDA.

Current and past pesticide use-patterns have resulted in three categories of human pesticide exposure (Fig. 1).

Figure 1
CATEGORIES OF HUMAN PESTICIDE EXPOSURE



Because medical problems are different, the monitoring needs will be reviewed for each.

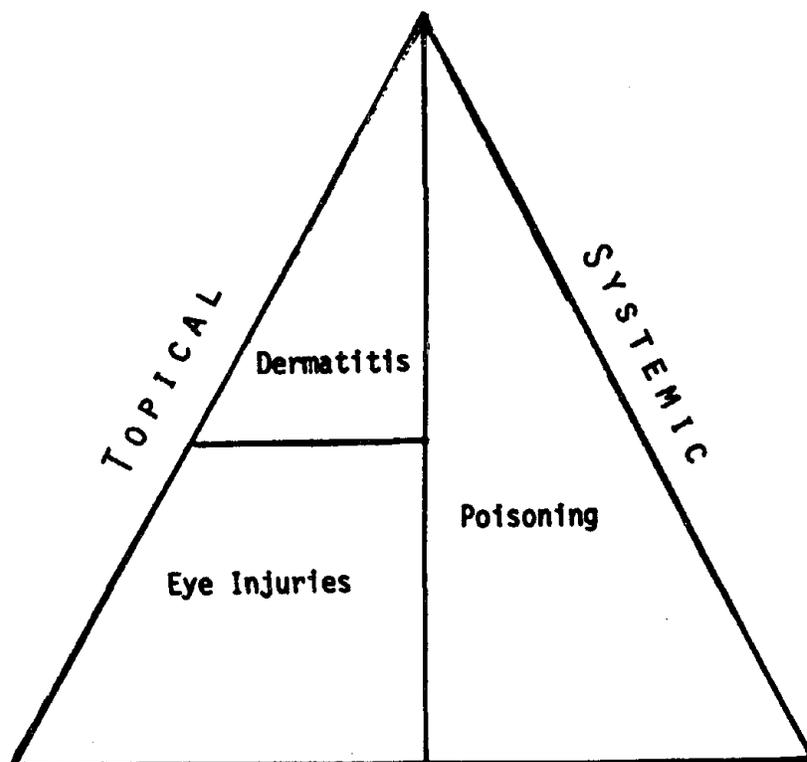
ACUTE ILLNESSES

Fig. 2 summarizes the major medical problems of acute pesticide exposures. Systemic poisonings are the most serious, whereas the topical exposures to the skin and eye represent the most adverse effects. Eye lesions, which may present as conjunctivitis, iritis, or corneal ulcer are most commonly observed in workers who are subjected to accidental splashes of the concentrate. Rubbing of the eye with hands and clothing is another means of contamination. Dermatitis will be discussed more fully and expertly by Dr. Maibach, so I will mention only that it is a common occupational hazard.

Figure 2

EPIDEMIOLOGY OF PESTICIDES

ACUTE EXPOSURES

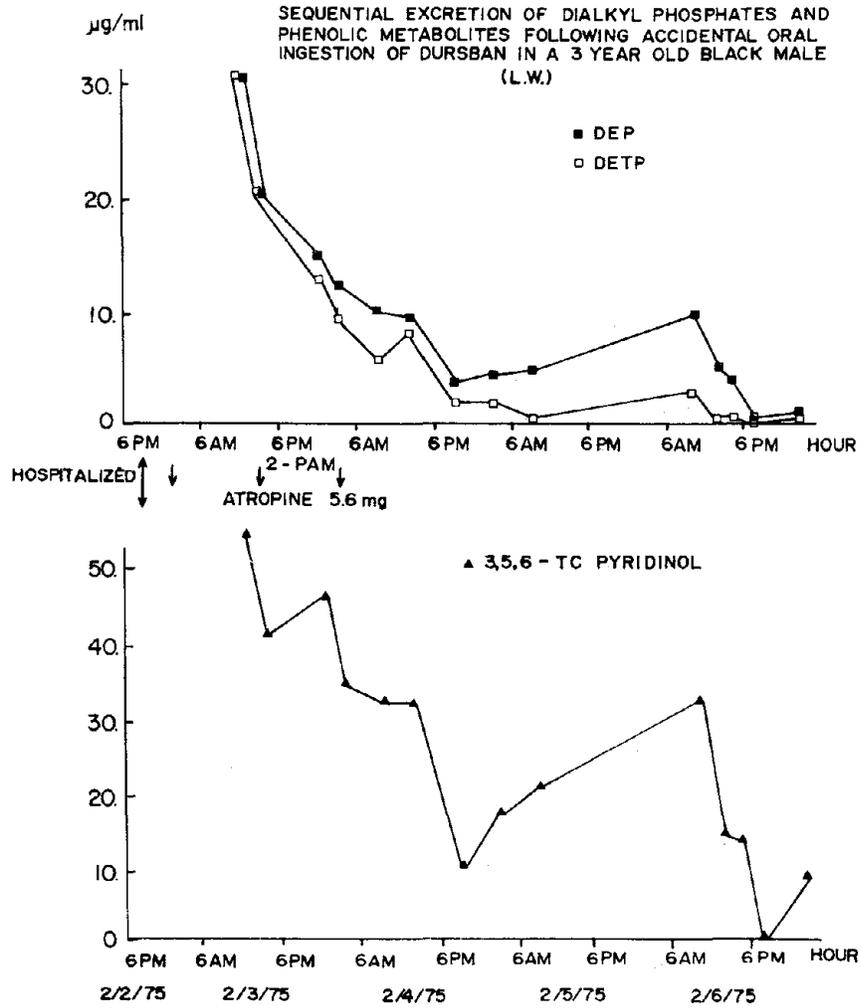


The World Health Organization estimates that there are approximately 500,000 cases of systemic pesticide poisoning occurring annually with about a 1% fatality rate (2). The data are hard to come by and different countries have used different approaches. In Indonesia, the acquisition of this information is one of the responsibilities of each of 12 Provincial Pesticides Protection Teams (3). Similar utilization of "agromedical" personnel have been recommended for safe and effective poisoning management for El Salvador, Egypt, and the Phillipines (4-6). United States incidence data are also difficult to obtain, the most accurate coming from California (7); here, physician reimbursement for the treatment of pesticide-related illnesses is linked to the notification of disability.

Establishment of a good monitoring system is essential for meaningful pesticide legislation. This is achieved, in part, by quantitative delineation of the poisoning mechanism. The two major mechanisms in the US are the application or mixing of the pesticide, and the picking and thinning of products of high foliar crops. Each has different preventive strategies; thus, incidence data on applicator versus picker poisonings provide useful information for the administrator.

Because pesticide poisonings mimic a variety of more commonly occurring illnesses, laboratory verification of the suspect exposure is an important component of monitoring. Reliable laboratory procedures can validate the illnesses caused by organophosphate and carbamate compounds. For the attending physician, cholinesterase determinations and pesticide metabolite studies of blood, gastric juices, and urine reflect sound clinical management of this emergency. For example, Fig. 3 shows the sequential excretion of alkyl phosphate and phenolic metabolites in a child who ingested chlorpyrifos. Absolute specificity was obtained from the combined finding of these two metabolites (8).

Figure 3



CHRONIC OCCUPATIONAL EXPOSURE

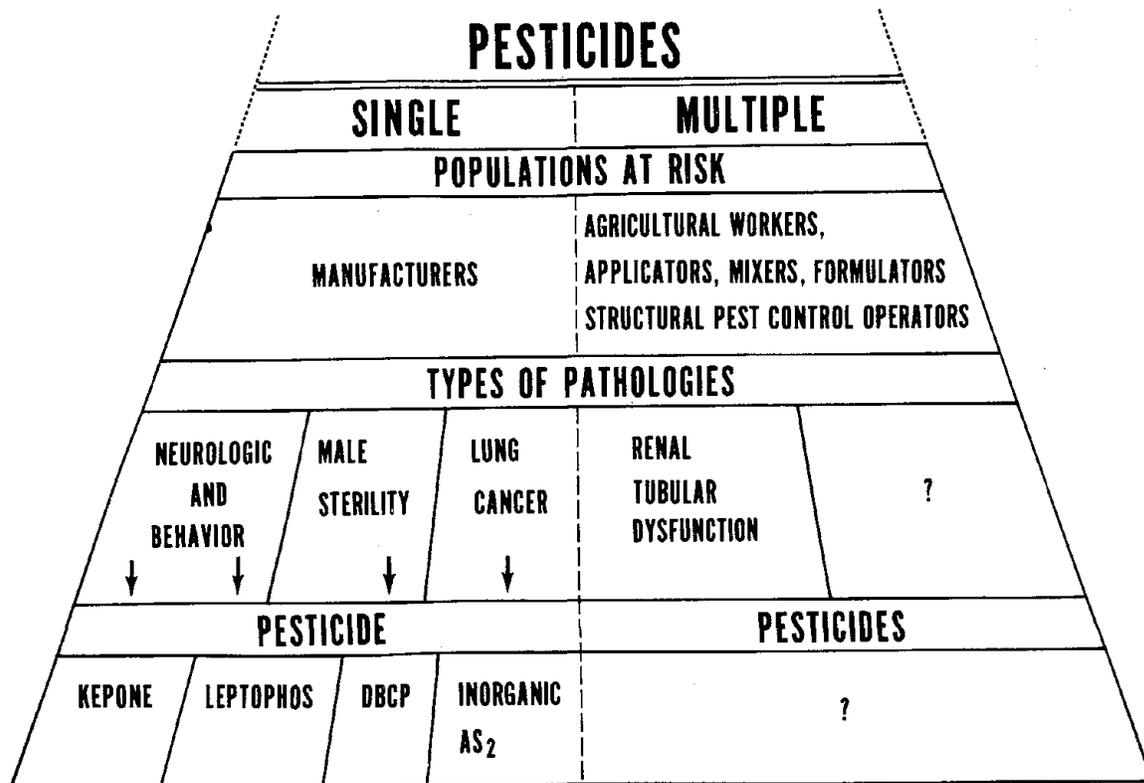
Pesticide Manufacturing Workers

In recent years a variety of medical problems have been recognized among workers in pesticide manufacturing plants in the US. Some examples are shown in Fig. 4 where a variety of pathologies--including neurological, testicular, and pulmonary diseases--are linked with the suspect pesticide.

Chlordecone (Kepone) was one of the first organochlorine pesticides to attract attention because of the widespread occurrence of neurological disorders in the worker. Additional studies demonstrated toxicological effects in the nervous system, liver, and testes (9,10). When animal carcinogenicity was also demonstrated, the chemical was voluntarily withdrawn from commerce. Leptophos, a fat-soluble organophosphorus compound, is another pesticide that was suspected of causing neurological diseases; delayed neurotoxicity was evident in animals several years before there were reports of human and animal (water buffalo) poisonings (11). More recently, DBCP has become associated with male sterility and inorganic arsenic with increased lung cancer as a result of a study and in-depth medical evaluation of pesticide plant employees (12).

Figure 4

PESTICIDE-LINKED PATHOLOGIES



NIOSH estimates that there are approximately 350,000 workers who are exposed to pesticides (13). Because of the seriousness of the medical problems--particularly cancer--attributed to chronic exposure to pesticides, NIOSH has recommended a variety of industrial hygiene practices: engineering control, work practices, medical surveillance, and training of the worker. Three criteria of toxicity were developed with a required control standard for each. Carcinogenicity from long-term occupational exposure is a most pressing concern; thus, it is important to have morbidity and mortality records that provide cancer prevalence data. Short-term tests for mutagenicity open the door for a new type of monitoring that can identify potential carcinogens.

Agricultural Workers

In the United States and other areas of the world, the agricultural worker represents a sizeable population at risk. There are estimated to be 1,275,000 farm workers in the United States (14); the nature of their work and their job mobility impose serious social and health problems. Poverty, illiteracy, and sub-standard housing are part of the life-style of the agricultural worker. If he lives in a migrant labor camp, malnutrition, excessive communicable diseases, and inadequate immunizations are prevalent. Stillbirths, birth defects, infertility, male sterility, and cancer are also thought to occur more frequently in this population; although, reliable nation-wide incidence data is needed. Studies of the agricultural worker in California have highlighted the special health problems (15-17); mortality rates from respiratory diseases in farm laborers were triple the rate of their employers or managers (18).

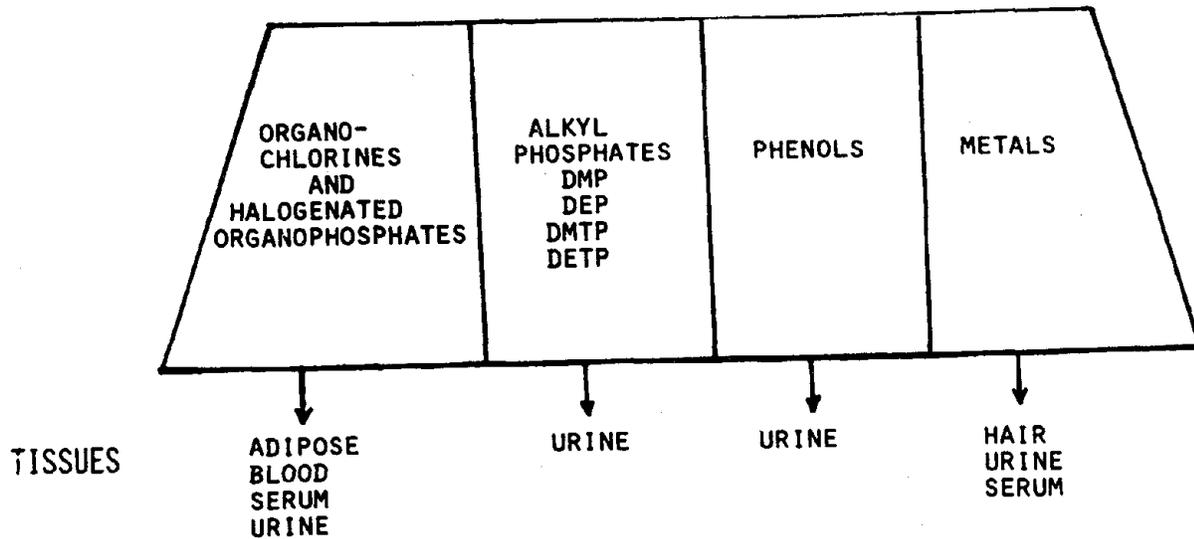
Some have attributed these health problems to occupational exposure. Although such claims have not been substantiated, it must be emphasized that an agricultural worker's exposure differs qualitatively from other groups and from the multiplicity of the chemicals involved; not infrequently, the wife and children of the worker are also heavily exposed. These latter exposures are from the field as well as from contaminated clothing, tools, etc. brought into the home. While the implications regarding the reproductive functions of the female and the growth and development effects on the child have not been fully evaluated, we have found that mean 24-hour urinary excretion of 6-beta-hydroxycortisol was significantly greater in migrant children with high serum DDE levels (19). This finding should preclude the employment of children in the fields.

Manufacturing, agriculture, and health interests are vitally interested in the health of the worker. For different reasons, all are equally concerned with limiting the amount of pesticides used in the future. This mutual agromedical interest in pesticide protection is a philosophy that has found favor in a variety of developing countries. Perhaps this is the best approach for the safety of manufacturing and agricultural workers in the United States.

In the past, pesticide exposure has been determined from person-years of exposure, job categories, concentrations of pesticides in the work environment, and biological indices (including cholinesterase levels and metabolite concentrations in tissue and urine). A variety of pesticide chemicals and their metabolites can now be detected in man; Fig. 5 illustrates some of these and their sources.

Figure 5

CHRONIC EXPOSURE, LOW - INCIDENTAL



Saracci points out that "incidence data is the best measure of disease occurrence but they are costly to acquire;" (20) thus he believes that suspect illnesses should be matched with the most accurate measures of biological rather than crude proxy indicators. Future studies of these occupational health concerns will need both environmental and biological assays of pesticide exposure.

INCIDENTAL EXPOSURE

The amended FIFRA mandates that "the Administrator of the US Environmental Protection Agency shall formulate a National Plan for Monitoring as is necessary to implement the FIFRA." (21) The National Pesticide Monitoring Plan is the Agency's response with the following objectives:

- to assess levels of pesticide residues and metabolites in designated environmental components throughout the nation;
- to detect and quantify geographic and chronological variations and trends in pesticide residue levels in monitored environmental components;
- to conduct intensified monitoring of potential environmental problem areas;
- to coordinate the programs comprising the Networks to facilitate interprogram comparisons of residue data;
- to coordinate and integrate Federal, regional, and State monitoring;
- to develop a National Environmental Pesticide Data System (NEPDS);
- to produce, evaluate, and disseminate monitoring data on a timely systematic basis.

Historically, the monitoring of residues has been scattered among several Federal agencies; such dispersion of responsibility has reputedly limited the program's effectiveness (22).

The National Academy of Sciences' review of EPA's decision-making also criticizes the program and recommends that "EPA should accept and act upon its statutory responsibility for the implementation of a National Pesticide Monitoring Plan by determining the data that are needed for the regulation of pesticides and by exerting leadership among the Federal agencies with monitoring programs to assure that the NPMP adequately addresses these needs." The report also urges that EPA include other relevant data such as US cancer mortality by counties. The last suggestion adds an exciting new dimension to future pesticide monitoring programs by proposing that the exposure assessment data be linked with geographic pathology findings.

The recent clinical pollution accidents clearly demonstrate that localized geographic clusters of pollution can occur. The Kepone incident in Hopewell, Virginia was one example; more recently, the Love Canal near Buffalo, N.Y. is another. Events such as these dictate that human monitoring is more important than ever.

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PESTICIDES

Percutaneous Penetration and Dermatitis

Howard I. Maibach, MD

Dermatitis can be conveniently divided into two very simple classes irrespective of etiology: immunologic and non-immunologic. The most likely cause of pesticide-induced dermatitis is irritation or the non-immunologic type. Thus, if you choose a pesticide according to its proclivity to produce irritation and then select a vehicle for the formulation that in itself minimizes irritation, you will have a product that is least likely to produce irritant dermatitis.

Another category is photoirritation or phototoxicity. At the moment, we know of no commonly used pesticide that is phototoxic. With additional testing, however, the chances are good that some of the current types of irritation will turn out to be photoirritation. This is a special type of irritation, for you can use these materials at a particular time of the day (when the offending wavelength of light is not present) and be completely rid of the problem.

Allergic (or immunologic and allergic contact) dermatitis has been reported with several of the agricultural chemicals. It is thus very likely that much of the agricultural dermatitis is in fact allergic.

Now that we know how to conduct very reliable tests (i.e., predictive tests for allergy), it is time that we in industry, academia, and government go back and rank the relative sensitization proclivities for all these materials. There is no standard reference on how you test workers for their allergic sensitivity. Usually a bit of the chemical is placed on the skin under a Band-Aid; the skin is examined several days later for its response to the chemical. There is now a bioassay method that is being refined; while there is presently no published reference on this, you may call or write me and I will give you details on the concentration of the chemical, the vehicle, and how to perform the patch test. Some materials when put under a Band-Aid or other occlusive device merely give irritant responses, which does not help you to diagnose for allergy.

The only type of dermatitis that can kill you in a hurry is an old disease that we've renamed: contact urticaria syndrome. This syndrome has been around as long as we have had industrial chemicals; or longer, inasmuch as it also occurs with natural substances. As soon as you touch the subject chemical, you get local hives. If the compound is absorbed through the skin and if one is acutely sensitive to it, he may develop asthma. An anaphalactoid reaction may follow with shock and eventual death. Is this an important consideration in dealing with pesticides? We don't know. We really cannot blame government or industry, because we did not understand all there was to know about this problem. When people went into shock, the physicians weren't likely to do a good physical examination to see if there was a co-occurrence of hives. We now have predictive tests for contact urticaria, but they are not as well-developed as the tests for other forms of dermatitis; at least, there are working models.

For those of you who are interested in predictive toxicology, see Advances in Modern Toxicology, Vol. 4 "Dermatotoxicology and Dermatopharmacology"; it describes all of the syndromes I've told you about and has a chapter on how to properly conduct a patch-test.

PERCUTANEOUS PENETRATION

There is no single pesticide in our studies that is not systemic. Though the route of exposure may be topical, the subjects are systemically exposed. Even a modest amount of exposure will lead to instant microgram levels within the body; milligram levels are met with great ease.

What are some of the principles of pesticide penetration? The first is that you no longer have to guess about the extent of penetration. One can predict exactly how much of any pesticide gets through the skin, including the mean and the standard deviation. Animal models have been made and all without risk to man. The techniques are quick, efficient, and inexpensive.

The second principle is that the agricultural worker's largest chronic exposure is most likely to be a pesticide. Learn as much about these chemicals as you would about the pharmacology of the cardiac glycosides, for example. Think of the skin as being enormously complicated and variable. For instance, there are parts of your body in which a pesticide is 40 times more penetrable than any other part of your body. A factor of 40 in human biology is a very big factor. What is the future role for all of this penetration data? Now that we have exquisitely sensitive techniques for measuring penetration, we are in a position to determine means for preventing penetration into the body. If, on the other hand, we can't prevent the chemicals from getting through the skin, there may be techniques developed for getting the chemicals off the skin before significant penetration has occurred. Many pesticides and other chemicals have a special affinity for the skin and cannot be removed simply. The skin acts like a crab and boxes in the chemical so that you can't remove it.

What is the relevance of this to the worker? We tell him to wash off. There are in fact some instances, especially with pesticides, when washing the skin causes more of the chemical to go into the body instead of less. For example, if you apply malathion at a given dose (4 ug/cm of skin) and allow it to remain for 24 hours before washing off, about 10% of the dose will have gone into the body. After four hours, you still get 10% penetration. You can't decrease the amount very significantly even if washed off at 15 minutes. We don't know the mechanism; all we can say at this point is that washing seems like a reasonable thing to do. The general emergency rule is to wash immediately after a spill--you should be able to remove at least 75% of it instantly--15-20 minutes later may be too late. On the other hand, it may not be reasonable; we had better experiment to find what is reasonable.

Penetration is certainly of far more concern than is dermatitis, insofar as you may be able to change how much of a chemical goes through the skin so it can't produce horrendous effects. And there may be better ways of cleaning the skin. We are beginning to get some insight into this, and by using the techniques for studying penetration, we may be able to find better substances than water for removing harmful chemicals from the skin.

PESTICIDES

Pesticide-Induced Infertility in Male Workers

Donald Whorton, MD, MPH

In the last few years, there has been increasing concern about the workplace and its effect on human reproduction in both the male and female. I am going to discuss only the male and 1,2-dibromo-3-chloropropane (DBCP), primarily because there have been very few female workers in any of the workplaces that have been evaluated thus far; also, no one has done any studies on the female.

EVALUATING TESTICULAR FUNCTION

In order to evaluate testicular function, there have to be a few guidelines. First, you need to know what the differential diagnosis is. An individual with a low sperm count does not automatically indicate a chemical exposure as the etiology. It is more likely that heat is responsible. One thing everyone learns in medical school is that the testes are usually of lower temperature (about 2° C) than core body temperature. The important thing in taking a medical history is to determine if there has been a recent fever greater than 38.5° C. That much fever for two days will be responsible for a low sperm count over the next two-three months.

There also may be an anatomical problem. The main thing in adults is varicocele; the testes won't function at all if they are not brought down by the age of five, and there is some question as to how well they will function if descent is delayed. Infection, post-pubertal mumps, bilateral orchitis, and other trauma can also lead to infertility. And, there are all sorts of drugs that can affect sperm production and testicular function: antimetabolites, especially the alkylating agents that are used in cancer chemotherapy; colchicine for individuals who have gout (individuals who don't have gout apparently are not affected); nitrofurantoin, used for urinary tract infections; estrogens; as well as various pesticides, arsenic, and alcohol. Even lead has been implicated, especially at high levels. There is likewise some relationship between smoking and lowered sperm count. Any kind of endocrine disorder can interfere with any other endocrine function, including the testes. Finally, there is ionizing and microwave radiation.

In evaluating testicular function, there are two areas to think about: the seminiferous tubules and the interstitium. Sperm is produced in the seminiferous tubules, starting with the primary spermatogonia and proceeding through the phases of mitosis and meiosis to spermatid and thence spermatozoa. The latter are led next into the epididymis where they remain to mature for about two-three weeks. The entire process from spermatogonia to sperm takes about 70 days, but the sperm is not ready for ejaculation until about three months.

SEMEN ANALYSIS

Semen analysis is not a difficult laboratory procedure; one can do a sperm count or sperm density, a sperm motility (the semen has to be relatively fresh and kept warm), and a sperm morphology. Most morphology thus far is fairly gross; there is some work at Lawrence-Livermore Labs to evaluate sperm morphology as a more precise indicator of testicular function, but it is still at the experimental level.

There is a hormonal relationship to testicular function. For the seminiferous tubules it is follicular stimulating hormone (FSH), while the luteinizing hormone (LH) stimulates the Leydig cells in the interstitium to produce testosterone. Among other things, testosterone affects male appearance; thus, body habitus and other outward aspects about the individual can give you some indication of what may be going on internally. The pituitary gland produces both FSH and LH; FSH stimulates the seminiferous tubules in some unknown fashion to generate sperm. LH stimulates the Leydig cells to make testosterone, which in turn acts as a negative feedback.

DBCP

DBCP is a heavy liquid used agriculturally as a nematocide--nematodes are parasitic worms that burrow into the roots of plants. In the US the afflicted crops are citrus, grapes, peaches, pineapples, tomatoes, and soybeans. In Central America and Israel, DBCP is used on bananas.

As originally reported in 1961, it was classed as a mild irritant as well as a hepatic and renal toxin. That same report mentioned that it produced testicular atrophy in animals (1). Cancer in animals was reported initially in 1973 by the National Cancer Institute (2); that study has been repeated (3) to indicate stomach and mammary cancers in rats when introduced by gavage. DBCP also has been shown to be mutagenic in the Ames Salmonella test.

Evidence of its effect on infertility and sterility in man was reported in 1977 (4). The following data is taken from that article: Of the initial group of 36 men that we looked at, 11 had vasectomies (their sperm counts didn't mean anything), which left 25 to be split into two groups of 11 each and 3 that fit in between. Group A was the most heavily exposed, with 8 ± 1.2 exposure years, while Group B was 0.08 years (about 1 month). The difference in ages between the two groups, though significant, did not influence the sperm count (later study gave no difference). A comparison of the mean of sperm counts of Group A with Group B was 200,000 per ml vs 93 million per ml. Not only was this finding felt to be highly significant, but 9 of these 11 Group A individuals were azoospermic and 2 had sperm counts of one million. The FSH level for Group A was 11.3 mIU/ml whereas for Group B it was 2.6 mIU/ml; this is also highly significant. LH levels were 28.4 vs. 14.0 mIU/ml; again, significant. Mean testosterone levels were not different.

After the initial evaluation, we were asked to evaluate the entire plant. We asked all men in the plant to volunteer for an examination. Of those 2/3 of the plant's population who participated, there were 35 non-vasectomized and non-exposed persons whom we used as controls and 107 non-vasectomized workers who were exposed. We plotted the sperm counts of the two populations on a cumulative distribution curve. One of the problems with sperm count data is that it can go from zero to almost 700 million, so the usual plot of numbers becomes very distorted. Also, the exposed population included all those who ever worked with DBCP, from a minimal amount of time to a lot of time. In

the total plant population we had about 14% who were azospermic vs. 2% for the controls. For 91 of the 107, we were able to give some estimation of months of exposure; e.g., 1-6, 7-24, 25-42, and greater than 42. Some people have misinterpreted months of exposure to mean 8 hours/day, 5 days/week, for "x" months. Actually, most formulators (such as Occidental Chemical Co.) work on batch processes, so everyone is not exposed every day to the same thing. Also, in this particular plant 100 different products were made from about 200 different chemicals; DBCP was only about 20% of the entire production. Then too, not everyone worked every day.

We also looked at some of the individuals who worked in the field; i.e., those who were either applicators, set-up men, demonstrators, or tractor drivers. Of the 14 total, 5 had a sperm count of below 20 million. One of the azospermics was a tractor driver. Again, none of these individuals worked all year long--8 hours/day, 5 days/week--with DBCP.

We also wanted to know if there was some way other than a semen sample to evaluate or predict testicular function. We determined FSH, LH, and testosterone levels on the entire population. Only when you get a sperm count at less than 1 million/ml do you see a marked rise in FSH; otherwise, it's not a very good predictor. LH gives a similar pattern whereas, testosterone gives the opposite. It appears that the pituitary has to put out more LH to stimulate the Leydig cells to produce testosterone.

We also biopsied some individuals. One individual, who had been exposed off and on for three years, had a markedly reduced sperm count and a marked reduction in cellularity; yet you could see no inflammation in the stroma. Spermatogenesis was largely absent, though there were some foci in a few places. Another individual was exposed for ten years and had what would be called a Sertoli-cell-only syndrome. There was perhaps a little thickening around the capsule of the seminiferous tubule; there were Sertoli cells. Again, there was an absence of inflammation. The stroma was larger, probably due to collapse rather than growth of the stroma; there was no evidence of inflammation in the stroma. The hypothesis at this point is that DBCP crosses the blood-testes barrier to interfere with the primary spermatogonia and once you affect the basic germ cells, all the remaining organization disappears. There are some indicators that infertility is probably reversible in some individuals, but it is seemingly dependent on the degree and length of exposure.

In the screening procedure for testicular function, there are several things to look at: one is the semen analysis or sperm density; another is serum FSH, LH, or testosterone; the third is reproductive history (i.e., number and timing of children--this is not sensitive enough except for extreme cases). There are a number of problems associated with semen collection; one is to gain the cooperation of the individual or groups of individuals. Individuals usually decline to participate: because of a vasectomy; the individual or his spouse is beyond childbearing age; impotence--most people are not going to reveal it; other medical disorders that either cause impotence or preclude giving semen samples; some individuals, especially young unmarrieds, fear abnormal results and don't want to know; and finally, religious or cultural reasons--this has been very minor in our experiences thus far.

Abstinence periods must be controlled (it must be between 48-72 hours); if not, you can get some very divergent results. Masturbation is preferred; the sample may be collected at home, but it must be delivered to the laboratory with dispatch in order to preserve motility. An individual can have a wide variability over a period of time; he can go from a count of 20-million to 80-million, to 30-million, to 40-million, and then to

50-million. Reproductive histories often can't tell you very much; there is now a widespread use of birth control measures, including surgical sterilization, due to a trend toward small families. A couple must be trying to have a child before you can decide whether the history is useful or not. The age of the work force is an important consideration; if you have a work force that was beyond the childbearing age when it started working with the chemical, the investigation will be irrelevant. Stability of the work force obviously will influence the extent of exposure. Be wary as well of the marital status of the worker. For example, California has a high divorce rate and a high remarriage rate; if you look into the company records and see "five dependents," any or all of these may be from a wife's previous marriage.

In conclusion, a variety of studies have shown DBCP to have insidious and deleterious effects on the testes. The individuals whom we examined had no physical complaints (i.e., there was no impotence, no loss of libido, no problems of maleness) only a decreased sperm count. The experience with DBCP indicates that there is need to monitor testicular function in certain occupational groups, which need will probably increase in the future. The monitoring and screening method of choice at this point in time is still semen analysis, but there are problems of worker cooperation and a large investment of the physician's time, especially for counseling. A referral and registry system is needed for the "abnormal" cases; then there arises the question of interpreting the data and the establishment of an adequate control group.

DBCP is undoubtedly not an isolated event of chemically induced-reproductive dysfunction, there are surely others; this one just managed to become apparent by a peculiar chain of events. If we are to discover the other events of a like nature, a number of societal and technological obstacles must be surmounted.

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OCCUPATIONAL LUNG DISEASES-- General Principles and Select Topics

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INTRODUCTION

Although there is now a general interest in a healthful environment and concern for its protection, relatively few people in the medical field are aware that occupational lung diseases, which are preventable, affect thousands of citizens yearly. The correct recognition of work-related illness is difficult except when there is an epidemic outbreak of similar symptoms in a group of workers. The physician with little experience in industrial conditions and hazards is usually called upon to establish a diagnosis in a single worker. Recent data from a major urban hospital near a shipyard reveal that physicians paid little attention to occupational exposure while obtaining medical histories in patients who had asbestosis (1).

The difficulty of recognizing various work-related lung diseases may be due in part from the delay in their clinical onset from the time of last exposure. The delay in onset may take as long as 15 years in cases of silicosis to 30 years for asbestos-related neoplasia. Even the symptoms for farmer's lung may be nocturnal, appearing 6-8 hours after exposure to moldy hay. Moreover, it may be difficult to recognize exposures to low and supposedly safe levels of inhaled particles, like asbestos fibers. To add to the difficulty, not all the individuals in a homogeneous population with similar degree of exposure will develop the disease; "individual susceptibility" and other co-factors, such as smoking, are apparent variables in the development of asbestos-related neoplasia (2).

Then too, exposures to occupational hazards are not always work-related. For example, asbestos-related disorders and beryllium disease may result from neighborhood contamination near industrial plants or from household contamination by the working spouse. Likewise, a hypersensitivity pneumonitis has been noted from molds that inhabit home air-conditioners and humidifiers.

Lung parenchymal reactions to various environmental agents, such as certain spores, chemicals, and dusts are often non-specific; this implies that few unique syndromes exist to guide the physician to the correct diagnosis. Lastly, control measures devised to curb or eliminate an occupational disease may often result in a significantly different clinical presentation, not readily recognizable by the treating physician.

The aim of this discussion is to present an overview of occupational lung diseases according to the various pathological reactions they produce in the lung, concentrating on the less publicized environmental diseases, such as occupational asthma, extrinsic allergic alveolitis, and chronic beryllium disease.

PATHOPHYSIOLOGIC RESPONSES TO ENVIRONMENTAL AGENTS

A classification of occupational lung diseases according to their tissue reaction in the bronchopulmonary system is shown in Table I.

Table I

MECHANISMS OF PATHOLOGIC INJURY IN OCCUPATIONAL LUNG DISEASES

Mechanism:	Tissue Reaction:	Example:
Irritant		
	Alveolitis	Phosgene
	Bronchiolitis obliterans	NO ₂ inhalation
	Bronchitis	Coke workers
Immunologic		
Type I	Bronchial edema, plugging	TDI, byssinosis
Type III	Interstitial infiltrate, granuloma	Farmer's lung
Type IV	Noncaseating granuloma	Berylliosis
Fibrogenesis		
	Dust macules (little scarring)	Iron, tin
	Dust nodules (marked scarring)	Silicosis
	With focal emphysema, "PMF"	Coal dust
	With malignancy	Asbestosis

Inhaled vapors and fumes irritate the tracheobronchial tree. The site of action of a noxious gas depends on its concentration and relative solubility in water. Soluble agents like NH₃, HCl, and chlorine affect the upper respiratory tract. When inhaled in high concentrations they induce alveolar damage and edema. Less soluble agents, like phosgene, injure the more peripheral airways. Nitrous dioxide, a noxious gas of low solubility produced from fermentation of vegetable matter in silos, may result in bronchiolitis obliterans within 4-6 weeks after exposure (silo-filler's disease).

The majority of occupational lung diseases arise from the inhalation of organic and inorganic mineral dusts. Fortunately, lung defense mechanisms against inhaled particles are quite efficient. Most inhaled particles are deposited on the walls of the tracheobronchial tree before reaching the respiratory bronchioles. Their deposition is aided by the sharp changes in direction of flow at various bronchial bifurcations and the turbulent flow characteristic of central airways. In contrast, the most harmful particles, which are 0.5-5 μ in size, penetrate to the terminal bronchioles and deposit in the gas exchanging units. Deposited particles may be cleared by the alveolar macrophages and by lymphatic channels in the inter-alveolar spaces, or by the more efficient mucociliary apparatus if they are deposited in the bronchial tree. Alveolar and mucociliary transport are impaired by smoking, alcohol, and hyperoxia.

In contrast to mineral dusts, foreign proteins of organic dusts, enzymes and certain chemical compounds may induce immune responses as classified by Gell and Coombs (3).

Type I immune reactions are IgE antibody-mediated, characterized by positive, immediate skin tests and eosinophilia, and are diagnosed by immediate response to bronchial provocation tests. An example is occupational asthma due to the inhalation of toluene diisocyanate and coffee bean or wood dust.

At present, there is no firm data to incriminate cytotoxic immune reactions (**Type II**) in environmental lung disease.

In **Type III** reactions antigen-precipitating antibody complexes are present. They lead to an Arthus reaction to the offending allergen and are characterized by deterioration of pulmonary function 6-8 hours after bronchial provocation. This immune response is exemplified by a group of occupational diseases referred to as allergic alveolitis or hypersensitivity pneumonitis; these will be discussed below.

Type IV reactions, where humoral immunoglobulins are not involved, are due to cell-mediated immunity. These reactions are characterized by delayed skin reactions and the pathological formation of granulomas. A chronic beryllium disease, which will be discussed below, is such an example.

Inhaled mineral dusts deposited in lung parenchyma may be inert and evoke very little reaction—as in the case of iron, barium, and possibly coal dust. Silicates combined with various metals and metal compounds, however, are quite fibrogenic. Repeated exposure leads to interstitial fibrosis (silicosis), which is usually predominant in the upper lung fields, as seen radiologically (4). In some cases of coal workers pneumoconiosis (CWP), conglomeration of fibrous tissue results in the characteristic "progressive massive fibrosis," and may be associated with focal emphysema (5). Exposure to silicates in the fibrous form results in asbestosis, predominantly involving the lower lung fields. Pleural plaques and diaphragmatic calcification are good diagnostic clues in the chest roentgenogram. Asbestos-related tumors of the lung and pleura, particularly in the exposed patient who smokes, frequently complicate the course of asbestosis (6). Among various asbestos fibers, crocidolite and amosite fibers are the most carcinogenic.

SELECT PULMONARY DISEASES

Although Ramazzini first described respiratory illness among workers exposed to organic dusts in the 1700's, the importance of these substances in occupational lung disease has been overshadowed by the inorganic dusts described above. The inhalation of organic particles may lead to distinctive pulmonary reactions. The more common reaction occurs predominantly in atopic individuals and leads to occupational asthma. The less common involves the lung parenchyma and peripheral airways of non-atopic individuals and has been described as "extrinsic allergic alveolitis."

Occupational Asthma

Organic and inorganic dusts in the workplace may be responsible for the development of asthma in exposed workers, particularly in atopic individuals. Common etiologies of occupational asthma include vegetable dusts, fungal antigens, animal dander, grains, proteolytic (detergent) enzymes, and chemicals such as isocyanates, formaldehyde, and platinum salts (7).

The isocyanates are widely used in the production of polyurethane, which has application in the manufacture of plastics, foam, wire coatings, and shielding. The cardinal symptoms are cough, shortness of breath, and wheezing (8). Toluene diisocyanate (TDI), in addition to being a bronchial irritant, may produce sputum eosinophilia and delayed bronchial reaction; its effects can be inhibited by cromolyn, suggesting a possible role for both Type I and Type III immune responses. Although the mechanism of TDI-induced airway obstruction is unclear, the diagnosis is usually made by a history of exposure and work-related symptoms, and confirmed by bronchial provocation testing. Because exposure to TDI can lead to irreversible airway obstruction, persons who have experienced symptoms should avoid further exposure to the chemical.

Extrinsic Allergic Alveolitis

Pulmonary hypersensitivity reactions that result in bronchitis, asthma, and chronic interstitial pneumonia may be produced by a number of organic dusts. Moldy hay, maple bark, mushrooms, coffee beans, malt, pigeon excreta, cheese washings, sugar cane, and pituitary snuff are a few of the known organic dusts that may produce allergic alveolitis. Except for byssinosis from cotton (where the pathogenesis is unclear) these occupational lung diseases share a common clinical picture and mechanism of injury. The presence of precipitating antibodies and the time of onset after exposure, suggest a Type III immune reaction.

Farmer's lung is the prototype among this group of illnesses. Thermophilic actinomycetes in moldy hay serve as the sensitizing agents (9). Requiring water and heat for optimal growth, almost 90% of the spores are of respirable size, between 0.5-3.0 μ in diameter. Agricultural workers affected by the spores, develop malaise, fever, chills, dry cough, and dyspnea within hours of exposure to moldy hay bales. During the acute attack, basilar crackles are noted on physical examination and bilateral interstitial infiltrates are noted on the chest film. Farmer's lung may also develop insidiously without the dramatic acute episodes, presenting with interstitial fibrosis. The diagnosis of farmer's lung is usually based on exposure and clinical findings. Precipitins to these molds can be found in the serum, but they serve only as a marker of exposure since they occur in asymptomatic workers as well. Pulmonary function may sharply decline with provocative inhalation tests when the diagnosis is unclear. Symptoms may be relieved by the removal of the patient from the antigen source. Corticosteroids and bronchodilators are usually helpful during the acute attack.

Chronic Beryllium Disease

One of the least known, but most intriguing occupational diseases--beryllium disease--was first described in the United States in 1943. Most of the victims were women employed during World War II in the fluorescent lamp manufacturing industry. Since the exposures involved high concentrations of beryllium, the symptoms presented as dermatitis, conjunctivitis, bronchitis, and severe pneumonitis; occasionally with a fatal outcome. Once the occupational hazard was recognized, control measures were introduced. In 1949, the fluorescent lamp industry discontinued the use of beryllium-based phosphors. A report in 1962 based on data from the beryllium case registry indicated a marked decrease in the number of reported cases of the disease since 1949. Recent reports, however, suggest that the incidence of beryllium disease is again on the rise (10). Although some of the reported cases reflect a latent period of 20 years after a brief exposure, about half the cases are due to recent exposure in the aviation, gyroscope manufacturing, and nuclear reactor industries. The emerging clinical picture

of chronic beryllium disease is almost indistinguishable from sarcoidosis, presenting as an interstitial, non-caseating, granulomatous inflammation of the lung and other organs. Clinical findings include dyspnea, cough, fatigue, and weight loss. Diffuse nodular opacities, occasionally with hilar adenopathy, are present on the chest film. Laboratory findings may include hypergammaglobulinemia, hypercalcemia, and hyperuricemia. Urine assays for beryllium are helpful for documenting beryllium exposure, but they are not diagnostic. The diagnosis is usually confirmed by lung biopsy and the findings of beryllium in tissue. A discrepancy between beryllium content and tissue reaction has been noted, suggesting a state of hypersensitivity to beryllium in affected individuals. The treatment of chronic beryllium disease should be directed towards prevention and control of beryllium in the environment.

CONCLUSION

The clinical and pathophysiologic responses of the lung to environmental exposure are diverse, encompassing both obstructive and restrictive patterns of lung dysfunction. Recognition of occupational lung disease is dependent on the awareness of environmental hazards and elicitation of a thorough occupational history. Exposure during a recent job may be less important than a brief exposure twenty years earlier. The key to management is early recognition and prevention, before irreversible structural lung damage occurs.

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CELLULAR TRANSFORMATIONS

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Cellular transformations are biological mechanisms that manifest themselves in a group of diseases, among which are the most terrifying and dreaded by workers and their families--indeed by the entire general population. These diseases include inheritable abnormalities, malformations, and--above all--cancer. There is, to my knowledge, little or no evidence for an increase in mutation rates for any particular occupationally exposed group; although, there are now emerging techniques that might permit measuring mutation rates in the human population. An increase in stillbirth and congenital abnormalities has been claimed in some situations, but many of the cases are poorly documented or still under investigation. The largest problem by far relates to cancer, so I shall address myself to that.

Much, indeed most, of what we know about the induction of cancer by chemical or physical agents has its origin in the workplace. This is understandable, since occupational groups provide definable cohorts; furthermore, they are exposed to levels of potentially hazardous materials that are many orders of magnitude greater than for those individuals whose tumors arise from either drugs or unusual social practices (e.g., chewing of betel nut and smoking of cigarettes).

Occupational carcinogenesis coupled with experimental medicine has provided insight into the dose-responsiveness of the malignant transformation, species differences, individual and organ specificity, the role of metabolic activation, and the identification of specific materials in a complex exposure. I should like to illustrate some of these for you. The classic, indeed the initial, recognition of an environmental cause of cancer was Percival Potts' observation of the link between scrotal cancer in chimney sweeps. Also, Ramazzini, in the same century, recognized breast cancer in nuns as occupationally-related, since celibacy was regarded as a condition of employment. What is less well-known about Potts' report is that he was probably dealing with a new occupational situation; for in the immediate decades before his astute observation, Londoners had shifted from burning wood to burning coal. And, as you are probably aware, the content of polycyclic hydrocarbons in coal is higher than that of wood.

The excitement about cigarette smoking in the late 40's and early 50's directed us and others to develop animal models for inhalation cancer. We had great difficulty in producing any tumor yield by exposing animals to pure polycyclic hydrocarbons; however, when we implanted carcinogen impregnated threads or pellets in the bronchi of rats, the resulting tumors were massive squamous carcinomas of bronchogenic origin. The tumors metastasized to the lymph nodes as well as to the kidney and adrenals, not unlike human tumors. When we examined why we were getting tumors in this fashion and not by simply putting carcinogens into the lungs through inhalation or tracheal instillation, we realized that we were doing something to the bronchi by these operative or irritative techniques. Some prior experience with pure sulfur dioxide inhalation in the rat showed significant changes in the character of the bronchial mucosa, so we decided to combine sulfur dioxide with benzopyrene. We were then able

to produce the desired tumor: a well, differentiated squamous carcinoma, arising from the bronchus and spreading to the kidney.

The effect is something more than simply irritation, something that isn't quite clear yet. When we used sulfuric acid mist in place of the sulfur dioxide, we got no tumors; we believe that there may be some very specific effect of sulfite in the production of carcinoma. At any rate, it does throw some light on the nature of the hazard for people exposed to benzopyrene. Workers who are exposed to roofing tar (i.e., 6 million mcg per 1,000 cubic meters) have a slight increase in the incidence of carcinoma; after many years they develop only 1.5-2 times the expected incidence of lung cancer in spite of the enormous dose. One might wonder if the particular susceptibility of coke-oven operators may not be due also to a mixed exposure involving, among other things, oxides of sulfur. This view would tend to exculpate urban air as a cause of lung cancer in which the average urban levels are 6 versus 6 million mcg per thousand cubic meters for the coke ovens.

Using the pellet technique, it was possible to isolate the particular offender--hexavalent chromium as calcium chromate--in the roughly 10-fold increase of lung cancer in chromate workers. Chromium is an interesting material, as are all the metalocarcinogens, because it is negative in the Ames test. However, if one uses a cell system, such as baby hamster kidney cells, one can demonstrate the loss of contact inhibition. The cells lose their inhibition, show considerable disarray and grow in irregular fashion after exposure to calcium chromate. In another test they lose their anchorage dependence if grown in agar or methocel; the normal cells grow very poorly but the tumor cells grow and produce large colonies in methocel.

Ionizing radiation from radon and radon daughters is the cause of lung cancer in uranium miners. There is a dose effect expressed as "working-level-months", the product of the radon levels and the time of exposure. This can be validated experimentally. We can produce lung cancers with ionizing radiation at the proper dosage levels in 100% of the animals; thus, one can study the staged events in the course of carcinogenesis with a serial sacrifice experiment. The earliest change that we were able to detect was a reactivation of the basal epithelium of a squamous metaplasia, which preceded the obvious transformation to malignant invasive cancer, extending through the peribronchial connecting tissue. This occurred in a very nice dose-related fashion and a probit-plot fell on a straight line. When we used the same system with phosphorus-32, which has a half-life of 14 days, the points fell on the same line. In other words, ten of the five rads derived from phosphorus proved to give the same tumor yield as ruthenium even though each source delivered its radiation over contrasting periods of time.

This brings us to a consideration of direct-acting carcinogens, a group of highly reactive substances that are man-made and not necessarily persistent in the environment. These compounds interact directly with nucleic acids and require metabolic activation; thus, they are potentially potent cancer inducers. Their effects are not unlike those of ionizing radiation. One example is bischloromethyl ether used in the manufacture of ion-exchange resins, etc. If one exposes animals to very low concentrations of BCME (i.e., 0.1 ppm--higher levels resulted in death of animals before the stage of tumor induction), there is an immediate aberrant appearance in the epithelial lining, which suggests that the tissue has been radiated. If one keeps on exposing these animals for up to 100 days, the cells begin to form a squamous metaplasia. Cells that look ordinary and rather complacent apparently have some malignant message clutched to their bosoms; for if the exposure is stopped at 100 days, tumor will burst out 100 days later.

In addition, the animals develop lumps on the nose; when cross-sectioned, the lumps prove to be big tumors of the nose that invade the brain and penetrate the bone. This is not surprising when one considers that we are dealing with a highly reactive material, which in nose-breathing animals has major contact with the nasal epithelium. Another direct-acting carcinogen, dimethylcarbamoyl chloride, produces tumors that are entirely squamous cell. BCME is a great hazard to workers in the plant and in the laboratory, but it is rapidly hydrolyzed and does not persist, so it is of no importance to the general population.

This raises a pressing question that is demanding a lot of attention these days: How hazardous are industrial intermediates and products to the general population? Surely occupational cancers occur in workers, but these result from high-level exposures and must be considered totally unacceptable in our society. There is absolutely no reason for anybody to get cancer in the workplace. It has been estimated that occupational cancer contributes some 10,000 deaths out of the 350,000 cancer deaths which currently occur per year. Many of us presently see little evidence for any significant contribution of man-made chemicals and physical agents to the incidence of cancer in the general population, with the single extraordinary exception of cigarette smoking. It is some 30 years or more since World War II when many of the chemicals were introduced into the environment and one would expect that we should begin to see some perturbation of the tumor incidence curves. Statistics from the National Bureau of Statistics and the American Cancer Society fail to show any massive or significant increase in the most common tumors (i.e., colorectal and breast in both men and women), one striking exception being lung cancer. There are decreases in gastric cancer and cancer of the cervix, which latter has made the curve for the uterus come way down; there is some slight increase in cancer of the pancreas and some increase in prostatic cancer.

The United Kingdom has had a lesser decline in stomach cancer, probably they began their study with a more homogenous population having fewer extraordinary eating habits. The fall-off in cancer of the tongue is presumably due to the decline in pipe smoking and perhaps improved oral hygiene; they too have an increase in lung cancer.

The implication then is that in the general public, the microenvironment--that is, one that the individual helps create for himself--seems to be the important feature in cancer induction, with an emphasis on the role of cigarette smoking. For example, cancer of the larynx is nine times as frequent in smokers in a particular age group as it is in non-smokers. Alcohol is also an important etiologic factor. In regard to the other two common cancers (breast and colorectal), the impression is growing that there are dietary factors--not necessarily food additives--in the Western world that may be the determinant of the high frequency of those tumors. If this should prove to be the case, getting people to change their eating habits will make changing their smoking habits look like child's play.

OCCUPATIONAL HEALTH SERVICES TO SMALL BUSINESSES--Current Approaches

Eugene J. Ryan, MD

Those of us who practice occupational medicine feel we are in the ideal specialty of medical practice; we like what we're doing and we like to spread the gospel. It has been particularly heartening in recent years to find that our traditional focus on prevention is now being espoused by our treatment- and crisis-oriented colleagues in other medical specialties. For years, many of them thought that we were weird, and they wondered why anyone would practice our kind of medicine. Now they see things differently. They concur that the escalating cost of remedial treatment necessitates a concentrated effort to develop more effective preventive measures. Since we have been doing that for years, they now realize we are not weird after all.

For many of those present today, especially the residents and students, the picture of how occupational medicine is practiced among small industries is rather vague. Therefore, I will take a few minutes to give you a quick overview of the significant aspects of occupational medicine as it is practiced in a private office or clinic, such as our clinic in Phoenix.

Our functions are essentially the same as those practiced in the corporate medical department. I am in a good position to make the comparison since my first 10 years in occupational medicine were with the du Pont Co., the last 17 have been in a private clinic setting. In the main, we perform:

- physical examinations of all types, including pre-placement, periodic, work-fitness, return-to-work, vehicle operation, and the more detailed executive health assessment;

- treatment of job-related accidents and diseases;

- disability evaluations;

- medical and disability claims review;

- industrial hygiene, safety, and environmental evaluations;

- consultation with management on OSHA matters; and

- health education.

Most of these are done in our office, but we also make visits to plant sites for companies with plants in this area. There are also numerous companies who have no "plants" as such--banks, accounting firms, truck lines, manpower placement agencies, department stores, etc.--all of whom need and use our expertise in the same way as large companies with manufacturing facilities.

If there is one word that most characterizes our type of practice, it is "diversity." Life is never dull because of the diverse nature of groups with whom we deal. Those of you who are medical directors or staff physicians with corporate medical departments get to know very well the range of problems you are likely to encounter in your organization. A clinic such as ours, on the other hand, works with multiple groups having widely divergent functions and totally unrelated interests. Accordingly, the problems have been just as varied; for example:

a hepatitis scare in a fire department when they learned that they had resuscitated a person with active hepatitis;

carbon monoxide exposure in a drive-in island of one of the banks;

a meat-packing plant worker who actually got hung up on a wall meat-hook;

possible lead exposure in the lithograph department of a newspaper (we also have had an occasional case of good, old-fashioned lead poisoning when some of our police officers got involved in a modern-day shootout);

a department store with a possible addict--either drug or alcohol;

a truck line with a driver who may have been under the influence of alcohol and was insisting on returning to his base in California;

an airline with a combination homosexual and alcoholic;

a bus line with a driver whose routine annual exam showed a grossly abnormal electrocardiogram;

a manic-depressive "acting out" in the personnel office of an electric utility company;

a small 100-employee computer component plant which received from a local physician--who had never seen the inside of a plant--a worker's compensation claim of a two-pack/day smoker for "bronchitis due to fume exposure work."

In each of those instances, the organization had no medical department, company doctor, or plant nurse whom they could dial for help. We fill that role. Our biggest asset is that we are available to such diverse groups when they need us, regardless of the type of problem or situation.

Another role that we fill involves dealing with various management philosophies. In a corporate medical setting, the medical director and staff physicians come to know their management people and learn how to deal with a variety of ideas, eccentricities, and idiosyncrasies. In a private occupational practice, the personality factor is complicated by having to deal with a multitude of managements. There is the sharp one who knows every detail of his entire business, including how he wants his medical services handled. There are also those at the other end of the spectrum who have no concept of medical functions or programs, have incurred astronomical costs on workers' compensation and medical claims, and don't know the first thing about how to handle their problems.

The same extremes occur in limited-work programs. We had an interesting situation this year. Two large construction groups are competitors for major projects in the Arizona area; both are equally successful but each is at the opposite pole as far as limited work for injured employees is concerned. One group urges us to spell out the limitations in detail and send the patient back to work unless he is totally disabled; they will find something for him to do. The other company has the firm policy of no limited-duty for their people; it's either full production or stay home. We had an interesting discussion with the latter group when we began working with them this year. We had been working for several years with the first company, so it was quite different when the second company's rugged safety superintendent said dramatically, "Doc, you realize there is no such thing as light-duty in construction work; so if a guy can't do his full regular job, keep him off until he can go full-tilt." So, flexibility became one of our hallmarks, "No one way is the only right way to success!"

An employer of as few as 5 to 100 employees may ask, "Do I need occupational medical services for this small a work group?" It is important that he arrange to have either a physician interested in occupational medicine or an occupational medical clinic in the community for both emergency care and health maintenance services.

First of all, care of industrial injuries and illnesses is mandated by law. A certain percentage of any employee group will incur injuries in a year's time. Someone has to be available to treat those individuals. The numbers become particularly significant when you realize that the vast majority of businesses in our country today have fewer than 500 employees. Secondly, the realization of the need for preventive measures in the form of examinations, proper job placement, environmental surveys, rehabilitation, health education, and the like, evolves into another significant segment of medical work. A small plant cannot afford an in-house medical staff for all these functions; but with a single overhead cost, we can profitably provide all of these functions to numerous and different companies at a reasonable cost.

The need can be further quantified by the experiences of the full-time, private, occupational medical clinics in various cities throughout the country. Any number of them started as we did in Phoenix, with one man; now each must have a staff of several physicians to meet the needs of the clients.

Are current functions and activities different from previous years? Again, a great big unequivocal, "YES!" We are in a totally different ballgame from that of ten or even five years ago.

Hiring policies and practices have dramatically affected the pre-placement examination programs. For many years three standard terms were used in association with pre-placement examinations; namely, **accept**, **reject**, and **accept with limitations**. The more contemporary terms are: **equal opportunity**, **affirmative action**, and **job-relatedness**. For better or worse, these changes have brought about vast changes in hiring policies. Job-relatedness is now a key issue affecting various groups in a number of ways. It has innumerable benefits for handicapped persons because it enables them to demonstrate that they can be excellent employees and can function very effectively in properly selected jobs. We physicians are, in essence, the liaison for handicapped persons entering the business and industrial worlds. However, the effects of this social change can be strongly felt in a different way among small work groups. For example, a tightly-budgeted company of 50 or 60 people can't afford having a segment of its workers repeatedly off work with chronic medical problems. In past years, we would recommend after the pre-placement examination that the person not be hired because

of his high potential for future disabilities. Now, as you know, that potential disability is no longer a basis for declination; if he can do the job that day, you must hire him! We recently encountered an EEOC (Equal Employment Opportunity Clause) judgment that required a company to hire for a clerical position a man with a lymphoma who was in remission on chemotherapy. We have had several instances of people with bypass-surgery applying for manual work with small organizations. All of those situations required careful analysis, both medical and sociological; the marriage adjustment of these two fields is anything but simple.

One of the oftentimes misconstrued examinations performed in the occupational medical setting is the executive's periodic health evaluation. This exam involves a detailed appraisal of the whole person. It takes into consideration the whole combination of physical, psychological, personal, work, home, and family factors in which the executive is entwined in his daily life. It puts aside the usual concept of the executive who is in absolute control of his destiny and environs. It is one of the few occasions in a top executive's life when the power settings are reversed; he is on the receiving end, rather than issuing directions and orders. It is one of the few times when executives have the freedom, openness, and security to discuss their human frailties; e.g.,

the emotionally disturbed, psychopathic, or alcoholic spouse or child at home--realization that time and energy of managing the successful business may be a contributing factor to these disorders;

impotence--the most common thing we see in the over-50 age group.

The exam also provides the setting for the executive to be receptive to "orders" on establishing proper health habits. We have seen literally hundreds of executives who "saw the light" and stopped smoking after we explained the significance of the declining spirometry and the warning signs of impending COPD.

It is unfortunate that these programs are criticized on a statistically as not warranting the costs involved. To the executive--and frequently his family--it is a very personal and rewarding experience, regardless of the economic insurance it provides for the company.

As all of us know, the segment of our occupational medical work that deals with toxins, carcinogens, and mutagens is literally exploding. At this point, we are in a state of turmoil because the potential problem is so overwhelming; we realize we have only scratched the surface of the bank of knowledge that is needed to deal with it. Employers are asking us questions about long-range effects of some of their materials and products; we feel very inadequate when we tell them in many instances that we have no valid answers. Hopefully, the merging of the industrial hygienists' efforts with the work of research toxicologists and geneticists will provide the types of information that we are going to need over the next decade.

Disability evaluation has become a significant part of most private occupational medical practices. Our usefulness in this function is rather obvious. We have the medical knowledge derived from the attending and specialized physicians who have treated the case, plus information gleaned from our own examination of the person. We also have the direct, first-hand knowledge of the various job activities that might be performed by the disabled person. Therefore, it is logical and utilitarian that we serve in the disability evaluation process. Needless to say, this function also increases the

time we spend in courts and hearings.

In conjunction with disability cases is our increasing interface in the rehabilitative process. Our clinic considers rehabilitation starts at the moment of our first treating contact with the patient. Everything we do from that point on is directed to returning that patient to a full-work capacity as soon as possible. Fortunately, we can accomplish this goal without outside therapy or rehabilitative help in about 90% of the cases. The remaining 10% are directed to a specialty group for completion.

One of the newer and most encouraging aspects of our work is the increasing awareness for health and physical fitness programs. Management and employee groups alike are eager for specific programs dealing with stress, physical exercise, proper nutrition, and other health education topics. A number of local groups are now asking for some type of health newsletter for their employees.

It is interesting that companies are now listening to our advice after many years; namely, that medical and disability costs can be reduced if they are properly monitored. We all know that most companies have glossed over their medically-related losses as the "cost of doing business." We are now consulting for a number of companies who process their own medical and/or workers' compensation claims. Sometimes our medical decision is only to determine the validity of the claim. In other instances, we contact the employee's doctor to determine the status of the case. We might decide that the disability warrants a medical evaluation by an independent examiner, particularly if we have conflicting reports from different physicians. With continuing increases in medical costs, this service will be an expanding function of occupational medicine.

The days have long since passed when occupational physicians could establish a nice, neat set of standards and procedures for maintaining employees in a reasonably good state of health. Like all other medical specialties, occupational medicine is in the midst of a knowledge explosion; our cerebration is going to be taxed to the limit to keep pace with that eruption. Our functions are becoming more sophisticated and stimulating. New challenges are evolving every day, and we find we are taking our rightful place in the sun by meeting those challenges. It is, indeed, a gratifying and exciting feeling to realize that we can not only prevent harm or disaster from toxins and work elements, but positively influence the physical and financial health of our nation as one of the dominant factors in preventive medicine.

ARTHRITIDES

The Comparison of Radiographic Abnormalities With Symptoms in Bone and Joint Disease

Eric P. Gall, MD

Frequently, the practicing physician is confronted with a patient complaining of musculoskeletal pain. The relationship of this pain to an anatomic origin, the reconstruction of the mechanism by which clinical symptoms are induced, and the establishment of an accurate diagnosis comprises a frequent dilemma. Only when this dilemma has been resolved can the patient's problem be solved. Because radiographs of bones and joints are relatively easy to obtain, they are frequently used to help pinpoint the etiology of pain. Unfortunately, when dealing with musculoskeletal problems on a daily basis, one quickly learns of the pitfalls of relying upon the radiograph as the determining factor in relating cause and effect. The clinician must recognize at the onset whether a given roentgenographic abnormality does indeed explain the reason for the pain in the locale of the abnormality.

For years, heavy labor industries have debated whether a radiograph can accurately identify an individual with a high risk of skeletal injury. The mining, lumber, construction, and metalworking industries have provided significant data on this subject, as have a number of epidemiologic studies. As an example, I will refer to the lumbar spine in this discussion. Low back pain can be the bane of the rheumatologist's practice; its cause is difficult to determine, it is a frustrating condition to treat, and it forms a frequent basis for industrial compensation claims. Five years ago, the American College of Radiology, the American Academy of Orthopedic Surgeons, and the American Occupational Medical Association, in cooperation with NIOSH, held a conference on the value of low back X rays as a component of preemployment physical examinations (1). Many of these problems were discussed in depth, and I would like to share some of the data, ideas and conclusions with you.

First, though, let me review briefly the logical way to approach a patient with low back pain; then I will place the radiograph in its proper perspective. Naturally, no procedure should take precedence over a careful history and physical examination. Detailed attention should be given to the circumstances surrounding the onset of the symptoms; a precise description of the location, radiation, and character of the pain must be obtained. Factors that contribute to both exacerbation and relief of distress should be carefully sought. A review of symptoms and family history may reveal important clues. The examiner must be capable of assessing the spine, the appendicular skeletal system, and the nervous system. Since back pain often limits locomotion, causes changes in occupation, and alters many functions (including sexual activity) one must determine—if possible—the patient's personality traits both prior to and after the onset of his ailment. Only after such a comprehensive study can a physician determine the need for laboratory analysis and radiographic studies.

Assuming the physician at this point orders a routine lumbar spine series, how may the

results be interpreted? Many radiographs will disclose abnormalities wholly unrelated to the patient's complaints. For example, one frequently encounters asymptomatic spondylosis, spondylolisthesis, asymmetric sacralization of lumbar vertebrae, spina bifida occulta, diffuse idiopathic skeletal hyperostosis (DISH syndrome), and osteitis condensans ilii on radiographs obtained for intravenous pyelography, gastrointestinal series, etc. The extent of this occurrence must be appreciated, since it is of great importance to the patient's welfare and for the fair adjudication of industrial responsibility.

Torgerson and Dotter carried out a prospective evaluation of findings in 604 patients to determine the incidence of radiographic abnormalities in an asymptomatic vs a morbid population (2). Intravenous pyelograms of 217 patients (aged 40 to 70) with no history of back pain or injury were compared with the spine films on 387 consecutive patients with symptomatic back disease. Of the asymptomatic population, 22% had disc degeneration, 4% had spondylosis, and 1.5% had spondylosis with or without spondylolisthesis. This range of radiographic abnormalities in a "normal" patient population is impressive.

Among 550 patients undergoing GI series, none of whom had back symptoms, Southworth and Bersack discovered 23% with asymmetric sacralization of vertebrae, 2.2% with spina bifida of the lumbar spine, and 16% with spina bifida in the sacrum (3). The incidence of spinal osteoarthritis in these individuals differed little when compared with a group without congenital abnormality.

La Rocca has studied large groups of heavy laborers without back problems and compared them to individuals receiving industrial compensation for low back disorders (Table I) (4).

Table I

ASSESSMENT OF THE PRE-EMPLOYMENT RADIOGRAPH*

X ray Diagnosis:	No Complaints:	Compensated:
Normal	7%	2%
Degenerative arthrosis	85	98
Anatomic variants	65	66

*Summarized from La Rocca (4).

There were no statistical differences between the two groups in the matter of scoliosis, transitional lumbosacral vertebra, zygapophyseal tropism, spondylolysis or osteoporosis. Although degenerative changes were more frequent and degenerative arthrosis was more severe in the presence of compensable disease, this was not as striking as one might have anticipated. There was no correlation between the existence of degenerative arthrosis and any of the anatomic variants found.

Hadler, reviewing back disorders in industry, found that morbidity peaked between 30 to 40 years of age; and as one might suspect, it was highest in tasks requiring the lifting and handling of heavy objects (5).

In an industrial population of 3,000 employees, Magora found that 429 had significant

back pain which persisted for a year or more. Also, about 2% of the patients seen in general practice have back pain (6).

Since back afflictions represent a high level of cost to industry, the procurement of preemployment films for candidates in "high risk" jobs has become a customary practice. In some situations, more than 40% of the job applicants have been rejected for employment because of radiologic findings that may have no bearing whatsoever on symptoms or susceptibility to injury (1). Obviously, while intending to lessen industrial costs by screening out workers who may be prone to back ailments, the rejection of job applicants because of a radiographic abnormality alone is unjustifiable and creates needless hardships on those unfortunates who are refused employment.

It is also interesting to note that data of several industries show a significant occurrence of low back pain in persons who are not in "high risk" work; indeed, as many as 30-45% of sedentary workers complain of low back problems. In one survey, 85% of the employees with low back pain held positions that imposed no undue physical stress (1). Weyerhaeuser Lumber Co., on the other hand, screened employees with lumbar spine films for heavy labor jobs (7). They compared 209 individuals who were hired despite highly abnormal though asymptomatic low back films with 644 workers whose back films were normal. Work records revealed that loss of work due to back pain in the group with abnormal radiographs was 32/1000 man-years, vs 62/1000 in the normal x-ray group. Thus the radiograph as a preemployment screening mechanism is highly suspect; there is even some doubt about the concept of a "high risk" job in respect to low back syndrome.

From the Conference (1) came several recommendations:

Lumbosacral films may be of value in conjunction with or as part of a history, physical examination, and other diagnostic procedures.

The radiograph assesses current status, but it is not predictive of susceptibility to disability in a stressful occupation.

The notion of predictability is based on sporadic observation and not on valid statistical data.

Protocols may be devised which will assess the physical characteristics useful to an employer and employee. X rays should be no more important than other procedures.

The extent of the area to be filmed should be determined by the industrial clinician and a radiologist. AP and lateral views are the minimal examinations required.

Gonadal shielding should be used.

More attention to low back problems is needed.

Obviously the radiograph has a place in industry--it does provide a baseline for determining if an industrial accident at a later date has been the cause of an abnormality--but using it to determine the etiology of back pain and to predict the risk of developing a vertebral injury must be done with full knowledge of the limitations of the procedure.

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ARTHRITIDES

Effect of Repetitive Motion on the Musculoskeletal System

Nortin M. Hadler, MD

In a critical sense, there is little data supporting any contention that pattern of usage, aside from overt trauma, causes or precipitates any regional musculoskeletal disease (1). That is not to say that if you have such a disease you won't experience symptoms with usage or that you won't become disabled in the appropriate occupational setting. In other words, exertion does not cause emphysema or coronary artery disease, though it may bring on dyspnea or angina. Yet, the morbidity of some regional musculoskeletal disease and the pattern of usage are clinical correlates. Witness the implications of such time-honored diagnoses as "tennis elbow," "housemaid's knee," etc. Even these clinical correlates are anecdotal and do not prove the pathogenic role of the pattern of usage, though they may be describing the pattern of usage most likely to elicit the disease. Nevertheless, the description of the associated pattern of usage is clinically useful in suggesting the palliative and perhaps prophylactic proscription of the implicated motion or usage.

For other syndromes of extra-articular rheumatism a precipitating, if not causative, pattern of usage remains elusive. There are some data relevant to tenosynovitis at the wrist (2), but very little for common periartthritis syndromes at the shoulder. When one considers degenerative joint disease (DJD), the role of usage is debatable. Clearly usage must be involved at least to the extent of precipitating morbidity, because morbidity in part is defined by the functional impairment. Whether usage accelerates cartilage degeneration (3,4,5) or is even a primary pathogenic insult (6,7) is not clear.

The hypothesis of a more primary pathogenic role for usage in DJD leads to a corollary hypothesis: The pattern of usage should influence structure and function of the hand in a fashion compatible with the clinical definition of DJD. Furthermore, such a corollary hypothesis lends itself to formal testing. One can seek clinically detectable differences in the structure and function of the hands in groups of subjects, each with distinctive and different patterns of usage. Such groups can be found in industry; e.g., those having been employed for decades in tasks calling for highly repetitive, stereotyped, "atraumatic" patterns of hand usage. Our recent study (8) detects differences in hand structure and function in three groups of textile workers. Because the measures of structure and function have relevance to the clinical definition of DJD, we feel justified in asserting a more positive role for the influence of pattern of use on the pattern of DJD of the hands.

Our study was not designed to test for abnormality, but rather for the likelihood that a single independent variable,--i.e., the pattern of usage--influences the structure and function of the hands of three populations that are otherwise highly comparable. To test for abnormality, one would need to identify a normal control population with normal structure and function. Since the ideal control population should preferably lack

the influence of the independent variable (hand usage), there can be no ideal control population in this particular situation. An alternative control population would include all possible patterns of hand usage without bias; such a control population would be large, and it would be essential that we establish with confidence the absence of bias. With an independent variable as ubiquitous as hand usage, the identification of a bias-free control group is not only prohibitive, but also infeasible. Furthermore, biases in an inadequately constituted "normal" control group are every bit as compromising to the interpretation of the data as biases in the experimental group. The design for our study is not only expedient, but it is logically consistent and avoids the pitfalls of attempting to define a "normal" control.

Appropriate subjects were selected from a single, long-established worsted mill in a small rural Virginia town. The mill employs over 600 people and is a major employer in a rural community with a stable population; inter-job mobility is not commonplace. Three different manual tasks employing a large percentage of the workers were chosen because the task description has changed little over the past decades. Only female employees who have been working continuously in their respective task for at least 20 years were eligible.

All three tasks--burling, winding, and spinning--are highly repetitive, stereotyped, and bimanual to some extent. In terms of frequency, the subjects perceive only winding as a bimanual task. Furthermore, winding is distinct from the other two because of the predominance of wrist motion and a power grip with little fine-finger motion. In contrast to burling, spinning utilizes a three-finger hand, sparing the 4th and 5th digits.

Two categories of data were obtained by clinical examination:

The extremes of the active ranges of motion were measured to the nearest 15° with a small, plastic universal goniometer (9). All small joints of the hand, the first carpometacarpal joints and the wrist were examined and the data recorded in a manner similar to Treuhaft et al (10); (see Fig. 1).

The circumferences of all distal (DIP) and proximal (PIP) interphalangeal joints were determined with an arthrocircameter (1).

Radiographs were taken of the hands of all subjects. Each joint for which goniometric data was obtained was scored for DJD from 0 to 4 in the standard fashion (12). In addition, the minimal width of the mid-phalangeal shaft was recorded to the nearest millimeter. Malalignment was determined by measuring (to the nearest 5°) the discrepancy in the alignment of the long axes of the contiguous bony shafts at the PIP and DIP joints, excluding the thumb.

Four separate sets of data resulted from the clinical and radiographic studies: range of motion, malalignment, radiographic DJD score, and derivatized circumference. Differences between right and left hands were assessed. The results of the tests of significance are presented in Fig. 2. It can be seen that there are extensive right and left hand differences, all lending toward impairment in the right hand.

Extensive multivariate and univariate analyses were applied to the data to test for differences between the tasks. These analyses demonstrated several task-related differences at several joints and groups. When the p-values were both consistent in the several models of testing as well as statistically significant, the data for each task were inspected in order to rank the tasks. The task-related impaired joints are shown in Fig. 3.

It is not surprising to find that most of the task-related impairments are in the right hand; also, the right hand was more impaired than the left regardless of the task (Fig. 2). Furthermore, almost all subjects were right-handed and all except the winders perceived their task as right-handed. But important distinctions become apparent on closer inspection of Fig. 3. Recall that winding is perceived as bimanual, requires considerable wrist motion, and employs a power grip. The analysis of structures and function (Fig. 3) discloses impairment at the wrist in winders as contrasted with burlers and spinners and their impairment is bimanual. Furthermore, winders are less impaired than burlers and spinners at several finger joints; in particular, at the 2nd and 3rd digits of the right hand. These are the digits which burlers and spinners depend upon for precision gripping. Spinners are exclusively spared impairment in the right 5th digit; they use a three-finger precision grip which spares the 4th and 5th digits.

Figure 1

DATA-COLLECTION FORMS AND JOINT NUMBERING CODE FOR THE RIGHT HAND
(the mirror-image form was used for the left hand)

(Reproduced with the permission of the editor of Arthritis and Rheumatism)

For range of motion data:

joint-1 represents the range of deviation at the wrist;

joint-2 represents the range of extension-flexion.

For radiographic DJD score:

joint-1 is the radial-carpal joint;

joint-2 is the inferior radial-ulna joint;

joint-3 is the first carpometacarpal joint throughout;

joints-4 through 17 are the anatomically corresponding digital joints.

RIGHT HAND

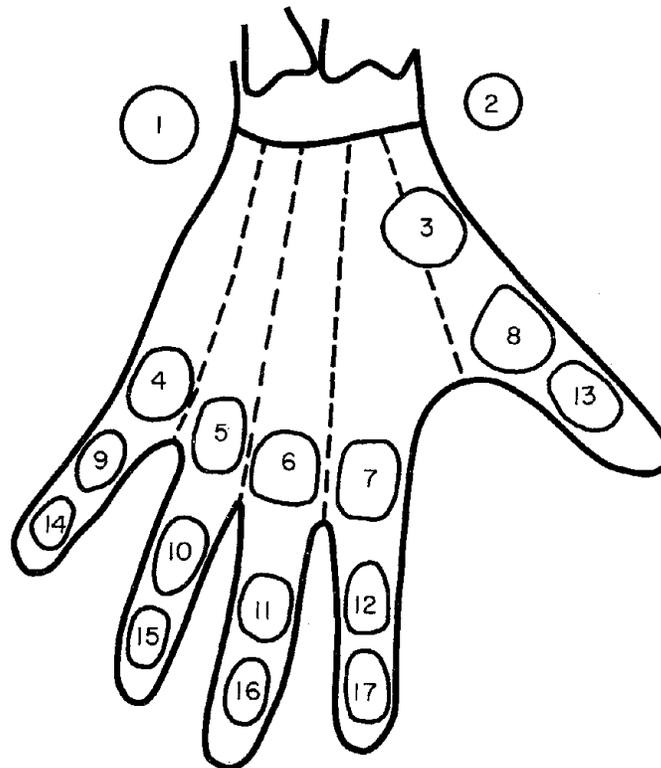


Figure 3

TASK-RELATED DIFFERENCES
(a stylized version of Fig. 1)

(Reproduced with the permission of the editor of Arthritis and Rheumatism)

The statistical analysis tasks are ranked and the task with the most impairment is indicated in the box corresponding to the involved anatomical region. Only the most consistent and statistically significant structural and functional impairments deduced from the Kruskal-Wallis and MANOVA analyses are noted.

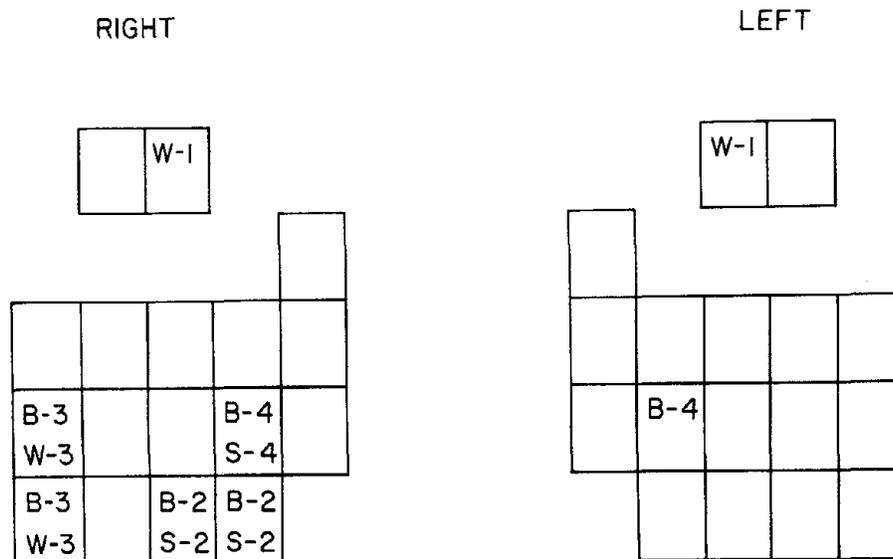
The notation for each task is:

W = winding, B = burling, and S = spinning.

The data from which the null hypothesis is rejected is indicated numerically:

1 = range of motion, 2 = radiographic DJD score, 3 = derivatized circumference, and 4 = radiographic malalignment.

No task-related difference was detected by any criteria at the right 4th DIP joint (joint #15 in Fig. 1); therefore, it is blank. At the right 3rd DIP (joint #16) a difference was detected in the radiographic DJD score. Winders were significantly different from both burlers and spinners; however, the difference is in the direction of impairment for burlers and spinners as indicated by their designation in the figure at this joint.



In summary, the task-related differences shown in Fig. 3 are consistent with the differences in patterns of usage for each task. These observations help to explain the preponderance of Heberden's nodes in women as hypothesized by Radin et al (13): that the precision grip, more commonly used by women than men, transduces more force across distal joints and thereby leads to an increase of DJD in women.

Studies similar to this but which seek an influence of pattern of usage on regional musculoskeletal diseases other than hand DJD are clearly feasible (1). Many of these "diseases" are highly morbid (e.g., the back (14) and shoulder syndromes) occurring with high frequency throughout the population and significantly impairing function. In industry, such morbidity is dramatic and easily quantified in terms of disability claims and lost workdays. However, the experimental design is not to study industrial diseases, but rather the diseases of individuals in stereotyped, repetitive tasks. A well-documented influence of a defined pattern of usage on any example of clinically significant regional musculoskeletal disease would potentially have prophylactic and therapeutic import. Regardless of whether the influence is found to be pathogenic or precipitous of symptoms, the definition of a culpable pattern of usage should provide medicine with a prophylactic statement and industrial engineering with a guideline for designing tasks.

For such studies to be successful, however, there are a number of conceptual and methodological pitfalls that must be recognized:

The issue is not whether people who work in mines, foundries, banks, etc., have diseases, but what particular pattern of usage is associated with a particular type of clinical pathology.

Prevalence data in industry has too many variables for it to be useful in establishing a relationship between disease and usage. I even question the reliability of this data as an indicator of the degree of risk for any particular group.

There is no "good" control group. Most occupations require musculoskeletal usage. Even the non-working quadraplegic has musculoskeletal disease!

No retrospective study can prove an association between a pattern of usage and a pattern of disease. This is probably the most pronounced fallacy in the design of the earlier studies, reflecting the bias of the investigators. The "negative" study is uninterpretable; whereas, the "positive" study is as likely to be coincidental as causal, or reflect the influence of a variable that has not been measured.

Only prospective studies where there are few and well-defined variables can represent cogent evidence of causality. But before one can undertake such studies, there must be some substantive suggestions as to the appropriate variables. We study an industry not because it is culpable or because employees are special examples of mankind, but because there is no other setting where usage is likely to be so repetitive and stereotyped.

The design of the initial retrospective studies is straight forward:

Groups of workers should be chosen solely because they are performing a stereotyped repetitive task for prolonged periods of time. As one becomes

familiar with the spectrum of industrial settings, prolonged periods of time (in terms of decades) becomes a feasible criterion. Such intervals inherently tend to control for age and inter-job mobility.

The collaboration of a skilled ergonomist is essential to adequately describe the pattern of usage in a biomedical sense.

The applied measures should have some obvious validity and measurable reliability. For example, past symptoms of pain compared to the radiographic demonstration of calcific tendonitis is unappealing. Examination of each subject by more than one observer can test the reliability of the measure.

The objective of the study is to test a null hypothesis--that no significant difference exists between the study groups. In this way, inability to reject the null hypothesis is a meaningful result and as important a bit of data as the inverse.

In addition to assessing the influence of pattern of usage on pattern of regional musculoskeletal disease, there are other promising approaches. The definition of precipitants of symptoms may yield to the investigative approach of Chaffin and his co-workers (15,16). They have shown, in a prospective study, that workers who are most closely matched in terms of strength with the physical demands of their job are least likely to complain of back pain. Questions of definitive diagnosis and role of predisposing lesions might well yield to newer diagnostic techniques; for example, scintiscanning and multivariate computerized analysis of detailed radiographic studies could be studied prospectively in highly selective populations. With these and other lines of investigation, there will be a day when we can offer considered and reasonable clinical judgements on many of the issues of causality in regional musculoskeletal disease.

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ARTHRITIDES

An Upfront Look at a Back Seat

Robert L. Swezey, MD

Postural factors play a significant role in the predisposition to and aggravation of musculoskeletal disorders. These factors are evident in bending and lifting, perhaps less obvious on pushing and pulling, and most subtle in relation to the seated posture from the standpoint of vocation. A variety of occupations place great demands on the seated posture (I hesitate to mention the extraordinary demands made on the supine posture by mattress testers); these occupations range from secretary-receptionist through light manufacturing, a variety of them involve driving, and include the whole spectrum of executive positions. It has been rumored that there is an inordinate amount of stress in the last occupation which may be inversely correlated with the amount of work accomplished. Although most occupations require some seating consideration, too little thought has been given to the design of the seating and its effect on the person. Glaring examples greet one at almost any visit to a hospital or a geriatric home, or to a physician's office where the usual criterion for the selection of seating is a misguided perception of aesthetic design. Our backs, like the feet that are placed in women's shoes, are often expected to contort into something that is either aesthetically appealing or possibly sexually stimulating.

It is clear that the optimum posture for seating should depend on the task to be performed while seated. Seating should provide an optimal alignment of the spine so that skeletal stresses will be minimized. The low back should be provided with adequate clearance for the buttocks in order to prevent inordinate stresses caused by the juxtaposition of the seat and either the pelvis or the dorsal spine. Depending upon one's requirements, the chair should be designed to swivel, roll, or allow the person who is seated to reach behind or to lean forward. The amount of padding, angle of the seat, the height from the floor, the presence of arms, the height of the arms, the shape of the arms, the slope of the back—all must be carefully designed so an average person can function optimally. The design should be adjustable so that persons who deviate significantly from the mean in body size can be accommodated comfortably (1-4). Seating impinges on the shoulder and elbow angles and stresses those areas of the body as well as the neck. The angle, height, and adjustability of the working surface must also be considered. For persons with hip and knee problems, or back problems, the design of the seating should facilitate a transfer from the sitting to standing position; with special modification of the back, the person can place his feet beneath him in order to lift his weight more readily. Patients with fixed contractures of hips or knees, such as ankylosing spondylitis, or people with severe degenerative joint disease and post traumatic problems may require specially designed seating to permit semi-reclining. A "perch" or modified stool may provide a solution that will permit the patient with backache—for whom sitting produces an inordinate stress—to relieve the stress of prolonged standing while functioning at his occupation. This may be an equally satisfactory solution for persons with persistent problems in other lower extremity joints (4-6).

In summary, there are a number of very real problems in seating that may spell the difference between the ability to work or not to work. Certain items of furniture can meet specified seating requirements if care is taken to consider the seating function, the patient's body configuration, and the specific musculoskeletal problem. If necessary, simple adaptations for poorly designed seating, such as chair leg extenders, seat cushions, etc., can be made.

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THE FUTURE OCCUPATIONAL PHYSICIAN-- WHAT SHOULD HIS TRAINING BE?

Bruce E. Douglass, MD

As background to our symposium, I want to sketch the strange history of residencies in occupational medicine. The American Board of Preventive Medicine was organized in 1948. From the start, the Board certified physicians as to their competence in public health; a few years later, it became authorized to grant certification in aerospace medicine, general preventive medicine, and occupational medicine. A basic body of knowledge in preventive medicine is required of all applicants, who then take additional examinations in one of the four specialty fields just mentioned. Over the years, about 740 persons have passed the examination in occupational medicine; it is estimated that at present about 420 of these are still in active practice. There are several hundred specialists in other fields, especially internal medicine, who have switched to occupational medicine, while thousands of doctors of all kinds are practicing occupational medicine on a part-time basis.

To my knowledge, there is no other established field of medicine or surgery with so few properly trained and board-certified individuals. Up through the 1960's, there were only a handful of residency programs, each turning out fewer than five residents per year; included were the universities of Harvard, Rochester, Pittsburgh, Ohio State, Cincinnati, Oklahoma, UCLA, and Michigan. Most of these programs were funded by federal training grants, inasmuch as the residents in occupational medicine did not produce income for the training institution.

As many of you know, when President Nixon signed the OSHA Act in 1970, calling for vast armies of occupational health professionals, the training grants for occupational medicine were terminated; thus, the bottom fell out of the training programs, leaving only the universities of Harvard and Cincinnati, both of which have long had a strong, basic commitment to occupational medicine. During the mid-1970's, several institutions began to rise slowly from the ashes and programs were started up at the University of California at Irvine, Mount Sinai in New York, the University of Oklahoma, and the University of Texas at Houston. Meanwhile, NIOSH (who is charged with the responsibility of providing manpower for compliance with OSHA legislation) began to fund its Educational Resource Centers; some of these Centers initiated new programs, while others continued with programs in existence. As our session progresses, you'll hear how various Centers have had success in staffing a faculty, establishing curricula and attracting residents.

Our program in Minnesota is joint with the School of Public Health of the University of Minnesota and the Institute of Agricultural Medicine of the University of Iowa. The Mayo Graduate School of Medicine has set up the program in close relationship to internal medicine for two principal reasons:

We hope its graduates, well-trained in medicine, will be able to participate in the clinical care of Mayo patients and help us bring the principles of

preventive medicine to bear on both the Mayo patient population and the hospital staff. We believe that internal medicine is a very important background for a practitioner of occupational medicine. Some of the leaders in our field began as internists; as internists, they have enjoyed a high standing in their medical communities, which is not always easy for the occupational physician. After all, many doctors, even though fully trained in some non-clinical field, are judged largely by the nature of their training and competence in clinical work; we feel, and have observed, however, that a well-trained internist gets along pretty well wherever he goes. And since the occupational physician often is an intermediary between the patient and private physician, he needs to understand the problems of his employee-patient and the consultative advice from outside sources. Internists are also competent to conduct examinations of corporate executives. Thus, the occupational physician with only a minimal amount of training in internal medicine, is very likely to be at a severe disadvantage.

Whether we will attract residents of this dual program, which requires a minimum of five years of hard work, remains to be seen. We anticipate that some residents will discover and enter the program after they have already had several years of medicine. As for recertification, we don't believe that even the most rigid academic institution will require a faculty member or staff consultant to stand for reexamination in more than a single field.

The basic features of another new residency we are launching outside the Minnesota-Iowa center is a program in general preventive medicine. Because this term is even harder to define and explain than plain preventive medicine, we decided to use the latter; I wish the American Board of Preventive Medicine would do the same. Except for certain academic pursuits, preventive medicine and occupational medicine are practically synonymous. I believe that private physicians aren't much interested in prevention; also, patients don't consult them for preventive information, nor are they ready to pay bills for health maintenance advice. In the workplace, however, one can really apply the principles of preventive medicine--the patients are in a defined location; they are usually available every working day for observation, advice, and treatment; and as groups, they make the cost of programs tolerable. Moreover, communications and record systems are extant, recall and reinforcement is a simple matter, and we may be sure that a health-motivated employee will take his enthusiasm home to his family.

Several years ago, Doctor Tabershaw called sharp attention to the predicament of the mid-career physician; i.e., one who has taken an interest in occupational medicine but who cannot gain competence or board-certification in this field in the absence of a structured training program. To remedy this situation, Doctor Tabershaw proposed that a non-traditional "university without walls" be established, at which an employed physician could take occasional, short, intensive course work and be given homework assignments. There would be return visits to the campus with long weekends of study, conference, and review of home projects. The proposal is still under consideration by the Occupational Health Institute; one of the reasons for the delay in getting such a plan launched has been the initiation of NIOSH's ERC program at the very time that several institutions were considering this nontraditional approach.

* * *

To lead off the forum, Dr. Paul Johnson will tell us about the program he has been developing in St. Paul as part of the Minnesota-Iowa consortium. Doctor Johnson is affiliated with the St. Paul-Ramsey Hospital, one of the teaching hospitals of the University of Minnesota; he is a faculty member in internal medicine and director of the Department of Pulmonary Diseases. Following him on the program will be descriptions of the various residency programs and philosophies in each of the 11 Educational Resource Centers.

Dr. Joseph M. Hughes, Arizona director of Mountain Bell Telephone Company, will then tell us from his own experience whether his residency in occupational medicine has prepared him properly for the position he now fills.

THE FUTURE OCCUPATIONAL PHYSICIAN-- WHAT SHOULD HIS TRAINING BE?

Paul Johnson, MD

What is an occupational physician; who is this person and what should he be?

I have talked to many persons: physicians in corporations and private practice; persons in management, labor, insurance, government; and academicians. I can only say that the preconceived role of an occupational physician is extremely broad. I believe he is a very diverse individual, including one who is delivering a high degree of primary care in an occupational setting or one who is largely an administrator, or one who may be a technical expert in a very specific area of knowledge. All the viewpoints given me implied that an occupational physician is someone who understands and has compassion for people, who understands the processes of both health and disease. From these rather fundamental characteristics, comes the major tenet of our program: He should first of all be well-trained in primary patient care. Because I come from the field of internal medicine, I feel that this is where the bulwark training should come for primary patient care. The unique knowledge and skills of occupational medicine are, in many respects, areas of preventive medicine—not core knowledge—that allow us to deal with individuals as we look at them in groups.

Our program at the University of Minnesota is devised as a minimum 4-year program; the first two years will cover primary patient care--i.e., traditional in-patient experience, largely in internal medicine but also neurology, psychiatry, and a 6-month block of ambulatory care and clinic experience.

In the outpatient setting, there will be emergency room experience much like all of you have had in the past. We also will utilize the University of Minnesota School of Public Health (which will lead to the MPH degree or its equivalent) for the standard courses in epidemiology, biometry, environmental health, and toxicology.

We also feel committed to the fact that the new occupational physician may be someone who is going to get increasingly into preventive medicine. We are strongly encouraging courses in such things as health education, alcoholism, drug dependency, nutrition, and cardiovascular-rehab and risk-factor reduction. Finally, there will be a supervised clinical year in occupational medicine; this will have many facets, with rotations through a variety of industrial settings within the twin-city metropolitan area as well as the Minnesota mining and agriculture regions. It will also include rotations through some of the medical specialties that have the highest rate of applicability to occupational medicine. For example, a person may spend time in pulmonary disease, with emphasis on pulmonary function testing, laboratory, and out-patient experience. In cardiology the emphasis will be on stress testing, risk factor reduction, hypertension clinics, and the like. We anticipate rotations through governmental health agencies and through a variety of occupational electives (e.g., audiology, psychiatry, alcoholism, and chemical dependency wards).

I think our program will be flexible; we expect that people may enter at various levels of training and have various career goals already worked out, thus modifying this general program which I've outlined. We anticipate that a person who completes the program will be board-eligible in both internal and occupational medicine.

THE FUTURE OCCUPATIONAL PHYSICIAN-- WHAT SHOULD HIS TRAINING BE?

Mario Battigelli, MD

Some 80% of the employees in the United States work in independent clusters of 20 persons or less and they are without the services of occupational physicians. We thus face a dichotomy, where the health of the American worker requires either of two possible solutions: The occupational physician who covers the 20% must stretch his efforts over the remaining 80%--this has a limited chance of working--or something must be done for the physician who provides the bulk of medical services (i.e., the general practitioner or family physician, or the physician in any specialty). We need doctors, not for industry or the academic environment; we need doctors to preserve and protect the health of the American worker.

A prestigious foundation has lamented recently that general education today is a disaster; medical education is no exception! Curriculum reforms in medicine have been initiated in the last 15 years in the United States as well as abroad. Postgraduate training in medicine has followed this trend but not without sluggishness and uncertainty. Not only do contemporary medical students receive little or no instruction in the biology of work, but postgraduate education of the physician minimizes the biological importance and risks connected with work. Programs in occupational medicine are few, often undersubscribed, and generally limited in their goals. Two areas deserve our most immediate attention: education of the medical student and education of medical graduate for contemporary practice in the complex of continuing education activities.

We recognize that the wealth of a nation is based on its physical resources or capital, but it also depends on the skill, dexterity, judgement, and health of its labor. Any factor that impinges on that physical, functional, and psychological endowment has medical significance. The demands can hardly be satisfied by a handful of physicians trained almost exclusively for the bureaucratic and administrative task of contemporary society. Yet the bulk of specific medical services for workers is provided by practicing physicians who are graduates of schools that do not incorporate courses in occupational medicine--practicing physicians who are unfamiliar with the real etiology of the disease or injury. Admittedly, major industrial casualties caused by trauma, familiar toxic substances, burns, and respiratory injuries are obvious and self-evident, and do not demand or require a special knowledge for management--apart from common medical judgement. But these cases are the tip of the iceberg. Those accidents and injuries for which a work etiology may be inconspicuous, yet relevant, require an alert and properly trained observer. Modern technology and its thousands of synthetic chemicals create constantly evolving hazards which the inexperienced, practicing physician may face with perplexity or downright ignorance.

The physician occupies an important and unique niche in medical research. Through his accepted social responsibility, he has the legal authority to study in the hospital wards and in defined population groups, the cruel but never meaningless experiments of nature

that constitute disease. Until medicine forfeits this responsibility, it will be our task as doctors to identify, care, prevent, and monitor side-effects associated directly or indirectly with work conditions.

Medical school curricula must incorporate a more rigorous program related to environmental effects, ideally at an early stage of the academic structure in order to give the young student an adequate awareness, interest, and orientation. The limited number of professional graduates in occupational health are clearly insufficient; their numbers will continue to be inadequate in the immediate years. Training in the occupational program emphasizes perhaps too strongly the bureaucratic and medico-legal aspects of the profession at the expense of diagnostic differentiations in the management of difficult cases. This limitation appears to deepen the chasm between the usual patient handling skills and the specialized professional profile of an occupational physician. These programs generate professionals who are best suited to serve large industrial management rather than the general public. Indeed, our graduates are largely hired by major industrial concerns or governmental agencies, while the independent practice of occupational medicine is indeed quite limited. This is not to belittle the importance of the task and the role of corporate medical officers, but it merely indicates the deficiencies for which we have been responsible in the past. In a world that is polarized between management and labor, medical issues are used as ammunition, for example, when the comparison of disease incidence rates and statistics are of a controversial nature.

Perhaps there is a real opportunity in the newly created ERCs--the opportunity for a redefinition and understanding of occupational medicine as an intimate and functional part of the practice of medicine. Perhaps the imagination and interest of today's medical graduates will be captured. If so, any investment by NIOSH in these programs will be repaid manyfold. To accommodate this approach, we need not destroy anything, only add or expand. The past history of the profession is distinguished, but past accomplishments are not enough. Diversity, flexibility, and imagination are necessary to reach the goal before us--making health programs available to all American workers to the full extent of our medical resources. Make no mistake, occupational medicine is a central, vital, and critical part of contemporary medicine.

THE FUTURE OCCUPATIONAL PHYSICIAN-- WHAT SHOULD HIS TRAINING BE?

David A. Fraser, ScD

Listening to Dr. Ryan describe the diversity of his practice reminds me of my own experience of about 20 years ago. At that time I had to decide on a training program for industrial hygiene. It was during this period that the AEC was supporting only those schools that followed their curricula standards. They had, in fact, taken a page from the catalog at Harvard University for their requirements. In essence, they were saying that our programs had to be the same as Harvard's. That we should emulate Harvard seemed an impossibility and also quite undesirable. We elected instead to reject the AEC's support in order to establish a more diversified program that would enlist a greater variety of students--chemists, biologists, etc. As it turned out, this was a very useful judgement in terms of the field as a whole. Our industrial hygienists today are making multidisciplinary decisions.

The same can be said of occupational medicine. It is difficult and impossible to predict far into the future what kinds of people will be required in this field. For one thing, we were not aware ten years ago of the types of governmental regulations that would be in force today.

Can we meet future demands for trained personnel by the classical methods? If we can't, there will be more regulations, laws, etc. More of the efforts of physicians will be syphoned off to meet the demand of the regulators. We as a society cannot afford this. Through the ERC's, we at Chapel Hill are going the classical route of residencies, in addition to providing a wide variety of exposures at different levels. We are offering to physicians a program leading to the MS degree if that fits their needs in the field. Beyond that, we hope to offer short-term training for those already in the field who cannot spare the time from their practice for full-time course work.

THE FUTURE OCCUPATIONAL PHYSICIAN-- WHAT SHOULD HIS TRAINING BE?

Edward A. Emmet, MD

I want to talk briefly about two programs, those of the University of Cincinnati and Johns Hopkins University. The University of Cincinnati has a very old program, training residents since 1952--having turned out about 120 graduates in occupational medicine. About 40% of these graduates have gone to industry, 40% to government, and 20% to academia. Most of them recently have taken the MS, but others have taken the PhD and DSc. Cincinnati is not affiliated with a school of public health, rather the medical school; the program has survived over the years, probably because of this fact. They have three programs: the first is a straight residency in occupational medicine with entry after at least one clinical year. Lasting a total of three years, the first two years are blended between course work and clinical experience. The courses are very important because they are not otherwise taught in medical school; e.g., industrial hygiene, epidemiology, and toxicology. We have clinics with the faculty as well as our own occupational health clinics--viz., specialty clinics in occupational dermatology and lung disease--and often become involved in field studies with industries that have medical problems in these areas. Residents rotate through the local industries and in the personal health clinic of the hospital. All of them are involved in field studies--often these are NIOSH hazard evaluation studies. The students write a thesis for the degree, usually around one of the field problems.

We also have training for what is called the occupational sub-specialist (Johns Hopkins has this feature too); one that is best developed is in occupational dermatology. Persons entering this program have trained full-time in dermatology and are board-eligible. Another year is spent in occupational medicine as described above. When finished, they should be experts in all phases. Our experience thus far has been very good.

The third program at UC is the "mini-residency." This is not designed for board certification, though some may use it for such. It was designed as an entry level program in occupational medicine where students learn the rudiments of the other disciplines beyond the usual medicine that they already know.

I think that occupational medicine is a sizeable specialty, which is not usually recognized--larger than some of the smaller medical and surgical specialties, and with a larger body of knowledge than, for example, ENT, dermatology, or others. The mini-resident spends four weeks in our department taking intensive coursework in pulmonary function, occupational health clinics, epidemiology, biostatistics, etc. He is then assigned a faculty advisor and works on a problem that is related to his own industry. He returns to the University twice a year for 2-3 days at a time over the next two years to report on the project. Each visit provides particular emphasis and more intensive training in topics such as epidemiology, clinical skills, etc. This program is now accommodating about 20-30 residents per year and is booked up over a year in advance.

In contrast to UC, the Johns Hopkins residency is new and established under the ERC. The first academic year consists of coursework in the basic disciplines (i.e., industrial hygiene, epidemiology, toxicology, etc.). Students are involved in projects with OSHA, and we're developing a clinic in which students will rotate; they will look at the needs of small industries, gaining useful experience and fulfilling a vital service to small industry. The second year is a clinical rotation in Johns Hopkins; this is flexible according to one's needs. We emphasize dermatology, pulmonary disease, rehabilitation, and emergency work. We also work at Baltimore City Hospital where there are many cases of occupational illness. The third year, also flexibly arranged, takes place in government, industry, military, or in our own ERC's safety and health department.

THE FUTURE OCCUPATIONAL PHYSICIAN-- WHAT SHOULD HIS TRAINING BE?

William N. Rom, MD, MPH

The University of Utah program is in its infancy, having been just recently funded by NIOSH. We and the Utah State University developed a center concept, termed the Rocky Mountain Center for Occupational and Environmental Health, as a prerequisite to a NIOSH application for the ERC grant. The University of Utah has the occupational medicine training (the residency, undergraduate program, etc.), while Utah State has the baccalaureate training in safety and health, industrial hygiene, and safety engineering. The University of Utah also conducts the graduate programs in industrial hygiene and safety and occupational health nursing.

The occupational medicine program differs from those elsewhere because it has taken the positive aspects of a number of others (esp., Harvard University and Mt. Sinai Hospital) but with balance. These aspects are didactic, research, clinical, and practical training. The first year of the two-year program is basically devoted to the didactic phase. The MS in Community Medicine from the Department of Family and Community Medicine (in place of a school of public health) is equivalent to the MPH and consists of four tracks: occupational and environmental health, biostatistics and epidemiology, health care delivery, and behavioral science. Residents are required to take a course in program evaluation (which instructs them in how to write a research grant); a part of the course requirement is that they write a grant application to fund their own research projects.

Two new courses in occupational health are occupational lung diseases and advanced studies in occupational medicine. Residents additionally take coursework in biochemical toxicology and a seminar course within our business school that deals with management methods. They are also encouraged to take an air pollution course and two, yet undeveloped, courses in industrial mining safety and fundamentals in industrial hygiene.

Research is epidemiologic in nature--similar to Mt. Sinai--the methodology is more circumspect.

The clinical component has several stages. We require four months of pulmonary, split between clinical and laboratory studies. Clinical training is encouraged as an aid in the differential diagnosis of pulmonary diseases. There will also be clinics in dermatology and occupational medicine.

The fourth aspect of this training is the practical side, encouraging a "hands-on" approach through a preceptorship. About two months will be spent, hopefully, between industry and labor unions. Health hazard evaluations will be conducted. We are in a unique position since the OSHA analytical laboratories are in Salt Lake City; herein are located the OSHA "health response teams" (these persons are used to investigate problems that are beyond the skills of the local OSHA inspector and/or require

advanced analytical techniques). We are to provide the medical back-up for these teams. There are also several combined programs involving occupational medicine and other allied specialties. For example, students directly out of medical school may enter a three year program that offers a family practice internship followed by two years in occupational medicine.

THE FUTURE OCCUPATIONAL PHYSICIAN--
WHAT SHOULD HIS TRAINING BE?

John T. Wilson, MD, ScD

Instead of going about this logically--through the Delphi approach or whatever--I have looked over my own experiences and those of some of my colleagues. We at the University of Washington believe that you should start with a good physician and then subject him to the various offerings in our school; we try to "do him no harm." There should also be a preventive emphasis in the program--including elements that have been discussed previously in the forum--with a base of epidemiology. Two major components should include organization and management (i.e., practical applications from operating systems); and finally, clinical practice. We have several different clinical options, including occupational medicine. Each resident works out a learning contract in consort with the faculty, which contract expresses the objective that he (and we) expect to achieve during the training period.

I wonder whether or not we are going to be developing persons who are adequately trained for the future. This is very hard to predict; however, if we don't do the student too much harm and don't stifle his intellectual curiosity, we shall have succeeded.

THE FUTURE OCCUPATIONAL PHYSICIAN; WHAT SHOULD HIS TRAINING BE?

Joseph M. Hughes, MD

My role is a bit different from the other forum members, because I'm going to present a few thoughts on what my residency did for me. My remarks assume a good clinical background; I say that because I think the occupational physician should be comfortable with knee injuries, back injuries, simple lacerations, and minor trauma. Our training, like everywhere else, involved the foundation subjects: environmental physiology, industrial hygiene, epidemiology, biostatistics, toxicology, and occupational diseases.

I feel that the major impact on my residency was the administrative aspect of occupational medicine. The basics of my present position were formed by my background in occupational health administration and the relationship of the medical department to management. Our class was tutored in the formal structure of a company, the position of the medical department in the hierarchy, and the pitfalls of reporting through different layers of management. We also came to understand that there is also an informal organization; this is how things frequently get accomplished in a company. Any astute physician can pick these things up when he joins a corporation, but then he observes them in a fragmented manner, and it may take time to see the total picture.

The director of my occupational medicine residence at UCLA was Dr. Jean Felton. As many of you know, one of his avocations is writing. Thus, a major thrust of our training was to develop capability in written communication. We had to write many small critiques on individuals who visited our class and on industries that we toured. Term papers were assigned to cultivate and improve these abilities. At the time, I was 30 years old, a medical school graduate, a good student of the languages, and I thought I understood the basics of grammar. But Dr. Felton and his little red pen were demoralizing! There were those days when I felt I had an iatrogenic pheochromocytoma after some of my papers were returned. In the end, I became adept at the art of written communications.

Physicians who have administrative responsibility should be able to communicate clearly—usually in layman's language—to other levels of management. Our communications also may represent our company to outside organizations.

To return to Dr. Douglass' question of me: Did my residency suitably prepare me for my present position? Today, I feel that the principles of occupational health administration and the skills of written communication were the two most significant benefits of my residency and they're utilized on a daily basis.

THE FUTURE OCCUPATIONAL PHYSICIAN-- WHAT SHOULD HIS TRAINING BE?

Loren L. Hatch, DO, PhD

As a NIOSH consultant in occupational medicine, I travel all over the US talking to federal and state agencies, large corporations, and others; I am pleased with what has been said here. There is a definite need for residency training programs in occupational medicine. As an occupational medicine educator, I appreciate this opportunity to offer my personal philosophy of what can be done.

When NIOSH became operational in 1971, it predicted that by 1980, 40,000 occupational health physicians, 20,000 industrial hygienists, and 80,000 nurses would be needed. If all eleven ERC's could each turn out 10 residents per year, in 14 years we'd have about 1,500 occupational physicians; at that rate, about 350 years would be required to reach our goal (at the moment we are only 39,000 short). So you can see why I am a little nervous. There is no question that we need occupational residencies, but this is not the answer for the future occupational physician. I can't picture anybody who is willing to give up his home, family, and job in order to go off to medical school for 3-6 years in order to become qualified by the American Board of Preventive Medicine as an occupational physician. The solution is the university "outreach" program. Every school teacher, for example, has an opportunity to obtain academic credits leading to a higher degree while working--attending the university one or two nights a week, on Saturday, a month at a time, or maybe two weeks in the summer. The same goes on in the field of agriculture. Farmers come in during the winter and go on to get their masters degree. Why isn't a similar program offered to physicians who want to study occupational medicine? The outreach programs in American universities today are well-established; however, access has been denied to physicians. My challenge to the universities is: develop outreach programs with academic credit in occupational medicine, law, business administration, and many other disciplines.

After this meeting, I suggest that you all write a paper about your experiences and work, and submit it to the New England Journal of Medicine, to JAMA, and to the family practice journals; i.e., to those publications that are read by the persons to whom you wish to give your message--not the occupational medicine journals. Secondly, tell all your colleagues to write to Earl Carter, Past-President of the American Board of Preventive Medicine. Tell him to declare a moratorium on residency graduates becoming board eligible in occupational medicine. I'm not saying that the moratorium last forever--say until 1990--nor that the Board lower its requirements. Academic credit must be given to physicians for their life experiences in dealing with the clinical aspects of occupational medicine. That's the only way they will be eligible to sit for the Board by 1990. That's not too much to ask, and I think that if there were a ground swell for this type of temporary abatement program, it would be highly successful. Also, write your state and national boards of licensure with the same thoughts.

There are at present, I believe, three questions on the national boards related to occupational medicine; all three questions deal with clinical medicine having an

occupational etiology. There is no way that medical schools are going to start introducing occupational medicine; there is not enough time in their academic schedules. The only way you are going to get it in the curriculum is when the graduates start failing their state and national boards. I guarantee you, the schools will then start teaching the subjects that need to be taught.

Here are my suggestions for what is needed in the way of course work: basic theories and methods of administration; program planning and evaluation; organizational management; personnel management; manpower management and utilization; fiscal management; principles of laws and regulations, especially federal and state regulations; health care; economics; behavioral science; and health education. The list continues with clinical preventive medicine, maternal and child health care, mental health, oral health; gerontology, rehabilitation, nutrition, addiction, alcohol and drug abuse, adult health, population dynamics, genetics, immunology, and occupational health; also, food, water, air, housing, industrial hygiene, occupational toxicology, waste disposal, insect and rodent control, and radiation.

These are only the basics, yet the 3,500-4,000 physicians in the field who are "practicing" occupational medicine know much of this material already, and they should be given academic credit for what they know. If you don't get the practical education through your residency programs or through life experience, where are you going to get it? You can have a great variety of residency programs, but there are certain things that you have to know if you are ever going to rise to the exalted position of certified occupational physician.

MEDICAL STUDENT OCCUPATIONAL HEALTH PROJECTS

New Relationships Between Labor and Medicine

Pyser Edelsack and
Ernest Drucker, PhD

Work is one of the major causes of disease and disability in our society. Recent studies by the National Institute for Occupational Safety and Health (NIOSH) show that one out of four workers in the United States is exposed to a toxic or carcinogenic substance on the job. Over 20 million workers daily handle substances known to increase their likelihood of developing not only cancer, but heart disease, pulmonary disease, hypertension, and a long list of metabolic disorders. NIOSH studies estimate that 390,000 cases of occupationally-induced disease and approximately 100,000 occupationally-related deaths occur each year in this country, and these are minimum estimates. It is, therefore, truly astonishing that the overwhelming majority of physicians who assume responsibility for the routine care of working patients know virtually nothing about the origins of the most common occupational diseases and even less about the conditions of the workplace. In practice, physicians usually fail to appreciate specific and often remediable relationships between a patient's work and his or her illness until it is too late.

The basis of this serious shortcoming in the practice of medicine in the United States lies, however, not with the individual practitioners. They were, after all, never taught about the relationship between work and illness nor provided with the clinical skills to effectively intervene in an illness that may be occupationally-related. This knowledge and these skills are not routinely expected of students in medical school, of residents in hospital training, nor of physicians in their postgraduate education and practice. Medical schools traditionally have provided little room in their curricula or in their clinical supervision for formal instructional programs in occupational health. During the years in which the young physician's conception of medical practice is being formed in the medical school and in hospital training, he gets virtually no information about occupational illness and sees no role models of effective clinical conduct in occupational medicine. The work reported in this session is an attempt to demonstrate the feasibility and effectiveness of some new models of medical education in occupational health based on an active collaboration between medicine and labor.

The deficiencies in occupational health educational programs can be divided into two basic components: specialty training and general training for all physicians. There is an estimated shortage of 5,500 physicians who are specially trained and certified in occupational medicine. Yet at the present time, many of the residency slots in occupational medicine go unfilled because undergraduate medical students are not aware of the profession and its potential, and because the residencies do not provide adequate stipends. Recent funding for occupational safety and health training centers by NIOSH may help to correct this problem, but this effort will still not meet the major and more critical need in the field; i.e., the education of physicians practicing in communities where people live and work.

The reason that this need must take precedence is obvious. The structure of medical care in this country dictates that most workers who develop an illness or disability will not first seek diagnosis or treatment at a specialty center in occupational medicine. Instead, they will go to the offices and clinics of physicians in their local communities. These primary care physicians then must be given the first priority for training in the prevention, detection, diagnosis, and effective treatment of occupationally-induced diseases.

There is a growing consensus about which elements of occupational medicine should be included in the training for all physicians. These include: early detection and diagnosis of the common occupational diseases; preparation of the in-depth work history; new screening, technology and examination procedures; how to utilize reference materials and regional specialty centers in occupational health; fundamentals of epidemiology; awareness of governmental agencies that are concerned with occupational health and safety (e.g., OSHA, NIOSH, and workers' compensation boards).

Much of this material can be absorbed into existing medical school and residency curricula. For example, early screening and detection of occupationally-induced diseases can be incorporated into physical diagnosis instruction; whereas, mortality and morbidity patterns among particular groups of workers can be taught in community medicine and epidemiology courses. Instruction in how to take a coherent social history should be part of the training to every clinician; with only minimum modification, the lessons can easily accommodate the work history. Some students have enthusiasm for seminars on legal, ethical, and political aspects of occupational health in medicine; hence, these courses should be incorporated into the elective structure of medical school curricula now.

But while much can be done within the existing curricula of most medical schools, there are a number of requirements that the medical school and its clinical teaching model cannot fill. We refer here to the physicians' need to understand work processes and the structure and dynamics of the workplace. This knowledge is crucial and directly related to his ability to understand and treat the individual worker. Just as a physician must understand a local housing situation and the economic resources of his 50-year-old cardiac patient who climbs four flights of stairs daily in his low-rent apartment, so must the physician understand the pathogenic world of the workplace and the avenues for disease intervention in order to treat an occupationally-related health problem.

That same cardiac patient may be at far more risk from carbon monoxide inhalation on the warehouse loading dock where he works than from climbing the four flights of stairs where he lives. Yet it is commonplace for the treating physician--even one who knows his patient well--not to appreciate this work exposure because he has never been to a warehouse. Abstractly, the physician might be aware of the damaging effect of carbon monoxide exposure on cardiac patients, but he may never think to associate his patient's workplace for such an exposure. Awareness of this relationship between work and illness can best come from exposure of physicians to real workplaces. As the individual patient is the best teacher for the individual clinician, so the workplace is the best teacher for occupational medicine. However, a factory cannot be brought into "rounds"--a visit to the plant is necessary. Thus, education in occupational health must get the student to the workplace. Our experience in operating a field-based program in occupational health at our medical school indicates that medical students can, with only minimal preparation, discern the major parameters of hazardous work and appreciate the conditions that produce these hazards.

Still more is needed if physicians are to prevent and treat occupationally-related illnesses. Physicians must understand working people and their lives, not because this will improve their bedside manner or their rapport with patients of a different social class, but because this is the only avenue that will enable them to appreciate the specific problems that impede effective treatment of occupational illnesses. To illustrate this point, let us refer again to the cardiac patient whose job exposes him to carbon monoxide and increases his risk for another cardiac event. Having understood the association and the exposure, what can the individual practitioner do? Advice to change jobs is easy to offer, but it may be difficult or impossible for the worker-patient to follow. The physician must be aware of seniority, rates of pay, and job availability in the particular workplace and community. These are the factors that determine the patient's ability to comply with the treatment plan, and they are factors with which most professionals lack experience or first-hand knowledge. Yet they are crucial to the treatment and specific for each patient. How may the physician learn about these elements of effective treatment?

This is where labor unions come in. Labor unions provide the opportunity for medicine to learn about the world of work and to develop the means of intervention in many cases of occupational illness. For over 150 years, American labor unions have provided the leverage for workers to assert their rights. Labor unions have traditionally demonstrated interest in the quality of life and the working conditions of their membership, and they have a long history of being willing to fight for changes that will benefit the well-being of their workers. Recently, several unions have begun to expand their domains so as to include the health rights of workers. The Oil, Chemical, and Atomic Workers' International Union (OCAWU)--one such union with a strong commitment to health and safety--has also demonstrated a strong commitment to the training of health professionals. In collaboration with the Department of Social Medicine of Montefiore Hospital and Medical Center and the Albert Einstein College of Medicine, the OCAWU has developed a medical internship program that meets the educational objectives not otherwise met in the traditional curriculum of a medical school; i.e., there is direct access of medical students to workers and the workplace. The relationship between medical schools and labor unions is one of mutual benefit. The union is interested in the training of health professionals and technical assistance on specific health and safety issues in workplaces around the country. As medical educators, we want to provide our students with a first-hand exposure to the workplace so they can gain special skills related to occupational health. In addition, this collaboration allows students to learn about elements of work and the workplace--i.e., the real problems and issues of collective bargaining, the relation between the risk levels of the workplace, profit patterns of industry, and the broader economic and social factors that directly relate to the individual worker-patient's ability to ameliorate a pathogenic work situation--beyond the narrow, technical conceptions of occupational health.

During this first project with the OCAWU, four students took a summer elective between their first and second years of medical school. We had been asked by the OCAWU to follow-up on a complaint in a local pharmaceutical factory in northern New Jersey, an area popularly known as the cancer-belt. The complaint was of high liver-enzyme levels among 22 workers in a plant force of 900. In order to investigate this problem effectively, the students first had to gain a working knowledge of the local union, of the work process, of how this union resolved health and safety problems in the past, and what educational programs it conducted in health and safety for its membership. The students conducted in-depth work histories on each of the 22 workers with abnormal liver function. These histories, taken at the union hall across the road

from the main plant entrance, included a complete description of the work process of each worker and the nature of his exposures, both past and present. In addition, a complete health history and medical history of each worker was taken. From the workers' descriptions of production processes and through library research, the students were able to gain a comprehensive picture of what was being produced in the plant and of how the workers were being exposed. Finally, students did specific literature research on chemicals in the plant that were known to be seriously toxic.

The students found that the liver-enzyme problem could not be isolated or related to one particular substance. In addition, they discovered that none of the 22 workers knew what their abnormal liver tests signified; thus, a need for worker education became evident. In bringing the project to a close, the students conducted an educational program for the workers by explaining the liver tests and the possible health implications. They prepared an educational leaflet for all workers and prepared an extensive report to the union, summarizing all of their findings and recommending that a study of the entire plant and its workers be conducted to determine specific health hazards. This recommendation was accepted by the Local and by the International; Dr. Irving Selikoff of Mt. Sinai has been engaged to conduct the study. One of the most important things realized by the students was the limitations to their medical education. This project stimulated these students to attempt to enlarge the occupational health curriculum back at the medical school and to gain further training in this field.

This one experience together with others in this session will point out the enormous opportunities that are available for teaching medical professionals when they work closely with labor unions in the workplace. It is clear that a whole set of professional learning objectives in occupational health are unachievable without a close working relationship with labor. This unique access to workers and workplaces can give medical students an understanding of the working conditions and real life circumstances of workers who could become future patients.

MEDICAL STUDENT OCCUPATIONAL HEALTH PROJECTS

Undergraduate Training in Occupational Health

Gary R. Fujimoto, Carol A. Eckert, and Robert J. Harrison

In 1915, in a paper entitled "Medical Supervision of Industry," a medical student wrote:

"We know the importance of occupational disease; we know the direct and indirect causes and all its great variety of clinical and social manifestations. We also know the ineffectuality of the present system of regulation. The future holds its secrets, but real control of industrial disease through medical supervision must come, for it is one of the answers to society's growing need for a better, more efficient, and more humane method of doing the world's work. Economic necessity as well as our dawning social consciousness makes its future certain."

This student's essay won first prize in a contest sponsored by the American Association of Industrial Physicians and Surgeons, the first professional association of industrial physicians. Unfortunately, neither economic necessity nor our social consciousness has done enough to ensure the health of our working population. Our present system of education does not even ensure that physicians are aware that the health of our working population is important. We would like to describe in general terms our own experience with a summer project in industrial medicine.

In the spring of 1976, several medical students from Albert Einstein College of Medicine arranged to conduct a summer project with a 900 member local of the Oil, Chemical, and Atomic Workers International Union at the Merck pharmaceutical plant in Rahway, New Jersey. The members of the local already suspected that some of the materials they handled were hazardous to human health, and some suspected they had become sick from their work.

As we discussed health concerns with union members, we quickly became aware that our medical skills and access to technical and educational resources could provide a vital service. At the same time, we came to understand that this was a profound learning experience upon which our basic sciences and clinical training would be built.

We interviewed the local union members about the work process, known chemicals, and particularly hazardous conditions in the plant. Working out of the union hall, we had the cooperation of the shop stewards, who helped to identify problem areas and to arrange for interviews with individual workers. We designed and administered a medical questionnaire to assess the prevalence of occupational injuries or diseases, and discussed our findings with the company medical director. Many questions were asked by union members regarding chemicals with suspected hepatotoxicity; these were answered with pamphlets and information sessions at the local union hall. When we encountered difficult problems, we called on the resource people within the New York medical community. We also acted as advocates in several cases where individuals

were dissatisfied with some aspects of their medical treatment.

After eight weeks of investigation, there were several accomplishments. First, we felt a multitude of occupational diseases and hazards existed in the plant; often their causes appeared to be multifactorial. The workers were aware of some of the potential hazards, but they needed more information to be able to recognize other dangerous exposures and clinical manifestations. Training in the utilization of existing laws was needed to correct undue hazards. Although plant health and private physicians were already involved in worker medical care, worker education appeared to be the key towards furthering compensatory and preventive measures. Our findings were issued in a nationwide report of the Oil, Chemical, and Atomic Workers International Union, including our recommendation for a follow-up by the Mount Sinai Environmental Health Sciences Laboratory.

Second, we developed a role for medical students; to provide technical services, act as liaisons, and work as advocates for workers in the medical system. The combination of our enthusiasm and skills with specific union needs and organizing capabilities planted a new awareness of occupational health and safety in the minds of many workers.

Third, we added significantly to our medical training. We acquired the ability to direct our questioning towards specific problems encountered with various types of jobs, and learned the basic skills required to take occupational histories. We learned the rudiments of epidemiology and the importance of a scientific study to associate cause and effect between exposure and disease. We were introduced to a field that is desperately in need of qualified health professionals; for two of us this experience has been critical in our recent decisions to pursue careers in occupational medicine.

After this summer experience, our awareness has been heightened to the fact that there was no organized occupational health curriculum in our medical school. We have worked with the Community Medicine faculty to design a reading and discussion elective in occupational health for subsequent first-year classes. Summer-held projects for other students have been arranged in following years through the Department of Community Medicine. Accumulated experience with these projects is now beginning to facilitate more rapid recruitment and orientation of students, and it has increased interest among unions to participate in those projects.

The lack of preclinical education in occupational health is matched only by a total neglect of the subject in our clinical years. To enhance our own knowledge and inform a wider medical community, we organized a seminar in a clinical-pathological format which focused on the socioeconomic factors and preventive measures of coal miners' pneumoconioses. We have also arranged a clinical elective at the occupational medicine clinic at the Mount Sinai Hospital in New York to teach occupational history-taking. Recently, we participated in a study conducted among residents in Michigan exposed to polybrominated biphenyls.

We have had to go beyond the traditional medical curriculum to acquire the basic knowledge needed by all physicians who treat a working population. From our contact with other students at different institutions, this is a common failing in medical education. When these issues are addressed, medical education seems to recognize and teach the well-defined pathological entities, such as silicosis or lead poisoning. Beyond this, the physician-in-training needs to be taught how to analyze causal relationships between substance exposure and human illness. It is not enough just to consider, diagnose, and treat an occupational disease. Our technologically complex society

demands that physicians also have an awareness of preventive medical screening, corrective legislation, workers' compensation and workplace monitoring.

We feel it should be the responsibility and task of a department of social, community, or environmental medicine to define curriculum areas in occupational health within the existing basic sciences and clinical curricula. Topics in occupational medicine can be integrated with the existing courses of general pathology, dermatology, neurology, gastrointestinal, pulmonary, cardiovascular, pathophysiology, etc., and these topics should be discussed from the viewpoint of the social as well as the scientific and clinical aspects. Students must learn to take occupational histories as a routine part of their course in physical diagnosis. This should be continued on the medical wards with the participation of the housestaff. Site-visits to a factory should be a required experience for all students. More extensive field-work experience should be offered and encouraged for those students who are interested. Moreover, we feel that active financial support for such educational programs should be established from both public and private sources.

In summary, our experience has convinced us that the current commitment in our medical schools to occupational health is grossly inadequate. The dialogue between the scientific and medical community and the worker on the factory floor will remain meager unless our health professionals are trained to identify and educate their patients about occupational and environmental problems. The workplace is an exciting challenge for future physicians who can learn from and provide service to the worker in need. It should be the goal of medical schools to train physicians to prevent as well as to treat, and to be aware of the issues of public health as well as individual patient care.

MEDICAL STUDENT OCCUPATIONAL HEALTH PROJECTS

Occupational Health in a Nitroglycerin Plant

Scott Shannon

I did a literature search first to find out what I could on nitroglycerin; it wasn't as much as most of you know about it, but it gave me a lot of insights into the medical problems. I then went to a small town in southeastern Arizona and started interviewing some ex-workers, workers who had retired or had been fired. They were, on the whole, happy to talk with me and they told me of their problems--their headaches. One said he had been to Tucson and the doctor couldn't get a blood pressure on him. The doctor told him he should be dead. He ended up quitting the job; he said that he probably wouldn't be alive today if he had continued working there. And a lot of other people had problems (such as burns, etc.) that weren't directly connected with nitroglycerin; they seemed to think that working at this powder plant was not the best thing that had happened to them. Some people wouldn't talk even though they indicated that they knew there were problems; they felt a lot of intimidation from the management. I couldn't relate to this too well, but you have to remember: These people were in a very small town; they either work at that plant or not at all. This is the main employment in the town; if you're not otherwise skilled, it's the only employment. One of the former chemical laboratory analysts told me that there had not been a test for nitroglycerin levels in the plant air over the past two years. The company had all the necessary equipment, but they never got around to doing the tests. The analyst had talked to the safety engineer about some suggested changes in the ventilation system to remove airborne particles of nitroglycerin and nitroglycol; it was soon after this that he was fired. It was not uncommon to find that people who had questioned the plant environment's unhealthful conditions soon found themselves unemployed.

After I got a group of data on these workers and their problems, I began to see a pattern that fit in with the literature. When I went back to confer with Dr. Abrams, he said, "I think you're going to have to get access to their records in order to get a more reasonable and valid data base." He wrote a very tactful letter to the president of the company asking for access to some of their records, saying that I was an ignorant, incoming medical student and probably couldn't do them any harm. As soon as the president got that letter, he sent one back saying, "I'm sorry, but it is not our policy to release records because of the hazards in the plant; someone like the medical student wandering around would create a lot of liabilities that we don't like to have."

In the meantime, before I learned of the reply that Dr. Abrams received, I went to the plant and talked to the vice president while the president was out of town. He didn't know anything about this situation and, not wanting to appear stupid, set up an interview for me with the safety engineer. I tried to play as dumb as possible, just to see what sort of attitude this fellow presented; he was unaware of any papers or research that indicated any harmful effects of nitroglycerin and nitroglycol on humans. He also knew of no standards for either airborne or other exposures. He remarked that workers who had retired after 30 or 40 years were in better health than

he was. I said, "That is very nice; may I have the names of these retired workers." He said, "We don't release any records." I concluded my interview and then went to see the physician of reference, whose patients were largely the people who were sent to him from the factory. He said that he'd seen no heart disease or cardiovascular problems in any of these people. He then gave me some interesting sociological perspectives about Mexican-Americans--most of the employees are Mexican-American workers because it is very close to the border--how to tell the difference between an American-Mexican and a Mexican-American: One was a hard worker and never complained, whereas the other was always looking for the handout, always ready to tell the big lie in order to gain attention and money. In other words, the people I had talked to were giving me the big lie in order to gain attention and perhaps a monetary award. I was convinced that they were sincere, that the problem in the plant was recognized by the employees.

Although I couldn't gain any hard data without access to the workers' records; this project made me realize that one cannot gain access through the routes that were available to me or to Dr. Abrams. I couldn't gain any valid numbers for a statistical analysis, but I have had an empirical learning experience. I now realize how naive it was to think that I could go in there and gain this information. It taught me that true polarities exist in the world--labor vs management.

I really feel that the company did not consider the health of these workers to be important. In fact, it was ignored. They did bi-monthly blood pressure checks, but the literature indicates that exposed people become acclimated to the nitroglycerin; the blood pressure thus stabilizes after a while. The best evaluation is a cardiovascular test under stress to measure the elasticity of the arteries and the general condition of the cardiovascular system.

MEDICAL STUDENT OCCUPATIONAL HEALTH PROJECTS

Organizing a Clerkship in Occupational Health

Howard Frumkin

INTRODUCTION

Work on the clerkship began in the autumn of 1977, when I enlisted the cooperation of several medical school faculty members, other medical students, and interested community people in the Philadelphia area. The core group of about eight people worked throughout the academic year, developing a basic framework and course syllabus, seeking funding and faculty, and arranging academic credit and field placements. Although conceived as an educational project, the clerkship did not develop as a program of any particular school, but enjoyed the support of various individuals and programs from a number of schools.

Briefly, the clerkship was an eight-week summer program, containing an academic component that totaled about two full-time weeks and a fieldwork component of about six weeks. The academic component was built on a formal syllabus with classes and assigned reading; for the fieldwork, teams of two students designed and carried out independent projects with faculty supervision.

BASIC ASSUMPTIONS

In general, the program was conceived as a course in a particular field of community medicine. First, we assumed that this kind of course would be amenable to the same teaching methods that are standard in clinical medicine courses, especially the emphasis on practical experience. Second, we assumed that community medicine entails an understanding of the perceptions and needs of target communities in order to develop the best responses; in other words, extensive personal contact with the community members, an orientation toward solving their problems, and empathy with their world-view are the essential qualities. Third, we assumed that a course involving community fieldwork can and should be beneficial both to the students and the community.

In terms of occupational health, we noted the need for close cooperation among various groups--workers, hygienists, nurses, physicians, management, and government. Therefore, we felt it appropriate that instruction be multidisciplinary, both in the composition of the faculty and in the career goals of the students.

Our aim was to provide a valuable experience to future occupational health professionals and to other health practitioners as well. In fact, much of the program was designed with the general practitioner in mind. We attempted to convey a basic understanding of how industrial processes affect health; of the dynamics of worker attitudes toward health and disease; of major sources of information in the field; and of possible solutions, both therapeutic and preventive.

FUNDING

Inasmuch as there were to be no overhead costs, we needed funding only for printing and faculty stipends. That money was provided by the American Medical Student Association through its Preventive Medicine and Health Education Project. AMSA is interested in funding innovative, community-oriented projects in medical education, and considers applications from medical students. Other possible sources of funds were NIOSH, medical schools, medical associations, labor unions, and philanthropic foundations.

SYLLABUS

Two decisions had to be made in designing the academic component: what to teach and how to teach it.

What to Teach

A list of "minimally necessary" topics was acquired from medical students, industrial hygienists, union leaders, and medical school faculty. Included were:

- Basic principles--chemical and toxicological, physiopathological, legal and social.

- Research abilities--how to find information in the literature, how to read studies critically.

- Clinical abilities--how to take an occupational history, special skills (e.g., spirometry, audiometry, etc.).

- Survey of major health hazards and their industrial settings.

From this list, the following syllabus was developed:

Research methods--

- Major information sources and authorities
- Industrial epidemiology
- Analysis of industrial processes and their hazards

Technical background--

- Basic industrial toxicology
 - Chemistry of toxic substances
 - Modes of entry
 - Metabolism
 - Clearance
 - Site, mode, and specific toxicants
 - Immune responses and hypersensitivity
 - Genetic susceptibility

Major health hazards

- Chemical
- Radiation
- Noise
- Heat
- Stress
- Accidents

- Health effects
 - Systemic (stress)
 - Respiratory
 - Dermatologic
 - Industrial cancer
 - Others, as appropriate
- Basic principles of industrial hygiene
- Special safety and health problems of female workers
- Historical and legal background
 - The rising concern of industrial health
 - The American labor movement
 - Relevant legislation
- Clinical background
 - Eliciting the occupational health history
 - Relevant testing (spirometry, audiometry, etc.)
 - Medical reporting responsibilities
- Basics of patient education

Each topic on the syllabus was intended as part or all of a classroom lecture, demonstration, workshop, or other method.

How to Teach

Several questions arose in this phase of the program. One was whether to teach about health hazards by "industry" or by "medical" problem. Using an industry-by-industry approach was tempting because future clinicians, aware of the hazards of specific kinds of occupations, would have a headstart in diagnosis and treatment of conditions presented by their patients. However, the inherent repetition and endless enumeration inherent in this approach would be boring. On the other hand, proceeding methodically through case histories of various occupational medical problems, while avoiding repetition, would burden the syllabus with undue detail, most of which the individual student would rarely need.

The most desirable approach seemed to be a compromise. First, we tried to provide appropriate "triggers" for use in diagnosis and a source for further information. Secondly, we addressed both major medical problems and major industrial exposures in the Delaware Valley area. Field trips were taken to a variety of worksites--from a chemical factory to a confectionery plant--to complement "syndrome-oriented" lectures on dermatitis, cancer, stress, and the like.

The second question concerned the interplay of the clerkship's academic and fieldwork components. There is a certain logical appeal in having fieldwork preceded by a thorough academic treatment of the topics that are likely to be encountered in the field; however, several considerations mitigated against this procedure. With two weeks of classroom, there would have remained only six weeks in which to assess the workplace situation and to conceive and carry out a project. Clearly, this would be an inadequate apportioning of time. Further, we felt that students, during the fieldwork, should come together regularly to share problems and perceptions, and to gain encouragement. Intermittent classroom sessions would provide an ideal context for such interaction. Finally, we felt that the most effective transmission of academic content would occur if practical exposure framed and animated the classroom time. We finally settled on having the lecture, workshop, and discussion periods on Monday (occasionally Tuesday as well) with informal group lunches at midday. The remainder of each week was devoted to independent fieldwork.

FACULTY

Three standing faculty members were hired and placed on salary; two were practicing physicians from the faculties of two Philadelphia medical schools, with expertise in occupational health and related clinical techniques. Each pair of students was assigned to a standing faculty member who, in weekly meetings, monitored individual progress and offered appropriate guidance. The third standing faculty member was the senior staff member of the Philadelphia Area Project on Occupational Safety and Health (PHILAPOSH), a coalition of labor and health concerns. He offered expertise in the organizational, legal, and historical aspects of occupational safety and health. The non-medical standing faculty member, like the medical, held weekly meetings with each pair of students. The standing faculty members agreed to attend all lectures and were prepared to discuss both academic and fieldwork issues with students. Thus, the three standing faculty members, in both medical and non-medical weekly meetings provided continuity, close supervision, and a means of evaluating student performance at the course's end.

Besides the standing faculty, there were about 20 guest lecturers; speakers included medical faculty members, OSHA officials, industrial hygienists, company consultants, labor representatives, and others. Medical faculty members and OSHA officials were helpful in locating speakers on lesser known topics. Every invited speaker, when told of the clerkship's origin and goals, agreed to participate without fee. The only difficulty in recruiting lecturers was the occasional need to select between two or more well-known local authorities on the same subject; in some cases, panel presentations were arranged.

FIELD PLACEMENTS

Arranging for field placements was done largely through the cooperation of PHILAPOSH. This organization consists of about 50 sponsoring union locals in the Delaware Valley; it works with them to promote workplace health and safety. PHILAPOSH was able to identify and recruit the requisite locals that could provide favorable educational experiences and would themselves derive benefit from the efforts of students. Some union leaders took active responsibility for assisting students; their unions had health problems that the students could study rather thoroughly and begin to ameliorate, and they were at convenient locations.

A pair of students was assigned to each field placement. We decided to notify students of their field assignments about two weeks before the clerkship's inception, to permit them to do background research in the industrial processes and exposures involved. Students were to meet with members of their respective unions during the first week of the clerkship; thereafter, they were to assess the workplace and think about appropriate projects.

In the ideal field placement, students would have a relationship with both management and workers, permitting access to health records and the shop floor on the one hand, and close cooperation with the worker population on the other hand. If both were impossible, we opted for the worker contact and arranged for students to work out of the union halls.

We appealed to the Delaware Occupational Medical Association, a group of about 100 company physicians in the Pennsylvania-New Jersey-Delaware area, for assistance in arranging field placements in their plants. The lone response was an exciting offer from a large, non-unionized chemical corporation. Its medical staff invited students to

contribute to the writing of a health/safety manual for workers. Although this project involved less than optimum worker contact, it carried tremendous educational potential. It is regrettable that no other company physicians advanced an interest in working with the students.

A standard protocol was recommended for the design and execution of field projects. Students were encouraged to consult the standing faculty members and their union contacts in tailoring the protocol to individual needs. The protocol ran as follows:

- Describe the industrial process
- Name the hazards
- Research the hazards
- Describe existing health and safety measures
 - medical monitoring and records
 - air monitoring and records
 - personal protective equipment in use
 - ventilation
 - signs and labels
 - training and education program
 - other
- Suggest improvements in existing measures
- Pursue one or more of the following, as appropriate
 - conduct medical screening
 - conduct air sampling
 - conduct survey research
 - write an appropriate health/safety manual for workers
 - design and administer a training program to workers

Students were required to write final reports of their field experiences, including data, evaluations, and conclusions. A final two-day session was planned for presentation of these papers to other students, program faculty, and interested union members. In addition, appropriate reports were promised to relevant union locals and companies, community medicine departments in Philadelphia, and PHILAPOSH. Final evaluation of the students was based on the standing faculty members' knowledge of the students' performances and on the final presentation.

ACADEMIC ACCREDITATION

The issue of academic accreditation is closely related to that of student recruitment. Many medical schools permit students to receive either academic credit or a stipend (not both) for non-standard educational experience. We decided to seek accreditation for the clerkship from the Philadelphia medical schools, so that students who wanted credit could claim it. Further, we recognized the independent value of raising, for discussion in medical curriculum committees, the issues inherent in this clerkship.

Academic accreditation turned out to be the most difficult, time-consuming, and frustrating part of preparing the clerkship. We began by seeking the support of one or more faculty members in each school who were identified with occupational or community health. Then we joined the faculty member(s) in presenting a final proposal to the curriculum committee.

The first difficulty arose even before facing the committees. In several instances, the one or two faculty members who taught occupational health were narrowly and

aggressively company-oriented. They were wary of the community (i.e., labor) orientation of the clerkship and hostile toward the involvement of PHILAPOSH because of its past advocacy toward workers' health rights. They were unwilling to present the clerkship to their school's curriculum committee and often did not reconsider until other schools began accrediting the clerkship.

Where faculty members initially agreed to present the clerkship to their curriculum committees, approval generally followed lengthy discussion. A number of interesting issues was raised in these discussions. For example,

concern that student project reports would be presented to unions as professional opinions and erroneously used as such in contract negotiations. In addition to the ethical problems inherent in such misuse, legal problems could arise for the school. We agreed that a disclaimer be prominently displayed on each student report, stating that the report not be regarded as anything more than student research.

concern that the lecture materials on union programming and legislative developments were inappropriate to a medical school course. We responded that these were essential to a thorough consideration of the issues, and that a minimal amount of class time was involved. The committees generally conceded.

a desire from each curriculum committee that one faculty member at each school act as a liaison between the school and the clerkship and supervise the clerkship students from that school.

the committee at one school wanted to evaluate the clerkship using the standard questionnaire developed for its other courses. We agreed to administer the questionnaire at the end of the summer.

Strictly speaking, only one school's accreditation was necessary, since medical schools routinely permit cross-registration. In other words, any student could participate in the clerkship; he would receive credit at his own school through the school that had endorsed the clerkship. We did not attempt to seek advance accreditation for nursing, industrial hygiene, and other allied health profession programs; instead, we sought credit on behalf of individual students who desired it, expecting that its status in the medical school would facilitate success at other health science schools.

Most of the preparations were completed by early April, but transactions with curriculum committees and uncooperative faculty members prolonged the accreditation process until early May.

STUDENT RECRUITMENT

By late May, brochures were printed and distributed to the Philadelphia medical and public health community plus interested parties at about a dozen other nationwide medical and public health schools. Faculty members and AMSA chapter chairpeople were urged to recruit students personally; the clerkship was presented to an AMSA regional conference in Washington in early May. Ads were placed in several medical school newsletters. Only two applications were received by the third week in June. A substantial number of students expressed interest, but they had already made summer commitments. It was impossible to conclude whether the disappointing response was

due to late publicity or a lack of student interest. On the assumption that the former was true, the clerkship was rescheduled for 1979, with plans for an earlier publicity campaign.

PROBLEMS

As you can see, I am more qualified to speak on the development than on the administration or evaluation of an occupational health clerkship. By way of conclusion, I would like to tell you of a few problems that I encountered and which might arise in the development of similar programs.

The first is the problem of context; i.e., the setting in which occupational health is taught. Although it is possible to develop a superb clerkship--with top-notch teaching and rich field experience--still, only a small number of students will be affected. It seems important that all physicians have a rudimentary consciousness of the environment's role in disease, bearing in mind the parallel importance of environmental, occupational, and social considerations in every level of medical education, from basic sciences to grand rounds.

Compared to other medical fields, occupational health has a large and obvious, political component, which leads to faculty conflicts. Although faculty members in most basic and clinical sciences can be assumed to share the same paradigms, such is not the case in occupational health. For example, when a person becomes sick in a certain environment, one can focus on either the environment or the person. This is a subjective judgment which frames the entire course of subsequent inquiry and often one's conclusions. A number of Philadelphia faculty members believe that workers are primarily to blame for their own diseases, through ignorance, carelessness, and sloth. These faculty members were dismayed at the community orientation of the course and the involvement of groups like PHILAPOSH, and they resisted academic accreditation. Though these individuals have notable expertise, their victim-blaming approach may be incompatible with instruction in community health.

Another problem related to faculty conflict is the need to define a course orientation. Most medical instruction takes for granted the primacy of patients' health. The same commitment in developing the clerkship aroused considerable controversy. Should the views of labor and management be presented alongside each other in order to gain "objectivity," or should the role of management in occupational health be studied only to understand its pathogenicity? Either approach involves a political decision. This inherent feature of occupational health makes it something of a pariah in medical curriculum committee meetings, whose agendas are ordinarily far less contentious.

There is also the need to include political issues in the course syllabus. Yet, medical educators prevailingly feel that only pathophysiological considerations are appropriate in medical school instruction.

And finally, I want to mention credentials. Teaching staffs are traditionally filled with PhD's, DrPH's, MD's, etc; indeed, this is an unwritten requirement for many medical schools. But occupational health expertise grows with experience and often not from formal training. Shouldn't we aim at the most knowledgeable and dynamic teachers to put before the medical students instead of selecting by academic degree? As instruction in social medicine becomes more sophisticated and as community needs are increasingly emphasized, we may have to acknowledge experience in the real world as among the truest credential.

MEDICAL STUDENT OCCUPATIONAL HEALTH PROJECTS

Residency Training and Union Work

James Keogh, MD

When I was a resident at Baltimore City Hospital in 1975-76, I had the opportunity to work with the Health and Safety Department of the Oil, Chemical, and Atomic Workers International Union. Basically, I worked with the non-medical staff reviewing occupational health matters. I was involved in the worker education activities, as well providing medical input to the teaching and training of shop stewards and local union members. My situation was a little different from the other members of this panel because I had been a physician for a couple of years and was able to operate independently, without other medical advice or supervision. While not an ideal model for medical students, it did encourage the OCAWU to urge its locals to work closely with medical schools and persons like Pyser Edelsack in the task of getting medical students into field work. The project also helped me a great deal.

I am now practicing internal medicine in a Baltimore community that is largely blue-collar; we see a great deal of disease which, until recent years, we did not recognize as being occupationally related. Because of persons like Don Whorton and others, we're now able to recognize these diseases and we're also able to teach our residents about occupational health.

Listening to the previous presentations and talking with the students beforehand leads me to a couple of points that I would like to lay before you. What we have largely heard here over the last couple of days is a very different perspective about workers' health than we've talked about before. The view of the real problems of occupational health that the students have come upon may be typified by what Scott had to say about the dynamite plant. The most critical problem is the lack of knowledge by the ordinary working people about what it is they're working with and how these agents might affect them. This point is driven home to me more since I've been away from the workplace and now practicing medicine in a working-class community. A great deal of occupational disease just walks into my office and now, with a little bit of perspective, I'm able to recognize some of it. Perhaps the most critical thing that students in these field projects have learned is the great difficulty that workers have in protecting themselves from environmental hazards. One arises out of lack of knowledge of the situation; another out of the negligent or improper behavior of management, unions, and governmental agencies who should be watching out for the workers' health and safety; and finally, workers are often unwilling to do anything about unhealthful situations because of economic reasons. That workers wouldn't talk to Scott Shannon at his plant is not an uncommon reaction. Oftentimes patients in my office will talk to me about a problem, but they will resolutely refuse to pursue it themselves or allow me to ask the state or federal agencies to pursue it for them because of possible threat to their jobs. There is also the striking lack of effectiveness of primary practitioners in this field. The average primary practitioner or internist really is not playing his role of protecting his patients from occupational hazards or in treating them properly. Obviously, these

physicians are not being taught well in the medical school; another is an attitudinal problem. In other words, very few physicians have had the experience of working with their hands or of learning about occupational hazards and how they affect workers. Then too, unless your practice is located in a very small town, you will see people from 50-100 different employers; as such, it is most difficult to get a handle on occupationally related complaints or symptoms when you may only see one or two workers from a particular plant. It is much easier for a physician at the worksite (i.e., a plant physician) to recognize that a rash of headaches or some other problem may be traced to a hazardous condition in the plant. Unfortunately, in all too many situations the physician at the worksite considers his responsibility to the company, denying that there are any health problems. The plant physician who ought to be most interested is unable to acknowledge the problem because of the economic and institutional pressures, while the primary practitioner--without bias--is not able to recognize the occupational relationship.

Yesterday, a lengthy discussion of the residency curriculum called for a different kind of training for the specialists in occupational medicine; today's students have presented a slightly different perspective. One aspect is the medical student who has had the opportunity to learn about occupational health and goes into a workplace; returning to the medical school, he raises hell--the students are not being taught about occupational medicine! Perhaps some of these ex-students will get the curricula changed. They have discovered how ossified our academic community of medicine is. Many of us who have contact with large university training centers and with the people who control undergraduate and postgraduate medical education also recognize this condition. Admittedly, it is very difficult to put a new idea into this kind of setting. Again, I think the more effective way of doing so is to have a groundswell from the students themselves. They are quite capable of putting together a curriculum. I know of examples in Buffalo and a number of other places where the students have gone to the faculty, urging them to get their act together and start teaching these courses. I think the most critical aspects of teaching and designing any curriculum is not only the course material but also the attitudes that go along with it.

The best way to attract general practitioners and students who want to become specialists in occupational disease is to get them into situations where they really come into contact with the patient. It is less critical to cover all technical information and more important to have students, residents, and interns recognize occupational diseases; that they can elicit a proper history if they listen to the patient. This is not an easy thing. Most patients do not readily discuss their occupations; they are often quite surprised when a physician or health professional actually wants to hear about what they do. Much of the time when workers question a connection between work and illness, the physicians just "tune them out." I can relate about 20 such anecdotes from my own experience in Baltimore. Thus, the critical aspect of a medical student's training is to put him in contact with the workers and let him learn from the patient. I think the place to learn occupational medicine is in the worker's living room, or sitting down and talking individually with him. I fear that increasing pressures by the federal government and by the medical community may make that possibility more difficult; it may, in fact, move toward a strict curriculum for everybody in the medical school, that may sacrifice some of the real learning activities of these kinds of projects.

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