OCCUPATIONAL HEALTH AND SAFETY SYMPOSIA

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FOREWORD

A continuing goal of the National Institute for Occupational Safety and Health is to encourage effective health and safety services for working men and women.

Since the passage of the Occupational Safety and Health Act of 1970, a growing number of physicians have entered the part-time practice of occupational medicine. A major consideration of the Institute's Division of Occupational Health Programs is to assist these physicians to incorporate the concepts and skills of occupational medical practice into the total delivery of health services. Toward this end, NIOSH co-sponsored the AMA's 35th Annual Congress on Occupational Health and cooperated in developing the scientific program for the Congress.

The symposia of the Congress were presented by scientists from the Institute and from a variety of medical specialties and the safety profession. These eminently qualified speakers contributed to a unique review of selected health and safety topics. NIOSH is publishing the major papers presented at the Congress in this text to bring the benefits of this unusual program to as many individuals in the field as possible.

John F. Finklea, MD

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Director, National Institute for
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PREFACE

The positive response of health professionals to the workshop and subsequent published proceedings of the 34th AMA Congress on Occupational Health, ("Occupational Medicine Symposia," May 1975) co-sponsored by the National Institute for Occupational Safety and Health, led to NIOSH's co-sponsorship of the 35th Congress and publication of the major papers presented.

This reference text, comprising the symposia of the AMA 35th Annual Congress on Occupational Health, is presented with the hope that it will stimulate interest of physicians and other health professionals in the particular opportunities and dimensions of occupational health practice, including the control of injuries.

Papers are published essentially as presented. However, they have been edited by NIOSH for written presentation and, in some cases, titles were assigned to facilitate the use of this publication. Except for NIOSH speakers, the papers do not necessarily represent the views of NIOSH but are presented to reflect the concerns and controversies of occupational health practice.

ABSTRACT

This second volume of the *Symposia* is a continuing product of cooperation between NIOSH and the American Medical Association aimed at developing information to assist private practitioners with part-time occupational medicine responsibilities. The volume consists of papers presented at the NIOSH co-sponsored 35th AMA Congress on Occupational Health conducted at Cincinnati in September 1975, and is published by NIOSH. The *Symposia* topics were: epidemiology for part-time occupational physicians; identification and rehabilitation of the problem drinker; potential trauma in the work place; agricultural hazards; maximum utilization of the handicapped worker; behavioral aspects of injuries; occupational injury controls; and hazardous vapors, particulates and noise. In addition, the luncheon address of John F. Finklea, M.D., Director of NIOSH, is included.

These volumes are intended to furnish, over several years, an introductory text, highlighting the aspects of occupational medicine most significant to part-time plant physicians, to private medical practitioners generally, and to others with related interests. The concept arose from a 1974 NIOSH survey of AMA-member physicians to determine the special problems and information needs of these physicians. Publication by NIOSH extends the availability of this text to the thousands of such physicians unable to attend the AMA Congresses, although a copy of the appropriate volume is also sent to each registrant at that Congress. The 1975 Congress was supported by NIOSH-CDC Cost-Sharing Contract #210-75-0033.

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EPIDEMIOLOGY FOR THE PART-TIME
OCCUPATIONAL PHYSICIAN

EPIDEMIOLOGY

Anita K. Bahn, M.D., Sc.D.

A brief background of some basic epidemiology concepts and methods will provide a framework for this session. Epidemiology is defined as the study of the distribution of disease in population groups and the determinants or causes of disease. Its principal tool is the rate, a fraction defined as the number of cases of a disease divided by the population at risk for the disease

$$\left(\frac{\text{cases of a disease}}{\text{population at risk}}\right)$$

In studying disease causation, typically, a problem is approached first with descriptive epidemiologic methods; that is, data from death certificates, medical care and other routine records or surveys, are amassed by geographic area or population group. Any differences in rates by place, time and person (age, sex, race, occupation, etc.) lead to generation of hypotheses to account for the variation in risk of acquiring, or dying, from a disease. These hypotheses are then tested by methods of analytic epidemiology; that is, more focused studies.

A schema of the three major types of analytic studies, retrospective (or case control) studies, prospective (or cohort) studies and historical prospective studies is shown in Figure 1. Further detail about these analytic methods, their advantages and disadvantages, are presented in Epidemiology, An Introductory Text.[1] As will be discussed later, occupational groups are almost uniquely useful for historical prospective studies, a method which overcomes many of the disadvantages of the other two methods.

Figure 2 shows the feedback loop of the epidemiologic study cycle; that is, results of hypothesis testing lead to some answers, but also to further questions and hypotheses which in turn stimulate further data collection and focused studies. The contribution of basic and clinical sciences, demography, biostatistics and other disciplinary study, is integral to epidemiology.

It should be noted that epidemiologic studies are generally based upon observations. Experiments in which subjects are randomly allocated to groups which are then exposed or not exposed to a

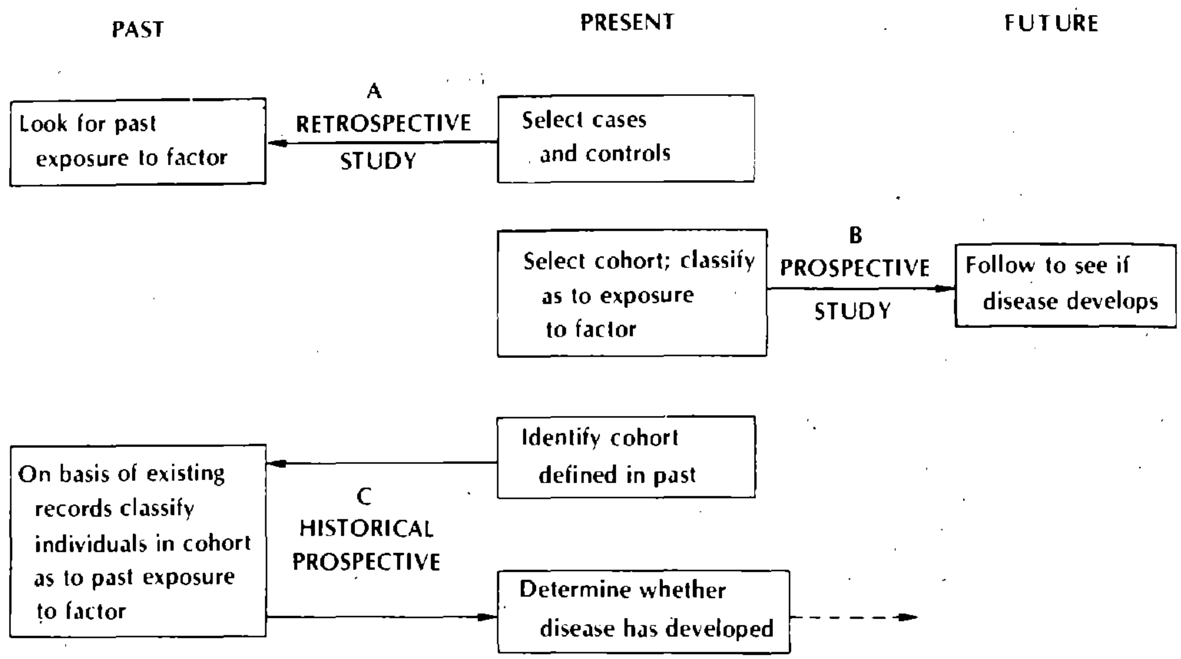

Figure 1. Comparison of retrospective, prospective and historical prospective study designs. (From: J. S. Mausner and A. K. Bahn: Epidemiology: An Introductory Text, Philadelphia: W. B. Saunders Co., 1974.)

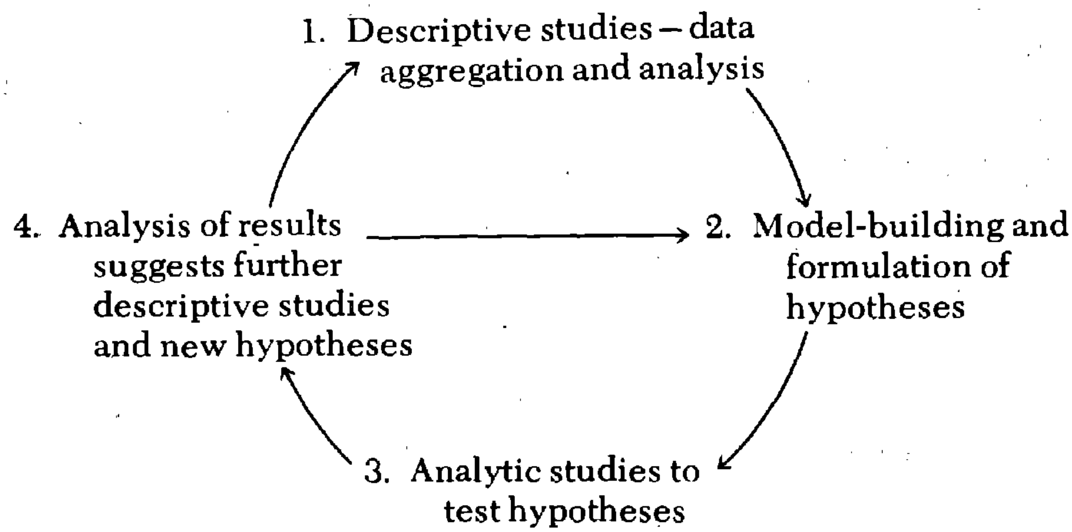

Figure 2. Scheme for an epidemiologic study cycle. (From: J. S. Mausner and A. K. Bahn: Epidemiology: An Introductory Text, Philadelphia: W. B. Saunders Co., 1974.)

supposedly noxious factor cannot be carried out on human populations today. Instead, evidence for causation must depend upon the types of observational studies outlined above in which assignment of individuals to exposed and non-exposed groups is not under the control of the investigator, but is the result of some type of selection (e.g., smokers vs. non-smokers, those occupationally exposed to a chemical or not). In such circumstances, the epidemiologist can only observe the outcome. Therefore, deductions regarding risk factors must take into account selective biases which may be present.

An important concept of disease causation is that, in general, disease is not caused by a single factor or agent as shown in the ecologic model of the epidemiologic triangle (Figure 3), but rather is influenced by multiple, interactive factors. Even in infectious diseases, illness cannot be ascribed solely to the infectious "agent"; interaction with host and environmental factors also must be considered. Therefore, another ecologic model of disease, the wheel (Figure 4) is to be preferred in which the agent may be located in any of the environmental sectors in man himself.

This model shows man with his genetic makeup in the center surrounded by the biologic, physical and social sectors of the environment. The importance of the genetic core varies with the disease. The occupational physician may identify the importance of this "core" in hypersusceptibility problems within the workforce. Hereditary alpha-1 antitrypsin deficiency and chronic lung disease, glucose-6-phosphate dehydrogenase (G-6-PD) deficiency and hemolytic anemia after exposure to selected chemicals or drugs, and hypersensitivity to organic isocyanates are examples of hereditary disorders or metabolic derangements that should be taken into consideration in preplacement screening and medical surveillance of employees with pertinent exposures.[2]

The concept of a defined <u>population</u> or group of persons under observation or at risk for a disease is central to epidemiology. This principle applies not only to disease causation, but also to the application of knowledge to control measures, whether they be (1) promotion of health and prevention of occurrence of disease; (2) early detection of disease; or (3) adequate treatment and rehabilitation. These three types of control measures are referred to, respectively, as (1) primary prevention; (2) secondary prevention; and (3) tertiary prevention.

The concern of the practicing epidemiologist with populations (persons at risk of disease, or the denominator of rates) as

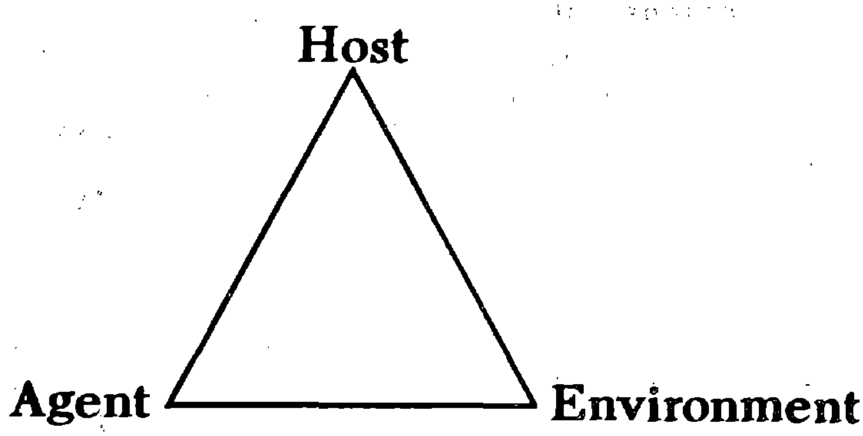

Figure 3. The epidemiologic triangle model of man-environment interactions. (From: J. S. Mausner and A. K. Bahn: Epidemiology: An Introductory Text, Philadelphia: W. B. Saunders Co., 1974.)

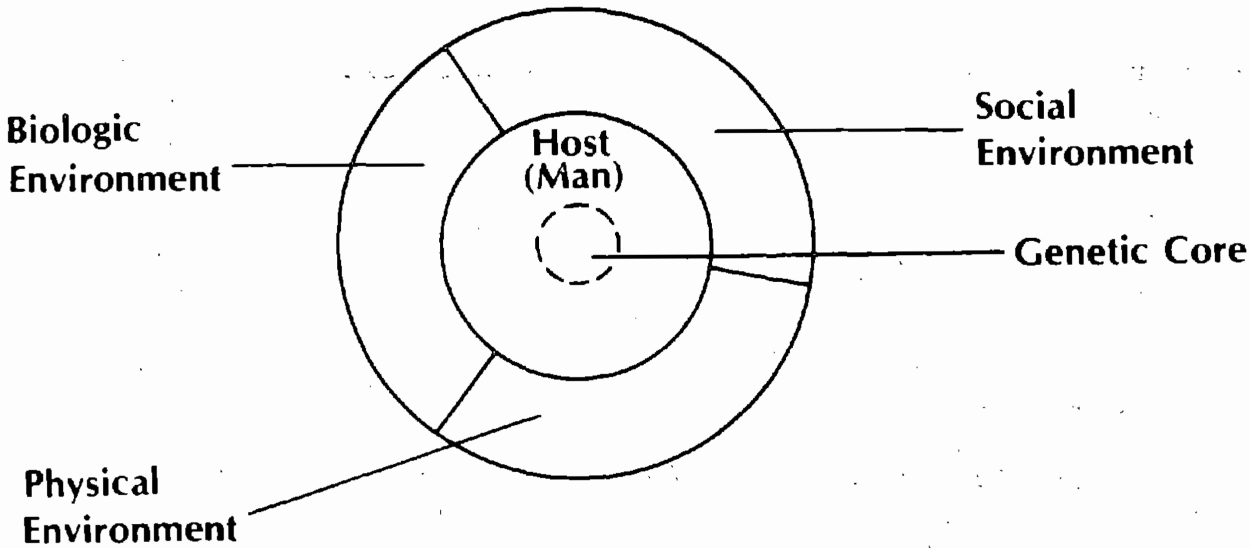

Figure 4. Wheel model of man-environment interactions. (From: J. S. Mausner and A. K. Bahn: Epidemiology: An Introductory Text, Philadelphia: W. B. Saunders Co., 1974)

well as with the cases (numerator) contrasts with that of the practicing clinician who focuses only on the numerator, those individuals who come for care. The community clinician generally is unable to "see" the total population from which his patients arise. Individuals are referred from ill-defined population groups or geographic areas which are served by other physicians. It is difficult for any one physician to obtain a holistic view of the health status of the community or to effect preventive measures on any broad scale. Even clinicians in a prepaid group practice or health maintenance organization, or in large industrial plants, do not have the opportunities for such insights or influences since other physicians also serve these groups.

The part-time occupational physician in the small plant, however, is in the enviable position of being in both worlds. He is a clinician who has the opportunity also to be an epidemiologist. He has responsibility for the health of a group of individuals who represent a clearly defined population at risk. He is their triage clinician and also can practice preventive medicine on an individual and group basis. He can monitor the health status of his population for both known and unknown noxious factors and use observation and an inquiring mind to contribute to new epidemiologic knowledge.

Unlike the typical clinician, the occupational physician has two "sides" to his responsibilities - as stated, to monitor the health of individuals in order to detect impairment in its earliest state; in addition, to monitor the workers' environment. These two health approaches are:[3]

> "a) evaluation of (precursors of) health impairment emphasizing where possible the detection of early and reversible effects;
>
> b) evaluation of exposure; this may indirectly indicate the presence of precursors of health impair- if dose effect/response relationships are known."

Some suggested ways in which the part-time occupational physician in the small plant can intertwine the roles of clinician-epidemiologist are enumerated. These will be discussed under seven major headings:

1. The environmental work setting
2. Risk factors of the industrial population
3. Mass health education programs
4. Screening for early detection of disease

5. Epidemiologic studies
6. Evaluation of ongoing programs
7. The Health Record Systems

THE ENVIRONMENTAL WORK SETTING

The worker spends a major part of his day in his work environment. As illustrated in Figure 4, the environment encompasses not only physical aspects (temperature, humidity, chemical and mechanical exposures), but also social-psychological aspects. The latter, through "stress" and other intervening variables, affects the physical and mental health of the worker. It should be remembered that[3]:

> "Health does not mean only absence of disease but also optimum physical and social well being. Health is not something that one possesses as a commodity, but connotes rather a way of functioning within one's environment (work, recreation, living)."

Thus both overload and underload (i.e., not enough stimulation) are important.

What is the epidemiologic role of the occupational physician with regard to the work environment? This can be demonstrated in a number of ways. First, by weekly or monthly tallies and graphs of absenteeism, the incidence of symptoms, complaints, and diseases he can note any unusual frequency by type of worker, by time or by location within the plant (Who? When? Where? are the cardinal epidemiologic questions). Any investigation can then be undertaken for possible etiologic factors. One must be wary, however, that the number of cases observed may increase without any true change in the background or endemic level of a condition, merely because the number of employees in the plant has increased; therefore, rates must be computed for correct inference. Or it may be that, for a number of reasons, more of the workers with a condition are now seeking help without a real change in the condition's incidence or prevalence. Incidence is defined as the number of <u>new</u> cases per population unit per time period; whereas, (point) prevalence refers to the number of <u>existing</u> cases in the population at a point in time. Prevalence depends upon the duration of a disease or condition, as well as its incidence ($P \sim I \times d$). Therefore, for study of disease causation or occurrence, incidence rates are used rather than prevalence rates.

	Industry			
	A		B	
Number of industrial fatalities per year	100		50	
Average number employed in the industry	10,000		1,000	
Rate or *risk* of an industrial fatality per year	$\frac{100}{10,000}$	$= .01$	$\frac{50}{1,000}$	$= .05$

This illustrates the common fallacy of the lack of a *denominator*. A denominator is needed to form an appropriate *rate* in order to evaluate risk.

From: A. K. Bahn: Basic Medical Statistics; Grune and Stratton, New York, 1972.

Table 2

Use of a Table of Random Numbers

Problem: Given a population of 90 cases, to select a random sample of 20 cases.

Procedure:

1. Arbitrarily assign a number to each case from 01 to 90.
2. On the table of random numbers, arbitrarily pick a 2-digit column.
3. With closed eyes, select a random start in that column.
4. Beginning with the starting number, continue to sequentially select every 2-digit number in that column (and in the next 2-digit column, if necessary) until 20 cases have been selected.
5. In the event a random number not included in the sequence 01 to 90 occurs (e.g., 98), skip that number and proceed to the next random number listed.
6. Similarly, if a random number already used occurs again, disregard it and continue to the next random number listed.
7. To assure that a number is not picked twice, keep some record in numerical sequence of numbers selected.

Example: In the tenth 2-digit column, a blindfold random start is made with the number 61. The 20 numbers used to select the sample are shown by check mark. Numbers not used lie outside the sequence 01 to 90, or are repeats, and are crossed through.

(In this example we have moved down a column but we could have chosen to move in some other direction).

25	19	64	82	84	62	74	29	92	24
23	02	41	46	04	44	31	52	43	07
55	85	66	96	28	28	30	62	58	83
68	45	19	69	59	35	14	82	56	80
69	31	46	29	85	18	88	26	95	54
37	31	61	28	98	94	61	47	03	10
66	42	19	24	94	13	13	38	69	96
33	65	78	12	35	91	59	11	38	44
76	32	06	19	35	22	95	30	19	29
43	33	42	02	59	20	39	84	95	61 ✓
28	31	93	43	94	87	73	19	38	47 ✓
97	19	21	63	34	69	33	17	03	02 ✓
82	80	37	14	20	56	39	59	89	63 ✓
03	68	03	13	60	64	13	09	37	11 ✓
65	16	58	11	01	98	78	80	63	23 ✓
24	65	58	57	04	18	62	85	28	24 ✓
02	72	64	07	75	85	66	48	38	73 ✓
79	16	78	63	99	43	61	00	66	42 ✓
04	75	14	93	39	68	52	16	83	34 ✓
40	64	64	57	60	97	00	12	91	33 ✓
06	27	07	34	26	01	52	48	69	57 ✓
62	40	03	87	10	96	88	22	46	[illegible]
00	98	48	18	97	91	51	63	27	[illegible]
50	64	19	18	91	98	55	83	46	09 ✓
38	54	52	25	78	01	98	00	89	85 ✓
46	86	80	97	78	65	12	64	64	70 ✓
90	72	92	93	10	09	12	81	93	[illegible]
66	21	41	77	60	99	35	72	61	22 ✓
87	05	46	52	76	89	96	34	22	37 ✓
46	90	61	03	06	89	85	33	22	80 ✓
11	88	53	06	09	81	83	33	98	29 ✓
11	05	92	06	97	68	82	34	08	83 ✓
33	94	24	20	28	62	42	07	12	63
24	89	74	75	61	61	02	73	36	85
15	19	74	67	23	61	38	93	73	68
05	64	12	70	88	80	58	35	06	88
57	49	36	44	06	74	93	55	39	26
77	82	96	96	97	60	42	17	18	48
24	10	70	06	51	59	62	37	95	42
50	00	07	78	23	49	54	36	85	14

Secondly, the physician could compare the incidence rate of health problems, e.g., industrial fatalities, hearing loss, pulmonary function loss with that of similar plants in the same or other companies. Here again, comparisons must be made on a rate basis; Table 1 illustrates the fallacy of comparisons which lack a denominator. Also, in comparisons of rates, between groups, appropriate consideration must be made for differences in the composition of the groups that can influence disease frequency. Such variables as age, race, sex, etc. must be used to calculate group specific rates, group adjusted rates, etc. in which that variable has been adequately taken account of in evaluation for fair comparisons.

The physician can also practice "shoe leather epidemiology" in its true sense by taking for example, a random walk, at random times, around the plant as a keen observer of the work environment. As in community practice, not all those who are even overtly ill will seek care. The alert physician could spot excessive fatigue in a group of workers, or a potentially dangerous environmental situation, job dissatisfaction or work instability, and take effective action.

A friendly and confidential attitude towards employees will encourage them to seek the physician's advice when trouble is brewing so that epidemics of physical and psychological illnesses can be averted. Exit interviews of a sample of employees may yield constructive suggestions as to how to improve the work environment. Or, by use of a table of random numbers (Table 2) individuals could be selected for confidential interview about any stresses of their work milieu, job satisfaction and suggestions for improvement.

The work environment provides a major clue as to the job-related examinations needed for employees. After reviewing, on a periodic and continuous basis, the quality of the work environment, its potential exposures and its physical demands, the attentive occupational physician prepares a "Hazards List". This list includes all major environmental agents used in operations of the plant; it identifies the location of use and the number of employees exposed to each agent. Information of this type allows for the better understanding of medical fitness required for the job, identifies monitoring needs for workers exposed to specific biological, physical, or chemical agents, and leads to an increased clinical index of suspicion in the detection of early or subclinical effects resulting from accidental or inadvertent exposure to potentially hazardous agents. This type of information is vital, also, in the planning of epidemiologic studies on working populations and in amassing data on biological variability in dose response.

RISK FACTORS OF THE INDUSTRIAL POPULATION

Current data on age, sex and occupational task of the workers are needed not only as the denominator of rates, but also because these characteristics constitute the primary risk factors or determinants of disease occurrence. The health hazard appraisal charts of Robbins[4], for example, indicate the probability of death for various causes, by age, sex, race and other parameters, such as smoking, high blood pressure, cholesterol level.

In addition to these general prognostic or risk factors, there are risk factors specific to the industry. Knowledge is accumulating rapidly on the toxic effect, both acute and chronic, of chemicals and other industrial hazards and stresses. However, although acute effects are generally well-known, chronic sequelae may be insidious and obscure. For example, it is not known whether there is a zero threshold for the carcinogenic effects of many agents. The loss of Forced Vital Capacity (FVC) among persons working with asbestos in a plant for more than twenty years was substantial according to a recent study[5], and could not be accounted for by smoking or by age. Cigarette smoking may have an additive or synergistic effect for different types of environmental exposures; some studies have imputed smoking as a required cocarcinogen, for example, for asbestos[6].

Knowledge emanating from epidemiologic studies about dose response, risk factors and induction periods for various diseases and exposures will assist the physician in reducing environmental stressors, in planning health education programs for workers, and in mounting cost-effective disease screening programs.

MASS HEALTH EDUCATIONAL PROGRAMS

Stallones has pointed out[7] that we are deficient "in education of individual members of a community with respect to how they may best conduct themselves so as to protect and promote their health". Although the industrial setting does offer the occupational physician unique opportunities for practicing preventive medicine through effecting changes in the plant's work environment, in general, modification of individual behavior so as to reduce personal hazards is the principal impediment in preventive medicine today.

Effective education programs of the public (or workers) are difficult to achieve. The generally poor outcome of programs and clinics directed toward reducing the addictive disorders (obesity, smoking, alcoholism) and the difficulty of maintaining compliance with anti-hypertensive drug regimens attest to the fact that it is much easier to induce individuals to take a single preventive health action than to do or not to do something every day of their lives. This does not mean that permanent behavioral change is impossible, but that we no longer naively believe that it can be accomplished merely by lecturing or showing slides of cancerous lung tissue.

The occupational physician should recognize, however, that expert health educators can assist in initiating, conducting, following through and evaluating workers' health education programs. Also, that unions may favorably influence workers' acceptance of these programs, and their willingness to be "recorded" with an addictive or other problem. The union can assure privacy and that the individual's right to his job will not be affected by his level of compliance. The occupational physician can serve primarily as the catalyst in getting workers' health educational programs under way in a dignified, confidential and effective manner and in assuring that such programs be scientifically evaluated as to outcome.

Workers' adherence to safety measures against the specific hazards of the industry is a major educational task of the occupational physician in conjunction with nursing, safety, industrial hygiene and management. The statistics which the physician maintains on injuries by location, type of job, time of day of occurrence, etc. are invaluable in monitoring such programs. Again, analysis of the data in terms of rate (rather than just number of injuries) both before and after educational campaigns and installation of safety devices, is needed for proper evaluation.

SCREENING FOR EARLY DETECTION OF DISEASE

Screening for disease, as suggested by Figure 5, is the application of tests or procedures to groups of apparently well persons to separate those who probably have a disease from those who probably do not. Those who screen positive then proceed to further diagnostic tests. In a recent series of articles in Lancet[8] arguments for and against mass screening for asymptomatic disease were presented in terms of effectiveness and efficiency.

Certain measures are critical in the evaluation of a screening program: One is concerned with such characteristics of a test or procedure as its reliability (that is, repeatability) and its validity (that is, whether it is a good preliminary indication of

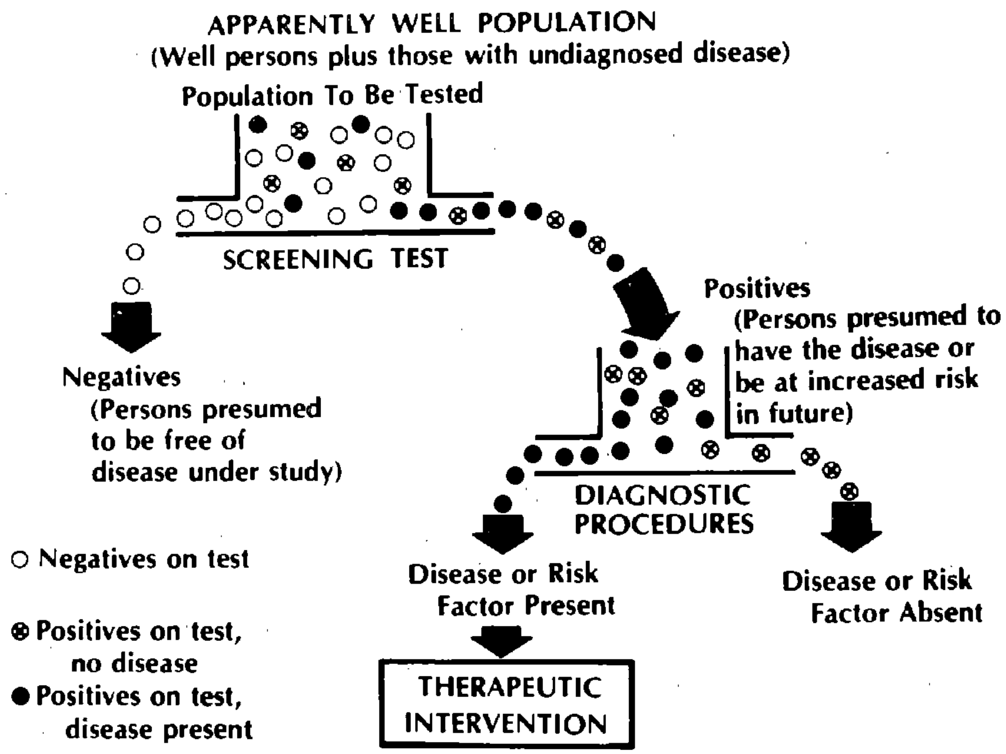

Figure 5. Scheme for mass screening program. (From: J. S. Mausner and A. K. Bahn: Epidemiology: An Introductory Text, Philadelphia: W. B. Saunders Co., 1974)

which individuals have the disease and which do not). Thus validity has two components: Sensitivity -- the ability to identify correctly those who have the disease; and specificity -- the ability to identify correctly those who do not have the disease.

The symbolic definitions of sensitivity and specificity and of their respective complements (percent false negatives and percent false positives) are shown in Figures 6 and 7. In general, high sensitivity is achieved at the expense of low specificity and vice versa. This can be demonstrated readily with tests which measure a continuously distributed variable, such as serum cholesterol and intraocular pressure. For such tests it is possible to vary the sensitivity and specificity by changing the level at which the test is considered positive (Figure 8).

In many occupational health conditions, however, it must be remembered that we are dealing with a continuum from no observed effect, to a compensatory effect, early effect of dubious health significance, early health impairment, and finally, manifest disease.[3]

The prevalence of disease in the population being screened affects both the predictive value of a positive or negative result of the screening test, and the test's yield of cases. Therefore, prevalence also determines cost-effectiveness of the screening program. Too often screening programs are applied indiscriminately to population groups without targeting in on those who are at high risk for disorders amenable to early detection and intervention. Age, race, other personal characteristics such as weight, past medical condition, smoking history, and familial history of disease may be risk factors. Type and duration of occupational exposures represent additional risk factors for the industrial population.

In mass screening for disease several measures of risk bear consideration. Relative risk is the ratio of the incidence rate of those exposed to a factor to the incidence rate of those not exposed $\left(\frac{\text{incidence rate among exposed}}{\text{incidence rate among non-exposed}}\right)$. Attributable risk is the arithmetic or absolute difference in incidence rates between an exposed and non-exposed group. Population attributable risk proportion is a measure which reflects both the relative risk and the proportion of the population that has been exposed to the factor. This measure would show, for example, that a large proportion of the deaths from lung cancer in the total population are due to smoking, not only because of the high relative risk (10:1) associated with smoking, but also because of the large proportion of the population that smokes. Thus it has been estimated that

Result of Screening Test	Disease State: Disease	Disease State: No Disease
Positive	*true positive* TP	false positive FP
Negative	false negative FN	*true negative* TN

$$\text{Sensitivity} = \frac{TP}{TP + FN} \qquad \text{Specificity} = \frac{TN}{TN + FP}$$

Figure 6. Results of screening test illustrating sensitivity and specificity. (From: J. S. Mausner and A. K. Bahn: Epidemiology: An Introductory Text, Philadelphia: W. B. Saunders Co., 1974.)

Percentage sensitivity =	percentage of people **with** the disease who are detected by the test	$= \frac{TP}{TP+FN} \times 100$
Percentage false negatives =	percentage of people **with** the disease who were not detected by the test	$= \frac{FN}{TP+FN} \times 100$
Percentage specificity =	percentage of people **without** the disease who were correctly labelled by the test as not diseased	$= \frac{TN}{TN+FP} \times 100$
Percentage false positives =	percentage of people **without** the disease who were incorrectly labelled by the test as having disease	$= \frac{FP}{TN+FP} \times 100$

Figure 7. (From: J. S. Mausner and A. K. Bahn: Epidemiology: An Introductory Text, Philadelphia: W. B. Saunders Co., 1974.)

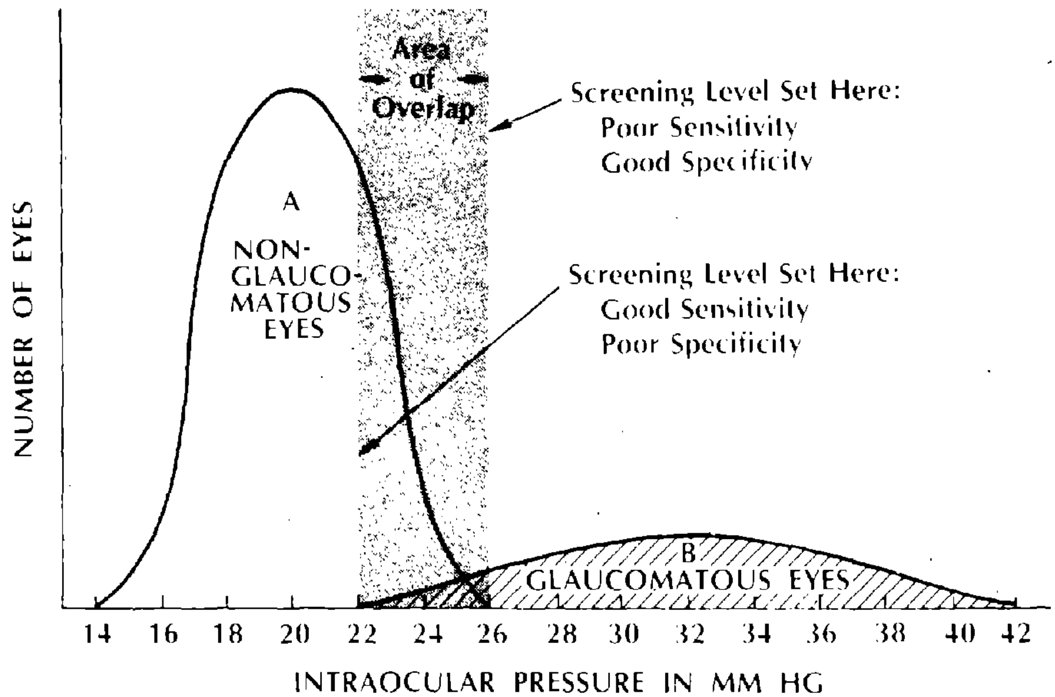

Figure 8 Hypothetical distribution of intraocular pressures in glaucomatous and nonglaucomatous eyes, measured by tonometer. (Adapted from Thorner, R. M., and Remein, Q. R.: Principles and procedures in the evaluation of screening for disease. USPHS Pub. No. 846, U.S. Govt. Printing Office, Washington, D.C., 1961.)

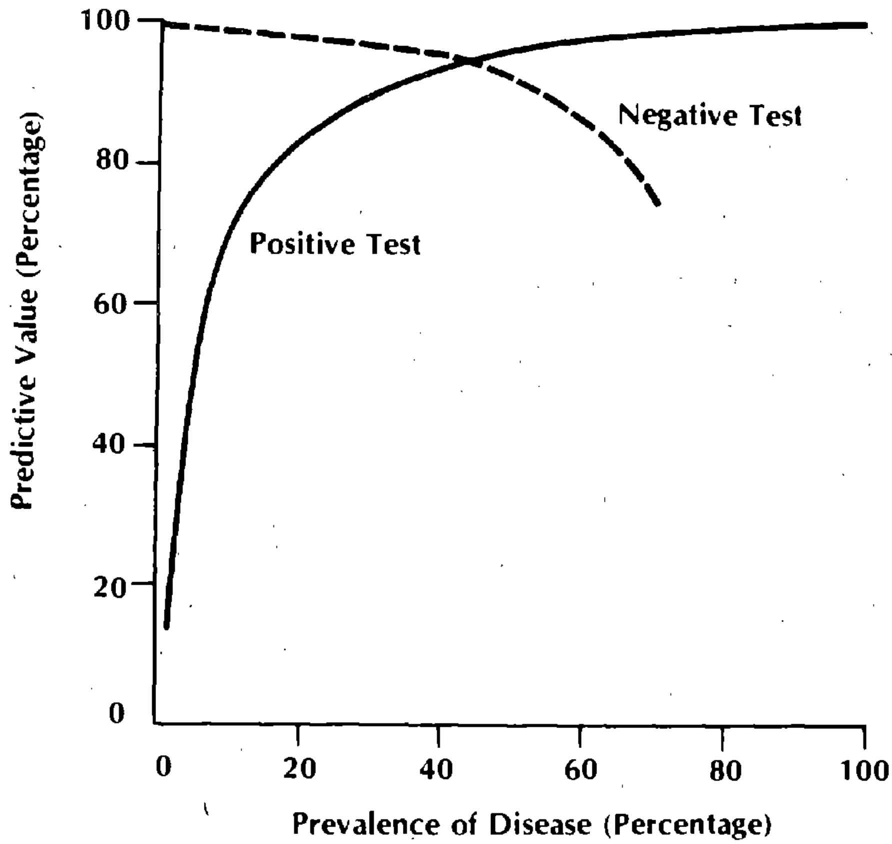

Figure 9 Relationship between prevalence of disease and predictive value, with sensitivity and specificity held constant at 95 per cent. (Adapted from Vecchio, T. J.: Predictive value of a single diagnostic test in unselected populations. N. Engl. J. Med., *274*:1171 1966.)

80% to 85% of lung cancer deaths in the United States can be attributed to smoking.

Relative risk is an important measure in considering whether a characteristic (such as family history of cancer) should be taken into account in the screening protocol. However, if a condition, such as familial multiple polyposis, is infrequent in the population, even though nearly all persons with that genetic characteristic develop cancer of the colon, it is of little practical consideration in a mass screening program. On the other hand, even if the relative risk is only 3:1, if many individuals have been exposed then this exposure must be considered in the screening protocol.

At this point, for illustration the features of a cost-effective, multisite cancer detection program known as CANSCREEN (Institute for Cancer Research, Fox Chase Cancer Center, Philadelphia, and Preventive Medicine Institute, New York City) can be outlined. CANSCREEN features: (a) a self-administered questionnaire of medical history, symptoms and risk factors; (b) use of trained paramedical personnel (with consultant back-up) for clinic screening; (c) automated decision logic based on symptoms and risk factors to determine type and frequency of examinations; (d) intensive preventive education to reduce controllable risks (smoking, excess alcohol use); (e) storage of serum and other biologicals as a basis for clinical and biologic research; (f) a collaborative program in two cities (New York and Philadelphia) using a computer data base. This program is being initiated in some occupational settings.

Screening programs in industry present sensitive problems of confidentiality. The employee must not feel that his job security is jeopardized by his truthful statements about medical history, symptoms, or habits or by the findings of the screening examination. The manner in which confidentiality can be assured, perhaps with the aid of the union, will not be addressed here, but is a key to the success of the program.

EPIDEMIOLOGIC STUDIES

The current exciting advances in science relate to the hitherto unsuspected major role of environment (chemicals, drugs) in the etiology of cancer and other diseases. There is an urgency to discover new risk factors as the basis for intervention programs, particularly where large numbers of workers may be exposed.

As the clinician for a defined population, the occupational physician can make a significant contribution to knowledge about disease causation. Clusters of cases of typically rare disease could be the signal of an unusual phenomenon whose origin may be related to an occupational exposure. Even for those diseases which tend to occur with greater frequency, a much larger than expected aggregation of cases by time and place might be observed. Although such aggregation is easier to recognize among current employees, systematic review of compensation claims and death certificates of those no longer employed would provide additional data for the inquiring physician.

That occupational groups could serve as the cohort for historical prospective studies was alluded to earlier (Figure 1). The classical prospective study, while providing direct measures of incidence, is impractical where large numbers of subjects must be followed over a very long period of time for diseases of low frequency and with long induction periods. However, in a historical prospective study it is possible to identify from records all the employees of an industry who were exposed to a noxious agent in the past. One could then determine from routine records (death benefits, disability pensions, etc.) the fate of members of this cohort without requiring additional years of observation. Such studies necessitate, however, that industry maintain good records on employment period, on exposures (cumulative dosage) or at least on detailed occupation, on health status, on date and cause of death and on nearest relative for follow-up purposes. Selikoff has conducted a number of important studies on retrospectively identified occupational cohorts, such as asbestos workers.[9]

Thus, the occupational physician with epidemiologic interests could be most helpful in assuring good record maintenance. He could also participate in historical prospective studies to test specific hypotheses, or to determine whether there are as yet undiscovered etiologic hazards in the occupational environment. We are still in an embryonic state with respect to knowledge about industrial agents, their threshold, and association with chronic diseases.

Industries concerned about the welfare of their employees could gain the interest and cooperation of the union in conducting such studies. Epidemiologists in schools of public health and schools of medicine are available to assist the part-time occupational physician in these endeavors.

EVALUATION OF ONGOING PROGRAMS

The occupational physician, with the safety and health team, will find the need, from time to time, to determine the effectiveness of ongoing programs and decide to either phase out certain programs or augment them. This decision is best made with "hard" data. Program priorities can be established rationally if adequate determinations of population at risk are made and if morbidity and mortality experience is recorded in an easily retrievable fashion. Financial and manpower data specific to program activity is rarely reported in occupational medicine; but without such information, the "cost" in cost-effectiveness and cost-benefit determinations of ongoing operations cannot be made.

The staff should have firmly in mind at the onset of initiation of a program, the program objectives and measures of effect to be monitored. With changes in plant technology, age and sex of employees, variations in exposures, and with new health legislation, there is a continuous potential for inducing shifts in health program priorities.

THE HEALTH RECORD SYSTEMS

The occupational-epidemiologist is dependent upon health records for the delivery of adequate direct health services and for the practice of epidemiology-based preventive medicine. The range of record types and quality in occupational health programs is considerable -- from simple, handwritten notes on index cards to sophisticated detailed forms coded for data processing.

The needs of each place of employment are, to some extent, unique and the health data records and system should be designed with these in mind. Frequently missing from employee health records, however, is a description of current and past occupational exposures, as well as primary location of work (if applicable). This type of information provides a basis for both numerators and denominator classification and could be confirmed during the occupational physician's periodic review of the work sites.

SUMMARY

This paper has attempted to acquaint the part-time occupational physician in the small plant with some basic concepts and methods regarding the epidemiologic approach to prevention and screening for disease.

Unusual opportunities exist for those curious and concerned to practice preventive medicine of a high order including monitoring the health of workers ranging from changes in biochemical and morphological parameters to changes in the physical state or functioning of physiological systems; changes in well being as evaluated by medical history and questioning; and integrative changes resulting from effects on several physiological systems.[3] Equally important is modification of the environment and initiating cost-effective screening programs for early detection of disease and health education programs.

The physician must be knowledgeable, not only about general risk factors of disease, but also about those risk factors specific to his industry. By his curiosity and his knowledge of the steps in accumulating evidence about disease causation, he can contribute to knowledge about new risk factors.

His assurance that good records are maintained on the health status and occupational exposure history of employees can be invaluable for historical prospective studies. He has the unique opportunity to follow individuals over time since by and large he is working with a "closed" population. Confidentiality and rapport with employees, willingness to listen, and to observe and to conduct "shoe leather epidemiology" investigations are essential criteria for these endeavors.

The essence of the practice of epidemiology in the industrial or any other setting is an inquiring mind, alertness to opportunities for study, a critical view toward one's own data and those of others, concern both with the denominator as well as the numerator (cases or events), recognition of the need for comparison or control groups, and awareness of the role of chance (statistical significance) when evaluating data.[10]

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EPIDEMIOLOGY FOR THE PART-TIME OCCUPATIONAL PHYSICIAN

CLINICAL EXAMPLES OF EPIDEMIOLOGICAL APPROACH TO OCCUPATIONAL MEDICINE

William S. Lainhart, M.D.

The medical literature is replete with examples of disease entities associated with occupational exposures. Probably no organ or system has been spared as being the target of physiological or pathological change pursuant to a single, a sporadic or a continuous exposure to an environmental agent. (The word "single" may be used here as denoting one exposure in the sense of time but also in the sense of one compound, substance, or physical stress.) Therefore, the following examples which I have chosen to illustrate the use of the epidemiological approach are limited to disorders of the respiratory organs because those are examples with which I am most familiar. Similar examples might be chosen from other organ systems to demonstrate the same approach to occupational medicine.

The respiratory tract, as with other organ systems, has a limited number of ways to respond to external noxious agents, be those agents animal (micro-organisms), mineral (particulate) or vegetable (particulate), or any combination thereof, in origin. In addition, the human tissues upon which those noxious agents impinge may have been altered or somehow "sensitized" by previous external agents or by such "intrinsic" factors as physical configuration of the organs themselves, hereditary factors, etc.

Respiratory tract responses may be measured in a variety of ways -- some very simple (as exemplified by a relatively uncomplicated questionnaire to elicit the commonly observed respiratory symptoms such as cough, sputum production, shortness of breath, or wheezing following exposure to irritants) and some very complicated (as exemplified by laboratory procedures to determine alveolar ventilation or diffusing capacity or to differentiate and locate the source of potentially or definitely malignant respiratory tract cells). Between these extremes, there are a number of diagnostic tests which may be applied to individuals within a study group to determine changes in those individuals and in the group which could provide diagnostic leads to increased potential for an actual disease state.

Inherent in determining any response of a portion of the respiratory tract to a noxious agent is a system of classification of that response -- whether that classification be a simple clinical notation of a 1- to 4+ redness of the throat or a detailed statistically usable system for recording roentgenographic changes consistent with dust deposition or the physiological or pathological response to that dust. At any rate, a pre-determined, rational, explainable, reproducible system of classification must be devised in order to compare results. Two examples might be instructive:

1. The Medical Research Council of Great Britain devised a questionnaire now familiarly known as the MRCQuestionnaire. With only slight modification, this tool has been widely used throughout the western world to ascertain the level of cough, sputum production and dyspnea in individuals and groups with the relation of those symptoms to smoking, weather conditions, and temporal considerations (time of day, time of year, length of time such symptoms have been present). With the addition of an occupational history of exposure to particular agents, such a questionnaire becomes a tool in the determination of respiratory illness associated with a particular occupation or occupational exposure.

2. After much discussion and a fair amount of professional and semantic compromise, a classification of the pneumoconioses (dust disease of the lung) was published by the International Labour Office in 1971. Such a classification translates "spots on the lungs" into a code consisting of numbers, letters and abbreviations. Although such a classification might be used to denote a clinical diagnosis or to suggest physiologic or pathological changes, its original intent was merely descriptive, i.e., to characterize discernible radiologic changes in a consistent way so that the x-ray reports could be coded into computer language and, therefore, used to classify individuals (primarily, in this case, workers in the dusty trades) into categories of intensity of roentgenological changes (that is, both number and size of lesions), type of roentgenographic change (rounded or irregular opacities) and those with or without radiologic signs of other chest disease (abnormal cardiac shadow, possibility of lung cancer or tuberculosis, etc.).

Although now relatively standardized (but in no way universally accepted) these classification systems do point the way toward a common language of the interpretation of clinical or laboratory findings so that epidemiologic techniques may be utilized to compare groups within a factory (i.e., exposed or not exposed to compound x or material y), commonly exposed groups within two factories geographically isolated or between groups in different countries.

Several examples of clinical disease referable to occupational exposures might be illustrative.

Chromium (in the hexavalent state) compounds have been incriminated in skin and mucous membrane irritation and corrosion, dermatitis, and have been related to an increase in the incidence of lung cancer. However, ulceration of the nasal septum has been associated with exposure to mist or dust containing chromates. These ulcerations apparently occur primarily in those persons who have the habit of nose-picking, as a result of the development of redness or irritation of the mucosa, then rhinorrhea following exposure to chromate dust-laden air. Blanching of the mucosa and formation of tough, adherent crusts follow. The septum may perforate within a week or two and the perforation may continue enlarging for up to three months. Healing will occur (following cessation of exposure) by formation of vascular scar tissue.

Chronic bronchitis as a disease entity is somewhat similar to pornography in that it is easily recognizable to most, but, at the same time, almost impossible to define in a way which satisfies all researchers. The MRC questionnaire mentioned earlier is an attempt at such a definition which is now beginning to be recognized internationally as quite useful. It has been stated that chronic bronchitis is a British disease which does not occur in the United States. I would suggest that this geographic difference may only be a semantic one for we do have a symptom complex (cough, sputum production, dyspnea) which has been variously called bronchitis, emphysema, chronic obstructive lung disease, chronic lung disease and others. The British Medical Research Council has proposed a definition of chronic bronchitis which states that this entity involves chronic or recurrent cough with expectoration on most days for at least three consecutive months in the year, for more than two successive years. Inherent in this definition is that such conditions as pneumonia, tuberculosis, bronchiectasis, bronchial carcinoma and the pneumoconioses have been excluded. Although the symptom complex of "chronic bronchitis" may be, at times, indistinguishable from that seen in cases involving the conditions on this list, epidemiological studies have indicated in Great Britain that:

1. The prevalence of bronchitis is higher in more urbanized areas;
2. The prevalence of bronchitis is increased in unskilled workers as contrasted with professional and managerial workers;
3. Mortality rates from bronchitis of iron and steel molders or foundry workers are three times those of precision workers, carpenters and joiners.

However, it must be stated unequivocally that any epidemiological investigation as to occupational bronchitis must involve consideration of the well demonstrated relationship between smoking and chronic bronchitis. Still other factors to be considered are atmospheric pollution (strongly suggested by studies which indicate an excess of bronchitic symptoms and lowered mean pulmonary function of British workers when compared with American workers in the same occupation) and the importance of genetic differences in population groups.

The pneumoconioses have been studied in workers exposed primarily to certain well-known dusts containing silica and silicates, beryllium, coal mine dust, and asbestos but a list of the pneumoconiosis-producing dusts must also contain numerous other mineral and organic dusts which are capable of being deposited in the lung and to which tissue reactions take place. As a matter of fact, the term pneumoconiosis is most difficult to define for it can be considered in several ways (given that exposure to a particular dust has occurred or is occurring):

1. Can gross or microscopic evidence of dust deposition and tissue reaction be demonstrated?
2. Can symptomatology be related to exposure?
3. Can measurements of pulmonary function be related to exposure?
4. Can roentgenographic changes be related to exposure?
5. Can symptomatology, pulmonary functional changes and radiologic changes be correlated?
6. Finally, can morbidity and/or mortality be related to dust exposure in a meaningful way, i.e., is there a dose-response relationship?

Thus, the definition presently utilized by the International Labour Office involves a diagnosis based on pathology only without reference to symptomatology or physiological changes, or radiologic changes, although these changes are obviously related to the pathology engendered by a dust which when retained in the lung provokes a tissue reaction.

From the epidemiological point of view, morbidity or mortality in the presence of dust exposure must be considered in the light of other factors which may contribute to that morbidity or mortality. Thus, given an exposure to a dust known to or purported to cause a pneumoconiosis, factors such as age of the individual worker, his or her previous illness history, his or her "pollution" history (i.e., personal pollution, that is, smoking history, or atmospheric pollution as mentioned earlier in relation to urbanization), previous employment history and expectation of employee groups (regarding disease-producing potential of a material), must be involved in attempting to correlate dust exposure at different levels or for varying time periods to the presence of "disease", however this latter term is defined. I am reminded that even in those American coal miners who had worked at the face (the dustiest area in the mine) for more than 40 years (obviously, the greater part of their working lifetimes), only about one-fourth showed radiologic changes consistent with pneumoconiosis, less than one-fourth had persistent productive cough (whether they were smokers or not) and less than 10% had dyspnea (of any degree).

Asbestosis is another pneumoconiosis which, although recognized and described before the turn of the century, has only recently been studied and popularized in this country. The inhalation of asbestos fibers is related to asbestosis, lung cancer and mesotheliomata of the pleura and peritoneum. The pneumoconiosis produced is different from classical silicosis (and, probably coal workers' pneumoconiosis) in that the basal areas of the lungs tend to be involved more often than the upper lobes, the roentgenographic changes tend to appear as more diffuse shadows and the clinical picture of dyspnea, cough and increased sputum production tends to occur before the radiographic changes. The normal vascular pattern on the posterior-anterior view of the chest is replaced with small fine, medium or coarse opacities and pleural changes (thickening and plaque formation) occur much more often than in the other pneumoconioses. Although these irregular parenchymal and distinctive pleural changes have been described in various ways and at various times in the past, the ILO classification referred to earlier, was the first systematic attempt to codify these changes along with the so-called rounded (more-or-less regular) opacities considered to be more typical of silicosis or coal workers' pneumoconiosis. (It is to be noted that there have, as yet, been no systematic studies reported of the roentgenograms of individuals exposed to asbestos and to silica to determine the relation, if any, between the type of small opacity present and other factors such as functional change, morbidity, mortality, or symptomatology.)

Cancer of the respiratory tract has been related to several occupational exposures. The majority of such relationships have been determined by the epidemiological approach, through the steps of 1) awareness of an unusual occurrence of a particular tumor on the part of an astute clinician and 2) substantiation of an initial impression through investigations which take into account such factors as type and extent of exposure, age and sex of those workers exposed, comparison of findings in the study group with those in control groups or in a similar component of the general population. Extensive national (and now international) statistics have been accumulating regarding the occurrence of various forms of neoplasm in specific age, sex, and ethnic groups. In addition, data are becoming available on the geographic distribution of cancer and the occurrence of cancer in various socio-economic groups. Although the evidence is mounting that cigarette smoking is strongly related to lung cancer, epidemiological studies among asbestos workers have shown that although such workers have an increased risk of cancer if they do not smoke, that risk is increased over 80-fold if there is the concomitant insult of asbestos exposure to cigarette smoking. In addition to the more common forms of lung cancer, the presence of mesotheliomas of the pleura and mesothelium in asbestos workers has been shown to be associated with asbestos fiber exposure.

The list of respiratory tract carcinogens is long and includes, in addition to asbestos fibers and dust, some compounds of chromium, beryllium, cobalt and nickel, radium, radioactive ores and substances, and certain organic chemicals associated with tars, pitches, asphalt, carbon black, soot, etc.

The investigation of the role of a respiratory tract carcinogen in the development of disease among workers exposed to that particular material involves, given our present state of the art, several pertinent but, at the moment, unanswerable questions:

1) What is the mode of action of the carcinogen?
2) What is the role of co-carcinogens?
3) Does heredity play a significant role?
4) Is there a dose-response relationship demonstrable?
5) Can one develop predictive tests to highlight susceptible individuals or population groups (given the long latent period in the development of cancer)?
6) Can schemes be developed to predict which new compounds or agents will show carcinogenic properties?

Although partial answers to some of these questions have been published, the present state of our knowledge allows us no alternative but to apply epidemiologic techniques to the further elucidation of various aspects of these answers. The extended latent period between exposure and overt or demonstrable cancer, the enigma of individual susceptibility or potential for the development of neoplastic disease, the multiplicity of new compounds in the workplace and their potential for interaction, and the recognition of newer (not-before-suspected) carcinogens in industry, all militate toward large scale, long term, and carefully documented studies, the results of which would be made available to the scientific community.

But, you say, such massive studies are impossible in my industrial medical practice. That may well be the case but the first step in any study is an idea -- an awareness -- an interest in an unusual occurrence. You have heard today of some of the available sources of information regarding occupational diseases. However, you are the one on the firing line whose index of suspicion must be high, whose area of interest must at least include a knowledge of the industry or plants you serve, whose general medical expertise remains current enough to allow you to recognize that an occurrence of disease (or for that matter, injury) may be unusual enough to prompt you into your own investigation, albeit limited.

EPIDEMIOLOGY FOR THE PART-TIME OCCUPATIONAL PHYSICIAN

PART-TIME EPIDEMIOLOGY AND PART-TIME OCCUPATIONAL MEDICINE

Reuel A. Stallones, M.D., M.P.H.

In one sense, to speak of part-time epidemiology is something like talking about part-time cardiac surgery. However, just as an internist or pediatrician needs to be aware of the relations between their observations and the possibilities of surgical intervention, so also should physicians generally appreciate the significance of certain observations in epidemiological terms. Epidemiology exists to assess the differential risk in the occurrence of illness between different groups. The risk differentials are then interpreted as due to differences in exposure or in susceptibility to the operation of those causes. Cause, in this context, has a much broader connotation than etiologic agent, for it includes the complex of circumstances that are involved in exposure and susceptibility, as well as the proximate inciting agent. This view necessarily entails consideration of the environment within which the events occur.

Every species evolved under environmental pressures which shaped and determined the characteristics of its members. Thus our present configurations and abilities are the result of thousands of generations of man-environment adjustment, in which the marvelous plasticity of the genetic machinery permitted that adjustment to be ever more finely tuned. A significant aspect of species adaptation is the promotion of individual adaptive mechanisms, so that each of us has the capability to adjust locally and temporarily to special environmental problems. We can, for example, on exposure to a hot climate adapt over a period of one to two weeks by markedly increasing our rate of sweating; or, we can adjust to a sudden physical exertion by a marked increase in cardiac output in a matter of seconds.

All organisms modify their environments, if only by their existence, but man has been most notable for his propensity to change the shape and character of the space around him. People have moved mountains, altered the course of rivers, created deserts, and moved plants and animals from one end of the earth to every other. When necessary, we have developed means to package small samples of a livable environment and exist in those packages in places where otherwise we could not hope to survive -- in extremes of heat and cold, under the sea, and in space. The long term problem with massive environmental modification is whether we shall so change the environment within which we evolved that our adaptive mechanisms fail and we cannot adjust to the environment we created.

That disease frequencies differ from one place to another is an observation that has intrigued scientists for many hundreds of years, and has provided much valuable information for epidemiological study. Whenever a major geographic difference of this kind is found, the explanation must be either that the two populations differ in genetic constitution or that exposure to different environmental circumstances is responsible. The number of diseases directly attributable to an identified genetic defect is quite small, and therefore the great majority of geographic variations in the risk of disease must be directly determined by environmental differences. This conclusion is of the greatest significance for the future of preventive medicine, for it offers hope that these environmental factors can be understood and modified to reduce the occurrence of disease.

Man-environment interactions are a complex set of relations between human beings and other humans, other animals, vegetation, climate, and the physiographic characteristics of a place. In a general way, the environment of the community at large exerts significant influence on all of the persons residing there, and establishes overall patterns of environmental adaptation.

The environment to which we are most immediately exposed may be considered to consist of four components, the general community environment, our homes, our workplaces, and our recreational sites (Figure 1). We might think of them as transition states and an adequate environmental assessment should take account of the characteristics of each, time spent in each, and the transitions between them. A partial listing of some of the elements of these environmental compartments is given in Figure 2.

The physician in occupational medicine will focus his attention on the workplace, but he should maintain an awareness of the broader environmental complex. The place of employment clearly presents many special opportunities for exposure to conditions that lead to illness and disability, and the importance of recognizing their association is very evident, both for humanitarian reasons and also to maintain productivity. Places of employment are commonly artificial environments, subject to manipulation and control, within certain restraints of feasibility and cost.

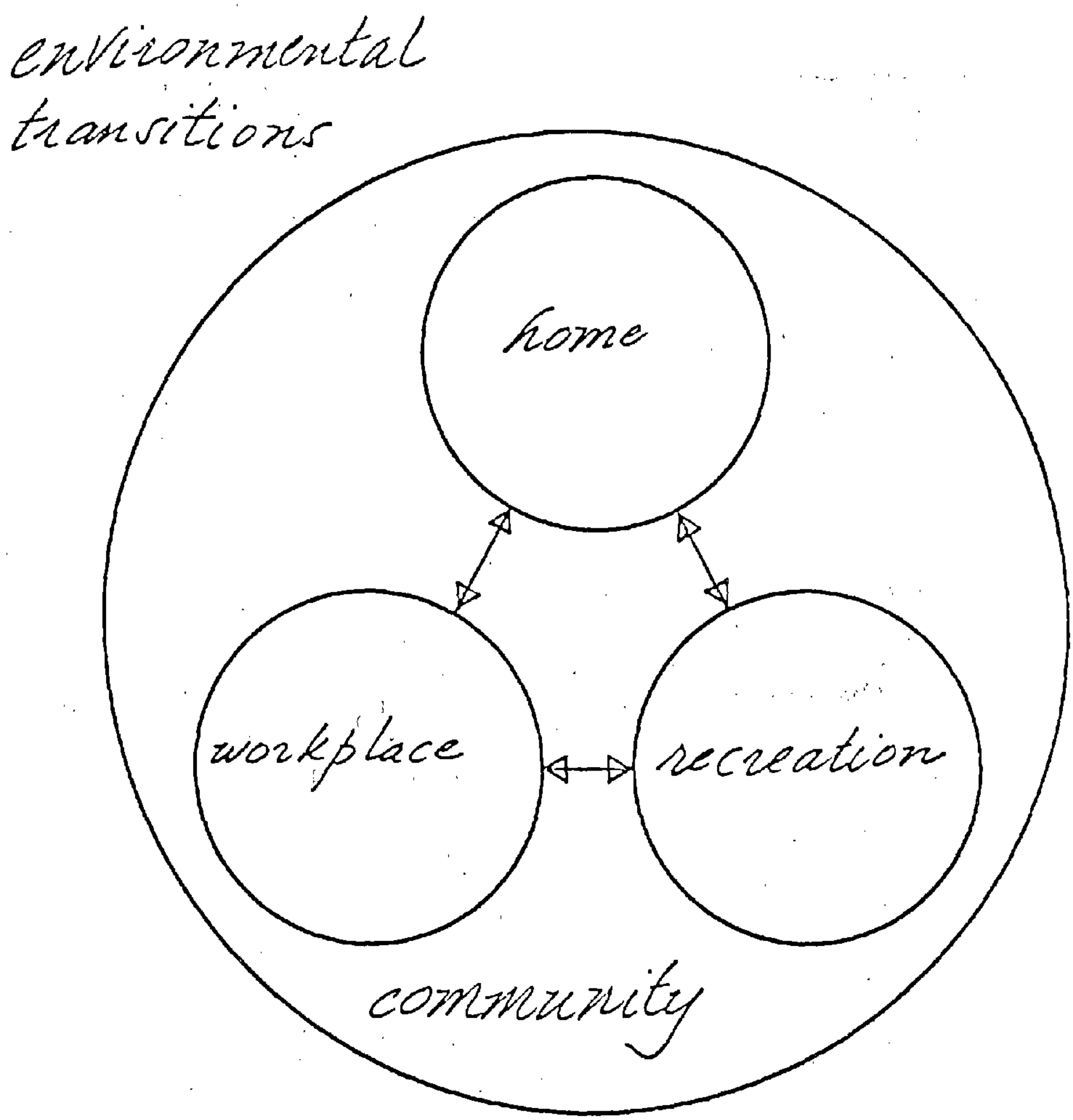
environmental
transitions
home
workplace
recreation
community

FIGURE 1

COMMUNITY ENVIRONMENT

GEOLOGICAL STRUCTURE/TOPOGRAPHY/ALTITUDE
TEMPERATURE/HUMIDITY/PRECIPITATION/SOLAR RADIATION
AIR QUALITY AND COMPOSITION
WATER AVAILABILITY, COMPOSITION, QUALITY
TRANSPORTATION
BUILDINGS
VEGETATION
ANIMAL
POPULATION DENSITY AND DISTRIBUTION
SOCIAL ORGANIZATION

HOME ENVIRONMENT

SPACE ARRANGEMENT
ENERGY USE
CLIMATE CONTROL
LIGHT, AIR, WATER, WASTE
ANIMALS
HOUSEHOLD DENSITY
HOUSEHOLD ORGANIZATION

WORKPLACE ENVIRONMENT

HAZARDS
- TOXINS
- MACHINERY

PHYSICAL ACTIVITY
HOURS OF WORK

RECREATIONAL ENVIRONMENTS

SPECIAL HAZARDS

FIGURE 2

Two major ways exist to determine how these environments should be managed. The first is based on a priori perceptions of hazards. That a given procedure may be dangerous may be perfectly evident, and appropriate steps may be taken to eliminate or reduce the risks to employees.

The second approach depends upon monitoring the experience of people in the workplace. This is necessary when the hazard is occult or previously unrecognized. If an illness breaks out in high frequency, or if a few cases occur of a disease which is very uncommon, then the simplest monitoring systems are likely to signal the appearance of a problem. However, if the illnesses resulting from occupational hazards are very uncommon, or have a long latent period between exposure and clinical manifestations, then the surveillance mechanisms must be more sensitive. Additional complications arise when workers are spread over a number of sites and when they migrate from one company to another or from job to job.

In order to assess properly the associations between work and illness, we need to be able to compute specific incidence rates. That is, the records systems must not only record illness, but must maintain an account of persons exposed to potentially dangerous situations. This may be done through personnel records according to job classification, place of employment, industry, or similar relevant characteristics.

The Occupational Safety and Health Act established a legal requirement for the maintenance of records as needed "for developing information regarding the causes and prevention of occupational accidents and illness." These will include "accurate records of, and...periodic reports on, work-related deaths, injuries, and illnesses other than minor injuries requiring only first aid treatment...", and further, "accurate records of employee exposures to potentially toxic materials or harmful physical agents..." Despite our understandable reluctance to establish dossiers and linked record files on individuals, these procedures cannot be as useful as they should be unless the opportunity exists to merge experience across companies throughout an industry and to trace individuals as they move. Evidently such record systems are subject to abuse, but reasonable safeguards can be incorporated, and the current social climate provides strong protection against their use for other than proper purposes.

At the center of all of these concerns is the physician in occupational medicine, whether full-or part-time. Upon his shoulders rests the responsibility to observe the health and illness experience of the work force, to assure that medical data are accurately recorded and maintained and to proffer advice on matters of health and safety. If he is to fulfill this responsiblity he should develop an awareness of epidemiological principles, an appreciation for the concept of differential risk across population groups, and an alertness to unusual events and aberrant circumstances that signal the need for special investigations and protective mechanisms.

IDENTIFICATION AND REHABILITATION
OF THE PROBLEM DRINKER

THE CRUCIAL ROLE OF MANAGEMENT AND LABOR IN EMPLOYEE ALCOHOLISM PROGRAMS

Ross A. Von Wiegand, M.B.A.

This discussion focuses on the fact that the most effective method developed to date for achieving broad scale early detection of alcoholism on a systematic basis, as well as the most effective method of motivating a victim of this disease to accept treatment, is through employee alcoholism programs.

At the outset I want to call attention to the fact that Occupational Physicians, beginning with Dr. George Gehrmann of DuPont, Dr. John L. Norris of Eastman Kodak, Drs. John Wittmer and S. Charles Franco of Consolidated Edison Co. of New York, and countless others, many of whom are in this room, have played a major role in the initiation and development of programs that deal effectively with the problem of alcoholism in industry.

Any discussion of these pioneering efforts must recognize the major contributions made by Mr. R. Brinkley Smithers of the Christopher D. Smithers Foundation. Through his personal influence and support he was able to bring together the Medical Directors and Presidents of major U. S. corporations at conferences which stressed the seriousness of the alcoholism problem in industry, and methods of dealing with it.

He funded many citizen-based community Councils on Alcoholism, which created a receptive climate for occupational alcoholism programs. He played a major role in funding research by the Labor-Management Services Department of NCA, which led to the development of the modern approach to employee alcoholism programming.

He supported the publication of the <u>Physicians' Alcohol Newsletter</u> by the American Medical Society on Alcoholism, and his Foundation has issued many publications on occupational alcoholism, including "Alcoholism In Industry - Modern Procedures", by Harrison M. Trice, Ph.D., of Cornell University, another pioneer in this field.

This discussion will focus on the following points:

1. The scope of the problem
2. The inherent difficulties of overcoming denial

3. The importance of motivation.
4. Historical background of employee alcoholism programs.
5. The new methodology.

I can think of no better way of setting the stage for this discussion than quoting an eminent authority on this disease, Luther A. Cloud, M.D., Assistant Vice President and Associate Medical Director of the Equitable Life Assurance Society of the United States. This quote is from an editorial entitled, "Treatment Is Not the Problem", in the Labor-Management Alcoholism Journal, November-December 1974, published by the National Council on Alcoholism, Inc.

He says:

"When I was a student in medical school, I received training in the specifics of the care of a tropical disease, endemic to the rainforests of Africa, known as 'dengue fever'. I became completely familiar with its symptomatology, etiology and the indicated course of treatment.

"In due course, I entered private practice, and among my first patients was a man with a disease called 'alcoholism', a condition which had been almost totally ignored in the curriculum of my school.

"This man was the first of many such patients --- all suffering from a disease I had never, until then, studied. On the other hand, you would be amazed at how few cases of dengue fever turn up in the waiting room of a physician practicing in the Borough of Manhattan.

"I had a fairly complete set of answers; but they were the answers to the wrong problem.

Paradoxical Disease

"As my interest in working with alcoholics increased, I became familiar with the various forms of treatment available, and in time I became reasonably knowledgeable in the most effective methods of dealing with the symptoms and the sequelae of this disease.

"During this same period, I also discovered that the efficacy of my treatment was not always the determinant factor in whether or not the individual patient recovered from the disease.

"And I learned why.

"I discovered that alcoholism is a disease for which the patient does not want to be treated! ....

"I discovered that those of my patients who were recovering from alcoholism --- those who managed to obtain and maintain sobriety --- where the ones who were effectively motivated.

"I had a fairly complete set of answers insofar as the medical treatment of alcoholism was concerned --- but they were the answers to the wrong problem.

"The problem was not treatment alone; the problem was motivation.

"There was another problem, closely allied to the problem of motivation. This was the difficulty of achieving early detection of the disease. The same reasons that kept the alcoholic from seeking treatment, operated to compel him to conceal his illness. ....

"The answer to both problems ---early detection and motivation --- lies in employee alcoholism programs which base referral to treatment on declining job performance, with the offer of a firm, fair choice between accepting the referral or accepting the disciplinary consequences of the poor job performance."

THE SCOPE OF THE PROBLEM

A conservative estimate of the number of men and women suffering from the disease alcoholism in the United States is 9,000,000.

All of the companies with which the National Council on Alcoholism has worked in installing formal alcoholism programs report alcoholism prevalence of at least 6% to 10%

Applying the lowest percentage (6%) to a current labor force population of 85 million gives us a population of over 5 million men and women employees suffering from the disease. A number of studies have shown that the average cost of alcoholism per employee, in terms of absenteeism, spoiled materials, poor judgment, disciplinary actions, hospital and medical costs, accidents and many other factors, is at least $3,000 annually per employee. This figure of $3,000 applied to 5 million employed victims produces a figure of 15 billion dollars direct cost of alcoholism annually to industry.

THE INHERENT DIFFICULTIES OF OVERCOMING DENIAL

The major problems militating against the goal of overcoming denial and the effects of denial are:

(1) The difficulty of early detection. The well recognized skill of the alcoholic in concealing his problem, combined with his opportunities for protective coloration in a society which not only accepts but strongly encourages alcohol as a social lubricant, makes the difficulty of early detection obvious.

(2) Society's continuing tendency to visualize the alcoholic as a Skid Row stereotype, to view alcoholism as a "self-inflicted disease" and to regard the victim as some sort of irresponsible, gutless, morally weak individual, provides a powerful incentive for the victim to both conceal and deny his disease.

(3) The powerful nature of the addition is such that the victim cannot accept the notion that he can live a satisfying life without it. The very thought of total abstinence is so terrifying that his motivation for concealment and denial are further reinforced. The validity of this point is strongly supported by the high rate of suicide among alcoholics which demonstrates that even death is often preferable to total abstinence.

(4) The deep-seated feelings of guilt, remorse, and shame of the victim, coupled with his feelings of hopelessness with respect to abstinence, are powerful preventives to his seeking help or accepting treatment.

In most cases a person prone to alcoholism, even in the early and middle stages of its progression, is aware that his drinking pattern differs from that of most of his friends. As the disease progresses, he becomes increasingly aware that his drinking is becoming more uncontrollable, and that it results all too often in embarrassing social, financial, employment, family, legal, physical, and other serious problems.

He generally is also all too aware that if he continues to drink, such problems will continue and probably become more serious. If he could control his drinking, he would. He tries and fails repeatedly. Yet for the reasons listed above he continues to vigorously deny having the problem. Kindly advice, lectures, or even threats from anyone regarding his drinking are as useless as a lecture to a tubercular patient to stop coughing; logic will arrest neither of these diseases.

To summarize, all the foregoing factors combine to produce a situation which is not usually present in the patient's attitude toward most other so-called "legitimate" illnesses --- the fact that the patient does not want to be treated!

THE IMPORTANCE OF MOTIVATION

The previous observations point up a major prerequisite to successful treatment, that is, to somehow motivate the subject to accept treatment.

We must deal with the reality that most persons with alcohol problems will rarely accept treatment unless and until the consequences of not accepting treatment are more intolerable than accepting treatment.

A useful analogy is the case of a person who fears the pain associated with filling a tooth cavity. When such a cavity progresses to the point of exposing or inflaming a nerve, the resulting intolerable pain usually overcomes the fear of the dentist and only then is successful treatment accomplished.

The fellowship of Alcoholics Anonymous (AA) has long recognized the importance of motivation. This recognition is commonly expressed in the statement: "AA is not for those who need it, but rather for those who want it." It is also inherent in the AA expression describing the movement: "AA is a program of attraction rather than a program of promotion." A common practice in most AA groups is that requests for direct help must come from the alcoholic person. AA recognizes the futility of trying to help someone who does not want help, at the request of a spouse, relative, or friend.

To summarize, this section has focused on the accomplishment of motivation as an essential prerequisite to successful treatment.

HISTORICAL BACKGROUND OF EMPLOYEE ALCOHOLISM PROGRAMS

From the early Forties to as late as 1964 most of the existing alcoholism programs were based on the theory that an alcoholic could be identified by observation.

The basic approach of these programs relied on a system which required identification of alcoholics as such, or the supervisor's suspicion that the employee had a drinking problem, as the basis for supervisory action and referrals to treatment.

This approach originated in the decade of the Forties, when the earliest programs came into being. These programs, some of which go back more than 25 or 30 years, operated necessarily on a basis of trial and error since there was virtually no knowledge or experience available on how to deal effectively with employee alcoholism.

These programs quite naturally reflected the notions held by the general public in the Forties. At that time the disease concept of alcoholism had negligible acceptance. Most of the public considered alcoholism a self-inflicted disease and a moral problem. More importantly the term "alcoholic" was associated with the Skid Row stereotype. It is important to realize that no one was really considered to be an alcoholic until he was in what we now know to be the late or final stages of the illness.

Thus, this first approach was based on two erroneous assumptions:

(1) That the "alcoholic" was readily identifiable by the supervisor through observing the physical and behavioral symptoms associated with the popular stereotype, such as bloodshot eyes, shaking hands, alcohol breath, loud and obnoxious conduct, and lack of cleanliness and personal grooming,

(2) That any employee not having such readily identifiable signs could not be an alcoholic and was, therefore, of no concern to the program administrators.

Unfortunately, a number of programs are still in existence which operate on this conceptual approach. Constructive action and referral procedures are initiated only for those employees who show readily observable signs of alcoholism and who, therefore, are in the late or terminal stages of alcoholism.

This approach obviously misses all employees who are suffering from the early or middle stages of alcoholism, which is to say that the majority of alcoholic employees receive no help from the program. Likewise, the company misses out on the major economic and personnel rewards obtainable through earlier detection.

The breakthrough in accomplishing early detection in employee alcoholism programs first began in 1964. Its origin was the result of many surveys of employee personnel records of a number of large national multiplant corporations conducted by the Labor-Management Services Department of the National Council on Alcoholism.

The conclusion warranted by the data developed in these surveys was:

> Every employee who is suffering from alcoholism even in its early stages, will have a deteriorating pattern of job performance which is readily observable by any reasonably alert supervisor.

This pattern is manifested through such objective factors as absenteeism, poor judgment, erratic performance, excessive material spoilage, decreasing productivity, poor interpersonal relationships, lateness and early departures, customer complaints, failure to meet schedules, and countless other instances of poor performance.

The importance of this conclusion is that these deteriorating patterns of performance were easily identifiable long before the supervisor had the slightest evidence that a drinking problem existed.

Yet analysis and follow-up of the employees thus identified as "problem" employees revealed that at least 50% to 65% of such employees were in this category primarily because of their drinking problems.

It was this observation, validated by the studies conducted by the National Council on Alcoholism, which led to the crystallization of a new methodology which is currently resulting in far earlier identification.

THE NEW METHODOLOGY

The new methodology consists of a system which focuses exclusively on monitoring job performance. Under this system all employees whose performance drops below acceptable standards, and where regular corrective procedures fail to restore acceptable performance, are referred to professional counseling and diagnostic services for identification of the employee's problem, followed by treatment appropriate to whatever the employee's problem is.

This approach solves what has been one of the principal and most persistent problems of alcoholism programs --- the unfortunate practice of getting management involved in the diagnostic, counseling, and other functions which should be solely the business of qualified medical and paramedical professionals. Under the new approach, the participation of all members of management is restricted to what is the proper and legitimate concern of management. It draws a clear and logical distinction between the "Management" and "Treatment" functions of the program. It eliminates the illogical and nonproductive practice of a suspected employee being "confronted" by a group of unqualified laymen such as supervisors, personnel staff, and union representatives, about his "drinking" problem.

THE TESTED METHOD

The most effective labor-management employee alcoholism programs in existence today employ the "job performance" early identification method as outlined above. This is combined with another new development in motivational techniques, the discovery that employers, with the cooperation of labor, have one of the most effective motivational tools developed to date --- the employee's desire to hold his job.

It has been found that neither labor nor management can provide the degree of motivation needed by working unilaterally. The reasons are obvious.

Labor, because of its relationship with its members, can give understanding and sympathetic offers of guidance, counseling, and treatment. Yet the evidence is overwhelming that persons with alcoholism rarely accept such offers. On the contrary, the most common reaction is one of intense resentment at the implication that they may have alcoholism.

Management has an effective approach through its legitimate need to initiate corrective action when the employee's job performance falls below reasonable minimum standards. The effectiveness of this tool is greatly enhanced if the union has been fully informed of the basis for such action.

The motivation is accomplished when the employee is offered a firm choice between:

(1) Accepting a referral for assistance through an absolutly confidential source of professional help, including identification of the cause of his performance problems, and diagnostic and treatment services, or

(2) Accepting the disciplinary consequences of his unsatisfactory job performance consistent with the established practice of the particular organization.

A detailed outline of this program is beyond the time limitations of this discussion. However, it is described in step-by-step detail in the booklet titled "A Joint Union-Management Approach to Alcoholism Recovery Programs" available from the National

Council on Alcoholism, Inc., 2 Park Avenue, New York, N.Y. 10016.

The programs utilizing the approach outlined in this discussion are regularly achieving alcoholism recovery rates ranging from 60% to 80% of the total number of men and women employees who are identified through the job performance approach and who are then medically diagnosed as suffering from alcoholism.

One example of the effectiveness of this program is given by Dr. Nicholas A. Pace, Medical Director of General Motors' New York headquarters office. He states, in an article appearing in the August 13, 1975 issue of the New York Post, that "The G-M program, under which 600,000 workers are covered for up to 45 days of treatment, has involved 8,000 heavy drinkers in the past two years with a recovery rate of 80 per cent.

"Other results are equally gratifying:

---an 85 per cent reduction in lost man-hours among those treated

---a 70 per cent reduction in the sickness and accident benefits paid to them.

--- a 47 per cent reduction in their sick leaves."

Unfortunately, of the approximately 1,600,000 American corporations, only some 400 to 600 have adopted some sort of formal alcoholism program. We have a long way to go.

In conclusion, I wish to make a personal remark to this audience of Occupational Physicians. On behalf of the National Council on Alcoholism, I wish to express our deep appreciation to all members of this profession for their efforts in initiating the alcoholism programs now in existence. This constitutes an enormous contribution to the alcoholism movement, and to the suffering alcoholics and their families.

I also assure you that all the experience and resources of the National Council on Alcoholism are available to all of you whom we might assist in any way in your present or future employee alcoholism program goals and objectives.

IDENTIFICATION AND REHABILITATION
OF THE PROBLEM DRINKER

THE PROBLEM DRINKER

Phyllis Tuttle, R.N.

Having been asked to address this subject in a general way, I am about to take the risk of being described as presumptuous, as I extend the meaning of the word "general" to include the concept of elementary or basic, and to talk a bit about problem drinking and alcoholism.

There is hardly a term in current public health thought as vague, elusive, and ambiguous as the term "alcoholism." That it means many things to many people is bad enough. That many people use it without even attempting to specify the idiosyncratic meaning the term has for them makes the situation worse, both for those who wish to promote services and programs for the alcoholic and for those who wish to introduce concern with alcoholism into systematic theory and research.

Whether we like it or not, the term alcoholism is firmly established in the thought and actions of all of us. We seem to have taken hold of the term in spite of (or, perhaps, because of) its ambiguity.

I would like to define, as simply as is possible, the terms problem drinking, alcoholism and alcohol abuse, as I see them. All of these conditions are included within the context of drinking behavior which exceeds the bounds of community limits regarding drinking and impairs job performance. The individual who regularly drinks to excess and who impairs his job performance whether by a hangover or by attempting to carry out his job obligations while actually under the influence of alcohol is an "alcohol abuser" or problem drinker. Over a long period, often as much as 10 to 15 years, tolerance to alcohol can reach a level where the organism is unable to function without the ingestion of alcohol, and when alcohol is not available to the organism, there are physiological withdrawal symptoms. This phenomenon of increased tolerance and the presence of a withdrawal syndrome when alcohol is not available is alcoholism. As few persons are able to know another's tolerance levels or to foresee the symptoms of withdrawal, we must of necessity base our concerns and our actions on behavior or job performance.

By these definitions we see that all problem drinkers are not alcoholics, but I think it is safe to say that all alcoholics are problem drinkers. And from this definition it can be assumed that the problem drinker, differing from the addicted drinker or alcoholic, can control his drinking and his hangovers in a setting of good or close supervision and consistent and persistent application of disciplinary or corrective procedures. In this category, one would expect that after one or perhaps even repeated warnings regarding drinking on the job or coming in hung over, the individual is able to confine his drinking to occasions which do not interfere with job performance.

Those employees who are not able to control their drinking in this same well-supervised setting are the persons who fall into the category of alcoholism or alcohol addiction.

Although most adults in our country drink alcoholic beverages, it is only a small percentage of these people who have problems related to the use of alcohol. Of the nine and a half million alcoholics in our country, it is estimated that at least half of this number are to be found within the work force. It is reasonable to assume that 1 of every 20 employees is or will become an alcoholic. Because alcoholism is characterized by a loss of control over behavior, it is understandable that the alcoholic will be found to be a problem employee as the disease progresses. However, the ways in which the alcoholic becomes a problem employee are very subtle in the early stages of the development of this condition. Some employees who become problems because of irritability, periods of absence from the job where formerly none occurred and erratic judgment may sometimes be troubled persons in the early stages of alcoholism. When such people have had good work records, we are inclined to overlook the temporary lapses and rationalize them away. Sometimes a misguided sense of loyalty leads fellow employees and supervisors to "cover up" for such problem employees. On the other hand, it is just at that time that we have the best chance of helping them. It is the aim of occupational alcoholism programs to help you to identify these people early, to help others to identify them, and to help the problem employees to find help for themselves.

It is generally accepted that the causes of alcoholism are multiple and include physical, psychological, pharmacological, socio-economic and cultural factors. Because of this multiple causation, it is impossible to say why some people who use alcohol abuse it or become addicted. Take some clay, some sand, a piece of wax, some wood shavings and some meat and throw them all into a fire.

Observe how they react. One dries up, one hardens, one instantly melts, one blazes and one starts frying - and yet every one of them has been acted upon by exactly the same force. Human beings react in different ways under identical influences of environment and circumstances. Reacting to exactly the same external force - alcohol - one person may become relaxed, another may become hostile and aggressive, and still another may be headed for destruction. The important fact is that what is done to people is far less crucial than what they do in reaction that determines whether they will be diagnosed as a social drinker, a problem drinker or an alcoholic.

In the 3 years that I have been with Ford, I have learned that the basis for most resistance to instituting programs or procedures for implementing our policy is the belief that such programs would be asking that current disciplinary procedures be waived for these problem employees, leading to a breakdown in the enforcement of all discipline and order. Therefore, I would like to start any discussion of an occupational alcoholism program by stating that one of the most useful motivational tools to be used in working with the alcoholic is a firm, clearly-stated disciplinary procedure which is used consistently. In working with spouses of alcoholics, we emphasize over and over again, "Don't make threats unless you are willing and able to follow them through." Because of the sensitivity of the alcoholic, he, or she, will know when a threat is rea when it is only words the alcoholic will skillfully manipulate the spouse, the supervisor, or the personnel person with whom he is interacting.

There are good reasons why this motivational tool of our job is effective when corrective procedures are adhered to. These are found in the very nature of the illnesses about which we are concerning ourselves. The repetitive drinking behavior of the alcoholic, in spite of the problems these behaviors cause, is perhaps best explained by the fact that these substances provide a "good" feeling or escape from the stresses and problems of every day living. Most of us drink or take drugs such as Alka-Seltzer or aspirin on occasion, and if you can look at your own actions you will perhaps be better able to understand what I am saying. When you have a drink after work, before lunch, or at a party, you find it to be relaxing, helping to make you feel more at ease both with yourself and with others.

I have never known an alcoholic who started drinking with the intent or purpose of becoming an alcoholic. The alcoholic started drinking for the same reasons the rest of us did. We do not know for certain why his drinking became more frequent, excessive, or necessary. Perhaps he got a "higher high," or perhaps because of a lower frustration level he needed "to relax" more often. In all probability, it was a combination of both of these factors. With the social and legal acceptability of drinking in our society, this individual, once he started drinking, was trapped. For his tolerance increased - instead of getting sleepy after a few drinks or being sick from drinking too much, he was soon able to consume large quantities of alcohol with no outward signs of drunkenness or intoxication. Thus we find one of the early warning signals of this disease to be increasing tolerance. In lay language, we are talking about the individual who is said to have a hollow leg, the gal or fellow who ends up driving the others home in spite of the amount of alcohol consumed.

Coupled with the fact that the drug is doing all this and even more for the alcoholic, is the complicating factor that most people start drinking while in their teens. This is the time in life when one must learn the lessons of life, or in other words, mature. This learning includes how to cope with and handle problems. If in these years a person has found what for him is a panacea for dealing with frustration and stress, it is not surprising that he returns to this panacea rather than learning other coping mechanisms.

This is the situation of the alcoholic who is often described as immature. In working with him it is important to recognize that, when alcohol is taken from him, he finds himself in great distress as he attempts to cope, not only with everyday problems, but with the compounded problems which his drinking has created. So, the alcoholic is an individual with many problems and few skills with which to handle these problems. Clearly, a return to drinking will make him more comfortable for the moment.

In other words, the more rewarding or comfortable any behavior is, the more one can expect the individual to find ways of reverting to that particular behavior when under stress. Only when any given behavior hurts or causes discomfort in a degree greater than the pleasurable consequences of that behavior can we expect a change. And this is another reason for consistent and firm discipline or corrective action.

This threat of loss of a job, with its accompanying loss of self-esteem, as well as the loss of the economic means for obtaining alcohol, is often the motivational tool necessary to direct the individual into treatment. At this point the individual can be made aware that his drinking will cause more pain - job loss - than pleasure. And so, too, at this point the alcoholic finds himself having to make a realistic choice of continuing the drinking and losing his job and all self-respect, as well as his livelihood, or accepting treatment and retaining or regaining his self-respect.

If established progressive corrective or disciplinary procedures are not applied consistently, the alcoholic will find ways to manipulate supervision in such a way that he will be able to continue to drink. This inconsistent or lack of use of disciplinary procedures can be accurately described as "killing the employee with kindness."

The best program for your location will be one geared to the needs of your particular location and population. In planning your program, utilize alcoholics. Ask for the help of your training people. Look at as many as possible of the films and materials which are available. Work together as a team - recovering alcoholics, medical staff, training and industrial relations personnel and, at locations where there are hourly employees, the designated Union program coordinator.

Whether responsibility for your program is placed in the medical department or within the personnel function of the company, seems to me to be immaterial. At Illinois Bell and at Ford Motor Company such responsibility lies in the medical department. In other companies such as American Telephone & Telegraph, my local police department, and many other effective programs, such responsibility lies within personnel. There are valid reasons available for placement of this type of program in either. However, wherever responsibility is, the physician will find himself involved, and the more knowledgeable he is about the problem, treatment methods and facilities, the more effective will be the program.

The need for continuing educational programs is a priority area. Such education must include management and all supervisory personnel and, of course, employee information. A separate paper could be presented on this subject of education, but in the interest of time I will merely mention it here. However, if you have questions and/or interest in this aspect of an occupational alcoholism program, any of the three of us will be happy to address this subject in greater detail during the discussion period.

Other areas which should be of interest to you are involvement of the physician with community action groups and community resources.

Before concluding this presentation, I would like to talk a bit about treatment and rehabilitation.

Most alcoholics require outside intervention and professional treatment to interrupt the progressive process of addiction. Because programs and agencies already exist in many local communities which can provide the expertise, continuing treatment and follow-up needed by the alcoholic, it is the policy of most companies to refer those employees who have problems with alcohol to local community programs.

Successful referrals to treatment and rehabilitation programs in your community require that you be aware of the range of services available to you. Your most valuable resource is the local or nearby affiliate of the National Council on Alcoholism. The Council can be the key to finding all the available resources that are appropriate in your community. If there is no Council nearby, such information should also be available through your Public Health Department or the Mental Health Centers within your community or state.

To conclude on a positive note, I would like to report that a recently completed follow-up study of a sample of clients being treated in federally funded alcoholism centers has shown a 71% recovery rate at 18 months following admission in terms of alcoholism intake. And, as with all other chronic conditions, the earlier that the problem is identified and the drinking pattern interrupted, the better is the chance for recovery.

IDENTIFICATION AND REHABILITATION OF THE PROBLEM DRINKER

ALCOHOLISM IN INDUSTRY -- PROPOSED SOLUTIONS

Robert R. J. Hilker, M.D.

Alcoholism is a widespread yet highly misunderstood disease. We are familiar with the symbols associated with other important health problems: the cross of the National Lung Association, the sword of the American Cancer Society, and the heart and torch of the American Heart Association. Alcoholism, unfortunately, has too often been symbolized by the skid row drunk. If concepts of alcoholism are influenced by this distorted view, then it impedes our efforts in prevention, treatment and rehabilitation. Only 3% fit this picture--97% are working.

Growing concern over alcoholism has resulted in various methods designed to control this disease. The methods were basically aimed at control of the use of alcohol, and could be classified as: 1) prohibiting the manufacture, distribution or consumption of alcoholic beverages, 2) indoctrinating people in the consequences of excessive drinking, 3) controling the manufacture, distribution and sale of alcoholic beverages, and 4) substituting "counter attractions", such as recreational facilities in isolated communities where drinking seemed to be the only release from boredom. Laudable as the aims of these efforts may have been, they have not been successful.

Failure comes not only through the wrong approach but also because there are serious obstacles to treatment. Here are some examples: 1) Most alcoholic employees are hidden and protected. The family or the immediate supervisor often may try to deal with the problem in their own way. 2) The alcoholic employee denies drinking heavily and has little motivation to seek help. 3) The alcoholic employee cannot be forced to seek help. 4) There has been a lack of consensus about the cause of this disease. So, although the medical profession recognizes there are different types of alcoholism, treatment has developed in a haphazard, empirical fashion. 5) There has been professional apathy toward treating alcoholics. This starts at the medical and nursing school level where, even now, courses in this illness are grossly inadequate. 6) Alcoholism has been recognized as a disease only recently. 7) Hospital facilities are inadequate to care for and rehabilitate the acutely ill alcoholic. 8) Law enforcement agencies and businesses alike have generally taken a punitive attitude toward the alcoholic. 9) Alcoholism is generally not covered under insurance plans.

Fortunately, we now are better able to understand and treat this disease. There are now many good programs in industry and the medical profession has begun to show greater interest. For instance, the American College of Physicians recently made a special effort to alert its members to its obligations in understanding and treating alcoholism. The American Occupational Medical Association and the American Academy of Occupational Medicine have programs to help combat this disease. The American Medical Association has published an excellent manual on alcoholism. Many hospitals are developing specialized facilities and programs specifically for alcoholics. Excellent inpatient treatment centers are available in most areas of the country. These treatment centers are branching out into outpatient long-term followup care as a further method of treatment.

Great concern has been expressed at all levels of government. The National Institute on Alcohol Abuse and Alcoholism has been established in the Department of Health, Education and Welfare. One branch is solely concerned with the problem of alcoholics in industry. State and local governments are developing programs of education and facilities for rehabilitation of the alcoholic.

Business management is more aware of the problems of alcoholism, its costs, and the variety of solutions. For instance, the National Industrial Conference Board has published a monograph, "Company Controls for Drinking Problems", for all its members. Almost every management journal has carried articles about alcoholism. The press, radio and television have brought the consequences of alcoholism and the techniques of rehabilitation to the public. Unions, too, are more interested in this illness and in the fate of employees suffering from it. This interest has led to union-sponsored educational and rehabilitation programs and negotiations of insurance benefits for alcoholic employees.

The work of Alcoholics Anonymous is legendary. This incredibly successful organization was founded in 1935 by two alcoholics - a physician and a stock broker - and has now grown to an estimated 600,000 members. By their conspicuous success, they have contributed to the recent change in public opinion about this disease. In short, industry, the occupational physician and nurse are now feeling many internal and external pressures to develop new and better programs for alcoholism.

A program for the control of alcoholism in industry does not need to be expensive or extensive. The program can easily be tailored to the number of employees, the budget and available facilities. There are some factors which are common to all successful programs in industry:

1) Recognition of alcoholism as an illness -- its inclusion in disability and insurance plans.

2) The understanding and support of all levels of management of the company's position.

3) A written statement of policy.

4) Union support

5) Education of all employees and their families.

6) Education of all levels of management in the techniques of recognition, referral and rehabilitation

7) Establishment of referral sources either in the company or community.

8) Adequate long-term followup.

9) Research in various aspects of alcoholism.

10) Education of physicians and nurses in the problems of alcoholism and rehabilitation.

The program design will be determined by the budget and facilities available. Most large firms have a medical department. For them it is recommended that the alcoholism program be a medical department responsibility. The occupational physician or nurse must become familiar with the techniques of handling these employees. A counselor, who could be a member of Alcoholics Anonymous, a psychologist, or a trained social worker, may also be a part of the Medical Department team. This counselor would work directly with the employee and family. Adequate arrangements must be made with community resources for hospital and outpatient care and treatment. Continuous communication with the employee's department is essential. It is only through the constructive coercion of both departments that most employees will successfully complete a rehabilitation program.

In other industries the responsibility for the alcoholism program has been assigned to departments such as personnel or labor relations. For an industry with no medical facility, this approach is all that is available and a simple solution may be to have a volunteer counselor - perhaps an employee in AA - to arrange for the services of an outside physician or hospital rehabilitation program. Regardless of the type of program selected, it need not be expensive. Its success will depend on meeting the essentials of a good program and the zeal and enthusiasm of the people directing the program.

It is realistic and advantageous for industry to conduct a rehabilitation program. Government, public and union pressures will eventually force industry to do this. However, the same moral, medical and economic arguments that apply to emotional illness apply to alcoholism and drug abuse as well. Alcoholism will be found in any employee population. Industry can only protect itself against the actual and hidden costs by meeting the problem head on.

A brief summary of the Illinois Bell Telephone Company program will illustrate a successful operating plan:

First, there is complete cooperation of all levels of management in a commitment to recognize alcoholism as an illness, to treat it as such under disability and insurance programs and to offer a chance for rehabilitation.

The following written policy statement covering alcohol and other drugs has been well publicized in the company. It is presented here as a workable policy that has stood the test of time. It may be adapted to suit the individual needs of any particular industry.

> "The use of any drug interfering with safe and efficient job function is a matter of company concern and will be dealt with in an appropriate manner.
>
> "Alcohol is also a drug about which there is serious concern. Its excessive use will be considered in the same manner.
>
> "The company recognizes that drug misuse may be a serious medical problem. A rehabilitation program is offered in the Medical Department. Employees cooperating in a clinically supervised rehabilitation program may be eligible for benefits.
>
> "Possession or use of illegally obtained drugs or alcohol on the job or on company premises may be a cause for dismissal."

We feel it is important to treat alcohol and other mind-altering drugs in the same general policy statement.

Education of the employee population is accomplished in several ways. Members of the Medical Staff and nurses talk to many employee groups. Articles appear in the company magazine and newspaper. A pamphlet was mailed to the home of all employees, explaining the policy on alcoholism and offering help in rehabilitation. In addition, a condensation of the book "The Drinking Game and How to Beat it" was sent to the home. Films are shown at company locations and health education material is available in easily accessible locations. Employee education is seen as a continuing part of the health education program.

Managers are educated in three ways. First, medical staff members present the program at various operating staff meetings. Second, a videotape is shown at employee group meetings. Finally, a published guide is available for the supervisor.

This program has been in operation since 1950. Over the years it has grown in size and sophistication but still operates under the same basic concept of case finding by the employing department, constructive coercion and a sincere desire of everyone to help the ill employee.

TABLE 1--HOW REFERRED TO PROGRAM

	Women	Men	Total	%
Employing Dept.	86	277	363	90
Medical Dept.	5	11	16	4
Self	2	21	23	6
Total	93	309	402	

It is obvious to us that we must rely on the employing department as our case finder (Table 1). Not only must we rely on them, we must educate them in the art of case finding. This must be a continuing effort. Management changes. Goals change. We must constantly adapt our efforts to these changes. This can only be done by education - and re-education - of management.

TABLE 2--YEARS OF SERVICE WHEN REFERRED TO PROGRAM

	Women	Men	Total	%
Under 10	19	58	77	19
10 - 19 years	23	99	122	31
20 - 29 years	27	77	104	25
30 - 39 years	23	56	79	20
40 or over	1	19	20	5

TABLE 3--AGE WHEN REFERRED TO PROGRAM

Age	Women	Men	Total	%
Under 25 years	2	7	9	2
25 - 34 years	4	56	60	15
35 - 44 years	30	95	125	31
45 - 54 years	50	106	156	40
55 or over	7	45	52	12

The next two tables again show us an interesting aspect of our patient population. Table 2 shows the years of service. Over 50% of patients had between 10 and 29 years of service. Table 3 shows the range of ages. Here we see that 71% were between 35 and 54 years old. This data carries a message which is loud and clear. We were simply missing alcoholism in its early stages. Knowing the general natural history of the development of this disease, we can safely say that alcoholism had been present for a long time before it resulted in a job crisis of sufficient magnitude to demand correction. The obvious remedy to this is to alert our operating departments to have health evaluations much earlier than was done in the past. Repeat them again and again if necessary. It also made our physicians aware of the subtle nature of early alcoholism and has made them much more alert to the disease and much more efficient diagnosticians. Recently we have noted many younger employees are mixing drugs and alcohol, or are switching to alcohol as the drug of choice.

TABLE 4--MARITAL STATUS OF PATIENTS

	Women	Men	Total	%
Single	19	39	58	14
Married	33	227	260	64
Widowed	10	5	15	4
Separated	6	9	15	4
Divorced	25	29	54	14

The marital status of patients is of academic interest and did not materially change our program (Table 4). However, we have gradually come to the realization that alcoholism is often a family disease affecting both husband and wife. We now thoughtfully look into this possibility. The incidence of divorce or separation was much higher in women. This could indicate a difference in the view of society toward alcoholism in women, or could indicate that the married dependent woman is willing to endure more to save her marriage.

TABLE 5--ESTIMATED MAJOR AREA OF LIFE STRESS*

	Women	Men	Total	%
Self	69	277	346	86
Home	42	60	102	25
Job	12	24	36	9
Other	1	13	14	3

* Some Patients have two or more areas of stress.

Major life stress did not appear to be job-connected in many patients (Table 5). In those cases where it has been proven to be significant we have made every effort to change the job situation if the solution seemed reasonable.

TABLE 6--DIAGNOSIS OF TYPE OF DRINKING

	Women	Men	Total	%
Heavy Drinker	17	66	83	21
Chronic Alcoholic	54	201	255	63
Reactive Drinker	7	16	23	6
Symptomatic Drinker	15	26	41	10

Knowing the type of drinking is very important (Table 6). Heavy drinkers (21%) are not true alcoholics, but drink in a serious, damaging, recreational way. They are able to control their drinking much easier than the other types. Typical chronic alcoholics (63%) are people in whom drinking is compulsive and self destructive. Reactive drinkers (6%) simply react to life situations by drinking. Symptomatic drinkers (10%) are suffering from an underlying emotional illness. Alcoholism is a manifestation of emotional illness. We now know that different techniques of treatment are required. One cannot simply apply the same type of therapy to every patient and expect success! We believe that this is extremely important and may be a factor in the disappointing results of some industrial programs.

TABLE 7--ACCEPTED ALCOHOLICS ANONYMOUS

	Women	Men	Total	%
Yes	39	183	222	55
No	54	126	180	45

Fifty-five percent of patients accepted Alcoholics Anonymous (Table 7). These came almost entirely from the group of chronic alcoholics - 63% of the patients. The chronic alcoholic benefits from this fellowship and the support it gives. These same chronic alcoholic patients benefit greatly from seeing our counselor at regular intervals. This is actually extending the AA philosophy to a one-to-one basis.

TABLE 8---SUCCESS IN REHABILITATION IN 402 REFERRALS

	Women	Men	Total	%
Rehabilitated	52	178	230	57
Improved	20	40	60	15
Accepted Help	17	75	92	23
Not Controlled	4	16	20	5

A recent study of 402 employees for whom we had employment records for five years or more prior to entering the program and five or more years after referral illustrates the success that may be achieved.

The rehabilitation rate is important. "Rehabilitation" means no drinking for one year or more. Fifty-seven percent were in this category. An additional 15 per cent were improved. These employees were functioning satisfactorily on the job even though they had not totally quit drinking. This makes a total job rehabilitation rate of 72 per cent.

There is more to the story, however, than just rehabilitation. If it is truly successful it should have measurable parameters of benefit to the business. Among the parameters were: 1) job efficiency, 2) sickness disability absence (absence lasting more than seven days), 3) off-the-job accidents, 4) on-the-job accidents. A successful rehabilitation program should produce positive results in all of these areas.

Job efficiency was estimated by the employing department both before and after referral to our program. It is clear the rehabilitated employee is a better employee. (Table 9)

TABLE 9--ESTIMATE OF JOB EFFICIENCY

	5 Years Before		5 Years After	
	Employees	%	Employees	%
Poor	112	28	51	12
Fair	199	50	119	30
Good	91	22	232	58

TABLE 10--NUMBER OF SICKNESS DISABILITY CASES*

	5 Years Before	5 Years After
Women	299	75
Men	433	281
Total	732	356

* (MORE THAN SEVEN DAYS OF REPORTED ILLNESS)

It is well known that alcoholic employees have a greater absence rate. The statistics presented are for absences of eight days or more. No medical records are kept of absences of seven days or less. The disability rate after rehabilitation is approximately the same as for our whole employee population. These statistics simply mean the company has been paying the cost of alcoholism even though it had been called some other illness. By doing so it was literally helping to perpetuate an illness. By recognizing the problem, a marked reduction in cases was accomplished. A conservative estimate of the direct dollar savings to the company in sickness disability benefits alone is $459,000 during these five years. In addition there were savings in departmentally-paid absence costs, insurance utilization, and all the other hidden costs of alcoholism. (Table 10)

TABLE 11--NUMBER OF ON DUTY ACCIDENTS*

	5 Years Before	5 Years After
Women	4	1
Men	53	10
Total	57	11

* (ANY ACCIDENT REQUIRING MEDICAL TREATMENT)

TABLE 12--NUMBER OF OFF DUTY ACCIDENTS*

	5 Years Before	5 Years After
Women	32	6
Men	43	22
Total	75	28

* (MORE THAN SEVEN DAYS ABSENCE)

It is also well known that alcoholic employees have more off-the-job and on-the-job accidents. The results obtained by rehabilitation clearly has had a dramatic influence on the accident rate. (Tables 11 and 12)

When one considers the advantages to the company as well as to the sick employee, the family and society, the value of a rehabilitation program becomes quite clear.

POTENTIAL TRAUMA IN THE WORK PLACE

SOURCES OF OCCUPATIONAL INJURY OCCURRENCES

Alfred C. Blackman, P.E.

When the subject of "Accidents" is broached it appears that the listener immediately relates the subject to a personal experience. Since any one person has, in all probability, not had many such occurrences, the perception of the "cause" or "causes" is limited. Statistics published either by the National Safety Council or the U.S. Bureau of Labor Statistics indicate that there are approximately 2,000,000 occupational injuries annually that resulted in some loss of time by the injured worker. The incidence rate for all of the private sector is 3.4 lost work day cases per 100 employees. The same statistical data indicates that approximately 6,000,000 cases requiring medical attention occurred and were reported. Excluded from consideration are those incidents which require only "first aid treatment."

The incidence and severity of occupational injuries varies widely depending upon the industry. For example, Contract Construction has a rate of injury approximately 8 times as high as those industries classified as "Finance, Insurance, and Real Estate." This is not hard to understand when it is considered that the activities in these industries are quite different. In the construction industry, workers are in an outdoor environment, using large pieces of motorized equipment, working on and with temporary structures, handling heavy and bulky building materials, as well as using powered tools. In contrast, workers in banks, insurance companies, real estate offices and similar establishments are in a confined and controlled environment, are seated at desks or counters, filing papers or typing letters. Probably the greatest hazard is traveling on the highway in a motor vehicle as a part of the job.

Thus, the environment and the tasks performed by the worker are important variables in the occurrence of occupational injuries. Even within a given industry, tasks vary by occupations. Past studies have shown that carpenters and laborers in the construction industry suffer more injuries than electricians, although no data was available to indicate the number of workers in each occupation at risk. However, the tasks performed are different and pose different hazards. The carpenter builds scaffolds, concrete forms and builds floors for others to work on. The electrician installs conduit and wires in the walls after they are constructed. Again, the task becomes an important variable. Many other examples can be found to differentiate between the hazards created by the task.

Occupational accidents have been described as the result of interaction between human beings, the environment, the activity (or task), the machine or tool being used and the materials being used. These are five major components, each of which can have a significant number of variations. Even in a controlled environment such as one might find in a bakery, the task of operating a machine presents a different hazard than placing donuts in a box, or loading a carton of donuts into a truck for delivery to the consumer. In those operations that are automated such as bread wrapping, the machine malfunctions occasionally, which requires a person to remove the damaged product, and then make an adjustment or repair in order to continue the operation. The hazard created by this non-routine task is one that frequently results in an injury.

Accidents are, in my judgment, complex occurrences. To determine a single "cause" is not feasible or realistic. Rather, it is the combination of a number of variables, which, occurring in a sequence which result in an accident which may or may not result in an injury. The severity of the injury can be predicted by the type of hazard that is produced. The potential severity of an injury from hitting one's finger with a hammer is much less than having one's hand caught in a punch press where an amputation is practically certain. On the other hand sources of injuries can be identified. An example of this would be the frequency of eye injuries occurring during the use of grinding wheels. In this example, the task of applying metal to abrasive wheels would be an operation or activity that would justify a careful and thorough study of the entire operation including the equipment, the material, the environment and the type of personal protective equipment that would provide the worker with protection.

Although the number of occupational injuries is known, the details concerning the task, the environment or the machine or tool being used is not available in a form that permits the information to be retrieved. The report that describes the occurrence which resulted in the injury is usually completed by a person who has obtained the information from a third person. Although the report may describe what the injured person was doing, the nature of the injury and the part of the body that was injured, this only identifies the need for further investigation.

The physician who treats the injured worker is in a unique position to assist in the prevention of occupational injuries. During the course of treating the injury casual conversation can elicit information, which, if recorded, can add substantially to the information concerning a specific occurrence. Should the same type of injury reoccur frequently from the same task, this information can, at the very least, indicate the need for more careful study of that task, activity or machine.

POTENTIAL TRAUMA IN THE WORK PLACE

BEHAVIORAL - PSYCHOLOGICAL FACTORS AS RELATED TO THE OCCURRENCE AND PREVENTION OF OCCUPATIONAL TRAUMA

H. Harvey Cohen, Ph.D.

INTRODUCTION

Behavioral and motivational research within the National Institute for Occupational Safety and Health (NIOSH) is organized into three program areas. These are:

(1) Behavioral Toxicology which is assessing behavioral and neurologic responses to chemical and physical agents found in industry for their usefulness as early warning indicators of potentially hazardous exposures.

(2) Psychological Stress which seeks to characterize the health impact of job demands as distinct from the threat posed by exposures to known chemical and physical hazards.

(3) Behavioral Safety which is aimed at researching behavioral and motivational factors influencing accident risk at work and testing the merits of psychological approaches to accident control.

This paper will focus on the behavioral safety program area by offering examples of on-going research dealing with causal factors in worker accidents, psychological strategies for accident control, and management approaches to workplace safety. Those interested in the behavioral toxicology and psychological stress areas will find them described in several recent NIOSH publications[1,2,3]. Needless to say, the thrust for much of the aforementioned types of NIOSH activity has come from the Occupational Safety and Health Act of 1970[4] which explicitly directed the Institute to include psychological, behavioral and motivational factors in researching problems of worker safety and health and in developing needed corrective measures.

CAUSAL FACTORS IN WORKER ACCIDENTS

That human error, may lead to work accidents is without question. Aside from a variety of human factors, organizational, machine environmental and work process considerations may also contribute to accident occurrence at work. The frequent assertion that human errors underlie most of these mishaps remains utter speculation since an adequate data base for indicating the significance of different kinds of factors to accident causation in industry does not exist.

Moreover, reasons for the performance failures of workers or risk-taking behavior have not been studied in any systematic way. Indeed, the bulk of accident investigations in industry and reports of worker injuries acknowledge little more than the type of accident, e.g., slip, fall; the agent or source of injury, e.g., floor, ladder; and the part(s) of the body affected. Statistical surveys, essentially collating the data found in these injury reports, suffer from the same shortcomings.

Recognizing that data on accident causation are basic to realizing suitable and effective safety control measures, attention is being given to promoting accident investigation and data reporting procedures that could yield more useful information. One suggestion holds that concentrated in-depth studies of fewer worker accidents of a select type might prove more useful in identifying causal factors than low-key examinations of a greater number of mishaps[5]. In this regard, successful use of accident investigation teams in analyzing aircraft, highway, fire, and explosive accidents is noteworthy.

Recognizing these needs, NIOSH has initiated a contract study to develop and apply an investigation methodology suitable for determining accident causal factors. Essential features of the study include:

(1) The use of a multi-disciplinary team in investigating workplace accidents. The investigations are being performed by several specialists all with pertinent expertise and experience, including a physiologist, M.D./epidemiologist, industrial psychologist, safety engineer, records specialist, and the safety official at the plant where the mishap is reported.

(2) The development of a conceptual framework for organizing and classifying information about accident causation which takes account of factors pertaining to the worker (e.g. physical condition, attitude); the company (e.g. work policies, practices); job requirements; equipment used; and the workplace surroundings. These data will be obtained from interviews with the injured worker, witnesses to the accident, the worker's supervisor, plant safety official, attending medical personnel and other

management staff, as well as from physical measurements at the accident site, and review of available company records.

(3) The application of the methodology on a quick-response basis and its use in investigating specific types of accidents of high frequency and severity. The present study is focussing on occupational falls which, according to available figures, represent over 20 percent of all injury cases and 11 percent of all work deaths.[6] In-depth investigations of these accidents necessitate the multidisciplinary team being at the accident site within 24 hours after the mishap occurred. For this reason, such accidents are being studied at establishments fairly close to the contractor's location. All work establishments cooperating in this study have past accident experience suggesting fall-type injuries to be a recurring problem in their facilities. Plans for applying this same type of approach in defining the causes of other serious types of industrial accidents and injuries are envisioned in future studies.

(4) An analysis of the data collected during the investigations appropriate for defining common elements as either primary or contributing factors in the types of accidents studied. With regard to occupational falls, the current contract is expected to yield important insights into their occurrences bearing on needs for new or improved safety standards (e.g., frictional coefficients of work floor surfaces, design of work stairs) and recommended safe work practices.

In a parallel effort, NIOSH is accompanying local OSHA compliance officers in the quick-response investigation of worker fatalities in the Cincinnati area. Highlighting behavioral factors, one recent investigation involved an electrocution when a truck operator's hydraulic boom came into contact with a high voltage line while unloading bricks at a home construction site. Although the operator had ample room to maneuver his load, he nevertheless parked the truck too close to the power line. Under the weight of the first load of bricks, the boom tipped into the wire. Interviews with company management, other boom operators, and review of company records revealed that the deceased operator was known, and twice previously reprimanded, for taking risks to himself and company property in order to do the customer a favor by dropping loads at more convenient locations. This time the favor cost the driver his life. This incident deserves mention to dramatize the significance of human factors in accident occurrence and the importance of in-depth examination of accident causal factors.

A second project is aimed at demonstrating the utility of behavioral science principles in reducing worker accidents. An initial effort resulted in the development of an index of over 80 safety guidelines derived from psychological principles in the field of organizational behavior, engineering psychology, learning and motivation, and behavior modification.[7] The index was the product of psychological experts who reviewed established concepts in each of these fields for their potential application and value in enhancing worker safety.

An example of a guideline drawn from the field of organizational behavior states: To promote safety, organizational actions should suggest to employees that safety is an important objective of the work establishment.

In elaborating on this idea, it is asserted that companies cannot rely on a single action or event such as an annual safety campaign to convince employees that their employer values safety. Rather safety should be an ever present consideration clearly perceived by the workers in company policies and practices. One large chemical manufacturer has had considerable success with its policy that "safety is a condition of employment." All employees of this company are aware that safety is a valued part of their job and that their continued employment is dependent on their safety performance. The safety record of this company ranks best in the chemical industry.

An example of a safety guideline embodying a principle of engineering psychology states: Worker expectations concerning the physical placement, direction of movement, and relationships between task events and responses should always be met in order to reduce the likelihood of error or accident. For example, depressing an accelerator pedal on a vehicle is expected to result in increasing speed; turning the steering wheel clockwise anticipates movement to the right. Whenever equipment is designed without consideration for user expectations, the potential for operator error is heightened. An actual case involved a power industrial crane in which a joy stick control moved the boom in different directions. The crane was designed so that when the stick was pulled toward the operator, the boom moved outward. When the stick was pushed away from the operator, the boom moved inward. In other words, the directional correspondence between operator control and boom movement was completely reversed. On an occasion when an experienced operator was working in a hurried manner, he reverted back to the more natural but improper control response of moving the stick away from him when he actually wanted to move a load outward. This caused the load on the boom to swing backward, smashing into the cab of the crane and killing the operator.

A training guideline taken from the learning literature states: Proper responses to emergencies should be practiced to the point of being overlearned. Overlearning refers to extensive training on a particular task or procedure to the point where correct responses or behavior become more or less automatic. Overlearning can be particularly useful in training for emergencies (e.g. fire, disasters) so as to insure correct actions despite the evident stress.

A guideline taken from the behavior modification field states: Through appropriate use of reinforcers, behaviors related to safe work performance can be increased and behaviors related to unsafe performance can be decreased. A NIOSH study, currently in progress, is attempting to show how social-type reinforcers, chiefly recognition and praise from one's supervisor, can enhance the wearing of safety glasses among workers in a shipyard where eye accidents are quite common as well as improve certain other aspects of their safety performance. First-line supervisors, shipfitters and safety personnel are being given training through lectures and use of manuals stressing the importance of rewarding the desired safe behavior and the optimum conditions for reinforcing these acts. After training, these techniques will be applied to the shipfitter work crews in an attempt to shape safer job behavior. The effectiveness of this approach will be monitored by recording the frequencies of the specified safe behaviors, e.g. wearing of safety glasses, observed in the shipyard crews before and after the initiation of the reinforcement plan. In addition, the frequency of eye accidents and other worker injuries will be compared on a similar before/after basis. The total period of these observations will be three years. The study design includes suitable control groups of shipfitter crews who will have equal contact with supervisors and safety personnel providing the usual emphasis to safety matters.

As a means of selecting which of the above mentioned behavioral safety guidelines or other means should be prescribed in reducing job hazards, a diagnostic safety form has now been drafted.[8] The form consists of a set of checklists inventorying information about a given job such as job task characteristics, extent of job training, safety supervision, physical work environment, equipment used, relevant company policies, etc. Responses to items on the checklists are pooled from those individuals best suited to provide the data including the plant safety officer, job supervisors, and the job holders. The scoring procedure enables different remedial actions to be rank-ordered in terms of their importance relative to satisfying the apparent safety needs of the job in question. The diagnostic safety form is intended to be used by plant safety personnel without the need to resort to costly outside consultants. In this regard, a number of safety practitioners in industry are presently reviewing the form for its ease of application and interpretation. Subsequent plans involve field trials in select work settings.

MANAGEMENT APPROACHES TO WORKPLACE SAFETY

With regard to management-oriented approaches to worker safety, NIOSH is comparing the safety program practices of work establishments with good safety records versus similar companies with poorer records in an effort to uncover insights into effective safety programming. In a first phase of this project, just completed, questionnaires were mailed to 96 pairs of manufacturing plants in one state.[9] The members of each pair were matched in type of industrial operation, work force size, and geographic locale but differed by better than 2 to 1 in injury frequency rates based on 1972 and 1973 reports. The questionnaire inquired into aspects of management commitment to safety, safety promotions and training, hazard control, accident investigations, and work-force characteristics. Returns received from 42 pairs of respondents suggested rather subtle differences between the program practices of the high versus low accident companies. The more notable of these are as follows:

(1) Company Commitment to Safety: More of the low accident companies had their highest safety officials at top management levels of their firms, and more employed one or more full-time safety personnel relative to their high accident cohorts. Though the high accident companies indicated more persons involved in directing safety efforts, these were predominately part-time responsibilities with the amount of time spent per staff person on safety being less than that indicated for part-time persons with similar assignments in the low accident companies. These findings suggest a rather fragmented safety effort in the high accident establishments.

(2) Motivational Practices: More noteworthy than differing types of promotional practices was the finding that the low accident companies appear to use more varied incentives and promotional

techniques than their high accident counterparts. With regard to disciplinary actions for unsafe acts and safety rule violations, verbal and written reprimands were the predominant methods of choice for both the high and low accident companies. However, more high accident companies deemed harsher measures, such as disciplinary layoffs and suspensions, as being most effective in dealing with these problems. These results suggest a harsher disciplinary stance toward workers in the high-accident companies, than their low-accident counterparts.

(3) Job Safety Training: More of the low accident firms had (a) formalized and special training programs to meet specific job needs, (b) augmented supervisors' instruction with other techniques, such as group discussions and lectures by safety specialists, (c) provided continuing safety training to all employees as opposed to the high accident companies who tended to offer such training only to those persons in jobs showing recurrent accidents and especially to those who had accidents recently. In short, safety training programs tended to be more expansive, and available to more workers, in the low accident companies, versus the high accident companies.

(4) Hazard Control: Overall, more high accident than low accident companies indicated that they always included safety considerations in new facility design and process planning, in purchase and installation of new plant equipment. This finding suggests greater concern with physical controls on the part of the high accident companies at the expense, perhaps, of a more balanced safety program emphasizing both engineering and non-engineering measures. More low accident companies performed informal, daily worksite inspections while high accident companies used formal, written checklists more often than the low accident companies for inspection purposes.

(5) Accident Investigation and Reporting: Both high and low accident companies were equally responsive to major, lost-time accidents, but more low accident companies reported investigating minor injuries and narrow escapes as well.

(6) Workforce Make-up: On the average, the production workforce of the low accident companies was slightly older and had somewhat more company tenure and experience than the workforce in the high accident companies. The low accident companies also indicated a slightly greater percentage of their workforce as married. These findings suggest slightly more stabilizing qualities among the low accident company workforce.

Site visits have recently been completed to a subsample of companies who responded to the questionnaire survey. These data are being analyzed to amplify on the questionnaire results as well as provide first-hand observations of particularly effective hazard control measures. It is hoped that the over-all findings from this project can serve as a source of suggesting, on an empirical basis, techniques for improving company safety programs and plant safety performance.

SUMMARY

This paper has described a number of NIOSH research projects emphasizing behavioral and psychological approaches to the study of workplace accidents and their control or prevention. Such efforts include attempts to: (a) provide methodology and data for better defining causal factors in frequent, serious types of worker accidents; (b) demonstrate the utility of psychological principles drawn from organizational psychology, engineering psychology, learning and motivation, and behavior modification as techniques for enhancing worker safety; and (c) analyze the nature of successful safety programs in industry and their implications for management policy and practices. Initial work and results are promising, and give indications that their stated objectives will be met.

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POTENTIAL TRAUMA IN THE WORK PLACE

SOME FACTORS INVOLVED IN DEVELOPMENT OF MANUAL MATERIALS HANDLING STANDARDS FOR THE WORK PLACE

D. W. Badger

Despite the rapidly growing trend towards automation in industry, a significant portion of the U.S. work force currently is engaged in manual materials handling tasks. A considerable body of evidence suggests that these tasks are comparatively hazardous. Injuries associated with these jobs account for the largest number of medically related work absences, the greatest number of lost work days per year, and the largest amount of compensation paid (23% of all claims in 1973).[1,2,3] Many material handling injuries are to the trunk, and these comprise a high percentage of injuries to all body areas.[3] While much attention has been focussed upon low back injuries, they constitute only a part of the total number of injuries associated with the handling of materials. Development of an effective standard which might reduce the number and severity of these injuries would have profound effects upon occupational safety and health. Yet, a recent comprehensive survey of research in this area indicated there are too many gaps in our knowledge concerning the cause-effect relationship of injuries in materials handling to formulate a meaningful standard.[4]

During 1972, in an effort to establish a program leading to workplace standards, the National Institute for Occupational Safety and Health requested a group of specialists to recommend research likely to form the basis of a standard designed to reduce injuries related to the unaided act of lifting, carrying and placing of loads.[5]

While the recommendations of this group were aimed primarily at the prevention of low back injuries, some of them are applicable to other injuries related to materials handling as well. Subsequent activities by the Physiology and Ergonomics Branch of NIOSH in this area have generally followed the recommendations of this group, which include the following:

1) Development of methods for assessing employees' muscular strength capability and its relationship to back injury.

2) Development of methods for identifying and preventing excessive strain associated with lifting tasks.

3) Identification of postures in lifting tasks conducive to back injury.

4) Evaluation of differences in materials handling capabilities according to sex and age.

5) Evaluation of the effectiveness of vestibule training programs in reducing injuries associated with materials handling.

In another NIOSH sponsored meeting to identify research gaps in materials handling needed information on human factors tasks generally followed these recommendations.

Activities in the Physiology and Ergonomics Branch subsequent to these meetings are discussed below:

1) <u>Development of methods for assessing employees' muscular strength capability and its relationship to back injury</u>. While the physician's routine physical examination and the medical history are of prime importance in determining fitness for the job, supplementary information describing the strength capabilities of the employee appears to be a useful approach. Based upon Rowe's[6] observations that torso weakness (as demonstrated by simple abdominal muscle tests such as sit-ups) was more prevalent in those people with a history of low back pain. Poulson[7] suggested that torso isometric strength tests could be used to predict a person's ability to perform manual materials handling jobs. Chaffin[8,9] and coworkers described 103 jobs in terms of Lifting Strength Ratings (weight required to be lifted/predicted lifting capabilities of the strongest 2% of working males) and subsequently observed medical incidents reported over a one year period on 411 workers, whose torso isometric strength had been recorded. He found the highest number of back injuries associated with jobs having the greatest strength ratings and the largest number of injuries associated with workers with lesser strength capabilities. This work is being extended under NIOSH contract at the present time and will include observations on a projected 800 jobs over a two year period.

Another technique for assessing potential spinal abnormalities, termed lordosimetry, has been developed by Tichauer.[10] This laboratory study, also funded by NIOSH contract, utilizes a device to measure precise changes in spinal column geometry, both while holding loads (static effort) and while picking up and placing loads (dynamic effort). This technique appears promising for the assessment of individual lifting capacity and if verified, it can be used for identifying safe lifting limits for any worker population.

Finally, predictive models for strength capabilities, based upon anthropometric and functional measurements are currently being explored by Ayoub and coworkers.[11] In this NIOSH funded grant predictive models of strength capabilities are being developed, based upon extensive anthropometric measurements, measured torso and limb isometric strength and such functional parameters as heart rate and oxygen consumption.

2) Development of methods for identifying and preventing excessive strain associated with lifting tasks. For many years, work physiologists have investigated responses of men and women to rhythmic exercise and from such studies has emerged the widely accepted belief that sustained effort at 50 percent of the maximum aerobic capacity is an acceptable work load. However, lifting loads contains a high static component of exercise, and the cardiopulmonary response to this form of activity is rather different.[12] Recent studies by Lind and Petrofsky[13] sponsored by NIOSH suggest that cardiopulmonary factors may not be the limiting ones during repetitive lifting and placing of loads, but rather localized muscle fatigue. As a consequence, the dictum of 50 percent of maximum aerobic capacity as an acceptable load may not be applicable for establishment of work loads for lifting and materials handling. Lind found that repetitive lifting of 50 pound loads resulted in maximum aerobic capacity measurements closest to data obtained on the bicycle ergometer, with sharp decreases in V_{O_2} max both with heavier (80 lbs) and lighter (15 lbs and 2 lbs) loads. Interestingly, this 50 pound "optimal load" corresponds closely to the 53.8 lb load considered "acceptable" by the 50th percentile of male industrial workers examined by Snook.[14]

Studies by Tichauer[10] also bear on this problem. His lordosimetric measurements included simultaneous recording of electromyographic activity of postural muscles. He found that as the moment on different segments of the spinal column increases, there is a sudden, sharp increase in muscle activity of the erector spinae muscles. This was found to be true particularly with women, with most showing sharp increases in muscle activity with a moment corresponding to 285 inch-pounds. Hence static effort of these large postural muscles may be severe, even with relatively light loads, providing the bulk of the object is large enough.

The correct interpretation of these require further studies, but they emphasize the importance of localized muscular fatigue in evaluating physiological strain associated with lifting. Indeed, Brown[15] has emphasized the potential role of postural fatigue in low back injury. Valid techniques for objectively assessing muscle fatigue are required. Recent work by Lind[12], Chaffin[18] and by Wright[16] in our laboratory suggest the potential usefulness of power spectrum analysis of recorded surface electromyogram as a method for assessing fatigue, but again more studies are required before this method can be made available for routine use.

3) Identification of postures in lifting tasks conducive to back injury. Further effort is required to identify postures and motions which may lead to back injury either directly or through loss of postural stability. In this connection, it is interesting to observe that the time-honored straight back, bent knee lifting technique has come under sharp attack, particularly by Brown.[14] The question is, are there lifting postures which tend to minimize strain on the musculoskeletal system? Analysis is needed of the lifting components of particularly hazardous jobs (e.g., refuse collectors) as well as evaluation of different lifting techniques currently advocated.

Also, work by Yagoda[17] in evaluating postural stability has potential usefulness both in a prospective materials handling standard and in job re-design. In this approach, the assumption is made that strength is adequate for the job (lifting and carrying). The objective then is to define an envelope of postural stability, that is, the range of bulk and weight of loads, given the anthropometric configuration of the lifter, which permits a stable configuration, above which a slight slip or perturbation of the body is likely to lead to a fall.

4) Evaluation of differences in manual materials handling capabilities according to sex and age. Several investigators have shown conclusively that the lifting capabilities of women generally are 40 to 70 percent that of men, although there is a wide range of variation in both sexes depending on profession, training and heredity. This serves to emphasize the importance of considering sex differences when developing a standard. Tichauer's lordosimetry technique[10] may be a useful tool for individual evaluation of lifting strain on the musculoskeletal system. The idea of utilization of strength testing in an objective manner prior to placement on a materials handling task seems particularly relevant here. Sex differences in lifting capability are greatly influenced by level of training. The importance of training in modification of individual differences in weight lifting is considered in the next recommendation.

5) Evaluation of effectiveness of vestibule training programs in reducing materials handling injuries. Several investigators have emphasized the effectiveness of training programs, particularly for self-pacing[14,19,20] Lind[13] has shown that

in untrained subjects, periods of time up to 3 months are required to achieve stable physiological end points during lifting tasks. Whether such training periods are feasible on an industry-wide basis in materials handling tasks remains to be investigated.

What has been given above has not been intended as a review of the tremendous amount of research related to materials handling, but only outlines the types of activities currently underway with NIOSH support. Many areas have been neglected, including the important aspect of psychosocial factors involved in materials handling tasks. What was intended is to convey some insight into the complexity of arriving at an acceptable materials handling standard that is truly effective both in protecting the worker and in reducing the leading cause of injury in industry today.

Hopefully, joint efforts by industry and the biomedical community will also lead to better workplace and container design. Lastly, the worker bears a significant portion of responsibility for increasing his fitness and suitability for employment in manual materials handling jobs.

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POTENTIAL TRAUMA IN THE WORK PLACE

DESIGN AND USAGE OF PERSONAL PROTECTION

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INTRODUCTION

The concept of personal protective equipment is, of course, as ancient as our early civilization. There are only few, if any, who are not familiar with the biblical story of David and Goliath in which the latter was equipped with "a helmet of brass upon his head, and he was clad with a coat of mail; and he had greaves of brass upon his legs..."[1]

Our history books describe the magnificent advancements in personal protection achieved by the Roman Legions as they were carving the vast Roman Empire. The personal armor developed for and used by the European kings and dukes in the struggles and battles on the continent are pieces of personal protection equipment creating a veneration even to this day. However, these were instruments of war; our present concern is with personal protective equipment used in an occupational battleground; we direct our efforts for the benefit of Americans who are at work to earn a living in order to sustain a life style which the fruits of their labor will permit them.

The OSHAct makes it mandatory for each employer to furnish to each employee a place of employment which is free from recognized hazards that are likely to cause death or serious injury. The requirements in the Act place a burden on employers and their safety professionals and industrial hygienists to take prompt steps to eliminate any hazards or at least reduce their intensity. As a result, they often find that there is a need to introduce extensive engineering revisions of manufacturing processes or methods while in many other situations the need is only for relatively simple changes in the work practice.

The approach to safety and health hazards through engineering solutions is generally more reliable and often more desirable than protection dependent on personal protective equipment or human behavior. Engineering solutions can, in many cases, help eliminate or reduce the cause of accidents; examples of this kind can be found in exhaust systems; in power presses equipped with integrated safeguarding features such as sensing devices, and in power transmission equipment installed and protected with machine guarding. But when such an approach is not practical, the use of personal protective equipment is not only mandatory but it often provides the only means of protection against the specific work hazard. Dielectric protective gloves used against high electrical potential hazards are perhaps some of the more vivid examples of personal protective equipment, that, when used properly, can effectively prevent a fatality or a serious injury by electrocution. Members of the "Wise Owl" club provide rather convincing evidence as to the wisdom of using eye protective devices against objects possessing kinetic energy.

CONSIDERATIONS FOR NEED

When it is determined that there is a need to provide personal protective equipment because a work hazard exists it is, in fact, a partial admission of defeat. In essence, it is a recognition that the hazardous situation itself can't be eliminated entirely. But it is also necessary to recognize that many engineering solutions can be applied. The flying particles off a grinder can be blocked by a transparent shield rather than to have the operator be totally dependent on eye and face protective equipment. Corrosive, fuming or toxic chemicals should, where possible, be confined to closed pipes and vessels, supplemented by effective exhaust ventilation, rather than to have the worker protection totally dependent on chemically-resistant protective clothing and respirators.

In our imperfect work environments it is recognized that the situation is seldom reached when it can be stated that personal protection is no longer necessary. The essential thing to keep in mind is that work safety derived from the usage of personal protective equipment is really the last line of defense. After everything possible has been done to enclose the process, to substitute material, to safeguard the press, and to rearrange the work schedule; only when it is recognized that nothing remains but to protect the worker should considerations be given to the kind and extent of personal protection required.

DESIGN CONSIDERATIONS

When we discuss personal protection in the work place we are addressing ourselves to the need to protect various body parts against hazards found in the work environment. The main effort must be placed on recognizing the source, type, and intensity of the hazard and the body part (or parts) which is most likely to sustain an occupational injury by the hazard when not adequately protected. However, even when such situations are well analyzed and fairly well understood, there emerges a critical need to establish the level of tolerance that various body parts can sustain when assaulted by hostile work hazards, without experiencing an injury or a fatality. This, then, becomes the basis for the design of personal protective devices. When we possess technical information about the tolerance of the human body to withstand an electric shock without a serious injury or damage to our natural faculties, we can initiate the design of the protective devices which will provide adequate protection against such an electrical hazard. As we find in so many cases which deal with the design requirements for personal protective equipment, the medical information on human tolerance to assaults by hostile work-place forces is simply not readily available. Yet, as it will be shown, it must become known through medical research lest we are willing to accept personal safety devices which do not provide real personal protection and remain safety devices in name only.

<u>Head Protection</u>: The present OSHA standards which pertain to head protection are based on the American National Standards Institute standards Z89.1-1969 and Z89.2-1971.[2,3] The existing ANSI standards have evolved from previous standards and do not represent the results of exhaustive research in industrial head protection.[4]

In terms of impact forces, the standards specify a requirement to attenuate an average force of 850 pounds when the imparted energy is 40 ft-lb. The energy is derived from a steel ball 3 3/4" in diameter and weighing 8 pounds dropped from a height of 5 feet onto the apex (crown) of the helmeted head form. The transmitted force is computed by the Brinell formula:

$$F = 2.2 \text{ X } H \text{ X } \frac{\pi D}{2} \text{ X } D\sqrt{(D - D^2 - d^2)}$$

where:

F = transmitted force in pounds
H = average Brinell hardness number of impression bar
D = diameter of the impression ball in millimeters
d = diameter of the impression in millimeters

What was the basis for such requirements? The 8-pound steel ball was evidently chosen because of its availability in large ball bearings.[5] The choice of the 5-foot drop height appears to have been arbitrarily chosen, "as to give impact against which you reasonably expect a wearable piece of headgear to provide protection."[6] Such a requirement is obviously not related to simulation of occupational accidents and, therefore, it can hardly be considered as a sound basis for the design of devices for head protection against impacting forces. Certainly, there is no medical basis for such performance requirements.

By the application of human tolerance data, it should be possible to reduce the likelihood or severity of injuries from impact of objects against the human skull in typical occupational environments where hazards to the head exist. The human tolerance leads to the following general principles: (a) effective absorption of the impact energy by the deformation of the helmet structure and component, (b) use of energy absorbing material in the head protection gear to cushion and spread the impact, and (c) design of head protection gear to reduce sharp-body penetration.

The degree of human tolerance to head impact is not well established, although considerable work has been done in this area. Since head impact research can't be based on a direct approach involving human subjects, the human tolerance to impact can be investigated only under indirect methods or at subinjury levels with human volunteers. Also, live animals and human cadavers have been assaulted in numerous ways and the resulting damage inspected and analyzed. However, the studies are too few and the methods are of such limited value that the present knowledge of human tolerance to impact remains inconclusive.

It has been reported that the values for maximum allowable transmitted force through a helmet designed and fabricated to present standards have been the maximum allowable force to the cervical vertebrae.[6,7] However, published research demonstrating human tolerance to dynamic cervical compression is not available.

Studies of vertebral tolerance[8] show the average ultimate static compressive strength of the cervical vertebrae to be 830 pounds and that of the lumbar vertebrae to be 1,200 pounds for ages 20-59. Patrick[9] has stated an approximate dynamic tolerance of 2,000 pounds for the lumbar vertebrae. If this static/dynamic ratio is applied to the cervical vertebrae, we find that the cervical dynamic tolerance is in the order of 1,360 pounds. This, then, is the level of tolerance presently being considered in developing criteria suitable for the design of head protection against impact.

<u>Hand Protection</u>: What is quite amazing to find in this country is the lack of suitable safety standards for hand protection. The exception is the ANSI standard J-6.6-1971[10] which

contains performance requirements and test methods for industrial gloves used against the hazards of high voltage. The J-6 gloves, possessing dielectric properties, provide effective protection when used conscientiously and this fact was demonstrated on numerous occasions. Considering the National Safety Council published data on part of body injured in work accidents[11,12] we find that injuries to fingers account for 16-17% of all injuries. Only injuries sustained by the trunk of the body were higher. Numerically speaking, we are recording 400,000 finger injuries every year in this country which account for 10% of the compensation costs.

In our present efforts to develop performance criteria for fire-fighters gloves, it is quite likely that some of the performance requirements and test methods will be applicable to industrial gloves. For example, an injury due to cold, like injury due to heat, is a function of both the temperature level and the duration of exposure. In this type of injury, the tissue is irreversibly damaged due to oxygen deprivation and/or actual freezing of individual cells. The available literature on injuries due to cold is quite limited - certainly it is less extensive than that for injuries due to elevated temperatures. The data used are chiefly those of Stoll[13] and Meryman.[14]

The length of time required for permanent damage at subfreezing temperatures has not been completely established. Stoll gives a tissue temperature of 32°F(0°C) as the point of instantaneous degradation. She also describes a threshold range of reversible injury as corresponding to the range of threshold pain (tissue temperature of 18°C) to severe pain (tissue temperature 10°C). As more data on human tolerance becomes available, the subsequent design of the hand protective devices becomes more functional and by far more effective in reducing injuries from cuts, punctures, thermal energy, penetration, electrical potential, liquid penetration and abrasion while allowing for the task-related properties of dexterity, grip, and tactility.

<u>Eye Protection</u>: When we refer to eye protection, we must consider the fact that the human eye is one of our most prized possessions. We critically depend on sight for gathering most of the information about our environment and one could readily see that in the work environment, where hazards abound, the need to process the information becomes acute.

The present OSHA requirements are based on ANSI standard Z87.1-1968 "Practice for Occupational and Educational Eye and Face Protection." The main feature of the existing standard, with reference to impact resistance of spectacle lens, is based on the requirement that the lens withstand an impact force derived from a steel ball, 1" diameter, dropped from a height of 50 inches. The velocity of the steel ball on impact computes to be about 16.6 ft/sec, and as a result the kinetic energy imparted to the lens, with the ball weight of 2.5 oz., is 0.64 ft-lb. Now let's consider industrial operations involving high speed cutting, grinding, milling and drilling. The kinetic energy at impact for an ejected carbide steel sawtooth can be computed as follows. The peripheral velocity of the saw blade is given by

$$V = \frac{(\pi)\ (d)\ (rpm)}{60}$$

where: V = peripheral velocity, ft/sec
d = wheel diameter, ft
π = 3.14
rpm = revolution per minute

For a saw blade 12 inches in diameter traveling at 4000 rpm, the velocity is:

$$V = \frac{(3.14)\ (1)\ (4000)}{60} = 209 \text{ ft/sec}$$

For an ejected sawtooth weighing 2 grams (0.004 pounds) the kinetic energy at impact is:

$$K.E = \frac{1}{2}\ \frac{w}{g}\ V^2 = \frac{(0.004)\ (209)^2}{} = 2.7 \text{ ft-lb}$$

It is apparent from the above example, which relates a common occurrence, that the kinetic energy of a flying particle can be four times that which safety lenses are required to withstand under the present standard for eye protection. It would seem reasonable, then, to expect that the design of safety lenses, for protection against particles possessing kinetic energy, be based on information derived from ballistic tests. At the present time, no such requirement exists.

In another area of eye protection it is necessary to examine the adequacy of Table 1 in the Z87.1-1968 standard. Table 1 calls out shade numbers of absorbing lenses and the required transmittance for these shade numbers in the ultraviolet, visible and infrared portions of the spectrum. The requirements are based on the only good absorbing lens materials which were available for use at the time Table 1 was first generated, during or before the 1930's.

An obvious deficiency of Table 1 of Z87.1 is the fact that it places no limits on ultraviolet transmission in the region from 200 nm to 300 nm which is known to be very effective in damaging the cornea (photokeratitis). Another shortcoming in Table 1 is that all infrared radiation from 700 nm to the limits of glass transmission is lumped into one integrated measurement. It is now known[15] that the wavelength region from 700 to approximately 1300 nm is transmitted through the ocular media and is absorbed in significant doses in the retina, while radiation of wavelength greater than 1300 nm is absorbed before reaching the retina. Allowable infrared transmittance of the filter should, therefore, be split into two values: wavelength regions shorter and longer than 1300 nm. (This has been done in the ISO Standard for welding filters (ISO/TC94/SC6, April 1973.)

As a result of intensive scientific work carried out in the last three decades (nuclear bombs, lasers, and space exploration) much work has been done to quantify Tolerance Level Value (TLV) data for human eye. A very thorough review of this work may be found in papers by Sliney and Freasier[16] which contains a list of ninety references to earlier work. A more recent work by Pitts[17] updates TLV knowledge in the 200 to 300 nm region. In a spectral region where few measurements have been made of eye sensitivity to radiation, the 300 to 400 nm region, NIOSH is presently supporting research carried out by Doctor Pitts. It is expected that with the availability of data in these critical regions, the design of eye protection against radiation hazards may contribute significantly to the reduction of eye injuries from such hazards.

Another aspect of the eye protective equipment is that of quality control - an integral part of any good design and manufacturing process. In recognizing the need for strong relationship between effective quality program and worthy safety equipment, we are involved in a research effort which delineates such a relationship. The research is aimed toward the development of criteria for physical defects (such as trapped bubble and striae) and mechanical defects (such as rough edges) classified as Critical, Major A, Major B, and Minor. For example, any defect in lenses which is likely to result in a condition immediately hazardous to safety and health of the user is to be classified as Critical. The other classifications are defined proportionally downward.

The total quantitative lack of such specifications in the present Z87.1-1968 Standard is one of the standard's major shortcomings. It is expected that the quality control classifications, once fully developed along with their correlative test methods, will become part of the design and performance criteria for eye protective equipment. As such, it will be suitable for employment by manufacturers and by any accredited laboratory engaged in testing and certifying eye protective equipment.

ASPECTS OF MOTIVATION

The subject of human needs has been discussed by many researchers and it became further delineated with the emergency of the Industrial Revolution. Maslow's[18] classical theory of needs, when viewed from the personal protection angle, seems to provide additional insights to the subject of employee motivation with regard to personal protection.

Maslow identified five levels of need hierarchy. They are, in brief, the following:

1. Physiological Needs: This need is the most basic in the hierarchy. The needs of hunger, thirst, sleep and sex fall in this need category. According to Maslow, once these are satisfied they no longer motivate and, therefore, the person will strive for higher level of needs.

2. Security Needs: The second level of needs is of great interest to all of us who are involved in occupational health and safety. This level of needs stresses the emotional as well as the physical safety. Studies have shown that unless security (safety) is satisfied, people will not be concerned with higher order needs. This implies that the physiological and safety needs are fundamental needs ingrained in each of us.

3. Social Needs: This third or intermediate level of needs loosely corresponds to the affection and affiliation needs. It is essentially a need that we all have to belong and to be accepted.

4. Esteem Needs: The esteem represents the higher needs of man. The needs for power, reputation, achievement, and prestige can be considered as components of this level.

5. Self-Actualization Needs: This level represents the culmination of all the lower, intermediate and higher needs of man. A person who has become self-actualized is self-fulfilled and has realized all of his/her potential.

The needs hierarchy is presented in this paper since it is considered to be relevant to worker motivation and workers usage of personal protective devices. If we accept the premise that security (safety) needs are rather fundamental to the welfare of the worker, we can then examine the next level of needs - the social needs.

One thing that we recognize and experience is the fact that we live in a midst of drastic changes in people's expectation. This is true almost everywhere, but with the passage of the Occupational Safety and Health Act of 1970, nowhere is it more forceful than in the work place. Many workers in the professional and managerial groups find it relatively easy to meet their basic needs. At the same time, although perhaps to a lesser degree, blue collar workers also find these basic needs fulfilled and as a result they became relatively secure about them. But in order to obtain an acceptance of our safety concepts and programs, such as the usage of personal protective devices, we are likely to find that it is necessary to create and maintain a social work climate which lends itself to the fulfillment of the social needs among workers. We are likely to find that the work practices need to stress the social acceptance of personal protective devices by making it fashionable to wear and use such devices. In the final analysis it is the social climate that management and labor create for safety and health which will have the largest impact on the reduction of occupational injuries through the proper design and usage of personal protective devices.

CONCLUSIONS

The central issue of the research activities in the field of personal protective equipment is, and must remain, the need to provide effective protection of the worker at his/her work station. There are several approaches available to achieve such a goal and these approaches depend on the particular work tasks and their related hazards. However, often the protection of the worker could be afforded only by means of personal protective equipment. For this reason, it is necessary to bear in mind that the design of the personal protective equipment, to be truly effective, must be based on real world performance criteria and on medical research data on human tolerance to assaults from occupational hazards.

As a national institute, we are directing our research efforts to develop suitable criteria for personal protective equipment standards which:

(a) Are substantiated by scientific research and engineering test data.

(b) Consider the entire spectrum of human factors and thus "humanize" the standards.

(c) Strive for acceptance and <u>usage</u> of personal protective equipment by workers

(d) Are devoid by any ambiguities in the definition of terms used in the standards.

(e) Provide for technically-sound, feasible, and realistic test methods and procedures.

SUMMARY

The development of performance criteria as the basis for the design requirements of several personal protective equipment is being discussed in the paper. It is pointed out that the state of knowledge on the tolerance of human beings to assaults from work place hazards is not well established. As a result, many design aspects of existing standards of personal protective equipment are unrelated to the real world hazards and, therefore, the effectiveness of the protective equipment remains questionable. Several examples, reflecting present research efforts in the area of personal protective equipment, are presented and discussed in the article.

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FARM HAZARDS - INDUSTRIAL HYGIENE ASPECTS

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FARMING IS AN INDUSTRY

Traditionally industry has been viewed as having been spawned by a socio-economic-political revolution in which an agrarian society moved toward division of labor. It was capital intensive, high in energy use, profit motivated, with a functional distinction between management and labor. Presumably it produced a societally desirable product for a profit by an appropriate blending of capital, raw materials, physical resources, operational know-how, and labor.

This master-servant, management-labor, employer-employee relationship may cloud professional thinking. Public Law 91-596, the Occupational Safety and Health Act of 1970, has a general clause which states that the intent of the law is to:

> "...assure so far as possible every working man and woman in the Nation safe and healthful working conditions and to preserve our human resources..."

Yet a management-labor relationship is inferred when this shall be done by:

> "...encouraging employers and employees in their efforts to reduce the number of occupational safety and health hazards at their places of employment..."

If we look at agriculture, whether operated by a family as the labor unit, with the traditional "hired hand", or corporate farming on a large scale, the ingredients of industry are there. It is capital intensive. A large tractor can easily cost $25,000. There is high energy use associated with the operation of farm machinery. Hidden is the high energy use in making steel and agricultural chemicals. Certainly the end product is societally desirable - food and fiber. The profit motive must be present. The money market is the source of borrowed funds. Profits are calculated on the basis of cost per unit of product and return on capital investment.

It is true that there may be some blurring in certain instances with respect to traditional industrial roles. Management and labor may be the same. There may be no age or sex barriers to duties - or to wages and hours. There may be no unemployment and workmen's compensation - or no specific exclusions under laws, regulations or standards that relate to non-agricultural industry.

Modern agriculture is an industry. It cannot be excluded in a parochial view of what should be of professional concern to the industrial hygienist.

FARMING IS AN INDUSTRIAL HYGIENE SPECIAL CASE

The current official definition of industrial hygiene is:

> "...Industrial Hygiene is that science and art devoted to the recognition, evaluation and control of those environmental factors or stresses, arising in or from the workplace, which may cause sickness, impaired health and well being, or significant discomfort and inefficiency among workers or among citizens of the community..." (American Industrial Hygiene Association brochure, Industrial Hygiene, Definition, Scope, Function and Organization)

On the basis of the above definition farming cannot be excluded from industrial hygiene thinking or concerns. It should be noted that:

1. Workplace is the term used for the site where the activity is carried out. It does not say factory. It does not say mine. It is a <u>place</u>.
2. Environmental factors or stresses are not terms which, as used, make a distinction between those occurring naturally and those created as a part of the activity.
3. These factors or stresses may be endogenous or exogenous in the sense that they may arise <u>in</u> a specific location or <u>from</u> an operation.
4. The shift from homeostasis ranges from discomfort to overt, clinical illness.
5. The worker, the workplace and the activity are all part of a larger milieu, the community, whose members may be affected, individually or collectively.

Farming because of variety associated with climate, terrain, plants and animals involved, methods and techniques employed will still have the potential for many of the exposures that are usually classified by type as being chemical, physical or biological in nature.

At this point there should be little quarrel with the premise that the industrial hygienist can and should be interested in the hazards of agriculture. Before describing exposures inherent in farming that fall within the purview of the industrial hygienist, it may be desirable to speculate as to why farming has been largely ignored by industrial hygienists up to the present time. There may be a variety of reasons:

1. Governmental groups providing services may feel that their responsibilities, by definition, begin and end at a factory gate.
2. One sees most clearly those things that are close by, and there have never been enough industrial hygienists (or physicians) practicing in rural areas.
3. Evaluation and control of identified hazards would be professionally frustrating. Exposures would be intermittent, multiple, and usually done with the maximum of general ventilation - the open air.
4. Exploring the problems of a few workers, miles apart, would be an expensive and inefficient use of technical manpower.
5. Farmers have traditionally resisted any activity which might ultimately result in restrictions or controls over their activities.
6. The quantity and quality of medical practice in agricultural areas would not provide clinical and laboratory data that would contribute much to relating exposure to physiological response.

Our starting point in looking at the industrial hygiene aspects of farm hazards involve the following hypotheses:

1. Experience in the industrial sector must be extrapolated to its maximum in the agricultural area.
2. The agricultural worker is less inclined and on technical aspects is least able to understand industrial hygiene objectives and procedures.
3. The industrial hygienist must make his greatest progress in protecting the farmer in that time frame that precedes farmer involvement.

In sifting through the occupational protective approaches that are used in industry it becomes quickly apparent that medical aspects of control do not exist. There are no preplacement and periodic physical examinations. There is no medical monitoring, no rotation of workers or prophylactic measures. Only sheer professional naivete would allow serious consideration of requiring blood cholinesterase levels for migrant farm workers.

If medical controls are out of the question, we are then forced to rely on engineering controls. Some of the traditional ones would have minimal application such as isolation, remote control, enclosure, exhaust ventilation, substitution or change of process.

Only a few engineering control measures remain that would have application in agricultural pursuits. These are general ventilation, good housekeeping, personal protective equipment and personal hygiene. But there is little universality in the application of these measures. General ventilation would relate to climate, weather and season. Housekeeping would relate to limitations imposed by physical facilities and work tempo. Personal protective equipment may not be available or be inappropriate for agricultural use. Personal hygiene would vary widely in applicability, being affected by the facilities available and inclination of the worker to use them.

It is tempting to provide a litany of farm hazards of industrial hygiene interest or concern. Instead, industrial hygiene approaches will be viewed against midwest agricultural practices with the expectation that some can be transposed to other crops in other geographical areas. Tacitly assumed here is feasibility - physiological, sociological, political, financial and engineering.

CHEMICAL HAZARDS

<u>Brought to the farm</u>: The farmer is the end user of chemicals in a wide variety and in large amounts. Examples would be insecticides, herbicides, rodenticides, defoliants, soil sterilizers, growth regulators, fumigants, nematocides, fungicides, acids, alkalis, solvents, fuels, lubricants, veterinary pharmaceuticals, feed additives, fertilizers, soil modifiers, and others.

The agricultural worker cannot be expected to have the degree of toxicological expertise, the engineering know-how, and the time and resources to insure adequate protection against chemical hazards. He should be protected in spite of himself. The product should be "fail safe". In the area of labeling and usage instructions engineers and industrial hygienists have failed the agricultural worker.

Asking why is usually a good way of pointing up problems. In the handling of chemicals from the agricultural point of view I could ask why:

1. Why would a pesticide bagging operation at the producer's facility be protected but the farmer left to his own devices. Is he told how to open, pour, level and dispose of the bag? Is he instructed to burn or bury the container, bag, can or drum? Where does he bury it? And how deep?

2. Why are the reservoirs for the field application of farm chemicals, granular or liquid, designed with little regard for height, accessibility or size of charging opening needed?

3. Why, basically, must spraying and dusting place so much of the material on non-target areas?

4. Why is not greater attention given to problems that might be associated with the mixing of two chemicals from different manufacturers (such as herbicides)? Who has the responsibility to indicate any synergistic effect that may be involved?

Produced on the farm: A well-established exposure to oxides of nitrogen has been associated with recently filled silos. If the forage put into the silo has been raised under drought conditions and high nitrogen fertilization, then the problem seems to be more severe.

Sometimes a yellow gas can be seen above the surface of the silage within a day or two after filling. It may persist for several weeks. It may cascade down the chute and kill small animals, such as fowl, at the bottom of the silo. A brief exposure, such as that associated with entering the silo to recover a tool, may be fatal. Running the blower with which the silo was filled for a short while makes the silo safe to enter.

More and more silos are sealed after forage addition. Under these anaerobic fermentation conditions carbon dioxide may build up and oxygen be depleted. Self-contained respiratory equipment is usually not available, ventilation requirements are different than for the silos mentioned above, and entry into the silo is usually fatal. There are several such deaths annually.

Of growing interest are the hazards to personnel of gases present in large confinement feeding operations, usually in swine and poultry producing operations. Exposures above the TLV have been measured in swine feeding facilities for carbon monoxide, ammonia and hydrogen sulfide.

Of course there are exposures to exhaust gases from internal combustion engines - diesel, gasoline or liquified petroleum gas. Exposure problems can result from operations where these engines, large or small, may be operated in enclosed spaces.

In speculating why there is such a dearth of information on chemical exposures associated with agricultural pursuits some hypotheses may be noted:

1. Many farmers who have been made ill by exposures to chemicals recognize an acute response, stop work, use supportive home therapy and place heavy emphasis on rest.
2. Medical reports on chemically caused illnesses are sparse because the farmer does not present himself. If he does present himself the physician may be unsure of the diagnosis. Most of the time the physician has neither the time nor the inclination to write up the case for the medical literature.
3. The intermittent and/or seasonal aspects of chemical use allow detoxification to occur.
4. Work habits and personal hygiene are adjusted to minimize difficulties, based on personal experiences or those among other agricultural workers.

PHYSICAL HAZARDS

The farmer is exposed to a fair number of physical hazards that have been of traditional interest to industrial hygienists. Ordinarily one thinks of physical agents representing a significant departure from energy exposures which act deleteriously on the body. Those energy-related phenomena which result in physical trauma will be excluded here since they will be covered in another paper.

Extremes of pressure would not normally be considered a problem among agricultural workers. They might do some scuba diving but this would be avocational. They might fly their own light plane but probably not to unusually high altitudes and in the absence of oxygen equipment.

Heat and cold extremes are encountered. Cold is considered to be of lesser concern. Agricultural pursuits are at a minimum during winter weather. Where climate makes it necessary to anticipate severely cold weather the farmer is usually prepared with suitable clothing and shelter.

Extremes of heat constitute a more general, more widespread problem. I know of no data on the heat load on a worker in a field, at noon, where the ambient temperature is 100 degrees Fahrenheit or more, the humidity is almost 100%, the sun is blazing down from a cloudless sky and not a leaf is stirring. Such a situation definitely establishes a stress situation that is in excess of that recommended in the NIOSH Criteria Document, Occupational Exposure to Hot Environments. A wag predicted that this document, if made into a Standard, would outlaw agricultural pursuits in most parts of the United States.

Any problems of light would be comparable to those of concern in industry. For indoor seeing tasks there would be a need for enough light, from the right direction, of the correct color, with appropriate contrast, no glare and so forth. Sunlight is probably the larger problem, if a serious one exists, with a potential for snow blindness in the winter and skin cancer after years of exposure to non-covered surfaces of the body.

Vibration represents another unknown. If we consider the resonant frequency of human viscera to be in the 5-10 Hz area then one is concerned about someone spending long hours riding an unsprung vehicle over non-smooth terrain. Family physicians in rural areas have voiced the opinion that they see more cases of prostatitis during the corn harvesting season.

Chain saws are not uncommonly found on the farm and one might think of the possibility of encountering "white fingers" or Raynaud's phenomenon. It would be expected that chain saw usage would be highly infrequent and of relatively short duration.

Noise seems to be the one physical agent which is clearly identified as an industrial hygiene problem among farmers. There are protracted exposures to machine noises in excess of 90 dBA. The noise sources extend beyond unmufflered internal combustion engines to power transfer devices (gears, chains, belts, sprockets, tumbling rods) to fans, vibrating metal panels and other sources.

It is interesting that the left ear is usually more affected than the right ear. This may be explained by the position assumed by the operator as he works with trailed equipment. His left ear is closer to the source of the noise and the right ear is in the "shadow" of the head. Also, in the use of shoulder-held firearms the left ear will be closer to the discharge blast for the right handed individual and most people are right handed.

BIOLOGICAL AGENTS

This is a most difficult area for the industrial hygienist. In the first place, he has not considered the biohazard area to be of more than casual professional interest. He has felt much more comfortable working with chemical and physical hazards. In the second place, the medical literature has taken very little notice of the occupational aspects of biological agents. Currently, for example, a great deal of attention is being given to angiosarcoma and vinyl chloride with less than 50 cases, total, world-wide, with little mention being made of the several hundred deaths each year from insect stings.

Perhaps the point to be made here is the occupational aspect. The angiosarcoma cases were associated with an occupational exposure in an industrial setting. The insect sting deaths may not have been related to bee-keeping and thus were not occupational. Still, an agricultural worker might very well encounter bumblebees, wasps, yellow jackets, hornets and other stinging insects in the course of his duties.

The World Health Organization has listed about 170 diseases common to animal and man. Probably no more than a third of these have a possibility of infecting agricultural workers and perhaps a tenth of them could be regarded as having significant potential for producing an occupationally related disease. Again, it is the occupational aspect that is giving us the difficulty here. For example, if a farmer acquires brucellosis from handling infected swine fetuses, few would argue that the disease is occupational. If he acquires brucellosis from drinking raw milk, then this would not be occupational.

With the possible exception of medical concern associated with rabies and tetanus it would seem that there is little reason for the practitioner in rural areas to place undue emphasis on any unique occupational etiology. After all, histoplasmosis may appear in a child playing where starlings have roosted or it might be found in a farmer after cleaning out a chicken house.

Equine encephalitis might be of occasional interest but many more people seek medical care from falling off horses. Leptospirosis might be of occasional interest from an occupational standpoint, but more cases occur after splashing around in the old swimming hole and more people drown in the swimming hole than acquire leptospirosis. Poison ivy might affect someone cleaning out a fence row, but more calamine lotion would be needed in a scout camp.

CONCLUSIONS

The industrial hygienist, in viewing the agricultural sector, would probably feel that the following conclusions are justified:

1. Little epidemiology and related medical research has been done for the detection-evaluation phases of industrial-hygiene-for-the-farm. Controls must await such data.
2. In acknowledging that industrial hygienists have given little attention to the agricultural sector in the past, one must predict that this probably will change little in the near future.
3. Health and safety professionals in the industrial sector should extend their efforts into the end-user area, the farmer, and provide him with the protection not otherwise available to him.
4. Until now the farmer has been fortunate that his exposures have been mixed and highly intermittent. Specialization is occurring and the size of operations is increasing. Fewer people will be exposed longer and more severely, with probable difficulties resulting.
5. At the present time it would appear that chemical exposures are more important than biological or physical agents.

SUMMARY

Farming presents potential for industrial hygiene exposures - chemical, physical and biological - wherever done, by whatever method and at every scale. Illustrative examples are given of industrial hygiene problems associated with farming. Reasons why industrial hygienists have largely ignored the farming sector are discussed. Possible means for professionally serving this occupational group are voiced.

AGRICULTURAL HAZARDS

TRAUMA AND AGRICULTURAL MACHINES

William H. McConnell

Agricultural machines have revolutionized farming. In colonial days, almost 90% of the country's population was needed to produce enough food for everyone. Today, our present population is very well fed by a total agricultural population of 9,425,000 people and according to the U.S. Department of Agricultural Statistics of 1972, less than half of this number, or 4,446,000, make up the actual labor force (this includes 3,281,000 family workers and an additional 1,165,000 hired employees). The application of machines to agricultural production has been one of the major factors in the development of agriculture as we know it today.

This mechanization of farms according to latest information is represented by 4,562,000 farm tractors (wheel and crawler), another 820,000 garden tractors, 760,000 combines, 613,000 corn pickers and picker-shellers, just to mention a few of the more common powered propelled machines. The longevity of farm machines is another factor which must be reckoned with as in the words of General MacArthur, "Old soldiers don't die, they just fade away". The average life of farm tractors is 11 years and the same is generally true of other larger equipment. Only the operators on large acreages tend to replace their equipment with up-to-date models.

Agricultural machine manufacturers have made available to the farmer today an array of mechanical devices to assist him in his chosen occupation and he can, through the use of electronics, mechanics and hydraulics perform work tasks that were not even dreamed of a few years ago. Along with the development of these machines to extend the worker's limited time and multiply his efforts, we have seen the disappearance of such accidents as getting kicked by a draft horse, lacerated by a chip from an ax, cutting a finger while sharpening scythes, and having a foot stepped on while milking a cow. In its place, we have an ever changing scene of accident possibilities with powered machines and tools so diverse as to make demands on the safety expertise of the agricultural worker greater than that of the industrial worker. The problem presented today is how can better injury control be attained for today's agricultural workers and employees.

HAZARD ASSESSMENT

If we wish to examine the injury data for agriculture, we have only a round number estimate of about 200,000 disabling injuries annually according to the 1974 edition of Accident Facts put out by the National Safety Council. They also point out that in 1973 their figures indicate a death rate of 61 per 100,000 workers. This calculation can be used when making comparisons with other industrial rates in a manner similar to procedures followed by the Bureau of Labor Statistics in preparing their estimates. However, for our purposes today, we are interested only in information related to injuries with farm machines. NSC data from farm accident studies over the past several years indicate that work injuries are related to major farm machines in the following percentages: Tractor, 40%; wagon, 20%; elevator and conveyor, 16%; combine, 12%; mower, 4%; corn pickers and shellers, 4%; and balers, 4%.

It is obvious that good data is one of our problem areas. Dr. Keith T. Maddy, California Department of Agriculture, spoke to this issue at a USDA Research Leaders Conference early in 1975 in California. I quote, "A major need in the field of farm safety is for high quality data to identify what the actual problems are. Research is needed to develop improved systems for obtaining and interpreting such data. A number of surveys have produced incomplete and noncomparable data".

A significant step forward in data regarding accidental injuries was contained in some recent work done in Michigan Accident Survey by Howard J. Doss and Richard G. Pfister which is reported in the January-February, 1974, issue of the Farm Safety Review. This study produced some accident rate information on major farm machines from which it is possible to determine accident frequency rates for a number of specific types of farm machinery and are as follows per million hours of use: tractors, 8.4; corn pickers, 48.6; combines, 112.0; wagons, 71.9; elevators 573.6; balers, 106.4. All machines other than tractors have a combined rate of 40.9.

There is also a need to devote more attention to factors related to accident causes. One of the more recent studies done by Phillips, Stuckey and Pugh which specifically sought information on such variables as farm size, sex, family size, educational attainment of the head of the household and number of accidents per family, was exceedingly enlightening.

First, accident rates were significantly higher on farms of 200 acres or more. Secondly, the better educated farmers tended to operate bigger farms resulting in greater work exposure with an apparent greater number of accidents ensuing. In fact, the higher the level of education the head of the household attained, the greater the number of accidents registered by the family. Thus, the authors summed up these findings succinctly by indicating that apparently the more educated farmer operates more acres, utilizes more machinery, works longer hours and in general, is exposed to a greater number of accident potential situations.

The National Safety Council's Farm Department has been active in instigating a number of state wide studies which have become a useful information source for determining the size of the accident problem in agriculture. The present standardized accident studies tell us who, to what extent and how many are involved in farm accidents. However, the second level and more in-depth inquiry of particular accident problems (epidemiology) will be necessary if we are to develop sufficient specificity in designing successful counter-measure programs regarding safety problems.

MACHINERY TRAUMA

The most visible symptoms of machinery trauma are those which are of an obvious nature, thus this paper will dwell primarily upon the acute injury problems that are demanding immediate attention.

Trauma, in this instance, will be regarded as mechanical, electrical, and/or thermal insult to the body. In discussing it, we will be most concerned with the abnormal energy exchange relative to the mechanical type and to a lesser extent those abnormal exchanges of electrical and/or thermal energy. These energy sources will be examined specifically in relationship to the major powered propelled agricultural machines.

An example of such mechanical energy might be the unexpected event that takes place when a worker suspects a v-belt drive is slipping and places his hand on the v-belt to increase the tension in order to cause the driven part to start to rotate. In this process, the fingers of his hand do not clear the pinch point of the v-belt drive and he suffers a traumatic amputation of two fingers.

Large agricultural machines are not mechanically unique in that many of them, more likely than not, have a variety of power transmitting components such as chain and sprocket drives, v-belt drives, rotating shafts, gear sets, knives and so forth, which have common operational characteristics. Further, if properly guarded where and however the operator may be exposed to them, these components do not present a hazard in normal operation.

Then there are the functional components which L. W. Knapp has very appropriately described several times:

> "The mechanical injury problem is related to the inherent characteristics of machines which, by design, are expected to grasp, pound, shake, sort, pull, cut, vibrate, etc., agricultural products in a manner to make them usable for the farmer or the consumer. Major groupings of such machines by category would include soil tillage machines; planting machines; cultivating machines; forage harvesting machines; grain, fiber and vegetable harvesting machines; transport and elevating machines; agricultural chemical applying machines; and sorting and packaging machines.
>
> "Mechanically, these machines are an amalgamation of gears, chains, belts, hydraulic cylinders, motors, electronic devices, etc., that must be controlled by an operator. To err in the judgements necessary to optimize their potential, not only brings about an economic loss, but can result in a serious accident, for they may be powered by motors of considerable horsepower and exert forces of hundreds of pounds of energy. They are not sensitive to the differences between plant protoplasm, which they are to reduce to a desired form, and human protoplasm, should it be encountered inadvertently (that is, a corn picker will not reject a human hand if it is encountered among ears of corn on the husking bed)."

From a major grouping of agricultural machines, one could describe them to be associated in general with four basic operations, that of tillage, planting, harvesting and transport. At the present state of our knowledge with regard to trauma, and from information compiled by the Michigan Study, it appears that harvesting should be our number one problem area. High accident rates are noted in all of the six machines previously mentioned in the Michigan Study, with tractor injuries most likely related to transport on the highways.

The seriousness and the severity of farm machinery accidents, which in many instances can result in amputations and permanent disabilities, places them high on the priority list for countermeasure action. Now, let's look at the specific agricultural machines and discuss some of the typical types of injury associated with their use.

We know there is an agricultural accidental injury problem today, and as described in Accident Facts, 1974 edition, it ranks number 3 amongst all industries in the number of fatal accidents annually. The real question is why can't we solve this problem. I believe it is because we have treated it as a single problem. It is time we quit looking for all inclusive injury prevention techniques and give attention to the need for improved design as well as more actively attempting to determine the ultimate causes of various kinds of agricultural accidents. The basic methodology in determining which factors of man, machine or environment, were responsible for injuries has been overlooked too long. We have been consistently leading ourselves into blind alleys by looking for all encompassing solutions to accidents and have placed too much emphasis upon "operator error". What is implied by this course of action is if we can get the man straightened out, then we will eliminate the injury. This is a fallacy for surely we know that all people will not read and follow safe practices nor will they heed all visible warning signs. (Even after having an accident, they often duplicate the same unsafe practice.)

IN-DEPTH INVESTIGATION OF TRAUMA

Historically, agricultural accident statistics have been based upon analysis of information gathered from the various states records of death certificates, newspaper clipping services and occasional accident surveys; however, the 1960's brought about a rapid change in the overall methodology of securing data. The advent of the application of epidemiological techniques by the Institute of Agricultural Medicine and Environmental Health to the study of specific accident problems has caused the entire picture to be refocused. A new emphasis as to that which can be accomplished through in-depth study was revealed.

Farm family accident studies in Ohio and Michigan based on a statistically sound sampling technique have indicated specific areas where additional research was needed. These studies are most useful in pointing out problem areas for injury control needs but, even more importantly, pointed out the need for more comprehensive information on farm machinery accidents themselves. These two preceding statements further affirm the fact that expanding the data base if not sufficient when dealing with farm machinery safety. There is already a reservoir of data on agricultural injuries just waiting to be applied.

Assuming then that we need more comprehensive information on farm machinery accidents, let's explore the methodology and philosophy of the in-depth investigation, a research tool of considerable import.

First of all, we are describing a methodology which delves into three distinct areas contributing to the accident sequence which are the man, the machine or agent and the environment.

Obtaining this information requires someone who has had training, has experience with the activity being investigated or developed an expertise in this area and uses a professionally skillful approach to the information gathering sequence.

The basic job of the investigator is to get all of the factual information that is available such as the physical, mental and health characteristics of the individual involved, a specific determination of the terrain at the accident site, the climatic conditions at the time of the accident and the detailed description of the machine that was involved. While securing this information the investigator must be continually on the alert to determine the sequence of the events that led up to the actual accidental injury. In addition, he must also seek to determine why the victim was doing what he was doing just prior to the occurrence of the accident. This in itself is very useful in evaluating some of the natural behavioral patterns exhibited by victims.

Finally then, a report is prepared which will include basic information of the victim, the produce and the accident site along with pictures of the machine involved as well as the simulated re-enactment of the scene whenever this is possible.

Preparation of an accidental injury report requires a professionally trained investigator who not only has the technical skill to ask intelligent questions about a machine, but also possesses a great deal of expertise in interviewing and communicating with the people from whom he is seeking information. This latter skill is most important in securing the voluntary cooperation of an accident victim.

It has been our experience that when case reports are prepared by trained investigators the analysis of such cases for a specific machinery category can be very productive for the development of specific counter-measures. The abundance of factual information and particularly the natural behavior patterns of the victim uncovered during the interview not only make it possible to develop hazard patterns, but also makes it easier to establish priorities for counter-measures which could reduce the injuries associated with a particular type of accident.

Some might ask where is the reservoir of data on occupational injuries in agriculture? My answer is that we have a real world of agricultural accidents to sample, those of yesterday and today. There is no reason to speculate on how something may go wrong and cause an injury to an agricultural worker if we send skilled investigators out to the site of the accident and visit with the accident victim and witnesses.

Some will say that we need to expand the data base. However, I feel that the lack of the firm data base is no longer an excuse for continuing to proliferate agricultural occupational trauma exposures in the farm environment.

SUMMARY

Agricultural mechanisation has revolutionized farming but presents a problem in attainment of better injury control for agricultural workers and employees. A major need in agricultural safety is high quality data to identify actual injury problems. Acute injury associated with farm machines needs the application of epidemiological techniques. In-depth investigation of farm machinery accidents by specific categories is indicated. Trained professionals, in-depth investigators, can provide the factual background for implementation of appropriate counter-measures and more effective educational programs.

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AGRICULTURAL HAZARDS

ZOONOSES AS OCCUPATIONAL DISEASES

James H. Steele, D.V.M., M.P.H.

The Zoonoses were defined by the World Health Organization (WHO) in 1959 as "those diseases and infections which are naturally transmitted between vertebrate animals and man." In 1967 WHO classified the zoonoses as those directly transmitted, those requiring intermediate hosts, and the saprozoonoses in which organic matter can be a reservoir of the infectious agent. They can be further broken down into those groups caused by bacteria, fungi, parasites, and viruses, of which there are more than 100 different diseases of animals affecting man. Most of the zoonoses are worldwide in distribution, but many have been controlled both in the United States and abroad. In some regions they have increased, and even new infections have appeared. This report will be limited to a review of the present status of the zoonoses as occupational diseases in agriculture and related industries; it is an up-date of my 1968 paper on a similar subject.

BACTERIAL DISEASES

Anthrax The first bacterial disease is anthrax, which was the oldest agricultural occupational disease recorded by man. Virgil in the Georgics described the disease in sheep, and pointed out that men salvaging sheep carcasses that had died of a disease that turns the flesh putrid and the fleece dangerous, would themselves suffer disease that affects both limb and lung and they die a fiery death, meaning intense fever. Throughout the Roman Empire anthrax was a recognized serious occupational disease among livestock farmers, because the pustule was quite evident and the people recognized these black eschars that differentiated them from the lepromas of leprosy, which was also common in that period. As late as 1869 Russian literature warned land owners not to feed their serfs dead animals because this would cause a severe disease and kill off their best farm laborers who tried to salvage carcasses that had died of anthrax. Koch identified the organism in the early 1880's. The first attenuated vaccines were made later in the 1880's by Pasteur, whose experiment in vaccinating sheep produced 100% protection of his vaccinated animals and 100% mortality in his unprotected animals, the most perfect experiment ever put together.

This was the beginning of the control of zoonotic occupational diseases. We used those same vaccines as late as the 1930's. We had no effective treatment for human anthrax. Vaccination was a very important way of contending both with an economic and occupational problem. Since the development by Sterne, a South African veterinarian who identified a non-capsulated spore vaccine which was a stable mutant, this Sterne vaccine now is the vaccine of choice throughout the world, used as a live agent. The Sterne vaccine could be made cheaply by most countries of the world. It produced a drastic change in the incidence of both human anthrax and animal anthrax.

Glassman in 1957 reported estimates that there were possibly 100,000 cases of anthrax occurring in agriculture and agricultural associated industries. Ten years later there were probably less than a few thousand cases of anthrax being reported worldwide. By 1974 we have had in the United States only 2, 3 or 4 human cases per year where formerly we encountered many more cases among agricultural workers and rendering plant operators who helped to bring in a dead animal or fed the carcass to pigs. Cases like that have practically disappeared. Industrial cases associated with the carpet industry started to disappear in the early 1950's when synthetic fibers came in and the so-called coarse wools and hair brought from Asia and Africa were no longer used in the American market. The last two cases that occurred in veterinarians were in Louisiana in 1971. This was in connection with the Louisiana outbreak of that year, the first that had occurred in that locality in more than 30 years.

It is always difficult to determine why the disease has these long periods of latency. Last year in Texas, 1974, in an area 100 miles north of Houston we had a very severe outbreak of anthrax involving some hundreds of animals - not a human case occurred. The organism was found in surface water. This was confirmed by the Center for Disease Control (CDC) so is quite credible. In discussing this with experts in the field, we all agreed that anthrax had declined precipitously. Less animal vaccine is being sold today than at any time in this century since vaccines were first discovered. This is a cost benefit, that the average farmer may not have an outbreak in a county for 20-30 years such as the two cases I have cited. This is not only occurring in the United States but in Europe, all across Russia and in places like the Philippines, Australia and many parts of South America. Africa is a little more difficult to cite as there records are practically unknown.

Now as to human prevention, the United States had a large program of trying to develop new vaccines for industry and also for civilian hazards. An aggressin has been used. An aggressin is a filtrate of bacterial growth. These were used in animals 50-60 years ago without much success. But with refinement now Wright and his colleagues working at Fort Detrick demonstrated that these were quite successful in protecting people at high risk. The question of human immunization has been a problem for many years. Researchers have developed an effective non-viable cell free protective antigen for the protection of workers in industries where they may be exposed to bacillus anthracis. This preparation is well tolerated and greatly reduces the incidence of anthrax in occupationally exposed workers handling coarse wool and goat hair. Goat hair is used largely for the batting of our suits, and this is probably the most dangerous of all the animal fiber industries because goat hair is most frequently contaminated. Immunization has been recommended for certain textile workers previously cited, veterinarians and their assistants, and laboratory workers who may be exposed. The vaccine is available from the Center for Disease Control (CDC), U.S. Public Health Service, Atlanta, Georgia. In the United Kingdom the same vaccine is available from the Ministry of Health. The Russians carry on a lot of research in this area; some very fascinating experiments have been published in their literature. They use aerosol vaccines. They had tried this out first on guinea pigs and then sheep and a year or two before I was there in 1963 they had just published their human experimental data where people just sit around in a room and aerosol is injected into the room - this attenuated nonvirulent organism that the Western World calls Sterne vaccine and the Russian World calls their ST 1 and 2 provides a good immunity. One of the problems in anthrax is measuring immunity. There are no antibody levels to measure, as with other diseases, so you have to do indirect evaluation. You could do this with the guinea pigs and sheep but you could not do it with humans. You don't challenge humans no matter how totalitarian your state may be. So by indirect experiments in sheep and guinea pigs they came to the conclusion that the vaccine was of great value. They told me that they were distributing about a million doses of human vaccine a year. On one hand I had been told by the veterinary authorities that anthrax was under control and there was no hazard either in industry or public health. One of my conclusions was that they had something going well that nobody challenged or criticized, so they just kept repeating it. Now that was 1963. Things may have changed considerably and they may not now be vaccinating so many people. The important thing is they could vaccinate a million people a year without any undue side effects.

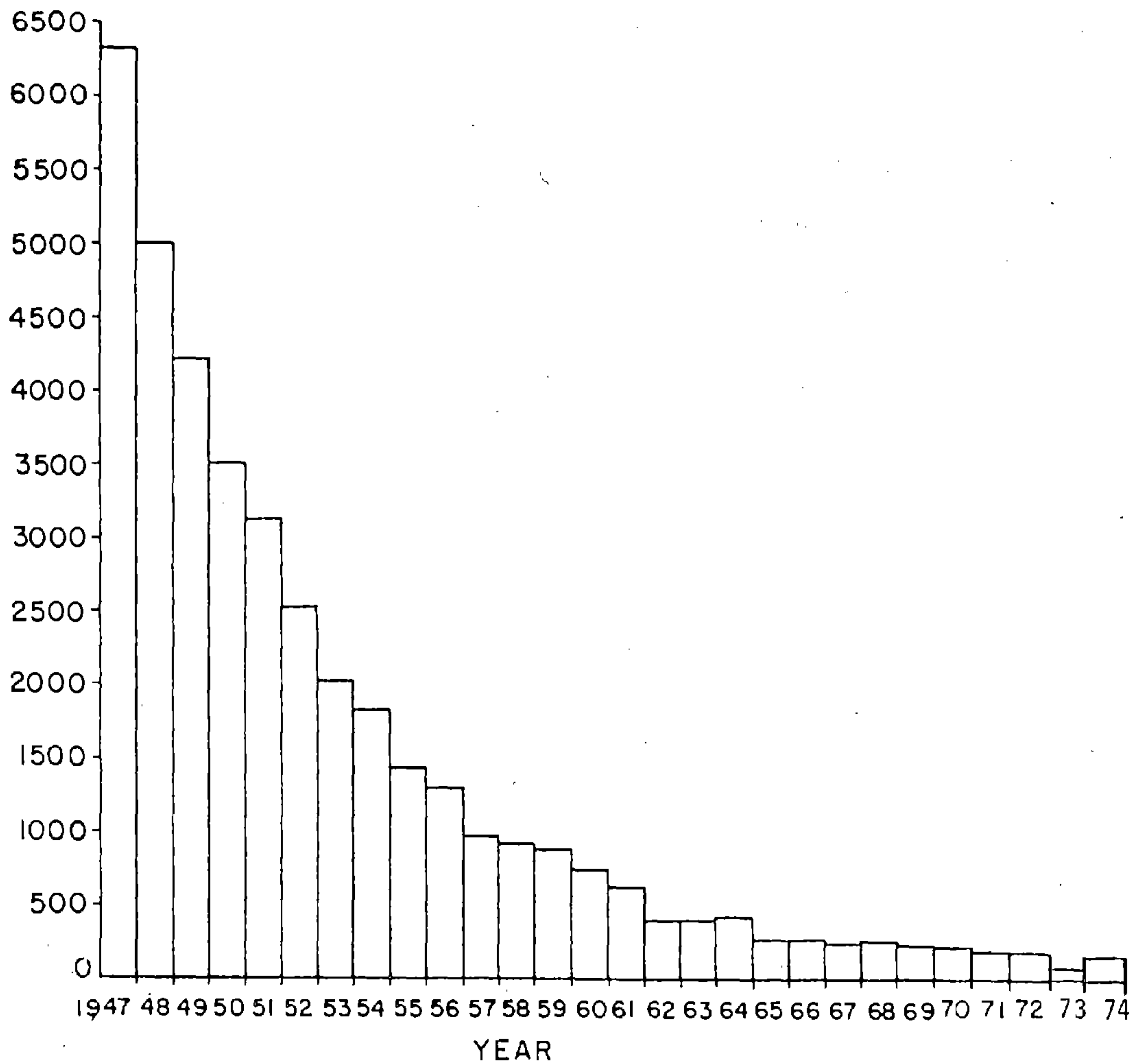
As to antibiotic therapy, it has been well known that anthrax responds very well to practically all the antibiotics. Penicillin is the agent of choice both in man and in animals except for the very acute type of anthrax. There you have a shock syndrome associated with the disease, an irreversible process. No matter how much antibiotic you give, intravenous or intramuscular, you do not reverse the course of that disease. In those cases both in man and in animals, on autopsy, mediastinal lymph nodes are badly inflamed indicating that the organism has broken through the lymphatic barrier and entered the general circulation. So you are dealing with a bacteremia at that point and usually death results from the organism entering the brain and causing bacterial meningitis. There is one complication that people should bear in mind that occurs in industry, an unusual side effect. Doctor Brockwin and his colleagues were called in after a human case of cutaneous anthrax was identified in one of the workers in a New Hampshire textile factory that was handling coarse wool and goat hair. Inquiry led to investigation of three deaths that had occurred earlier that month in the plant which had all been signed off as cerebral vascular accidents. Within a population in the 6th and 7th decade of life you can suppose that if a person is healthy one day, collapses that night, and is dead the next day, a cerebral vascular accident is a sensible diagnosis. But Brockman suggested that they re-examine these bodies. They exhumed two of them and were able to demonstrate the anthrax organism in the brain through the fluorescent antibody technique. Industrial physicians should bear in mind that when such sudden deaths occur in a cluster, they can be possibly anthrax.

So much for anthrax except one other point that is almost academic. What has happened to soil contamination with anthrax? These organisms have lived for many decades in soil. The Japanese in the 1890's impregnated threads with bacillus anthracis in tubes. They open up a tube every ten years. The last one they opened in 1967 still had viable organisms. Now this whole picture has changed in the United States and in Western Europe. My colleagues both in the veterinary field and ecologists and environmentalists, speculate that there may be a number of different factors at hand. First, the Sterne vaccine, an avirulent stable mutant, may have replaced what we call the wild population and has seeded the soils throughout the world. This one does not produce disease. Second, the farmers' broad use of antibiotics, is often as widespread as his use of insecticides. If you inject a cow on the inside it must be good on the outside too! Third, there are changes in our agricultural practices. The Gulf Coast of Texas up to the mid 1950's was what you call an anthrax zone - district. Everybody had to vaccinate, otherwise you were going to lose some cows that year. This has changed completely. Where formerly east Texas was largely a pasture area, today it is one of the biggest rice producing areas of the world, between western Louisiana, and Gulf Coast of Texas, and Arkansas. That area produces as much rice as any other geographical area of similar size in the world. We export more rice out of Houston than any other port in the world. So these three factors may combine to explain a situation as it exists in a local area of the United States. On the other hand I can't explain why the Mississippi or the Missouri River Valleys, or the Central River Valley of California, all which were formerly called anthrax districts, do not see much disease any more.

Brucellosis Another success story is brucellosis. Figure 1 shows how we dropped from a high of some 6,500 human cases in 1947 to about 170 in 1974. That decline has continued almost as predicted and is a beautiful example of animal disease control and decline of human disease concurrently. I reported to the Third Inter-American Congress on Brucellosis in early 1950 that this was the most serious occupational disease we had among our rural people and in our animal handling industries. We had the support of two groups immediately: the livestock and dairy farmers of America, and the meat-handling unions that were concerned about disease among their employees. These two groups focussed on Congress, and appropriations were made. We have probably spent well over two billion dollars between 1952 and 1974 in reducing the incidence of this disease in our animal populations from a figure of say 18-20%, the accepted figure for dairy cows in 1950, to less than .2 of 1% today. Many states can be identified as brucella free areas. If the human disease had continued at the level of 1950, and applying Jesse Steinfeld's 1975 figures on the costs of a human case of disease of this type, that such a case costs $8,000, we find that these two things balance each other out. We would have been spending two billion dollars on the care and the convalescence of the estimated 250,000 people that would have had the disease over the 25 years instead of this small number now that is down to the hundreds. So from this point on, we're practically home free in cost benefits so far as brucellosis as an occupational disease is concerned. We're going to run at 100-125 cases a year. There is always some pig that turns up with brucellosis somewhere. We've got 100 million of them and we can't keep track of all of them. Out of the 174 human cases reported last year, 37 were in people who had been traveling abroad and eating dairy products outside of the United States. Most of those were in Mexico. The human cases reported in Mexico have remained at a level of about 40,000 cases for the past 25 years without much variation. The same thing is true for the whole of Latin America for which I commonly use a figure of possibly 100,000 annual cases of brucellosis. Western Europe has followed a program very similar to ours, of eliminating affected animals, and the cost benefits there are

FIGURE 1

HUMAN BRUCELLOSIS, UNITED STATES, 1947-1973



Preliminary data. (From National Communicable Disease Center Zoonoses Surveillance Report, Annual Brucellosis Summary, February, 1974.

quite similar to what I have just cited here, in controlling human disease. In addition, I should point out that animals that are free of brucellosis carry their young to term, increasing their value; their milk production is higher; and when they come to be utilized for meat, they are not condemned or restricted.

One point as to human vaccination. We spent a lot of time on human vaccination. I was in school when Huddleson attempted to vaccinate veterinarians against brucellosis in 1936-1937. Practically the whole senior class at Michigan State developed either disease or sensitivity to the organism. My colleagues tell me that they can't get near a cow that's got brucellosis without getting a reaction. We were working with dead vaccines. Throughout World War II all kinds of vaccines were tried, especially Strain 19, which is the modified strain used in calves, first identified in the late 1920's by the old Bureau of Animal Industry. But this gave some very severe reactions and we more or less dropped human brucella vaccination investigation by the mid 1950's. The Russians pursued it using this Strain 19 vaccine but they were using it with scarification technique for everybody in the animal handling industries; veterinarians, slaughter house workers and railroad men hauling animals should be vaccinated. Many Russian veterinarians told me about the severe reactions they suffered. I do not feel that human vaccination has much place today even in the countries like Mexico that have a very high incidence of disease.

There has been considerable advance in therapy of brucellosis in man. Combined streptomycin-tetracycline is the therapy of choice, but even that fails under certain conditions; people have relapses and the physician must determine how long he wants to maintain the course of antibiotic therapy. When some people have had the disease, be it mild or severe, they become sensitized and any time they come in contact with the organism thereafter they will have a sensitivity reaction which is hard to differentiate from disease per se. They'll have fever, chills, and flushing and so forth, but take them out of the environment where they're in contact with either live or dead protein and those signs and symptoms will disappear immediately.

Today the investigators have done a lot of work in setting up sero-types. In that last paper, 1968, I was talking about three main groups of organisms - the abortus which is the cow organism, the suis that belongs to the swine and the melitensis which is the goat. Since that time all of these have been broken down into sub-sero-types. Geographically we can pinpoint these different sero-types, but with the vast movement of people and animals this is not as clearcut as it formerly was. But a new organism has appeared in this group that is going to cause a lot of concern in our urban areas. Originally we looked upon it as an occupational disease of kennel men. Brucella canis was first described in Atlanta, Georgia in 1960 and for the next ten years I thought we were dealing with occupational disease or kennel disease that was confined largely to experimental dogs and occasionally we would have a human case occur. For the first ten years, I took the position that this organism was not dangerous to man. We were working with it in the laboratory; nothing happened to anybody, and then two human cases occurred in Cornell University laboratory workers, and then cases just piled up after that. There is a paper in print by George Lovejoy, epidemiologist of the Memphis Health Department, in investigating 12 human cases of brucella canis in that town. He did a dog survey and found that 25% of the dogs in the lower economic areas of the town were infected. So here we have a new problem and we cannot say that this organism is related to any of the other three that I mentioned. It is related to brucella ovis, a sheep organism which does not cause disease in man, but where this one came from and how it evolved we can't say except that it turned up at the best possible place that it could, in Atlanta, Georgia where CDC is. It therefore got immediate attention and maybe there is a certain degree of serendipity to that.

Glanders Another bacterial disease is glanders. The reason I cite this one is that glanders is a disease that has practically disappeared in the world. It occurs in only a few places. We have not had a case in the United States in some 30 years. Haven Emerson one of the most outstanding public health men in the United States served on the Committee on Communicable Disease Control with me in the early 1950's just before he retired. He told me that at the turn of the century this was the most important occupational disease in big cities where there were many livery stables, and horses providing transportation. Today the horse is only a recreational animal practically anywhere in the world. We don't even use them in Texas any more to speak of. This disease disappeared through what we call just good selective testing by an agent called mallein. You put a few drops in the palpebral fold, it produces an inflammatory reaction; you get a little pus coming out and that was the death certificate for that animal. It worked so well that by the 1930's Canada and the United States, and Western Europe had eradicated this disease and many other parts of the world too. In Leningrad I was looking at a wall covered with photographs of bearded distinguished looking individuals. These 30 odd photographs were of veterinarians that had died of glanders between 1877 and 1914, the period when the school maintained some records. Subsequent to that in the 1920's Russia experienced some very severe outbreaks of glanders that you can say were practically human to human infections. So this is a disease that is of only historical interest except for places like India or Mongolia. But people do take trips to these remote places. You can go to Mongolia. These things can return.

Leptospirosis The next one I want to say a word about is leptospirosis. It is interesting and bewildering that more human leptospirosis is not encountered. This is a very widespread disease in domestic animals, swine, cattle, occasionally sheep, horses, dogs, rodents, many wild animals. There are some 150 different sero-types. The most important being that from rats, the so-called ectohemorrhagia which causes Weil's disease which was described by Doctor Weil in 1888. For this disease we have vaccines for animals that are satisfactory. As to human vaccination, this has not been successful to any degree, and I do not know anybody that is experimenting with human leptospira vaccination today except possibly the Russians. As to the management of human cases, the penicillin-streptomycin combination has been accepted by many people as satisfactory. On the other hand, I have had experience with laboratory workers that have splashed organisms into the conjunctiva, or ingested them through capillary tubes. They were given antibiotics immediately and they still came down with the disease. Fortunately, we have few fatalities, but we still do have 3, 4, 5 a year and these occur in a broad spectrum of workers. The most common one, the most readily understood are plumbers and those that are working in stagnant water or water that may be contaminated with rodent urine or other animal urine.

Salmonellosis Salmonellosis is the next one. This one I call the most important of the animal diseases in the United States. This is not only a matter of occupational exposure but is also important as a disease of ingestion. I think the largest occupational disease outbreak that ever occurred was in the Philadelphia General Hospital in 1967 where CDC had some 2,300 positive cultures sent in from the hospital during a period of roughly March 1966 to January 1967 and this was not only a matter of ingestion. The disease was introduced by what are called second grade eggs referred to in the industry as checked. Salmonella Derby was the agent. The first cases were seen in people that were on soft diets, either egg nogs or soft boiled eggs. Then it spread to the nurses that were taking care of the patients. Then the environment became contaminated. Subsequently more patients, more hospital workers, until we had something close to 100 people working in the hospital that were ill. You can imagine the legal aspects of the thing were just overwhelming. There were three or four nurses that died of fulminating salmonella disease. The industry where we see this most frequently is in the rendering industry where dead animals are handled. I also have a citation here on a study from France in which some 100 people working in the plant were examined over a period of some months and the infection rate in this group was about 50% but without any evidence of disease. They were shedding salmonella, the same kind they were getting out of the swine going through the plant. When you encounter situations like this, all you can do is think in terms of what the dosage is and that the host is dealing with a parasite in an effective way. Now as to therapy for salmonella. The experience at CDC with hospital outbreaks has been to the effect that frequently you prolong the course of the disease when you use antibiotics. You eliminate the gram positive organisms, an ideal situation for the gram negatives to continue to multiply and so the CDC recommendation in the Handbook on the Control of Communicable Diseases recommends supportive therapy except for typhoid fever where chloramphenicol is the drug of choice. As to vaccination, there is no satisfactory vaccination for salmonella disease in man. Typhoid vaccine under certain conditions is acceptable but I don't think everybody should be immunized against typhoid fever. We're much better off saying that we create an environment that is free of salmonella. But to do that is very difficult because all the species I have cited for leptospirosis likewise are infected with salmonella. In fact I can start with the smallest amphibia and end up with man, and say that every thing that is in between zoologically be they cold blooded or warm blooded can be carriers of salmonella.

<u>Tetanus</u> A word about tetanus. Tetanus is a disease that all physicians as well as veterinarians have recognized for long periods of time, and we all know the early antitoxin immunization procedures that were developed by Behring and his colleagues in the 19th century. But the point that I want to make here is that it was such an important disease in World War I that the French Army at the end of the war assigned one of their distinguished scientists Dr. Gaston Ramon to develop a better tetanus vaccine. Out of his investigations came the tetanus toxoid which, as you know, is the agent of choice today. It worked so well on horses they tried it on humans and you know the success of World War II. I include this disease not to point out that animals are the reservoir except that the intestines of all animals including man harbor the clostridium tetani. The control procedure is immunization and this is one of the most effective immunizations that we have for both man and animals. Among animals we only immunize valuable horses. I have been in Samoa, where tetanus is so widely disseminated that they also immunize domestic animals including dogs, but that's the only place I've ever encountered this procedure. The number of human cases in the United States is now less than 200 annually, and this will continue downward. I've always been

an advocate of having everybody who gets a license to operate an automobile show evidence that he or she has had tetanus toxoid. I've never gotten very far with this argument. They say, well you get that accomplished, and they'll insist on something else. Kids going to school have to have a long series of immunizations including tetanus, but every once in a while there is a person that comes up to adolescent age and wants to drive a car and just doesn't have evidence of tetanus immunization. I hope that may disappear in the next ten years.

Tularemia The next disease is tularemia. Wild animal reservoirs include many species. This one occurs all across the Northern Hemisphere but strangely enough, south of roughly 35 degrees latitude, which is more or less the North Carolina-Georgia state line extended across the continent, there is little tularemia. Most of the tularemia is in the temperate zones around the world, also in northern Europe, Russia, across Japan. South of the equator tularemia is practically unknown. Today we have very effective means of controlling tularemia through a live vaccine that was developed by the Russians. We have brought this vaccine back to this country. It's available through CDC for the populations that are at risk, meaning it is an experimental vaccine. The therapy of tularemia is a combination of streptomycin and any other antibiotic that you may want to use. There is a tremendous literature on tularemia in Russia for those of you who want to read more extensively on it. Today I look upon it as both a recreational and occupational disease.

Tuberculosis (Bovine) I do not believe there has been a proven case of bovine tuberculosis as an occupational disease in the United States in a decade or more. The incidence in our animal population is practically nil except once in a while we get a big outbreak as we did in Georgia last February, and that's what you call a clerical error. The herd hadn't been tested in some ten or twelve years, but those things will occur. Outside the United States I wrote a text book in 1969-1970 in which I pointed out that the economic losses for tuberculosis in South America, Africa and Asia exceeded all the foreign aid that the under developed countries received. This is on the basis that an animal with tuberculosis will give 30% less milk and this is on a linear equation that is compounded each year, and at the end of five years the carcass is not even worth salvage for meat. The elimination of bovine tuberculosis is by test and slaughter. We never use BCG. BCG was demonstrated to be of no value early; the new drugs, isoniazid derivatives are satisfactory if you've got very expensive animals and you can keep after it and maintain your dosage, but no area that I know of except South Africa is using any of the anti-tuberculous drugs except in zoos. Zoos will use them for very expensive animals or valuable specimens and they will also use them in colonies of chimps, orangutangs or gorillas which are expensive experimental animals.

PARASITIC DISEASES

Moving on to parasitic diseases. There are few among these of any major importance to talk about in the temperate zones. These diseases are mainly in the tropics except for hydatid disease. Hydatid disease is transmitted by the dog tape worm, and forms large cysts in the human lung and liver and sometimes heart and brain. This is practically a rare disease in the United States except for some cases recorded in Arizona, Utah and California. In school, I was taught that this disease was not present in the United States and only a few cases have been revealed in the last decade. But in countries surrounding the Mediterranean or across southern Asia, this disease is a major problem. I was in Cyprus this past summer. Thirty years ago hydatid disease was the most important reason for surgery on the island. Today with the elimination of the dog population, reducing it from 46,000 to 6,000, they have practically brought the disease under control. It will still be 30-40 years before people that were exposed in the last decade are no longer a part of the present scene. An interesting argument came up in Cyprus about why is it necessary to kill these dogs? There was a parliamentary investigation, and the chief veterinarian of the country took his evidence to the parliamentary group and then he went on talking. He said: "I dare say that one out of ten or you legislators have the disease and you don't know it." When you've got a disease like that you can make your point stick! He was able to obtain very effective dog control.

RICKETTSIAL DISEASES

One that I should mention here is Rocky Mountain Spotted Fever, truly an occupational disease of rural people and now of vacationers too. We have good vaccines for this but in many areas of the country people have forgotten to vaccinate and in 1973-1974 we had more deaths from Rock Mountain Spotted Fever than we had in the previous decade. To a certain degree complacency is the problem. Diagnosis is missed; vaccination isn't practiced. We had a death in Texas in April and investigation showed that the old farmer felt that: "A little fever isn't going to bother me," and when the rash came: "Some insect had been after me," and finally he was sick enough that he presented himself. But he was in extremis at that point and there wasn't much you could do about it.

Q. fever is another one of interest in the United States. Certainly it was occupational at the beginning. But today I think this disease is so widespread that we have successfully self-immunized our entire population, animals and human. All the sheep, all the goats and all the cattle have it, and at the time of parturition the fetal tissues are just teeming with the organism. Morbidity and Mortality reports from CDC reveal a scattering of cases, but as all good epidemiologists know, luck follows them around so they do find cases to report. When I went to Cyprus this summer, they told me about a beautiful outbreak of Q. fever among British soldiers fresh out of England, all out of Manchester, London and other urban areas. They probably never milked a cow in their lives. They had 100 cases of pneumonia among these troops and these fitted exactly parallel with the animal parturition period of November to March. On the other hand, in the native population or refugee population, which is very large, there wasn't a single case. As a vaccination against Q. fever, nothing of any importance can be recommended except possibly for laboratory workers. Even there I think they might just as well take the risk of having a mild case of acute fever as to risk the acute reactions I have seen from the vaccine. Controlling Q. fever is just impossible. To vaccinate the animals that have it is of little value. It doesn't interfere with lactation or parturition; they usually retain their fetuses to term.

VIRAL DISEASES

As to viral diseases, the arthropod-borne ones are present all the time. They are occupational for people working outdoors, as well as avocational. Children also are susceptible. We are all constantly being exposed, especially in a year like this with a lot of St. Louis equine encephalitis around. We are all asking ourselves "where has St. Louis been the past ten years?" We are certainly not seeing any more mosquitoes this year than usual. Certainly we have no explanation of why we should have an epidemic year of this disease.

A word about small pox. As you know, the announcement that small pox has been eradicated from the world will come sometime this year; I think they're shooting for a December 1975 date. Concurrently with the disappearance of small pox, I should make one statement. I was involved in responsibility to review the literature of the world to determine if there was any animal reservoir of small pox. There is no animal reservoir. There are animals that are susceptible to small pox, mainly sub human primates and cats. We can take the vaccinia and grow it on cats and you also can grow it in some other experimental animals, rabbits, guinea pigs, but none of these constitute a reservoir. On the other hand, with the disappearance of small pox, cow pox has disappeared, the type Jenner described, vaccinia. I have not seen a proven case of cow pox in the last decade but we do have a disease that is very similar called pseudo cow pox which has a very hard cornified lesion that is sometimes painful and sometimes not. And there is another disease that simulates that called orks or contagious eczema or "sore mouth" in which sheep get big sores in their mouths. People frequently vaccinate lambs against this disease and in handling the vaccine they infect themselves. Monkey pox is an occupational disease among people handling monkeys, of little consequence.

The most dangerous laboratory disease that we've ever encountered is the great African green monkey disease or Marburg agent disease which occurred in 1967 in Germany. I've written it up in some detail. There were seven deaths among physicians, veterinarians and people working in the laboratory. It caused a very severe hemorrhagic death with shock syndrome. That was the only time the disease ever appeared in laboratories. During the next seven, eight years, so far as we knew, it disappeared. Then in January 1975 two cases appeared in South Africa in young Australian people who were hiking around the continent. The young man died within days and the diagnosis was made by electronic microscopy of the tissues. They could do that within hours after they got the specimen at CDC - certainly one of the more dramatic illustrations of the use of the electronic microscope. As to control, we have no idea what its reservoir is. We get the disease by coming in contact with the organism and we would say it is one of the most dangerous diseases we know.

Vesicular diseases we have in many varieties in animals, but rarely in man. The most important for the world economy is foot and mouth disease. Fortunately, man is highly resistant to this. Only occasionally do we have laboratory cases where people develop lesions on their hands and other parts of the body. I know of no fatal case of human foot and mouth. There was a famous case in England in 1966 when an automobile mechanic developed the disease and the government put him in quarantine in the best hotel in London so he wouldn't come in contact with any animals.

<u>Chlamydia Infections</u> These are psittacosis and ornithosis. For years they were associated with the bird breeding industry. Today they are particularly important in the turkey industry. They are with us and will be with us. We have no way of controlling them

in birds. We can treat humans and birds effectively with tetracycline but they are all sporadic. Two years ago a friend of mine was giving a paper on "what happened to turkey ornithosis?" and that summer we had the first big outbreak in Texas in some 15 years.

Influenza Just one point on influenza. Now the consensus is that we constantly have re-combinations going around of organisms in man and animals and these are the ones that generate the new types that cause pandemics. Statements are being made that sometime in the 1980's we're going to see the next pandemic. This is of particular interest to me. I became ill with a highly pathogenic strain of the avian influenza virus that was demonstrated to be fowl plague. The organism was confirmed by Plum Island and reported back to CDC as the first human case that ever survived. Along with the letter confirming the identification of the organism was a subsequent paragraph to the effect that we should destroy all virus material we had, and tissues containing it, so I lived only by the grace of the United States Department of Agriculture.

Rabies I do not consider an occupational disease. Many people ask why; I say this is not a matter of vocation, but rather a matter of the accident of living. There are several fungal diseases like coccidiomycosis arising from the stirring up of dust in agricultural operations. Sporotrichosis occurs in those working with sphagnum moss in the florist industry. Ringworm can be acquired from working around infected animals. Griseofulvin is the agent of choice of treatment both for man and animals in these.

In closing I would say that we should not close our minds to the importance of these diseases that we've brought under control. Nature does have a way of saying:"Look, I want to survive as much as you do." Even infectious microbes seem to survive our best efforts to control them, at times.

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MAXIMUM UTILIZATION OF THE HANDICAPPED WORKER

MAXIMUM UTILIZATION OF THE WORKER HAVING ORTHOPEDIC DISABILITIES

Kenneth D. Arn, M.D.

The House of Delegates of the American Medical Association in 1962 stated that, "handicapped people, when placed in positions for which they are qualified, make efficient, loyal, dependable employees." The Council on Occupational Health then, after careful study, expanded this statement into the following guidelines:

"Comprehensive and documented studies of the performance of the handicapped have repeatedly shown excellent job performance, as well as less absenteeism and better safety records than in comparable groups of able-bodied workers. In most circumstances, such employment does not lead to increased workmen's compensation costs.

"The principle of evaluating ability, rather than disability, of a potential employee deserves continued emphasis. Strict placement requirements are unavoidable for certain jobs, but if the type of work permits, the handicapped individual should receive equal consideration with any other worker.

"The efforts of the President's Committee on Employment of the Handicapped in developing medical criteria for employment of specific groups, encouraging improvements in architectural design of buildings, stimulating rehabilitative procedures, and in promoting an educational campaign to industrial management and the public, merit support and commendation...

"Successful employment of the handicapped involves:

1. Proper medical evaluation of the physical and mental condition of the applicant and his capacity for work.
2. Proper job placement, in which the employee can utilize his maximum functions and skills, without affecting adversely his own health or exposing his fellow workers to increased hazards. (This requires cooperation between administrative personnel and the medical department.)
3. Periodic re-evaluation of the employee's health status to protect his capabilities for continuing satisfactory employment."

To better understand the response of a person to a handicap, one should understand the rule of body image and adjustment to a disability. The body image is a complex conceptualization, which one uses to describe one's self. It is one of the basic parts of the total personality, and as such, determines one's reaction to one's own environment. It is, in fact, the mental representation one has of his or her own body.

The two aspects of the body image concept are the individual's ideal or desired body image, and the actual body image itself. For the recently disabled person, the closer these two images relate to each other, the better is the psychological adjustment of the individual. However, when the discrepancy is wide between these two images, then the psychological adjustment of the individual is much poorer.

For a disabled person to adjust to the psychological impact of the disability, the body image has to change from the image of a non-disabled person to the body image of a disabled person. Of course, in the adjustment process, the body image will change from that of a non-disabled person to the actual body image of a disabled person; but for adequate psychological adjustment toward a disability, the ideal body image must make the corresponding adaptation. Thus, this adjustment to a disability is the acceptance of an altered body image, which is more in harmony with reality.

As a guide to the speed in which an individual will adjust to his disability, a group of three factors must be considered, namely:

1. Factors directly associated with the disability,
2. Factors arising from the individual's attitude towards his disability, and
3. Factors arising from the individual's view of the purpose of the body, and the relationship this view has with the type and extent of disability.

In the first group, the physical limitations imposed by the disability may cause excessive frustration, and in turn, result in behavioral disorders. As an example, an individual who is quite active in sports, plays golf, tennis, squash, and is quite active physically, will experience a greater psychological impact upon becoming disabled than an individual who leads a more confining, and physically limiting life, since the restriction imposed by the disability demands a greater change in the basic life style of the sportsman. Both factors directly associated with the disability have an important bearing upon an individual's reaction to the disability.

An individual's adjustment to his or her disability is dependent upon the attitude one has had prior to the disability. Now, if the attitude toward a disability was negative and strong, this individual will naturally have a greater adjustment problem than an individual with a neutral or positive attitude toward disability and the disabled. Also, the amount of fear an individual experiences at the onset and duration of the accident that led to the disability will determine the psychological impact of the disability. As a rule, the greater amount of emotion expended during the onset, the better the psychological adjustment to the disability.

The impact of the disability can be lessened by proper instruction and education of the individual regarding the disability that is present. Much time and effort should be spent in explaining in simple straightforward mechanistic manner to the individual the factors involved in the disability, and by this means, the individual will find it easier to accept and to adjust to the handicap. Therefore, it is important for psychological adjustment to a disability that the individual be instructed in terms that can be understood, both in the medical aspect of his disability, as well as the psychological aspects, as soon after onset as possible.

The third factor that determines the adjustment process based upon the individual's idea of the purpose of his body may be characterized as falling somewhere on a continuum. At one end of the continuum is the view that the body is a tool to accomplish work; it is a productive machine. At the other end is the view that the body is an esthetic stimulus to be enjoyed, and provide pleasure for others. Now, everyone falls somewhere in this continuum. Thus, to adequately predict the impact of a physical disability on an individual, one has to locate the placement of the individual upon the continuum, then evaluate the disability in light of the individual's view of the function of his body.

Thus, it may be concluded from these three factors that the degree of psychological impact is not highly correlated with the degree of disability. Disability and its psychological impact is a highly personalized event, as relatively superficial disabilities may have devastating psychological effects.

When the disabled individual has reached the maximum possible restoration, it is time to institute the vocational rehabilitation process, and the means to this end is the evaluation of the individual as to his limitations, and particularly his assets. The following are commonly recognized areas of evaluation important to the rehabilitation process:

1. Medical (general and specialty).

2. Psychological (intelligence, personality, aptitude, interest, academic achievement).

3. Social (family, community, peer group, work group).

4. Vocational (physical stamina, persistence, interest, dexterity, impulse control, acceptance of instructions in supervision).

In the field of orthopedic disabilities the medical findings are of considerable importance. Not only are we interested in the orthopedic disabilities, but also in the rehabilitation medical procedures which will give us an adequate idea as to the work ability of the individual. Highly important in this field are the contributions of the occupational therapist, the physiatrist, and the work evaluation coordinator.

The psychological evaluation is of great importance. By proper psychological testing, one is able to determine the response of the individual to his disability, and also to note personality changes. One can also obtain warning signs of some deep-seated psychotic condition that warrants further evaluation and treatment before the vocational rehabilitation process can be continued. Also, of prime value is the "intelligence" testing of the individual, for with this background, we can determine whether the rehabilitation process should be in the field of further education, or in the re-training of certain manual procedures.

The social evaluation certainly plays a role in the vocational rehabilitation process, as one needs to know the adjustment of the family to the individual and his handicap, and also the individual's reaction towards his family in the new light of being disabled. One should know the standing of the individual prior to the disability - how he was accepted by his peer group, his church activities, social activities, and fraternal groups. Also, one should determine whether the disabled individual will again return to an active social life.

Lastly, the vocational rehabilitation process is one that can be both quite simple, and yet be the most complicated endeavor undertaken in the total rehabilitation of the individual. Here again, the Work Evaluation Counselor can play a role in determining the physical stamina of the individual and his response to certain types of physical labor. Also, the psychological aspect of the disability could play a great role in the vocational rehabilitation process. For example, was the individual's disability directly related to his occupation, and would it be detrimental to return him to this occupation? Again, the cause and effect factors play a vital role in the vocational rehabilitation process.

The disabled job applicant may be confronted by obstacles to employment, despite the fact that he has gained satisfactory job skills. Employer attitudes and personnel policies may deprive him of the opportunity to prove his ability to perform successfully on the job. However, much progress has been made in this area in the past twenty-five years. Through extensive programs of education, and through improved services to the handicapped, increasing numbers of persons with a disability have been returned to gainful employment. One of the factors that played a great role in the rehabilitation of the handicapped is that of the industrial physician, and his acceptance of the guidelines that have been established by the Council on Occupational Health of the American Medical Association.

As George A. Michael once said, "anyone who wants to make a living folding parachutes ought to be required to jump frequently." And this is true in the field of vocational rehabilitation. We, as physicians, should be reluctant to state, "You can't do it - your disability is too great," rather, we too, should be required to jump often into the rehabilitation process, and to say, "Within limits, you can do it if you want to, and we will help you to help yourself!"

In conclusion, studies have shown that properly placed disabled persons are competitive with non-disabled workers in productivity, attendance, job stability, safety, and cost of employment. Improved employment opportunities for the disabled person will come after there is improved understanding and cooperation between business, industry, the agencies providing services, and the disabled persons themselves.

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MAXIMUM UTILIZATION OF THE HANDICAPPED WORKER

EMPLOYMENT AND PLACEMENT OF THE DIABETIC SUBJECT

Lain Tetrick, M.D.

A controlled diabetic is not a handicapped person and is therefore not an employment risk. A diabetic who is not controlled or who has complications secondary to his disease or because of poor control is handicapped and is a very serious employment risk. This entire paper regarding the employment and placement of the diabetic subject could be summed up in one word - <u>CONTROL</u>. What is meant by control? Unfortunately, it has as many connotations as the word control has in regards to behavior patterns of youths. To understand control, we must have a consensus among:

1. The Diabetic Patient.
2. The Family of the Diabetic.
3. The Medical Community.
   - A. Occupational
   - B. Private.
4. and the Employment, Personnel, Insurance and Union People must know what we are talking about.

Prior to World War II, it was practically impossible for a known diabetic to be considered for any line of employment in any kind of industry. Two major reasons existed to account for this:

1. The term diabetes meant a rigid syndrome and usually these were insulin-dependent subjects.
2. Working conditions were not consistent with good diabetic control.

Since then, progress in the understanding of the disease and its treatment, also time, and OSHA, have changed this.

When we look at the incidence of diabetes in our population, it can be appreciated why it is important to pursue the problem of employment. It has been estimated that <u>over 5 million</u> people in the U.S. have diabetes. <u>Only</u> 1.25 million of these take insulin - thus the non-insulin-dependent diabetic outnumbers the insulin-dependent diabetic by a ratio of 4 or 5 to 1 which would, under our classification, diminish the number who can be considered "handicapped". Diabetes is <u>10</u> times more prevalent by this concept after the age of 45 than under the age of 45. At least half the known diabetics are in the <u>45 - 65</u> age bracket when the disease is diagnosed. So it is apparent that most diabetics develop their disease while they are employed.

Because of "old" fears of the diabetic, in many of our industries it has been estimated that we in our medical departments in industry know of only 1 diabetic for every 3 or 4 diabetic employees - they may falsify their histories, control the urine, which is still the most common screening test used, for they're afraid they won't be hired. The relationship of diabetes to job capabilities is much talked about as evidenced from the above figure and we still are basing our concept on these facts and figures but we do need more bio-statistical information. It is one of our commonest ailments. The increasing incidence may be accounted for because:

1. People are living longer.
2. Population is increasing (until recently).
3. "Better" detection methods are available.

In 1 of 5, diabetes was discovered at age 65 or older - these are not employment or insurance risks. In about 22% diabetis appeared between the ages of 25 and 44, a definite employment and insurance problem. But in only 8 out of 100 or 8% - it was discovered at an age of less than 25 years. This is where our greatest problem arises concerning employment - the juvenile insulin-dependent diabetic.

In an attempt to gain information for standards on employment and placement of the diabetic in industry because of the high prevalence of diabetes in the general population, several surveys have been done. The first significant one was done by the American Diabetes Association (ADA) in 1957 involving 434 businesses and industries throughout the U.S. Even then there was a somewhat enlightened attitude toward employment of the diabetic. The large companies with the more sophisticated and better equipped medical departments seemed to be the most enlightened. They usually set the pace. That survey indicated that most companies did employ known diabetics and most of the companies which did not continued them in their employ after the condition was diagnosed. From this survey of the ADA, the suggested standards then were:

1. Diabetics should divulge their disease.
2. Diabetics are capable of performing any type of work for which they are physically, mentally, and educationally equipped.
3. Diabetics on insulin should not be assigned to jobs that are hazardous to themselves or others.
4. Diabetics should work steady, regular shifts. (Union problem).
5. Diabetics should carry cards or tags of identification.
6. Plant physicians should perform blood sugar determination when appropriate.

7. Diabetics should have complete examinations regularly.

In 1969 the Committee on Employment of the American Diabetes Association, Greater Chicago and Northern Illinois Affiliate sent out questionnaires to physicians who were members of the Central States Occupational Medical Association. This was the first such survey that dealt directly with the occupational physician. This was published in the Journal of Occupational Medicine in August 1971. We felt that we, the physicians, have the greatest influence in shaping and determining health policy regarding hiring and placement of applicants in the job world. The companies surveyed represented a large variety of industrial concerns from light to heavy and from insurance companies to foundries. Over two million employees were represented. It was found that 60% of the large companies and only 31% of the smaller companies (less than 3,000 employees) did blood sugar tests. Over 76% would recommend a known diabetic for employment who had been certified by his private physician as being in good control.

We asked the question - If your company disqualifies diabetics for employment is it because of:

1. Past poor experience?
2. Insurance reasons?
3. Others?

The responses were about evenly divided among the three categories. This prompted other comments leading to the summarization that disqualification was particularly likely if the diabetic:

1. Were under persistently poor control.
2. Had frequent insulin reactions.
3. Serious vascular complications.
4. Sought hazardous occupation.

This pretty well makes the kind of sense most doctors use in determining the qualifications of fitness of any worker for any kind of job. We also asked if the insulin-dependent diabetic was placed on rotating shifts. Over 40% answered "Yes" to this query. To the question: Do you find the diabetic either better or worse? no difference? 87.5% found diabetics either better (5.6%) or no worse (81.9%) than non-diabetics regarding reliability and absenteeism.

In a recent article, December 1974, JOM - a sub-committee of the ADA Committee on Employment and Insurance has attempted to present guidelines to the physician for the diabetic in industry. These guidelines are intended to:

1. Encourage enlightened employment attitudes and hiring of diabetics.

2. Provide a yardstick of proper medical maintenance for the benefit of both the hired diabetic and the industry. But first of all we must identify the diabetic. We must have a diagnosis. This should be relatively standard in the light of our present knowledge and statistics; however it is not easy to make the diagnosis of diabetes. It is actually one of the most difficult diseases to diagnose. Guidelines for diagnosis using the Glucose Tolerance Test are being re-examined. A screening test of the urine is not a diagnostic procedure. However, a glucose tolerance test is usually performed to rule out or confirm the diagnosis of diabetes. Some feel that fasting hyperglycemia must be present to diagnose diabetes mellitus. Criteria for the interpretation of oral glucose tolerance tests in use in the U.S. most commonly accepted are those proposed by:

TABLE I

References:	University of Michigan * (1, 2, 3, 4)		
	Whole Blood mg/100 ml	Plasma or Serum	Diagnostic Criteria
Fasting	---	---	All Levels At or Above
1 Hour	160	185	
1½ Hour	140	160	
2 Hour	120	140	
3 Hour	---	---	

* Glucose load 1.75 mg/kg ideal body weight as 25% solution. In otherwise healthy and ambulatory individuals under age fifty. For all procedures: Venous blood, Autoanalyzer (Ferricyanide) or Somogyi-Nelson Methods.

TABLE II

United States Public Health Service ** (USPHS) (5)			
Whole Blood	Plasma or Serum	Points	Diagnostic Criteria
mg/100 ml			
110	125	= 1	Total of 2 Points or more - Definite Diabetes
or above			
170	195	= ½	
or above			
---	---		
120	140	= ½	1 Point - Possible Diabetes
or above			
110	125	= 1	
or above			

** Glucose load 100 gm. For all procedures: Venous blood, Autoanalyzer (Ferricyanide) or Somogyi-Nelson Methods.

TABLE III

University Group Diabetes Program + (6)	
Diagnostic Criteria	
Sum of F,1,2,3, Hour Glucose Values mg/100 ml	
Whole Blood	Plasma or Serum
500	600
or more	

+ Glucose load 40 gm/sq meter of body surface. For all procedures: Venous blood, Autoanalyzer (Ferricyanide) or Somogyi-Nelson Methods.

We used the U.S.P.H.S. criteria as we feel we therefore would not "over-diagnose" and thus not penalize the job seeker. Utilizing these guidelines also helps us to have a handle on the employed diabetic, as well, in order to properly place him or even change his position in the course of his employment.

GUIDELINES FOR CONTROL

All diabetics in ideal and acceptable control categories are employable. A diabetic in the Unacceptable category, which I will describe, may be rejected for employment. We have attempted for many years to dispel the concept and the stigma that a diabetic is a handicapped person, for is the diabetic really handicapped?

> Webster states that the word figuratively means "any disadvantage that renders an achievement, or especially successes in competition - more difficult."
> "To place at a disadvantage".
> Synonyms - encumber, burden, impede, hinder.

The Federal directive on the affirmative action program to employ the handicapped may handicap our educational program to which I have just alluded.

1. Ideal Control
   - A. Has stable blood sugar values.
     1. Less than 160 plasma fasting.
     2. Less than 230 two-hour P.P.
   - B. Has no insulin reactions.
   - C. Has no acetonuria, and
   - D. Has proof of good medical supervision with visits to his physician at least every three months or more often (some will maintain that they are able to control a diabetic with fewer visits).
2. Acceptable Control
   Higher blood sugar values than above if:
   - A. No more than mild acetonuria occurring infrequently.
   - B. No more than 2 insulin reactions a month which are mild and easily corrected.
   - C. Proof of good medical supervision with visits once a month or more.
3. Unacceptable Control
   - A. Plasma blood sugar values greater than 230 with inadequate medical supervision (a redundant statement in most instances).

B. More than 2 insulin reactions a month.
C. Severe reactions difficult to control.
D. Evidence of frequent or severe acetonuria.

GUIDELINES FOR JOB PLACEMENT

Again the status of diabetic control is the most important factor for determining placement of the diabetic in industry. This is dependent upon:

1. The severity of the disease.
2. Adequacy of medical management.
3. Presence of complications.

Thus it is important that close communication exists among the private physician, the occupational physician and the employee.

CLASSIFICATIONS OR GUIDELINES FOR JOB PLACEMENT

I. Diet alone - with documentation of ideal control. These people are capable of performing any type of work for which they are physically and educationally qualified.

II. Diet and oral blood sugar lowering agent. These are capable of performing any job for which they are physically and educationally qualified.

III. Diet and insulin with documentation of ideal or acceptable control.

A. These are capable of performing any job for which they are physically and educationally qualified except:

1) They are not permitted to drive heavy vehicles, cranes, tractors, or commercial vehicles engaged in transporting passengers or freight. (This is mandated by the D.O.T. criteria for interstate commerce vehicular drivers).

B. There should be no assignment at unsafe distance from ground or near heavy moving machinery.

C. They probably should not work 12-8 shift as this tends to disrupt the diet-insulin-rest cycle.

IV. Presence of significant complications, regardless of treatment group. Same restrictions apply here as would be applicable to disease of the cardiovascular, visual, renal, nervous and other systems of other etiologies.

PROGNOSIS FOR WORK ATTENDANCE

It appears that poor attendance and absenteeism is no higher for the majority of diabetics than it is for the non-diabetic worker. The work of Moor, Buschbom at Richland, in 1974 in which a diabetic study group was age-matched to other studies of absenteeism in non-diabetics showed a favorable comparison with the non-diabetic. This study pointed up the importance of doing an age-matched comparison. I would like to see a larger study done matching the age, sex, job classification, and anniversary dates of hire. This would then give us a true picture of what happens. This contrasts with that of Nasr, Block, and Magnuson who in 1966 reported on "Absenteeism Experience in a Group of Diabetic Employees at the Ford Motor Plant". In this study the sickness absence of 213 known diabetics employed at Ford Motor continuously from January 1, 1959 to January 1, 1964 was compared with that observed in a presumably non-diabetic population matching for age, sex, race, job and duration of employment. They found among the white employees, sickness absence in the diabetic was <u>twice</u> that of control. Among the black diabetics, sickness absences were increased threefold. Absences of more than sixty days in any one year were six times more frequent in the diabetic. They concluded, however, that that study did not indicate whether better medical <u>control</u> would reduce the absence of diabetics, but did indicate that under existing conditions the loss experienced by the company and employee was such as to suggest more intensive measures for the early identification of these employees and increased medical supervision to lessen the impact.

We could, therefore, advance a more simplified classification to help the physician to determine the employability of a diabetic - much in the same fashion that the American Heart Association did long ago in categorizing the therapeutic and functional status of heart disease. I have summarized our concepts, which have not, I hasten to mention, been approved by my co-authors or the ADA for I have not presented it to them. However, it merely represents a capsulized summary of our paper and is not in conflict with it. A survey is presently being conducted by the Greater Chicago and Northern Illinois Affiliate of ADA, of physicians in our area to determine if they do or do not agree with this concept.

We would categorize the diabetic by these previously mentioned standards into a therapeutic and a functional classification.

Therapeutic Classification:

I. Diet alone.
II. Diet and oral hypoglycemic medication.
III. Diet and insulin without complications.
IV. Any of the above with complications.

Functional Classification:

A. Capable of performing any job for which the diabetic is physically and educationally qualified - i.e., I and II no restrictions.

B. Capable of performing any job for which the diabetic is physically and educationally qualified, but should not work 12-8 shift, i.e., III.

C. Incapable of performing work above ground level, operate mobile equipment, or work with mobile equipment, because of insulin requirement, i.e., III.

D. Incapable of performing any job because of poor control and/or complications, i.e., IV.

Thus we could have 2 categories of classification:

1. Employable:
   I A
   II A, II B, III B, III C.
2. Not employable:
   IV D.

Almost any profession, avocation or trade is available to the diabetic - all he has to do is to pursue it. If every parent of every diabetic child (this is where the problem lies) would accept the mandate - to see to it that his child is prepared in some area so that he can avoid the shift working, unskilled and insecure laboring jobs, the problem of employment of the diabetic would be greatly minimized, and our entire nation would reap the rewards. Diabetics make excellent physicians, lawyers, teachers, clergymen, executives, administrators, nurses, plumbers, electricians, bricklayers, architects, carpenters. Parents should not rely solely on schools, doctors, or television to motivate their child. The home exerts the greatest influence of all, so parent group teaching is essential to the future of the diabetic child.

The only truly handicapped diabetic belongs to the: 1) 8% juvenile diabetic group if they are not motivated to pursue a profession, trade, skill or art in which, as I mentioned, they can avoid the demands of the unskilled shifting laboring jobs; or, 2) Those who have complications so great that they fall into Class IV-D.

I have attempted to stress the importance of:

1) Re-examining our criteria for the diagnosis of Diabetes Mellitus. As Siperstein suggests - to under-diagnose diabetes mellitus probably does little harm, whereas to over-diagnose, the harm to the patient can be enormous.

2) Having guidelines which are liberal but realistic regarding the employment and placement of the diabetic.

3) Minimizing the stigma placed on the diabetic which has been brought about by over-diagnosing, misunderstanding, and unfounded concepts that diabetes is a universally disabling ailment - for it is not in the majority of those presently labeled as diabetic.

4) And the importance of control regarding the diabetic and his job.

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MAXIMUM UTILIZATION OF THE HANDICAPPED WORKER

MAXIMUM UTILIZATION OF WORKERS WITH EPILEPSY

George N. Wright, Ph.D.

The purpose of this paper is to help develop better understanding of the occupational aspects of epilepsy including medical, psychological, and safety implications. There has been too much propaganda for hiring handicapped emphasizing social duty and employer obligations. There is little help in sweeping statements that "it is only ability that counts" or that "the primary handicap of epilepsy is social stigma." Selection for hiring is based upon, or at least should be based upon, objective information about the requirements of the job matched by the characteristics of the job applicant.

A guide for the vocational evaluation of persons with epilepsy identifies the dimensions of the handicap and other worker characteristics as they relate to the requirements of jobs.[1] There are three major disability considerations in selective placement:

1. the worker should have the ability to accomplish the job tasks, that is to meet physical demands such as walking, lifting, climbing, and so forth;
2. the worker should not be placed in a position where he is a hazard to himself or jeopardizes the safety of other people and property; and
3. the job should not aggravate the worker's disability.

A worker is handicapped for a specific job if his disablement constitutes a functional limitation for any of the critical requirements of that job. However, we must distinguish between a job handicap and an employment handicap. Disability results in an "employment handicap" because it makes it difficult to secure acceptance for suitable employment. It is hard to get a job no matter how well suited, if one is labeled epileptic. This unwarranted rejection of known epileptics without regard fo the job requirements, makes this disorder today's number one <u>employment</u> handicap. Many disabilities create a more serious job handicap - in fact a seizure disorder does not preclude most tasks required with most jobs. Admittedly, epilepsy, if not fully controlled, can be a serious job handicap preventing placements in dangerous positions. But there is over-generalization of the handicap so epileptic applicants are not hired, even though they meet all of the physical demands of the job, there is no safety problem, and the work does not aggravate the disability.

This employment handicap associated with epilepsy creates a problem for industry as well as for the epileptic worker. Applicants with epilepsy refuse to reveal it because experience has taught them that epileptics are rejected from suitable employment. Consequently they do not tell about their seizure history and are often placed in dangerous situations. The natural anxiety over a new job plus their fear of disclosure may bring on a seizure. Dismissal typically follows without understanding or selective placement attempt and the worker moves on to another company. Under these circumstances, it is amazing that the system does not lead to more frequent personal injuries and elevated workmen's compensation costs. The fact that epileptic seizures rarely result in loss of time or costly compensation suggests that industry overgeneralizes the concern.

People who have epilepsy generally try to keep it secret in the face of unsound attitudes and practices. While one percent of our population have clearly definable epilepsy, less than one-third are identifiable in survey research.[2] Epileptics don't tell. We need to take the penalty out of the label. Federal civil service regulations since 1958 have prevented employment discrimination due to epilepsy.[3] State governments are doing their part by striking out discriminatory legislation which, until recently, made it illegal for an epileptic to marry, have children, and live a normal life.

The State of Wisconsin grants licenses to epileptic drivers when their seizures are controlled.[4] This enlightened legislation in 1945 repealed a law that said "no epileptic person shall drive." Now a driver's license is issued whenever there is medical certification that the would-be driver is seizure-free.

The late Dr. Edward Schwade, Epileptologist of Milwaukee, was responsible for the Wisconsin medical certification concept through which a seizure-free epileptic is not considered a dangerous driver. Experience has validated this proposition since selective licensure has reduced accidents while allowing capable epileptic drivers an important privilege. Doctor Schwade also promoted the idea that controlled epileptic workers should be certified as seizure-free by a qualified physician to eliminate their employment handicap.

The successful experience in Wisconsin, and more recently in Ohio and other states, where epileptics with controlled seizures are given the right to drive a car proves epilepsy is not a job handicap.

These people have no limitation attributable to their history of epilepsy if they are seizure-free. There is no vocational limitation and there should be no employment handicap.

The issue of utilization of epileptic workers then starts with the premise that if there are no seizures there is no physical limitation. If, on the other hand, seizures are likely to occur, we must assess the demands and circumstances of the position. The occupational limitations of persons subject to periodic epileptic seizures are addressed here.

There are many types of epilepsy and the job handicap imposed varies according to seizure symptoms. An older classification system describes the variations of seizure behavior: petit mal, grand mal, psychomotor, Jacksonian, focal (partial) motor seizures, thalamic and hypothalamic, febrile, and infantile spasms. The operational definitions of this older behavioral description have functional value in job placement where the overt physical manifestation is more important than clinical understanding. In 1969 the Commission on Terminology of the International League Against Epilepsy published a detailed classification. The main features of the new classification are the distinctions between seizures that are generalized from the beginning and those that are partial or focal at onset and may become generalized. There is a discussion of these classifications in the new book Epilepsy Rehabilitation.[5]

The job limitations of persons with epilepsy vary according to seizure types and pattern and degree of control. We can narrow down the topic of occupational handicap in two ways. First we can generally eliminate epilepsy which is under full control because the seizure-free person is unrestricted. There are a few exceptions, e.g., bus driving or airline aircraft piloting as an occupation, even though there is a long history of completely effective antiepileptic treatment.

We can focus on grand mal epilepsy as the most important seizure type in the work age population. In addition to convulsive episodes these people may have other epileptic manifestations, e.g., brief lapses of consciousness, tremor or psychomotor behavior. The remainder of this discussion, therefore, will focus on the most important problem of employees subject to convulsion.

An individual evaluation for selection and job placement must cover many factors. If the epileptic is subject to seizures it is essential to have comprehensive diagnosis and treatment by a neurologist or other physician specializing in epilepsy. Occupational pertinent questions are as follows: Which type or types of seizures are experienced now or in the past? How severe and how long are they? How frequent and regular? Are there precipitating factors? When do they occur? Is there an aura or warning and is it reliable? Is the seizure behavior (e.g., violent scream) disconcerting to others? What is the post seizure behavior and how long does it take to return to normal? What medication is taken and the apparent effect? How does the person feel about his disability? What other disabilities are there? Is there mental or emotional impairment?

Work activity, both mental and physical work, is good for the person with epilepsy - in fact seizures may be more likely to occur when the epileptic is idle than when he is occupied. Excessive emotional stress, however, should be avoided. The important consideration here is employment that is consistent with the applicant's physical and mental abilities.

Persons subject to seizures should not be placed in positions where their safety or the safety of others may be endangered by the loss of consciousness or uncontrollable actions. Environmental conditions to avoid are exposure to dangerous moving objects or mechanical and electrical shock hazards, situations where there is danger of falling from one elevation to another, exposure to burns, and work in cramped or otherwise hazardous quarters.

Examples of unsafe jobs include the operation of a crane, welding in which the torch may be dropped or thrown, handling molten metal, piloting an airliner, performing brain surgery.

Of all of the environmental characteristics and demands of jobs used by the United States Employment Service in job analyses, only a relatively small number would disqualify an applicant because of epilepsy.[6] Consider just a few job requirements which disqualify disabled persons other than epileptics: lifting and carrying heavy loads, crawling, running and jumping, hand and finger dexterity, gripping, reaching, back strength, agility, exertion, vision, perception, hearing, talking, temperature excesses or change, humidity or wet conditions, dusts and respiratory irritants, repetitious motion and exposure to communicable diseases. Epileptic seizures, including convulsions, do not prevent assignment to any of these tasks or environments, and they are only examples of the many job demands that are suitable.

There are some placement cautions in addition to the safety considerations mentioned. Emotional and behavioral problems are not infrequently associated with grand mal epilepsy. Public stigma and ignorance about the disorder damages the development of a positive self-concept. Moreover the unique ambiguity of this disorder is disturbing. But the problem may be due not only to the psychological impact of disability. In some instances, particularly where there is temporal lobe involvement, peculiarities of behavior may have a neurological basis. Careful evaluation of the neuro-psychiatric circumstances may be indicated for consideration on jobs where close interpersonal relationships and personal stability are essential for successful performance.

The personal acceptance of the epileptic worker by his supervisor and fellow workers is another issue. Generally speaking, after the initial shock of witnessing a grand mal seizure for the first time most people are sympathetic and accepting of the disorder. If the seizures are violent, loud and frequent, however, they will be disruptive in a work room where many employees are distracted. Assembly line personnel are particularly likely to be disturbed by such occurrences.

Vocational rehabilitation counselors and state employment service interviewers report that the epileptic client's greatest problem is finding and keeping a job. I recently conducted a study of epilepsy rehabilitation closures and found that relatively few, only 25%, of state vocational rehabilitation clients are adequately employed two years after services.

The worst candidates for vocational rehabilitation success are those epileptics who have many and varied self-perceived problems, who perform poorly on intelligence testing, who are multiply disabled, who have no dependents or poor family support, who have inferior education and training, who have a negative work history, who have poor social skills and activities and who have weak ego strength or long-standing psychiatric problems.

These indicators of vocational rehabilitation and placement difficulty can be used to identify high risk applicants who need comprehensive rehabilitation services prior to competitive employment. The 1973 federal Rehabilitation Act and its 1974 Amendment mandate that priority be given to the severely disabled with agency accountability for quality and adequacy of services. This means that every work age person with epilepsy should have the benefit of comprehensive rehabilitation services: optimal medical control, through work evaluation and career planning, job training, continuing counseling and help in finding appropriate work. The total rehabilitation of epileptics, however, will require employment opportunity and the proper utilization in industry of workers with epilepsy through selective placement. Operational policy which precludes hiring of all epileptic workers is both unwise and unjustified.

Out of all of the severe and lasting medical conditions, epilepsy is the number one handicap to employment despite the fact that it may impose little or no vocational limitation.

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BEHAVIORAL ASPECTS OF INJURIES

"ACCIDENTS" AND TRAUMATIC NEUROSIS

Herbert C. Modlin, M.D.

The diagnosis of traumatic neurosis rests on the concept of psychic trauma. In the general medical vocabulary, trauma refers to body tissue damage resulting from applied force: a black eye, a surgical incision, a broken bone, a bullet wound. Psychiatry has adapted this word to refer to damage upon the mental and emotional life of human beings and, by analogy, speaks of psychic trauma to a child who loses his mother, an adolescent girl who becomes pregnant, a middle-aged man who is discharged from his job. Certain kinds of accidents, also, can be psychologically traumatic.

Technically speaking, traumatic neurosis is not an officially recognized medical diagnosis; The Standard Nomenclature of Diseases published by the American Medical Association does not list the term. Although jargon, it specifies a useful concept if clearly defined whenever it is used. Keiser finds four separate definitions of it in current medical literature, and there are probably at least that many in the legal literature. Unless the antagonists, or even the protagonists, in a discussion of the subject state what the term means to them, they invite semantic confusion by using it. Some authorities recommend avoiding the phrase entirely and prefer to speak simply of psychiatric reactions to accidents.

The symptom constellations commonly following accidents are anxiety neurosis, hysterical neurosis, psychophysiologic disorders, and dependency disorders. Less common are depression and hypochondriasis. There should be no significant problem of assigning diagnostic labels; standard nomenclature is adequate for classification purposes. One variety of anxiety neurosis occurs only after sudden frightening accidents, and deserves the appellation "traumatic neurosis" if anything does.

The component parts of this syndrome are all subjective complaints voiced by the victim or his family. Objective findings are minimal and the diagnosis becomes clear only through accurate history-taking. It is exceedingly important for the physician to interview the spouse and close family members since, characteristically, the patient is concrete, unimaginative, verbally unproductive, and an inept observer of his own feelings and behavior. The symptoms are:

Anxiety. Patients regularly describe chronic free-floating anxiety; "Something is about to happen." Many suffer acute uneasiness when unable to avoid circumstances which recall the accident: hearing the hiss of steam, climbing a ladder, entering congested traffic, returning to the accident site.

Muscular tension. Symptomatic complaints are restlessness, fatigability, insomnia, impatience and the pervasive, "I just can't seem to relax."

Irritability. Hypersensitivity to noise, and commotion is most vividly demonstrated in the well-known "startle reaction" to sudden noises and intolerance of noisy offspring at home. Frequently the radio, television, or conversation of well-meaning friends will occasion an irritable lashing out or withdrawal.

Impaired concentration and memory. Psychological tests demonstrate no real memory loss; subjective complaints of this altered mental functioning result from self-preoccupied inattention to extra-ego matters in the environment.

Repetitive nightmares. Frightening dreams directly or symbolically reproduce the experienced accident.

Sexual inhibition. A notable lowering of sexual interests regularly occurs, sometimes to complete impotence or frigidity.

Social withdrawal. Interpersonal involvement with relatives, friends, neighbors, in clubs, church, recreation, the job is avoided - "Peace and quiet at any price."

A railroad switchman, working in the terminal yard at night, was unexpectedly pinned between two boxcars in such a way that he could not free himself. In much pain and mounting panic he yelled for help. His supervisor came, evaluated the situation wrongly, and signaled the engineer to back the train. Realizing that that maneuver would crush him, the switchman screamed at the supervisor and was able to halt further car movement. He was extricated and taken by ambulance to a hospital for ten days of treatment and observation. He sustained no fractures but had extensive ecchymosis of his back, shoulders, arms and thighs, and persistent low back pain from a subsequently diagnosed herniated disc. When seen for psychiatric evaluation two years later he was tense, restless, tearful and irritable. He dreamed nightly of runaway trains, imminent wrecks and locomotives speeding toward him. His wife informed of his irritability, intolerance of noise, insomnia, nightmares, anorexia, social withdrawal and total sexual impotence. Almost anyone would have been psychologically traumatized by such an experience, but would have recovered in a few weeks or months. For this man the accident was disastrous.

A second patient, a 45-year-old married man, had for 25 years been a truck and construction equipment driver. He was a dependable worker sought after by local contractors, and had been steadily employed. He was last hired as a driver of an earthmover on the midnight-to-morning shift. After dumping one load of dirt he did not notice that the now empty truck body had not fallen entirely back down to its horizontal position but remained caught, projecting slightly above the top of the truck's cab. He was driving along a temporary road at 35 miles an hour when the edge of the elevated truck body struck a low railroad bridge. In the crash, heard a quarter mile away, the steel bridge was so buckled that trains had to be rerouted.

His first awareness of an accident came five minutes later when he regained consciousness to find himself lying on the seat of the cab with his feet out the window. When I examined him two months later, he presented nearly every symptom of a traumatic neurosis syndrome: anxiety, panic attacks, severe tension, insomnia, nightly dreams in which he drove his earthmover into a black wall, irritability, startle reaction, loss of sexual interest avoidance of people, difficulty in concentration, and complete refusal to get into a wheeled vehicle.

How do we understand such seemingly disproportionate suffering from accidents producing minimal or no physical damage? Under conditions of perceived danger, as in the first case, the alarm reaction of the ego is activated on the psychological level, and the fight-flight mechanism on the physiological level. The autonomic nervous system and the consciously controlled skeletal musculature arm the human organism for attack to reduce or destroy the source of threatened danger, or for retreat to lessen the threat or avoid it entirely. If, however, as with the switchman, a victim is caught and immobilized, action either against or away from threatened danger is blocked. If the ego alarm signal and physiological fight-flight reaction are activated but cannot operate, the rapid buildup of psychic and physical tension suffuses the mental apparatus with excessive stimulation which upsets psychological balance; and as a result the unvented free-floating anxiety and muscular tension continue.

A variation of this pattern is illustrated by the plight of the construction equipment operator. He first became aware that an accident had occurred when he regained consciousness after the fact. The accident was already part of his past; realistic danger no longer existed to be met and handled. The fight-flight mechanism was automatically mobilized by his eventual awareness of something amiss but there was no target for the strong sense of danger with its accompanying anxiety and muscle tension to be discharged against. Action was not blocked, as in the first case; it was irrelevant.

An additional point about such accident situations as just described is that jeopardy occurs in familiar and presumably safe surroundings. The victim recognizes possible hazard (falling from a height, breakdown of machinery, errors of fellow workers, "acts of God"); but his accustomed experience without serious injury and his own self-protective dexterity acquired through routine precautionary practices and automatic response to danger signals (whether in walking a scaffold or driving a car in congested traffic), have lulled his natural sense of peril into a private feeling of personal immunity to calamity. Thus reassured, his psychological guard is down and he is maximally vulnerable to the psychic assault of an accident.

The hysterical neurosis usually consists of symptoms referable to the body site of a physical injury. Suggestibility is a prominent feature of this neurosis.

On a construction job a ten-pound sandbag fell from the third floor and struck a workman on the shoulder. An hour later, unable to work for pain, he was examined by the company physician who found no evidence of serious injury. After a week of physiotherapy he was deemed ready to go back on his job, but he returned with a "torticollis," his chin fixed over his left clavicle. Further examination revealed no physical basis for the distorted position. The disability was ended by one hypnotic session.

A 55-year-old carpenter, stepping back to admire a piece of work, fell into a hole twelve feet deep. Momentarily winded, he lay limply while fellow workers gathered around and cautioned him not to move "because something might be broken." He was raised by an improvised stretcher and taken to the nearest physician. Cursory examination revealed considerable back pain and absent patellar reflexes; the patient was sent by ambulance to a hospital. Unfortunately, he shared a room with a multiple sclerosis patient. When examined an hour after admission he was paralyzed from the waist down!

The serious disability of such a patient is often traceable to therapeutic mismanagement. If the symptoms remain unalleviated and a secondary gain of illness sets in; if a limp, blindness, loss of voice, or torticollis becomes part of a chronic invalidism - those conditions are formidably resistant to remedial treatment.

The psychophysiological reaction, that peculiar interweaving of psychic and somatic expression, is the post-accident condition least amenable to successful management. The persistent low back pain, the chronic post-concussion syndrome, the "cardiac neurosis" -

those are the most refractory problems.

The laborer lifts a heavy load: "something snaps," and pain develops quickly. Soft tissue injury is diagnosed and orthopedic treatment is instituted. After six months the orthopedist states that the tissues should be well healed and can no longer explain the patient's persistent pain and disability on an organic basis. Eventually the patient may be persuaded to seek psychiatric evaluation, and the psychiatrist may be hard put to explain the disability convincingly from a purely psychiatric frame of reference. The probable factor of secondary gain may loom large, but the primary causative mechanisms remain obscure.

Dependency reaction, that is, the exacerbation of a patient's latent passive-dependent manner of handling stress, may appear in relatively pure culture or may complicate any other clinical observations. One common characteristic of these accident casualties might be labeled "inadequate." They are psychologically underdeveloped.

A forty-year-old plasterer fell eight feet to a terrazzo floor when his scaffold collapsed. He was badly frightened, and suffered leg pain, but the findings were essentially negative except for a linear fracture of the right os calcis requiring no specific treatment. The patient sought psychiatric evaluation two years later because of persistent inability to work and chronic diffuse pain in both legs and hips, unconfirmed by physical findings. He lives with his widowed mother who devotes much attention to his welfare.

While on maneuvers during World War II he twisted a knee and spent a year in army hospitals. He was unable to work for an additional year after discharge from the service. In 1955 gastric symptoms were diagnosed as a pre-ulcer state, and diet and medication prescribed. A subsequent acute perforation of the stomach required only simple closure, but he could not work for eighteen months.

This seemingly uncomplicated man struggled through life at a marginal level of adjustment. At a casual, uncritical glance he might appear an undistinguished but solid member of society. Closer inquiry revealed: a sixth grade education; pathetically awkward and fruitless approaches to women; and continued dependence on his mother and a steadily employed brother. Physicians, insurance companies, and the general public tend to find such a person irritating or contemptible. He may be called lazy, dishonest, mercenary and so forth, but these are not sufficient explanations of his behavior for psychiatrists, nor should they be. Human psychology is not that simple.

Any kind of accident, life-threatening or inconsequential, may trigger one of the psychopathological reactions I have discussed. The unexpected, potentially dangerous near miss, in the absence of physical damage to the victim, usually triggers the anxiety reaction. The scaffold collapses, the steam pipe bursts, the crane tips over, the gasoline fumes flare into a flash fire. Such experiences undoubtedly would produce at least a degree of psychic disequilibrium in even "normal" persons.

Minor accidents - the mild concussion, the wrenched back, the pratfall - usually produce a psychophysiological reaction: aching back, recurrent headache, palpitation and dyspnea, weak legs, dizzy spells. This type of valid post-accident disability is difficult for the average man to understand and credit; he is prone to suspect malingering.

As a generality, there is a compensatory relationship between physical and psychic damage. The more extensive the tissue damage - fractures, lacerations, contusions, hemorrhage - the less likely a post-accident psychiatric disorder. Significant physical damage seems to bind or neutralize the reactive anxiety or depression the patient might reasonably be expected to exhibit; he has something "real" to cope with instead of something intangible. The medical and nursing ministrations; the bed rest; the traction harness and plaster cast; the visible evidence of "battle" injury to display; the sedatives, analgesics, and narcotics; the acceptable, even required, temporary state of regressed invalidism; the legitimate, socially condoned period of convalescent inactivity - all these factors tend to inhibit the development of a neurotic complex of symptoms.

Conversely, a sudden, frightening accident with little or no physical damage is a more likely precipitant of psychiatric disorders. After the fact, the traumatized psyche is not put at rest between cool white sheets; the hyper-irritable nervous system is not soothingly bandaged, poulticed, and fed intravenously; an invisible laceration of the ego is not legal tender for special consideration; and the victim's desire to retreat temporarily from everyday stresses is not socially approved. Incidentally, all these psychological treatments: immediate rest, sedation, isolation, enforced quiet, special attention under empathic medical authority, were routinely applied to disturbed soldiers in Viet Nam with a resultant remarkably low incidence of psychiatric casualties. It is unfortunate that those hard-taught lessons of military psychiatry have not been more tellingly applied to counterpart civilian problems.

The way in which the accident syndrome develops and is manifested can be influenced by a variety of factors including the attitudes and involvements of physician, attorney, employer, insurance company, psychiatrist, family and society.

The consequent havoc of a severe stress depends in a crucial degree upon the intrinsic strength of the stressed personality. The weaker the adaptive capacity of the psyche, the less the insult necessary to unbalance it. The more sudden and potentially dangerous the accident, the more likely it is to be psychologically unsettling - especially to an already teetering balance. A young man involved in a head-on highway collision miraculously escaped physical injury. The girl riding with him was killed and a passenger in the other car seriously injured. His post-accident anxiety and depression are easy to understand; so severe a stress would be difficult for the most stable person to handle with unruffled poise.

It follows that observers using a common-sense frame of reference are puzzled by, if not suspicious of, the considerable disability some persons demonstrate after seemingly minor or even trivial accidents. Their skepticism is based on conviction that life consists only of what can be seen, that all people are approximately alike ("like me" is the usual point of comparison) and that _a_ cause produces _an_ event. For psychological science, all these propositions are in error. People vary greatly in their personality strengths and weaknesses, and the capacity for flexible tolerance which the victim brings with him to the accident must be duly considered as one prognostic determinant of his post-accident recovery from its psychological impact. "One man's meat is another man's poison." What to an observer is a minor stress may constitute a major psychic assault to a given victim's uniquely vulnerable arrangement of internal resources and the particular set of external circumstances that happen at the time to be impinging upon him. Outsiders may well be unaware that he was already near the breaking point from antecedent stresses, possibly not consciously recognized by the victim himself. The accident, then, can be a "last straw" phenomenon.

Many who become ill, inadvertently and unconsciously discover a secondary gain (albeit second rate) in illness. Secondary gain is a common psychological coping alternative. In medicine it may complicate any medical, surgical, obstetrical or psychiatric condition - it is not peculiar to post-accident reactions. More about this in a few minutes from Doctor Ross.

Interacting medical and legal management of the patient-client further influence the prognoses of post-accident reactions. It is unusual for the psychiatrist to see a patient suffering a post-accident psychiatric syndrome before he has been examined by at least five physicians - sometimes eight or nine. Since in these illnesses early treatment offers the best chance for recovery, it is indeed regrettable that a great many patients are referred to a psychiatrist for the first time from six months to three years after the accident. Although the reports of the several examining physicians may mention the patient's nervousness, it is noteworthy that suggestions for psychiatric referral are rare. In our experience, nearly 90 percent of cases are referred to us by attorneys. These and other problems of medical management will be discussed by Doctor Raskin.

The best treatment is in a sense preventive; in having an early awareness of: the psychological etiology, the multiple factors in the patient's life which may predispose to prolongation of symptoms, the implications of litigation, and the critical importance of avoiding medically unnecessary consultations. Prompt psychiatric intervention (not necessarily by a psychiatrist) with full and repeated explanation to the patient concerning the true nature of his problem, can have positive results. If the patient believes the doctor understands; if he is told he suffers a legitimate psychic illness; if in his being treated he is given explanations, reassurance, and direct advice, the possibility of chronic secondary gain becomes less likely, and the outlook becomes reasonably favorable.

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BEHAVIORAL ASPECTS OF INJURIES

PROLONGATION OF DISABILITY AFTER A PSYCHOLOGICAL TRAUMATIC REACTION

W. Donald Ross, M.D.

Persistence of disability after an injury which is not accounted for by a persisting physical defect can be understood as the result of behavioral or psychological factors which existed prior to the injury, ones which came into operation with the injury and ones which supervened after the injury.[1, 2, 3]

Doctor Modlin has discussed the development of traumatic neuroses from factors operating with the threat involved in the injury and the interaction of these with the personality characteristics of the individuals prior to injury.

I shall present tables showing features of types and sub-types of traumatic neuroses according to the predominance of pre-existing, traumatic, and secondary gain (after injury) factors. I shall only touch lightly on the pre-existing and traumatic factors and concentrate on the psychological phenomena of secondary gain which often supervene after the injury.

Table I presents the diagnoses in the standard nomenclature for these neuroses according to whether the predominant factors are pre-existing, traumatic, or entailing secondary gain. This table also presents the specific etiologies for each type or sub-type and the other contributing causes for the persisting neurotic symptoms.

I would like to say a word about the two sub-types of traumatic reactions: physical and psychological. The words trauma and traumatic have been used for both physical damage and psychological stress. The failure to specify which use of the word traumatic is being employed is responsible for much of the confusion in dealing with individuals who are presenting symptoms or disability which are interfering with rehabilitation. Doctor Modlin has told us of the adult adjustment reactions which stem from traumatic anxiety.

The physical traumatic influences may have included injury to the brain (usually temporary) or the loss of a limb which was of importance in the pursuit of the individual's usual occupation.

TABLE I
DIAGNOSTIC LABELS, ETIOLOGY, AND PATHOGENESIS

Types *Sub-types*	Preexisting *Psychoneurotic*	 *Personality Disorder*	Traumatic *Physical*	 *Psychological*	Secondary Gain *Dependent Retaliatory*
Diagnosis in standard nomenclature (DSM II of APA)	(1) Neuroses; subtype to be specified (300.00 to 300.90)	(2) Personality disorders (301.00 to 301.89)	(3) Non-psychotic organic brain syndrome with brain trauma (309.22) (4) Adjustment reaction of adult life (307.30) (to amputations, etc.)	(4) Adjustment reaction of adult life (307.30)	Diagnosis is (1), (2), (3), or (4) or combinations thereof
Specific etiology or *causa sine qua non*	Psychological traumata in infancy, childhood, or adolescence	Disturbances in child-parent relationships	Temporary or permanent ego impairment from injury to brain or other bodily organ	Sudden overwhelming threat to life or self-esteem	Possibility of dependent or aggressive gratification by compensation payments, pension, or other change in responsibilities
Causes contributing to pathogenesis or *causa causan*	1. Inherited or acquired physical constitution 2. Experiences in adult life that weaken healthy defenses 3. May be aggravated by trauma or secondary gain		1. Previous personality and conflicts 2. Exhaustion 3. Situational factors 4. May become chronic through the operation of secondary gain		1. Previous personality and conflicts 2. Situational factors, including litigation and insurance 3. Unresolved traumatic neurosis

Neurotic maladjustments may occur with temporary or permanent impairment of the individual's ability to control his behavior patterns or to perform at his usual means of earning a livelihood, whether or not there has also been a repetitive traumatic anxiety reaction set in motion.

The secondary gain sub-types of neurosis may be dependent or retaliatory in nature. All is not gold that jitters. The worker may not be anxious only to maintain dependence on compensation payments or disability "benefits" but he may be unconsciously trying to get revenge for feelings of having been mistreated in employment, with a passive-aggression reaction having replaced his previous more adaptive behavior patterns.

The appropriate diagnostic label may be one of the sub-types of neuroses such as: Anxiety neurosis, hysterical neurosis, conversion type, phobic neurosis, or depressive neurosis. It may be one of the sub-types of personality disorders, or sometimes a non-psychotic organic brain syndrome with brain trauma, or a persisting adjustment reaction of adult life.

True malingering is rare. One survey in the state of Washington found "con men", who claimed self-inflicted as on-the-job injuries, at a rate of only one per one million claims.[4] Seemingly conscious malingering is usually an accompaniment of a personality disorder. Neurotic secondary gain is the result of unconscious defense mechanisms being used in the face of stressful psychosocial problems. The term "traumatic neurosis" should never be used as the diagnostic label when there are only pre-existing and secondary gain factors and no evidence for traumatic factors.

Table II presents the characteristic clinical features for the various sub-types of neuroses following trauma. A glance at the psychological traumatic column will remind you of the case examples given by Doctor Modlin. You will note that reactions stemming mainly from psychological or physical trauma have their onset at the time of the injury or threat, or from some state in recovery, such as when the individual returned to work situation in which the threat occurred. It is important to get a history about the person from some unbiased third party, as to whether an apparent dating of neurotic symptoms or personality disorder is an artifact. The occupational physician can get previous symptoms from the medical records and previous job instability from the personnel records. The parenthetical numbers here refer to the sub-type diagnoses tabulated on the first table.

TABLE II
CLINICAL CHARACTERISTICS

TYPES	PREEXISTING		TRAUMATIC		SECONDARY GAIN
Sub-types	*Psychoneurotic*	*Personality Disorder*	*Physical*	*Psychological*	*Dependent Retaliatory*
Characteristic Clinical Features	1. History, or anamnesis from third party, may reveal preexisting neurotic symptoms or manifestations of personality disorder 2. Symptoms or signs are those of the particular sub-types. For example:		1. Date from injury or from some stage in recovery 2. Psychiatric, neurological, neurophysiological (e.g. EEG) or psychological evidence of brain impairment at some stage or evidence of loss of function in some other organ important for work	1. Date from threat or from return to situation in which threat occurred 2. Repetitive dreams of dangerous situation 3. Increased irritability and startle reaction 4. Proclivity to explosive aggressive reaction patterns 5. A fear of returning to the situation, which may be masked by symptoms precluding return 6. Diminished interest in the outside world	1. Dating from injury only an artifact unless diagnosis (3), or (4) pertains 2. The symptoms of the particular sub-types among (1), (2), (3), or (4) 3. An apparent gain for immature motives of dependency or revenge, but a loss of self-respecting adult citizenship
	Anxiety neurosis (300.00) Hysterical neurosis dissociative type (300.14) Hysterical neurosis conversion type (300.13) Phobic neurosis (300.20) Obsessive-compulsive neurosis (300.30) Depressive neurosis (300.40)	Inadequate personality (301.82) Paranoid personality (301.00) Passive-aggressive personality (301.81) and antisocial personality or dissocial behavior (301.70 or 316.30) Adjustment reaction of adult life (307.30)			

The most characteristic feature for the patients whose symptoms are persisting largely because of unconscious secondary gain is that there is an apparent gain for immature motives of dependency or revenge but there is also a loss of self-respecting adult citizenship. These individuals are not happy. Studies with the Minnesota Multi-phasic Personality Inventory (M.M.P.I.) have shown they manifest depressive, as well as hypochondriacal and hysterical features.[5,6] They are envious of those of us who appear healthy and happy and able to enjoy the fruits of what we earn.

W. H. Auden, in his poem "On This Island", has portrayed the bitter feelings of beggared cripples:

> 'O for doors to be open and an invite with gilded edges
> To dine with Lord Lobcock and Count Asthma on the
> platinum benches, With the somersaults and fireworks,
> the roast and the smacking kisses -
> Cried the cripples to the silent statue,
>   The six beggared cripples.'

Now let us refer to Table III. It is important for us to realize that a pensioner's life is not a happy one in order to avoid lack of objectivity in investigation and treatment of these problems from resentment of someone seemingly trying to "get away with" an unearned income when we are working so hard ourselves. However, Doctor Raskin will have more to say about iatrogenic aspects of prevention of the "setting in" of the complication of secondary gain.

The treatment of these individuals, when they have reached the stage of secondary gain prolonging the post-injury neurosis, must give attention to as prompt as possible settlement of litigation or insurance claims. We would all find it easier to treat these patients if our compensation laws provided liberal benefits for financing rehabilitation and psychiatric or clinical psychological treatment but with a time limit on the continuation of wages above a welfare level. Sometimes it is necessary to advise a lump sum settlement before treatment can be completed.

Enrollment in a rehabilitation program, possibly in a sheltered workshop, should be started before attempts are made at individual or group psychotherapy. Marital counselling, for patient and spouse, may be very helpful, especially if there has been a reversal of roles as to who is the bread-winner in the family.

When these patients are depressed, even though they are blaming the depression on chronic pain, the tri-cyclic anti-depressant

TABLE III
TREATMENT AND PREVENTION

TYPES	PREEXISTING		TRAUMATIC		SECONDARY GAIN
Sub-types	*Psychoneurotic*	*Personality Disorder*	*Physical*	*Psychological*	*Dependent Retaliatory*
Treatment	1. Psychotherapy or psychoanalysis 2. Possibly with pharmacological aids 3. Possibly group psychotherapy	1. Psychotherapy or psychoanalysis 2. In more severe cases, psychotherapy, plus social management (e.g. group therapy or milieu therapy in an institution) 3. Possibly with pharmacological aids	1. Early diagnosis and activity toward rehabilitation in keeping with any temporary or permanent physical or mental changes 2. In some cases, remedial surgery	1. Early diagnosis and activity toward rehabilitation 2. In some cases, psychotherapy, possibly with hypnosis or intravenous drugs such as barbiturates	1. Prompt settlement of litigation or insurance for costs, but not stimulating temptation to continue unearned income 2. Rehabilitation with psychotherapy as required
Prevention	1. Preventive psychiatric considerations outside the scope of the neuroses following adult trauma		1. Prevention of accidents due to (a) mechanical factors (b) accident proneness (c) the accident syndrome 2. A comprehensive medical approach in traumatic surgery or interdisciplinary collaboration 3. Rehabilitation	1. Prevention of accidents 2. Early recognition and treatment of traumatic anxiety 3. Education of physicians and administrators on the psychotherapeutic benefits of talking out and early rehabilitative activity	1. Education of lawyers and administrators on the antitherapeutic effects of disability insurance and pensions, toward legislative changes 2. Emphasis on treatment and rehabilitation rather than on financial compensation

drugs will enhance motivation to become more physically active. In addition to reducing the depressive aggravation of pain, these chemicals have a direct analgesic effect which will reduce the number of depressing "pain pills" which the patient is taking.

These psychiatric aids are best used to help occupational therapy to merge into therapeutic occupation in a unit for physical medicine and rehabilitation or a bureau for vocational rehabilitation.

Doctor Raskin will, no doubt, be telling us more about prevention of these neuroses. I am impressed with the need for us to educate lawyers and lay administrators on the greater degree of humaneness for the poor injured worker than there is in financing rehabilitation and treatment rather than encouraging them to remain "crippled beggars" by perpetuation of secondary gain with its attendant miseries.

It is not widely known in the United States that psychoneurotic veterans in Canada and Britain, even if service connected, are not granted pensions but given free treatment and rehabilitation. Veterans' organizations and labor unions, which are so influential with our legislators, do not realize the cruelty to helpless neurotics, who could have more dignity and self-esteem, which is inherent in some of our veterans' and compensation "benefits".

I have done some lecturing and writing for lawyers who are really interested in the best welfare of their clients.[7] As for lawyers (and some doctors) who profit from maintaining disablement, we may not solve that problem until after we have solved the problem of malpractice insurance costs!

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PSYCHOPATHOLOGY FOLLOWING INDUSTRIAL INJURY - IATROGENIC FACTORS

Herbert A. Raskin, M.D.

Industrial injury with its attendant symptoms is never incurred in a vacuum. It is always experienced by a particular person within a gestalt-type milieu including that person's totality of intra-psychic function at the time of the injury, the character of his relationship to his job-peers-supervisors, and the nature of contact with medical personnel in diagnostic and treatment efforts. Frequently interjected into this milieu within a short period of time are insurance companies and lawyers. Whether or not functional psychopathology follows industrial injury invariably is dependent upon the characteristics of these factors in varying combinations.

You will note that I use the term "functional psychopathology" rather than "traumatic neurosis". The latter terminology usually connotes that it has been the accident itself that has had a "traumatizing", overwhelmingly frightening effect. The accident per se is held to be the critical danger factor in promoting psychodynamic change out of which develops the psychopathology.

It has been my experience that this is true in only a very small percentage of physical injury cases.[1] Most clinical psychopathology following physical injury is related psychodynamically to the particular symptoms being experienced and/or the manner in which other important persons relate to the injured person. The psychic trauma need have nothing to do with the accident producing the injury. Symptoms and care-providing people take on a symbolic quality. Diagnostic and treatment procedures are misunderstood or misrepresented.

Psychic trauma is always a complex reaction initiated by what Krystal terms "psychic reality" - that is, the totality of the individual experience, interpreted, as it were, within the particular person, by the mental associations it provokes. Experiential stimuli are traumatic not by virtue of their physical intensity but by their psychological meaning to the person and the emotions they evoke. The intensity of the stimulus is relevant only in the conceptualized frame of reference of what seems, to that person, to be a "danger situation". This bears most directly upon the particular emotions experienced. It matters little which of the various factors in the gestalt-milieu mentioned above constitutes the emotion-producing stimulus. Most critical is the "affect tolerance" of the person, the ability he has to deal with the feelings aroused. These feelings most usually will include anxiety, shame, anger, depression, guilt. Additionally there may be suspicion, passivity and dependence, seductiveness, and self-destructiveness with a fusion of these multiple reactions being most common.[2] The physician, nurse, employer-representatives, insurance companies and lawyers play vital roles in the constellation of emotions aroused and how the injured worker deals with them. What we say and do, how we perform and relate and what we do <u>not</u> say and do can have grave consequences.

The psychological meaning of physical injury and impairing physical symptoms is particularly significant in the population constituting industrial workers, both male and female. In the main, this population is a physically oriented group in contra-distinction to psychologically or philosophically, or intellectually oriented. The feeling of physical integrity and self-reliance constitutes a major basis for a sense of integrated personality functioning. They deal with themselves and life in a literal and concrete fashion rather than in abstractions and conceptualizations. Their self-imagery, self-representation, self-esteem depends on their physical being. Activity and stamina spell successful function and provide acceptance on the job, by social peers and even family members. They are intolerant of weakness or impairment. They are the "Bread-winner", whether male or female, with all the symbolic representations that go with that term.

Contributing significantly to this self-representation is the frequent reality of inadequate education, academic tools, absence of skilled-work training and self-acknowledgment that financial survival is almost wholly dependent upon physical capability. Many in the industrial population are "under-achievers". They are occupationally static, "stuck" in their jobs, do not even aspire to make foreman. They are inhibited persons. Physical injury may be taken by them as confirmation of their fears regarding themselves and create even further inhibition of occupation and personal function.

Shands and Meltzer[3] may have added another characteristic of the industrial population that has relevance. They recently reported a study of psychiatric evaluation by a Workmen's Compensation Board of 88 out of 120 persons referred. The patients demonstrated an inability to adapt to a new situation, plaintively repeating over and over that they just want to be the way they were before their injury. They seemed unable to accept that they are the <u>same person</u> who has suffered an accident.

The authors suggest that a cognitive deficit found on psychological testing seemed to make these people particularly vulnerable to disorganization and interpersonal disintegration in situations where they are required to adapt abruptly to a new self-definition, to "conserve" their feeling of self in the face of a significant change of context. They seem unable to "stand back" from themselves sufficiently to say "I have been injured, I have changed to some extent, but I'm still me".

Blinder[4] points to another facet of characterizing the man or woman emotionally pre-disposed to a post-traumatic psychological disorder. He cites the personality characteristics of hyper-conscienciousness, obsessive perfectionism, militant self-reliance, over-achievement, and great emphasis of physical appearance, activity, stamina. He agrees that typically strength and athletic prowess are the principle sources of self-esteem.

He brings to our attention, however, that frequently these traits have developed to conceal or defend against the expression of great feelings of insecurity, repressed anger, and unmet dependency needs. These persons often through compulsive work - "they live to work" - successfully unconsciously deny an intense craving for dependency and nurturance. They also often harbor a secret disappointment at being obliged to labor arduously at tasks they unconsciously feel to be beneath the level of their hopes and aspirations. Their over-achieving is artificial, and rather precarious protection from their own ill-perceived inherent weakness. I would add the frequently observed defensive shield of invulnerability which the injury may break down.

When the industrial worker is suddenly, often quite precipitously, deprived of these defensive mechanisms, he becomes particularly sensitive to the way we care-providers relate to him. This is but one way in which we can be instrumental in the evocation of emotional responses beyond his own affect tolerance level, beyond his own ability to deal with feelings. When an individual's affect tolerance is exceeded he may have to ward off the feelings, isolate them from conscious experience. This involves suspension of a significant number of ego functions and makes his psychological balance and integrity even more tenuous. Feelings of fear and helplessness especially predispose the patient to the phenomenon of regression.

In studying the psychological complications of convalescence, Krystal and Petty[5] direct special attention to the phenomenon of regression and narcissistic withdrawal, a turning backward from prior attained levels of psychological growth and maturation. This is especially true in a person who has experienced an illness or physical injury which results in a loss of a significant part of function. The clinical state itself may present a situation that is not acceptable to the patient. Often the enforced dependency and an inability, psychologically or realistically, to indulge it arouses great conflicts that have to be dealt with. Fear which may be provoked through any mechanism exerts pressure toward such regression. This process further favors the resomatization of anxiety, the retranslation of emotion into physiological, physical elements produced and there result additional symptoms or a heightening of those produced by the injury.

Successful convalescence requires a restructuring of self-representation, self-imagery. The sequelae of injury are added to the former self-image, especially body-image. Beyond the basic feeling of " and in spite of all, I survive", there is the question of acceptance, to one's self and to the world. Frequently, the patient will use the all-powerful doctor and other significant persons to test his acceptability.

This is complicated, however, by part of the regression involving the tendency toward projection (it's not me, it is you) which arises from the patient's failure to integrate the total experience. Instead of being able to acknowledge his loss, or even his clumsiness or preoccupation which may have been involved in the accident, he has to attribute it all to the company, the doctor, to somebody. This becomes manifest in a demanding attitude or belligerence.

Another aspect of regression may include the patient dealing with the question of "Why did this happen to me?". The problem of guilt feelings may cause the patient to look for, even seek, evidence of being punished and/or rejected. This can contribute toward the development of depression or even paranoid trends.

These factors add considerably to the problem of how the care-providers perceive and react to the injured patient. We must be ready to understand the psychological malfunction represented. We must deal with it objectively, not take it as a personal assault and then counterattack.

Bartemeier[6] also stresses the importance of regression. Every patient-doctor relationship is to some extent in all of us a re-experiencing of the child-parent relationship. Sick and injured people are often frightened and feel helpless, often dependent like children. For them the physician is the substitute parent-person possessed of medical knowledge and skill.

He notes additionally that physicians have varying degrees of awareness of their own feelings about patients. The patients, however, usually sense whether the physician likes them, respects them or dislikes them, and all else the physician may feel about them. The condition of illness often makes them more sensitive, more appreciative of being understood, more easily offended and less tolerant than would be their wont were they in good health.

The doctor's personal influence can be considerable in relation to the clinical course of the patient. Regardless of his attempts to hide his feelings from the patient, which too often might not even be the case, they sense his distrust, disrespect, suspiciousness, indecisiveness, uneasiness and uncertainty through the tone of his voice, his choice of words, his hesitancy of speech, bodily tensions, the suddenness of brusqueness of his movements and in numerous subtle ways. While the doctor studies his patient, the patient is observing many facts about him which he may never disclose but which may have an important influence on clinical developments. Direct correlation must be made to Krystal's observation of emotions aroused in the patient and his level of affect tolerance as major factors in the genesis of psychopathology following injury.

The first contact with the accident victim is of utmost importance.[7] After the accident, the patient usually views his environment as hostile, for the incident symbolizes being attacked. He frequently responds with counter aggression. At this time he needs more than anything the steadying influence of a friendly, sympathetic doctor as an aid toward restoring his psychic equilibrium. He needs to feel that he is being cared for. This is true whether the accident was a near miss, a minor one, or a major one.

Too often, however, the patient is immediately greeted with suspicion, implied if not direct accusations that he is faking or deliberately exaggerating symptoms in the pursuit of getting something for nothing. The patient then has to prove that he has been injured and is having genuine pain. There should be no tacit assumption that the patient is solely interested in compensation, a "free ride", until a thorough diagnostic study has been made. This must also include psychological factors; a casual observation of a "functional overlay" is totally inadequate in evaluating anything. Malingering must constitute a definitive diagnosis derived from definitive clinical evndence, not merely the absence of well-defined organic pathology.

In the continuing care of the patient there is no room for a doctor's concern with monetary problems, insurance claims or legal responsibilities. There is no room for bias for or against the patient, employer or insurance company. Over-identification by the physician with either the patient or the company or its representatives creates possible emotional damage to the patient.

A frightened patient will exaggerate the importance of his symptoms out of all proportion to their realistic significance. It is the anxiety associated with pain that provides its unbearable quality.[8] It is the anxiety mobilized which threatens to overwhelm all other perceptions and functions of the entire self, but especially to overwhelm conscious ego functions. Anxiety and pain are very closely related. Each state is modified and influenced by the other. Exposure to much pain is likely to produce excessive anxiety, and the presence of anxiety almost invariably predisposes to and increases pain responses.

A brief examination and cursory explanation only serve to reinforce the complaints and fears of the patient. Traumatic effects can also accrue because the attending physician did not listen to the patient's description of symptoms and follow through with appropriate reassuring examinations. Careful explanation is especially important and in language understandable to the patient. His questions must be answered and efforts made to make sure that the patient is hearing what is actually being told to him.

It must be remembered, however, that unnecessary, repetitive and prolonged examinations in themselves can often reinforce in patients the conviction that they are seriously ill and arouse needless emotional stress. This is especially true in litigation where a host of consultants usually enter the picture. Each pursues the gamut of diagnostic procedures and no one tells the patient anything. He often derives contradictory information and advice, if not manifold varieties of medications and treatment modalities with no idea of goals involved. Myelograms, electroencephalography, brain scans, electromyography, and arteriograms constitute highly consequential experiences. To the patient, each diagnostic examination has much meaning. He often does not differentiate evaluation modality from treatment modality. Seeing a doctor is supposed to make him feel better. The doctor is supposed to do something to help him. He walks out of each session more confused and still less understanding of what is really wrong with him. Too often no one is acting as his central primary care physician, correlating, explaining, directing.

The factors of prescription of unnecessary bedrest, time off from work, physiotherapy and other procedures further contribute to hyper-concern, preoccupation, ruminations, all of which are related to the genesis of anxiety and/or depression.

Let us add to this medical melange casual observations and remarks injudiciously made by physicians and nurses especially, somewhat less so by lawyers and insurance claim adjusters. The effect of the doctor's words can be tremendous. Keiser[7] cites two excellent examples:

A veteran having a lead particle imbedded in his brain. His physicians discuss the pros and cons of an operation in front of him. One doctor said, "the particle is dangerously near the vital centers and any movement in its location might cause sudden death". The patient became almost totally disabled with severe anxiety. Several years later, he was cured by other doctors who told him, after examination, that the "particle was still visible but had become encapsulated" and would not move.

Another patient was "bent almost double and groaning with pain localized in the thoracic spine". His symptoms were traced to the remark of an intern speculating on the possibility that a slightly different position of a laceration on the patient's back would have resulted in paralysis.

I wish I could count the number of cases I have seen where an examining consultant casually dropped the remark that surgery might have to be considered "sometime"; or, a doctor answering a patient's question regarding possible surgery as being totally contraindicated because of the risk involved. The physician here was not aware that the patient was already scheduled for admission to the hospital to undergo that same surgical procedure.

By the same token, however, the failure of the physician to make any commentary other than a few grunts as he proceeds frequently implies to the patient that the physician is hiding something horrible. This is most true in the various consultant contacts.

A final observation is that made by Keiser[7] regarding what he terms "uncertainty in the physician". The physician may be fearful to attribute symptoms to psychological causes. He may be reluctant to believe that psychological factors can actually cause physical symptoms. This uncertainty is conveyed to the patient even when the doctor tries to keep it from him. Psychological factors must be appreciated and investigated along with whatever other evaluative procedures are clinically indicated.

The possible bias of physicians regarding neurosis may also contribute to the patient either getting better or worse. Condemnation or contempt toward the neurotic, who is viewed as weak, adds but another destructive influence. Physicians must be cognizant of the symptoms indicating emotional illness, have knowledge of general treatment of emotional problems and be willing to seek psychiatric consultation where indicated.

To minimize the iatrogenic contributions to the development of psychopathology requires the careful and conscientious attending to these many forces being experienced by the injured person. A general principle of treatment can be stated. We must constantly maintain the "physicianly attitude", empathic identification with the patient and what he is experiencing, providing human assistance within the capacity of one's own personality. Each of these patients is entitled to respectful acknowledgment of his status as a human being. He should be availed of complete medical, psychological and social assessment and evaluation. He should then be provided the best available treatment of his own particular demonstrated medical, psychological and social needs.

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OCCUPATIONAL INJURY CONTROL

INTRODUCTORY REMARKS

N. J. Berberich, Jr., Ph.D.

The basic purpose of this session is to acquaint the part-time or on-call physician with some methods of accident prevention. In order to control the problem one must first understand it. We might begin by asking two questions. What part does the employee play? What part do the plant facilities and equipment play? At this time we hope to promote a greater knowledge of actual working conditions and show how they relate to the problem of Injury Control.

How can this be accomplished? We envision several methods of approach. First, study the past accident problems of the operation. Second, request that management take you on a plant survey. Learn first hand how the plant employees function by observing the actual plant operation. Look for possible hazards that might result in personal injury. Third, note those areas where you see potential accident situations arising. Fourth, maintain this information on file so that you might at a later date be able to substantiate a diagnosis or treat a possible occupationally related disease other than that due to physical trauma. Fifth, take care to note the physical and mental demands of various jobs so that the pre-employment physical will aid in establishing whether a person is capable of performing properly before he enters a job. This can save a company from needless compensation claims later. Finally, make recommendations to management concerning any evident hazards so that these can be corrected immediately. The foregoing suggestions represent just a few areas of consideration which might help you in better performing your function as an occupational health physician.

In light of the above remarks our speakers this afternoon will demonstrate, by example, how, through the use of engineering controls, namely ventilation and noise control as well as the use of personal protective equipment, the potential for employee injury can be reduced.

How does what you are hearing today relate to your role as an occupational health physician? You might say that these presentations represent only the industrial hygienist's viewpoint. This is not true, if you look at it in its proper context. The industrial hygienist is part of a very important team, as are you, namely the Occupational Safety and Health Team, which also includes the occupational health nurse, the safety engineer, union representatives and management. If this team is not a well functioning unit, the health and safety of the worker will always remain in doubt even though you might personally make every effort to discharge your responsibility.

Injury control can be accomplished through a team effort in which all members contribute their expertise toward the solution of problems. Because of the traditional role the physician has played in the community, his position on the health team must be that of a leader and as such he can be very helpful toward development of programs for a safety and health committee. Second, he can stimulate training programs of supervisory and management personnel to recognize changes in mental attitudes which might aid in avoiding "programmed accidents". Third, he must initiate investigations of accidents to prevent further injury problems and gather information about causative agents. Finally, he should insist on proper maintenance of records which will help isolate principal accident sources.

Through our discussion today we will attempt to broaden your knowledge of how the environment affects the health of the worker, demonstrate measures to be taken to solve the problems of exposure, and point out the role the occupational health physician, as part of a team, must assume to reduce injury to the worker.

OCCUPATIONAL INJURY CONTROL

TYPES OF VENTILATION AND THEIR USES

John M. Blankenhorn, M.S.

Ventilation, in one form or another, is the most widely used type of control. Many types of ventilation are not recognized as forms of control, nor are they even recognized as ventilation. In the next 20 minutes we will be discussing the various types of ventilation and we will break them down into three major categories: namely, natural ventilation, dilution ventilation, and local exhaust ventilation. Each type of ventilation has its advantages and its disadvantages. These advantages and disadvantages will be discussed.

The simplest type of natural ventilation utilizes outdoor air movement - the wind velocity that occurs naturally. No roof or walls are present to act as barriers to this wind velocity. The simplest example would be an oil refinery. The mere fact that the wind is blowing in the general area around the plant is sufficient to remove the toxic vapors from the processing area; or at least dilute them to a level below the TLV. The advantage of this, of course, is that no expense is incurred in connection with it. If you tried to do anything else in an oil refinery, considering the layout, the piping, and the vast areas that are covered, it would be extremely expensive. Disadvantage? What happens when the wind isn't blowing? True, there is always a little wind motion, but is there sufficient wind motion in a calm to remove these vapors and gases rapidly enough so that the concentration is held down?

The second big disadvantage is obvious. What happens in cold weather? What happens in the rain, if the man must go out to maintain vast pieces of industrial equipment such as reformers, catalytic crackers, and so on? The man, obviously, must climb around them and repair them in the rain. True, they don't have to do it too often; but on a routine basis they do have to go around and check the operation. So the advantage in using an atmospheric pressure gradient to create ventilation for the control of gaseous and vaporous contaminants is offset by the disadvantages of variable atmospheric air movement, the atmospheric temperature, and with anything else that comes with the atmosphere - rain, sleet, hail and so forth. There is no protection for the worker. However, this type of ventilation is rather widely used. Probably the best examples of it would be refineries, some large chemical companies, and some coke-making operations.

Natural ventilation can also be used to remove the contaminants from within buildings. Here, the problem is rather different. The air movement is dependent not only upon the atmospheric conditions (the velocity of the wind and the direction in which the wind is moving), but it is also affected by the "Thermal head" or the "Chimney effect" of the hot air inside the building. This effect will cause the warmer air in which the men are working to rise to the ceiling, and therefore, most of the natural ventilation will be floor-to-ceiling air circulation. The amount of dilution obtained, will depend upon the locations providing outside air. Frequently, the buildings will have windows located high upon the outside walls. Sometimes they have monitor roofs, so-called "saw-tooth" roofs. These saw tooth roofs have windows in them. The windows in the walls combined with the windows in the saw-tooth roof will cause an in-flow of air. The amount of in-flow depends upon a multitude of factors. How many windows do you have to open? What is the velocity of the wind? What is the direction of the wind? How many doors do you have open? All of these factors and many others, will determine the total volume of air which will enter the plant. As a rough rule of thumb, design engineers usually assume that in an ordinary shop building (no tighter than usual, no more cracks, no more ill-fitting windows than you would find in the usual shop), there will be approximately three air changes per hour; that is, three times the shop volume of air will be circulated through the shop during each hour. In a tight new building, this volume might fall to as low as one air change per hour. On the other hand, in an old building with a high wind velocity, it could go to six, seven or eight changes per hour.

Within the building itself, the location of the windows where the air is entering the building, and the locations where the air is leaving the building will determine whether or not there are corners or pockets in which the air may fail to circulate. For example, you may have a welding operation in a corner of a building. This corner could well be a rather stagnant pocket of air; and to have one air change per hour in that particular corner, three or four air changes per hour out in the general shops might be required. If you have a welding operation there, and the natural ventilation is not adequate, you will have troubles and will have to go to something besides natural ventilation.

This problem leads to rather weird ways of assuring that the air will be evenly distributed. You have probably seen some buildings that have a series of louvers just about at floor level and possibly three or four feet high. These louvers allow the air to enter close to the ground. This may be a great idea - sometimes. Suppose, for example, that the air is entering and is also blowing across the surface of the tank before it reaches a worker. The natural ventilation may be blowing fumes from that tank right into his face. Tomorrow, with the wind coming from another direction, it might well be blowing fumes to his left, or to his right, or straight up above him. So, natural ventilation can be used to control certain exposures, but the hazards it controls must be relatively non-toxic; for example, such a hazard as mild steel welding fumes. As a matter of fact, natural ventilation is one of the specified permissible conditions for mild steel fumes. The simple rule of thumb derived from the ANSI Standard says that if you are working with E6011 or E6012 mild steel welding rod on mild steel plate, and you have a shop volume of 10,000 cubic feet per welder with natural ventilation, the conditions will be adequate and acceptable for controlling the fumes. On the other hand, if you are using any other type of welding rod; if it has a different alloy, even if it's mild steel that has a rod coating which is alkaline or which contains fluoride, you must use something besides natural ventilation, because you are producing more toxic fumes. Iron oxide itself coats the lung; true; but it doesn't produce any disabling pathology or disease. It merely coats the surface of the lung. It doesn't interfere with vital capacity. As a matter of fact, men will sometimes tell you they are healthier because of it. On the other hand, fumes can become excessive in some of those corners where you don't get natural ventilation. If the concentration of fumes goes above the TLV so that the concentration is more than 5 milligrams of iron oxide per cubic meter of air, the worker may get nose, throat, and possibly even lung irritation. Whether this is due to the iron oxide or some of the gaseous products that occur in the arc, is a moot question, since the TLV of 5 milligrams per cubic meter will control other contaminants. If you do not exceed the TLV for iron oxide, the other contaminants will be well within acceptable limits.

The disadvantages of natural ventilation being used inside buildings are pretty obvious. It is not only a matter of wind velocity or wind direction and the amount of open wall space. In the winter time the men have a tendency to close the windows and doors, so that the amount of air circulating in the building is greatly reduced. They do this as a matter of comfort without much thought about the build-up of gaseous concentrations or welding fume concentrations, or ozone production. So they will close these open areas. They will close the windows. They will close or block the louvers. They will close the overhead windows, if they can. In the process, they limit the amount of air that is removed; the number of air changes per hour within the shop. In the winter time it is extremely difficult to get the number of air changes that you are looking for unless you happen to have an old shop that doesn't fit tight, and you have a strong wind. In cases like this, even the closing of the windows will not preclude your getting at least three air changes. But what happens on a cold, calm day? If the men insist on closing the windows and as many other openings as they can to cut down on the cold drafts, it will cause the build-up of concentrations above the TLV. This is another disadvantage of natural ventilation within a building or within a structure.

The second broad category of ventilation is what I prefer to call mechanical general ventilation, rather than "dilution" ventilation. I like to avoid the term "dilution" ventilation; because, when you say this, you assume that you are getting the dilution you want. As I pointed out before, any currents in a building may very well interfere with this so-called dilution. What do we mean by dilution ventilation? Instead of relying on thermal head or wind velocity, to remove contaminated air from the building, we use fans to blow the air out.

This is probably the most widely used and misused type of ventilation. It seems logical and it seems easy to apply it to an operation which is generating a fume or a solvent vapor. The reasoning goes like this - Close to the operation we have an outside wall, so let's just cut an opening in the wall and slap a propeller type fan with automatic louvers in the opening. This will draw the air away from that man's breathing zone, and therefore, it will remove the contaminants and we will be controlling that operation. It sounds good. It looks good. It's simple. But, there are many things wrong with it. The fan may be so far away from the tank that any cross-draft across the surface of the tank will overcome whatever the fan is supposed to be doing and blow the material back in the man's face. The fan may even cause the cross-drafts. But, the biggest problem we have is common to all kinds of mechanical ventilation. This problem is make-up air. Now, you must keep in mind that a propeller type fan (one of these four-bladed units that are mounted in the wall and driven by a belted down motor) can produce only a slight negative pressure inside the building. They are primarily air movers. Any time you put a fan in a wall or in any operation, you must keep in mind that the air must come from somewhere. This fact is frequently forgotten.

A typical example of this occurred when I was on a dry cleaning survey in Washington, D.C. I entered a little dry cleaning shop. You know what they look like. They have about a 30-foot front and they go back maybe 80 feet. This means they are actually like a tunnel 30 feet wide, 16 feet high and 80 feet long. As I got about one-third of the way into the shop, I detected the odor of Perchloroethylene. I walked past the dry-cleaning unit toward the back wall. In the back wall, the owner had installed a fan, five feet in diameter with automatic louvers. These light-weight aluminum louvers open when the fan is running and close when it is off. He had this five foot fan running. A fan that big should produce a tremendous amount of air-change in a building that small. How come I was picking up the odor of Perchloroethylene? I went back and looked at the fan. I looked through the rotating blades at the outside louvers. I noticed the louvers were just barely quivering instead of standing wide open. This meant that the fan was moving no air at all. I knew what the problem was, but I couldn't decide how to explain it to the owner. So, I went to the owner of the shop.

"You're getting a build-up of Perchloroethylene vapor in your shop and you are going to have to increase the ventilation or enclose the process."

"But that can't be, I've got that great big fan! I just put it in about six months ago. The fan's going all the time and it's working like a charm."

"Well, do you think it's pushing air out?"

"It must be pushing out a lot of air," he said.

"If it's pushing out vast quantities of air, where is the air coming from?"

"What do you mean,'where is the air coming from'? It doesn't have to come from anywhere."

"Oh yes it does!"

"It's coming from the shop."

"OK, how does it get into the shop?"

"Well, it's already in the shop."

"Look, have you ever tried to suck a thick milk shake up in a straw? You suck and you suck, and you never get a drop of milk shake in your mouth. Right?"

"Sure..."

"Your mouth was producing a suction, but the milk shake was so thick that it wasn't moving up the straw into your mouth. In other words, you were establishing a negative pressure in the straw but you were getting no flow at all. That's exactly what your fan's doing. Your fan is establishing a slight negative pressure within the building, but it can't do any more than that. It can't move a cubic foot of air unless that air can come from somewhere in response to the slight negative pressure that the fan is building up."

"Oh, yes. We've got a place where the air is coming from. Sure. It comes into the building from above the doors at the front of the shop. You know, it gets hot in here and we like to have fresh air come in through the transom in the front. That's where it's coming from."

"OK, let's go take a look at it."

So we went up to the front. I'm sure you've seen double doors that have a transom about a foot and a half high, and maybe six or seven feet wide. Now, the size of that opening should allow a fair amount of air to come through with that big fan in back. Not nearly what that fan could handle, but at least it would be supplying some air. We went up to look at it. Well, this transom is also where they put their air conditioners. So, that's where the air comes from! Good idea, except this happened to be the month of May. In November it had been cold outside, and they had placed a piece of Celotex across that particular transom so that the cold air could not enter. Yes, there was the fan back there running, but the fan can do nothing unless the air is coming from somewhere.

Another disadvantage when using dilution ventilation to control fumes is that vast quantities of air are required. For example, if you are working with something that has a threshold limit value of 1 ppm and you generate only one cubic foot of vapor per minute, you will have to dilute that cubic foot of vapor with one million cubic feet of air. That air will have to be air conditioned, or heated, depending upon the outside temperature. It will have to be tempered to meet the indoor criteria for temperature and humidity, whatever they happen to be in that location. So you can see immediately that it is impossible, or nearly impossible, or certainly unfeasible to use dilution ventilation to control vapors with very, very low TLV's. Unless you are talking about something that has a TLV of four or five hundred ppm (which cuts you down to possibly 2,000 cubic feet of air per cubic foot of vapor generated) dilution ventilation is not feasible. Beyond that, the economic cost becomes highly unreasonable. We usually don't consider using dilution ventilation for anything other than something like mild steel welding, or solvent vapor with a TLV of around four or five hundred ppm because the amount of air required for dilution becomes fantastic. You are going to have dilution air circulating all over the shop. It's going to cost you money.

The last type of ventilation which is used for control of atmospheric contaminants is so-called local exhaust ventilation. This type of ventilation has a higher initial cost and is more difficult to design; but the overall cost, considering tempering of make up air, installation cost, and yearly operating costs, is vastly superior to the other types. It is more amenable to the true job of protecting the man, of controlling the concentration of any particular contaminant, and of controlling in it a relatively small volume of air. With local ventilation, this is more readily accomplished - and more accurately, too. The basic idea behind local exhaust ventilation is to control at the source. The objective is to move in as close to the particular operation as possible and to capture the air contaminant when it is contained in a relatively small volume of air. A good example of this is welding fume again. The welding fume is generated in an arc which may well be one quarter of an inch in diameter with an arc length of three eighths of an inch. The iron is vaporized in the arc; and, in the air surrounding that arc, the iron is oxidized to iron oxide. As you can see, the fume is generated in a small volume of air. A large amount of fume is generated in that small volume. Because it is hot (well over three thousand degrees) the air has a tendency to expand and rise and carry with it the iron oxide fume. This is the reason you see the characteristic brownish plume rising from a welding operation. Now consider this. If you can capture those two or three cubic feet, containing all of the welding fume, you have to exhaust only two or three cubic feet of air to totally control the fume. Compare this with the 2,000 cubic feet per minute per welder which is required for dilution ventilation. You are never going to get the exhaust volume down to two or three cubic feet. You can't get that close to the arc. Even if you did, the air velocity would have a tendency to destabilize the arc. But, if you can do it in 10 cubic feet, and move it to the outside or to a filtering unit, you have accomplished a lot. When all the welding fume is concentrated in a few cubic feet, your make up air is only a few cubic feet. You don't have to supply nearly as much make up air.

Local exhaust can also be used on tanks. In the case of a solvent cleaning tank, you can put a slot about an inch wide across the back edge of the tank. Connect that slot to an exhaust duct. Establish a velocity of 2,000 feet per minute in that slot. The total volume of air which you will need will be related to the surface area of the solvent in the tank. Usually, it will be 100-150 cubic feet per minute per square foot of tank surface. Now, you'll have a high concentration of solvent in the duct because you are collecting all of the vapor close to the source, collecting it when it has diffused into a relatively small amount of air. The concentration in the duct will be high, but the concentration around the man - that's our main interest - the man - the concentration around the man will be minimal. That's what we're trying to do. Get minimal exposure of the man.

Now, lest you think that make up air is a problem only with the small shops, let me assure you that this is one of the most common problems in all industry. You will seldom see an industrial plant which does not have a negative pressure inside the buildings. This is primarily because there is a provision made for some of the equipment; provision for bringing in make up air to replace what the fan is pulling out. This air will be heated or cooled, depending on what is required at the particular time of the year, and it will be brought in at known amounts equal to what you propose to take out of the building. The drawback to this is that when they start building a plant, they install enough make up air units to equal the amount of air being exhausted by the local exhaust or dilution ventilation. But, unfortunately, there was never an industrial building built which did not have changes long before the first worker entered the plant. Once they start working, they are constantly adding new machinery. Machinery that requires ventilation. But they do not think about make up air. As a result, a negative pressure is produced. You can tell this yourself the next time you visit a shop. Go to one of the doors. The door should open outward. As you try to open the door, notice how hard it is to open. If the door swings open very easily, there is very little negative pressure in the building. But if considerable force is required to pull that door open, be a little suspicious of negative pressure within the building. Look down at the bottom of the door. Can you see where leaves and so forth have been blown back as air was drawn through the crack under the door? Are leaves, cigaret butts and bits of paper being blown away from the door on the inside? This indicates that there is a strong air flow through the crack at the bottom of the door. This is another good indication that you have negative pressure. If you have any negative pressure in the building, all of your ventilation fans will be reduced in their ability to remove air, because any fan works against a negative pressure in order to move a known volume of air. If you increase that negative pressure, you reduce the amount of air that's drawn from the building or drawn by any exhaust fan from any particular operation.

I once was invited to see "our new automated pouring line." I knew the man very well. He was a pretty good design engineer, so I thought that I would like to see this "automated pouring line."

It was a beautiful layout. The sand molds were filled and placed on a roller conveyor which moved them to the pouring line equipped with an effective side hood. The poured castings then passed into a cooling tunnel with ventilation provided by fans at both ends of the tunnel. It moved from the tunnel directly into a shake-out tunnel where the castings were shaken on a vibrating grid and the waste sand fell through to be conveyed back into the process. The two boxes of the mold went straight on down the roller conveyor and back around the automated line. The hot parts themselves were hooked off the roller conveyor by a worker. It was a beautiful design. When they started their first pouring, my friend ran around and flipped a half dozen switches. The fans started up, and everything worked beautifully - for about two minutes.

Then every door in the foundry popped open. The doors I am talking about are retained with a bullet catch that looks something like a large ball bearing with a spring behind it. These are usually built into the overhead doors that allow trucks to come in. But the negative pressure inside that building was high enough to pop those doors open. They all stood open about four or five inches.

This operation produced some other rather queer effects in the foundry. There was another cooling tunnel which relied on thermal head; that is, the actual heat of the gases rising from some very large castings on another line. After the automated pouring was started, the air was coming <u>down</u> that stack, blowing across the large castings, and blowing smoke and fume out into the open casting area. This was bad enough. The core oven, which was around the corner from the automated pouring line, was baking cores. It, too, relied on thermal head. When they started that automatic pouring line, the fumes were coming <u>down</u> the oven stack and out into the core room. Unfortunately, one of the breakdown products of the drying oils used in core-making is acrolein, which is extremely irritating to the eyes. It didn't take long for them to decide that they were going to have to shut down that automated pouring line. This is another example of failure to provide make up air. When that automated pouring line was operating, there was a negative pressure increase sufficient to overcome, not just thermal head, but even the thrust of some propeller type fans in the ceiling. The clean air could be seen coming down against the push of the fan blades. Any time you have a negative pressure inside a building, you are reducing the volume of air which any type of fan is drawing from that particular building. All fans operate by establishing static pressure across the inlet and the outlet. That static pressure is limited. If you increase the difference in static pressure across that fan, you will immediately cut down the output of the fan. There is no way of getting around that.

To summarize, the most expensive type of ventilation to install, but certainly not the most expensive to operate, is local exhaust ventilation. It requires a smaller fan, a smaller volume of air, and a smaller use of horsepower on a yearly basis because you are handling two, three, four, five hundred cubic feet of air per minute. The second most feasible, from our point of view (and a very poor second), would be dilution ventilation. Here, your contaminant must have a relatively low toxicity (a high TLV), or you have trouble. Dilution ventilation requires vast amounts of make up air. True dilution is difficult to obtain.

Natural ventilation is highly variable and is the very poorest type of ventilation in any type of building.

OCCUPATIONAL INJURY CONTROL

NOISE CONTROL

John M. Yacher, M.S.

The control of unwanted sound, or noise, can best be discussed by examining the principle of the source, the path, and the receiver. Appropriate measurements to determine the magnitude and identify the source of the excessive noise levels are required. The preferred order of applying control methods, then, is modifying the source to reduce the transmitted sound or vibrational energy, blocking the air-borne or structure borne transmission paths, and using administrative controls or personal protective equipment at the receiver. The selected method will depend upon the source, the location, and the economics of the situation.

NOISE CONTROL TECHNIQUES

In noise control analysis the approach is to consider where the most effective and economical control of the noise can be obtained: at the source, the path, or the receiver, and in what order, if more than one treatment is needed.

Source A full knowledge of the operation or process is needed to answer the basic questions: Can the machine or operation be eliminated or replaced by a quieter operation with equal or better efficiency (weld for rivet, and so forth)? Can the present noisy machine be replaced economically by newer equipment designed with lower noise levels (perhaps as well for increased production)? Can the specific noise source be corrected by minor design changes (avoiding metal-to-metal contact by use of plastic bumpers, replacing noisy drives by quieter types, use of improved gears, improved maintenance, and so forth)?

Can the specific machine elements causing noise be corrected by a local source approach rather than considering the entire machine as a noise source? Can the noisy machine elements be moved (such as pumps, fans, air compressors that service the basic machine but need not be an integral part)? Can the machine parts be vibration isolated to reduce airborne noise from vibrating panels or guards?

Some of the specific noise reduction methods that can be applied at the noise source are:

1. Distance or relocation
2. Vibration control or isolation
3. Damping of vibrating surfaces
4. Lagging of vibrating surfaces
5. Air (and gas) flow and jet noise reduction by design, mufflers
6. Hydraulic systems, acoustic filters, surge tanks
7. Motor air cooling mufflers
8. Mechanical drive enclosures
9. Balancing of rotating equipment
10. Noise source enclosures

<u>Distance or Relocation</u> Can a noise source be moved further away from the operator? Distance reduces noise level from a point source by 6 dB per each doubling of distance in a free field. In a closed space such as a factory work room, reverberant sound will eventually determine when no further reduction by distance may be obtained. The distance at which this occurs is called the critical distance. Relocation may apply to machine service units such as pumps, fans, drives, hydraulic systems, and air and steam flows that may be relatively easily moved and do not need constant attention.

<u>Vibration Control or Isolation</u> Vibration control or isolation can be investigated on two bases: Isolate a vibration source, such as a motor-pump assembly that is part of a machine, or vibration isolate the entire machine. A separate noise level test with the component on and off would help to determine if the component is a major contributor to the total noise.

Vibration control is necessary for quiet operation, and equipment mountings should be reviewed and changed from solid mountings to vibration isolating mountings of springs, rubber, cork, felt, or fiberglass as the situation requires. Vibration causes flat panel surfaces of machines, guards, and building structures to radiate noise. The excitation can come from rotating equipment, vibrators, tumblers, or shakers, and the introduction of isolation between the machine and such surfaces is often the complete solution to some noise problems.

Vibration isolators are commercially available. They are selected by specifying the weight supported, the deflection required, and the lowest vibratory frequency of the unit to be isolated. They are made from elastomers (rubber in compression and shear, ribbed rubber); other compressible materials (cork); fibrous mats (felt, fiberglass); and steel springs.

The selection of isolator pads follows the same general method, using the data from the suppliers as to the recommended grade, material, and thickness. A pump-motor set mounted on a common platform furnishes a typical isolation problem, and also one that has a simple solution: use four properly selected vibration isolators. Other vibration problems can be more complex, and the suppliers of isolating devices should be consulted.

Another problem is a machine on a rather limber floor. Such designs and specifications call for special expertise. Complex vibration in more than one plane also requires specialized assistance from the suppliers or a qualified consultant. Under optimum conditions, the reduction in noise level (in dBA) should range from 2 dB for a machine with no vibrating panels, mounted on a very heavy inertia block, to perhaps as much as 14 dB for a heavy machine on a second story and limber floor.

<u>Damping</u> Damping is the reduction of vibration and resultant noise by adding a layer or layers of vibration-absorbing material to either side of the vibrating surface. For example, metal parts striking a sheet metal pan cause noise that can be damped with a wide variety of materials including roofing paper, sheet lead, damping compounds, special tapes, acoustic lagging, and other commercially available materials to fit the problem.

<u>Air and Gas Flow Noise Reduction</u> To reduce the noise of air and gas flow and discharge, silencers are used: absorptive silencers contain porous materials to absorb and reduce noise; reactive silencers depend on reflection (impedance mismatch) of the sound waves as the basic noise reduction method. A combination of both types is used in some designs, with various configurations.

Commercially available silencers are specified by the insertion loss (by octave bands) and by other specifications such as velocity of flow, temperature, and allowable pressure drop. Large industrial silencers are also known as snubbers and are sometimes combined with spark arrestors. There is a great deal of art in silencer design. One unsolved problem with dissipative silencers is fouling of the absorbent by particulate matter. In general, under such conditions, do not use a dissipative silencer.

Fans and blowers when near or part of an operation can be a major noise source. Fan types used are propeller, axial, and centrifugal. Blades on centrifugal fans may be radial, forward curved, or backward curved, but backward curved blades are the quietest. The resulting air noise is a combination of blade-pass frequency and harmonic peaks plus broadband aerodynamic noise and turbulence.

Reduced speeds will reduce noise, and replacement with lower noise level fans such as backward curved blade types can be considered. If this is not practical or economical, the air flow noise can be reduced by commercial or custom-made silencers. Custom-made silencers that can be constructed in maintenance shops include acoustical labyrinths, parallel baffle silencers, acoustic lined plenums, acoustic lined ducts, and acoustic lined bends.

An absorbent lined bend should add about 5 dB attenuation, with length of treatment at about five times duct width. Commercial silencers are available for greater attenuation to fit any fan or duct size, and suppliers can give insertion loss at each octave band under varied conditions of flow. Note that noise travels both upstream and downstream, and silencers may thus be needed on both intake and delivery sides of the fan.

<u>Air Jet Flow</u> In industrial applications where high velocity air is discharged, shear-induced boundary layer turbulence can be a serious noise source. Normally, maximum levels from this aerodynamic noise occur in the 2,000, 4,000, and 8,000 octave bands. If velocity can be reduced, the noise level is reduced.

Low noise level jets are available commercially that use a divider at the exit to change a single jet stream into multiple smaller jet streams. These devices should be tested to see if they can do the job required. Some hand air guns use a version of by-pass jet engines, in which a mantle of slower moving air is aspirated over the jet. Jet noise reductions of as much as 10 dB can be realized. If the jet in question is from a vent, it could be moved to be vented outside the plant or it could be muffled. Air operated tools can be equipped with commercially available exhaust air mufflers.

<u>Hydraulic Systems</u> Hydraulic systems, as part of a machine or operation, can have specific noise sources. Motor-pump assembly contributes most to the overall noise pattern, being vibrated both by overall vibration and by the blade tooth or piston pass frequency plus harmonics. Noise levels depend on type of pump; Gear pumps are more noisy than screw pumps, piston pumps are in between. Noise levels of most pumps increase with speed.

Some screw pumps are available that, with a quieted electric motor produce about 81 dBA at 3 feet.

Fluid line noise sources are often sharp bends, flow restrictions, and undersize sections. These configurations cause cavitation and turbulence, causing vibration and noise. The major factors that affect fluid flow and possible noise are pipe diameter, fluid velocity, fluid density, coefficient of viscosity.

Vibration isolation of the pump-motor unit will attenuate noise from the vibration of the floor. Other noise reduction means include substitution of a larger pump at reduced speed and the addition of hydraulic mufflers, which may be tuned reactive, untuned reactive, or dissipative. Tuned or side branch mufflers may be used for limited frequency band attenuation for constant speed pumps.

If the pipe size for avoiding turbulent flow is not economical, other means of attenuation must be used, such as storing energy elastically with a flexible hose or surge chamber, use of elastic spacers, wrapping and supporting of the line, use of isolation type hangers, or increase in pipe wall thickness. Fluid lines can also be lagged.

<u>Motor Air Noise</u> Motor Air noise, if found to be a problem, can be reduced by acoustic line air flow chambers which are available for some motors. Totally enclosed fan cooled (TEFC) motors with integral quieting are also being manufactured. Less than 80 dBA at 5 feet is claimed for motors up to 5,000 HP.

<u>Enclosed Drives</u> Vibrating surfaces of a drive enclosure are noise sources. Damping these surfaces reduces radiated noise. If the drive enclosure is a steel box structure, the inside can be lined with a combination absorption layer (such as open cell polyurethane foam) with a damping layer backing. Such materials must be oil-resistant. If there are air vent openings for cooling, noise traps can be added. Quieter drives can also be considered, such as substituting belts for gears, "silent" chains for roller chains, and so on. Precision made and carefully aligned gears are always quieter than other types.

<u>Balancing</u> It is always preferable to reduce noise at the source by avoiding the generation of noise. Unbalanced rotating parts cause surfaces to vibrate and generate noise. All significant rotating parts should be balanced <u>in situ</u>, that is, in the machine at its final position. This is particularly true for large fans, where there may be unbalanced aerodynamic forces on

the blades. Rotating mechanisms that drive reciprocating devices can use counterbalance weights.

Noise Source Enclosures or Barriers These will be discussed later in greater detail in treating the noise path and are noted here to call attention to the fact that the technique can be used close to localized noise sources. Examples of such sources are drives, pumps, gears, steam and air vents, punch operations (die area), or other localized metal-to-metal contact areas of a machine.

Path of Sound After as much noise as possible has been reduced at each source, the next step is to reduce noise along the path from the source to the receiver (operator). The sound may be blocked by acoustical shields, barrier walls, partial enclosures, or total enclosures. All these techniques depend on interposing in the path a material, called an isolator, whose wave transmitting properties are as different as possible from those of the path. In air paths, such materials are ideally solid, nonporous, and limp. For liquid paths, a stream of gas bubbles is a good isolator. Along a solid path, resilient vibration isolators perform the same function, weakening the path. Our discussion will be in terms of the most important path, in air.

Acoustical Shields and Barriers An acoustical shield is an approximately square piece of material, usually (for visual access) safety glass or clear plastic (polycarbonate or polymethylmethacrylate), placed between worker and noise source. Such a shield is effective only if its smaller dimension is at least three times the wavelength contributing most to the noise exposure received. Thus, shields of reasonable size are effective only against high frequency sound, such as from concentrated air or gas jets. Examples include air ejection systems in punch presses, plasma guns, air guns, and metal spray guns. Improperly designed shields can interfere with access. However, they can be combined with automatic safety mechanisms to serve a mechanical safety function as well. A shield must be carefully engineered to the job if maximum noise reduction is to be obtained with minimum interference with manual access. For high frequency noise, reductions up to 8 dB can be obtained. Shields must be vibration-isolated from the machine.

An acoustical barrier is a much larger shield, typically free standing on the floor and usually much wider than high. Visual access can be provided by viewing ports of safety glass or clear plastic. For both barriers and shields, the sound arrives at the operator around the edges as well as through the material of the barrier. Because the former path most often limits the attenuation that can be obtained, the transmission loss of the barrier material need not be large. Indeed, for the best reasonable barrier, a reduction of 15 to 20 dB in A-level is about the maximum possible. Thus, at best the barrier (well-damped) need be no heavier than 0.5 lb per sq. ft., if the A-weighted spectrum peaks at 1,000 Hz; less may suffice if the maximum occurs at higher frequencies.

For best results, at least the machine side of a useful barrier should be covered with an acoustical absorbent, preferably oil resistant and cleanable. The barrier material can be plywood; it ordinarily needs no added damping, and ½ inch will usually be thick enough for a 10-dB reduction. If steel is used, damping must be added to control resonances. Handles and sometimes casters can be provided on the barrier for ease of moving. If the barrier is hinged (for stability), the joints can be severe noise leaks. These leaks can be controlled by a resilient strip of 1/8-inch-thick Neoprene over the gap. Use a width of at least three inches, placed on the concave side of the bend. Fasten by one long edge, with the other free to slide as the hinge bends.

Machine guards for mechanical protection can often be replaced by acoustical guards, covered on the inside by absorbent materials. These guards constitute a type of partial enclosure over the noise source. If visual access is needed, safety glass or clear plastic panels can be used. However, the acoustical guard will have to be more complete than the mechanical, and must be vibration-isolated from the machine. Much engineering must go into fitting the guard so as to cover all the noise leaks. The importance of the leaks can be seen from an example. If the guard is designed for a reduction of 15 dB and has a total area of 6 sq. ft., then a crack around it that is about 1/4-inch wide will pass as much sound as the guard material. In most acoustical guards, the leaks will limit the noise reduction possible; the chief task of the noise control engineer is to design for minimum leaks.

When a barrier is wrapped around a machine, with its top more or less open, it becomes a partial enclosure. Such an enclosure can be effective in reducing noise to workers nearby. However, the noise escapes through the top and contributes to the reverberant sound in the workroom. In addition, specular (mirrorlike) reflection from the ceiling can contribute reflected-path levels that can become obvious when the direct path is reduced by the enclosure.

These spill-over noise effects can be reduced by covering the inside of the enclosure with absorbent. Also, suspended absorbents may be placed over the openings to reduce the escaping noise. If all other machines in the workroom are quieted, then the ceiling reflection may become apparent. Such reflections are usually specular, and the patch of ceiling at which the reflection takes place can be located geometrically on building plans. Absorbent placed on the ceiling at this location will effectively reduce the reflected sound received.

Partial and total enclosures will usually need access for incoming material, product, scrap removal, operator, maintenance person, and vision. Doors, windows, and hatches will handle most access problems, but the usual precautions about avoiding leaks hold strongly at these openings. Hinged or sliding doors can use a gasket for a seal. A convenient material is the closed-cell foamed elastomer weather stripping sold with a pressure-sensitive adhesive. Special acoustical gaskets, designed specifically for sealing leaks, are also available. For less stringent sealing, the magnetic strip gaskets used on refrigerator doors supply both seal and positive closure. Hatches can be dogged down by quarterturn latches. Windows for visual access may need added internal illumination to make visual monitoring easy and positive. Heat buildup should be no problem with an open top in a partial enclosure. Noise reduction also removes acoustic signals that some workers use in evaluating the performance of a machine. Hence, if the reduction is great enough, acoustic cues may have to be separately supplied. This is easily done by a rigged microphone (at the site where the essential information is generated), feeding a small loudspeaker at the worker position.

Openings for workpiece, product, and scrap flow can permit noise to escape. Such openings should be in the form of tunnels lined with absorbent material. The length of the tunnel determines the amount of noise attenuation obtainable. In the design, the absorbent can be selected for maximum effect on the noise spectrum at that opening. Use of lined tunnels should be accompanied by some degree of automation.

<u>Total Enclosure</u> The next step of noise control, a total enclosure, has the same problems (and solutions) as the partial enclosure. The chief added problem is that of heat buildup. This problem is easily handled by adding a ventilating blower, together with silencers for both supply and exhaust air. Some internal ducting may be needed if there are heat-sensitive components in the machine, but these ducts can also selectively supply cooling air and remove hot air. More flow is needed at higher altitudes.

There is no doubt that the total enclosure will require a change in work habits, and as such will usually be resisted by all concerned. The shock of the change can be eased if the people most involved - the workers and the foremen - are provided an opportunity to enter into the design discussions. Enclosures can also force consideration of modernizing equipment, say, for automatic feed by conveyor, so that less personal attention to the machine is required. Such automation may also offset the difficulties that arise from less free access to the machine. In most instances the noise control engineer will have little difficulty with the acoustical aspects of enclosure design. The chief job is to ensure an industrially viable design, taking account of the requirements for access, minimum change in productivity, and minimum installed cost. To meet these requirements, the noise control engineer must work closely with the industrial, plant, and process engineers; with foremen and workers; with maintenance crews; and with management.

As a general matter, enclosures must not touch any part of the machine and should be vibration-isolated from the floor. Nevertheless, the enclosure must be pierced for such services as electricity, air, steam, water, oil, or hydraulic power. These services can be regrouped, together with mechanical controls, to a convenient location where the enclosure panel can be split. A resilient acoustical seal can then be made from two ring-shaped pieces of 1/8-inch (or heavier) Neoprene. Slot each piece at the pipe or conduit and overlap the two pieces with the slots facing away from each other. Seal the straight edges with strips of Neoprene or similar oil-resistant, heavy, and resilient material.

For mechanical controls operating through an arc-shaped hole in a panel, the seal can be of abutted, multiple strips of Neoprene. The control lever should be as thin as possible. Better yet, replace it by a servo control operated from the outside.

Many of the features of a convenient enclosure design are based on panels secured (by quarter-turn captive screws) to an angle iron frame. Thus, rapid access is provided for all types of servicing of the machine. This type of enclosure is to be as close as possible to the machine. Up to 20 dB of noise reduction is usually easily obtained. The angle iron frame can be of bolted sections, to permit quick and complete disassembly and removal.

Machine vibration may still create a problem by vibrating the floor, which then acts as a resonant sounding board to vibrate the enclosure. This problem is easily handled by vibration-isolating mounts, using steel springs, or elastomers in shear. Special care in design is needed if the exciting force is of short duration but is repeated, as in a punch press. Not all vibration-isolator suppliers recognize the need for careful selection of isolators in this special repeated impact situation. Be sure that you have enough data on the machines and the isolators to ensure an effective design. You will need data on three time scales: 1. duration of the impact; 2. time between impacts; and 3. the minimum period of oscillation of machine on a suggested isolator.

In any machine, the time comes when major repairs are due; additions or changes may also be called for. The panels can be made separately and fastened in place with a gasket material (such as weatherstripping) to close off chance leaks. If the panel material is a metal, its resonances can be distributed more uniformly in frequency if the panel is reinforced by bolted-on angle iron (bolting adds more damping than welding). The stiffeners should be placed so as to divide the panel into smaller areas, no two of which should be the same size and shape. Frames for doors, windows, and hatches can also be used as stiffeners.

Windows pose a special problem because they are a weak spot acoustically. Generally, if more than 20-dB reduction is needed, double glazing must be used. The inside layer should be of safety glass, because it must withstand cleaning to remove oil, grease, and dirt. All panes should be set into soft elastomer gaskets. Room temperature-setting silicone rubbers are useful here. The visual access that windows provide should be carefully thought out in terms of the information the operator needs. Glareless lighting of the components to be monitored is helpful. In extreme cases, closed circuit video monitoring can be used.

A special adaptation of the total enclosure for the machine is a total enclosure for the operator when this is the more practical or economical approach. Such enclosures may require air intake and exhaust fans, with noise traps, lighting, heating, or in some cases, air conditioning. As in machine enclosures, some inside absorption is recommended, such as an acoustic tile ceiling, and special care must be taken in window and door design to avoid leaks.

The most important information required for the acoustical design of enclosures is the transmission loss. This quantity represents, in decibels, the reduction of sound power in going through an isolating wall. It is measured by a well-defined and accepted standard. The transmission loss varies considerably with frequency, and the term sound transmission class is sometimes used. This is a single number indication of average transmission loss.

However, it applies specifically to speech sounds and acoustical privacy requirements. It should be used with caution in industrial situations, where sound spectra differ from those of speech and where reduction of A-level is the requirement. If a single number is needed, use the transmission loss at the band an octave below that for which the maximum A-weighted octave band level occurs at the operator position.

The noise reduction is the difference in level at operator and in enclosure after installation of the enclosure. It depends on several factors: the average transmission loss of the enclosure surfaces, the amount of absorption in the enclosure, and to some extent, the acoustics of the work room. The worker is usually close enough to the machine that room acoustics effects are not important. If the average absorption coefficient of the interior of the enclosure is at least 25% at the band an octave below that for the maximum A-weighted octave bank level, then noise reduction will be approximately equal to the transmission loss. A more useful measure of the effect of the enclosure is the insertion loss. This is the reduction of level at the operator position before and after introduction of the enclosure. Its calculation requires knowledge of total noise power from the machine, its directional characteristics, the total absorption within the enclosure, the transmission loss of the enclosure, the shape of the enclosure facing the worker, and the acoustics of the workroom.

A problem occurs in calculating the net transmission loss when the enclosure has panels, doors, hatches, windows, silencers, and leaks, each with its own area and associated transmission loss. A formula which can be used amounts to adding up all the sound power that escapes and dividing by the total area.

<u>Room Acoustics</u> In addition to the direct path from the noise source to the receiver (operator), there is also the sound reflected repeatedly from walls, ceiling, and other surfaces, such as equipment. The study of the sound fields generated by such reflections is termed room acoustics.

The sound level from a point source, with no reflecting surfaces nearby, changes at the rate of 6 dB drop per doubling of distance from the source. In a normal factory space with acoustically hard walls, floors, ceilings, partitions, and machines, sound is multiply reflected, and an operator may receive this reflected sound from essentially all directions. The result is a reverberant buildup of noise. This means that as the distance from the machine increases, the noise level will diminish for a while but a point will be reached where little or no reduction is achieved. Beyond this distance is the reverberant field, and the distance at which the change-over occurs is called the critical distance. The reverberant field is the only portion of the total noise that is affected by changes in room acoustics. For most industrial situations the operator is inside the critical distance. Thus, the noise that he receives is affected but little by adding absorption to the walls or ceiling of the work room This absorption will affect the sound level experienced by those who walk through, at some distance from the machines.

Receiver If noise source corrections and noise path corrections do not reduce the noise to acceptable limits or before these corrections have been applied, attention should be directed toward the receiver. This may be in the form of administrative controls or personal protective equipment or both.

Administrative Controls. Administrative controls can in some cases be developed to limit the duration of exposure to noise levels above 90 dBA to the permissible noise exposure time specified in the Section 1910.95 of OSHA (Occupational Safety and Health Administration) regulations:

Hours/Day	dBA	Hours/Day	dBA
8	90	1½	102
6	92	1	105
4	95	½	110
3	97	¼ or	
2	100	less	115 max.

For combinations of exposures, the sum of the actual daily exposure time divided by the allowed exposure time for each time period must equal or be less than 1.0 to be in compliance regarding noise levels and should be equal or less than 0.5 to reduce the need for wearing ear protectors. The sum of these ratios is called the daily noise dose. Administrative controls include the following approaches:

1. Workers at 90 dBA are not exposed to higher levels.
2. Workers at higher levels are removed from the noise after the above time limits and spend the balance of the day in lower than 85 dBA areas.
3. Work time is divided between more operators, that is, split shifts are arranged between high noise and low noise areas.
4. When less than full-time operation of a machine is required, time is split into partial days instead of an occasional full day operation.

5. Exposure is reduced by shift scheduling to reduce number of exposed employees and number requiring protective equipment.

Personal Protective Equipment Present (October 1974) Department of Labor "Guidelines to Occupational Noise Standards" (Bulletin 334), say: "The use of personal protective equipment is considered by the Department to be an interim measure while engineering and administrative controls are being perfected. There will be very few cases in which the use of this equipment will be acceptable as a permanent solution to noise problems."

The Department of Labor Bulletin 334 Guidelines cover the following major points on protective equipment:

1. Only approved ear protectors that have been tested in accordance with ANSI Standard Z24.22-1957, should be used.
2. Five dB less than stated attenuation of equipment should be allowed because test data were obtained under ideal conditions that are not normal in day-to-day operation.
3. Ear muffs and ear plugs should be fitted and supplied through a properly trained person who can educate the workers in the use and maintenance of the muffs and plugs.
4. Wax impregnated cotton and fine glass wool are acceptable, but cotton stuffed in the ears has very little value and is not acceptable.

In addition, it is our experience that ear plugs should be inspected periodically to ensure that they have not deteriorated and that the workers have not cut off the ends for greater comfort (but no protection).

Selling the use of protective equipment to employees and supervisors will usually require that an educational and promotional program precede the required use of ear protection. There should be continual follow-up by supervisors to see that the program is accepted and that ear protection is worn where needed. This program can be aided by signs in areas where protective equipment is mandatory. Supervisors should be aware that if a plug or muff is uncomfortable, it may not be worn. Other difficulties are with long hair, which can hide a plug that has deliberately been loosely inserted; plugs may be cut off and ear muff bands weakened to reduce pressure. Tight muffs over broad-temple glasses can restrict blood flow. Devices are available to ease this last problem.

Audiometry Audiometric tests should be made of all individuals working regularly in areas in which the noise level is ablve 85 dBA. This is an excellent way to determine how successful engineering or other controls have been. Several recommendations for an audiometric program include:

1. Test facilities and procedures are to meet established standards of ANSI S3.1-1960 and 3.6-1969 (or latest).

2. Tests are to be made as described in ANSI standard S3.1-1960 and 3.6-1969, and by a person certified as an audiometric technician by a course of training in accordance with Intersociety guidelines.

3. Audiometers used are to meet specifications in ANSI standard S3.6-1969 or latest and shall have a certificate of at least yearly calibration. They are to be subjected to a biological check at least once a month; a log of checks and calibrations is to be maintained.

THE TEAM APPROACH TO OCCUPATIONAL SAFETY AND HEALTH

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Occupational Safety and Health today has become a very complex subject. The requirements of the Act (PL 91-596, Occupational Safety and Health Act) have brought about a necessity for those in the health and safety professions to consider the total sphere of worker health. Often, in our hurry through our day-to-day activities, we adopt an attitude of corrective action rather than preventive. This has been no less evident in the area of worker safety and health.

If we are to be successful in our quest "...to assure so far as possible every working man and woman in the Nation; safe and healthful working conditions and to preserve our human resources...", we must adopt the "preventive" method of attack. This means that each of us here today, Physician, Nurse, Industrial Hygienist, Safety Professional and any of the sub- and para-professional persons who support us, must become more familiar with the part that each plays in this over-all plan.

In order to diagnose and treat a work related illness or injury, the physician and nurse should have some degree of familiarity with the hazards in the plant(s) which they are responsible for. To recognize an occupational illness, and treat it properly, is a prerequisite for cure. To prevent the recurrence of the same illness or injury, a knowledge of the physical and chemical hazards within the workplace would be extremely helpful, if not necessary.

Similarly, the industrial hygienist and safety professional need to broaden this understanding of industrial injury and illness. These often are the final manifestations of the conditions which they see everyday in the workplace.

In the design, development and presentation of training courses, we use the terms "Recognition, Evaluation and Control" to indicate levels and complexity of training. The preventive approach to worker safety and health, can easily follow this same scheme.

1. Recognition of the hazard and its medical complications.
2. Evaluation of the extent of the hazard, i.e. its concentration or level, and the diagnosis of the medical trauma it produces.

3. Control of the hazard, i.e. to eliminate it or reduce it to a level which will not produce permanent psychological damage and cure of the trauma produced by it.

By following this method of attack and working as a team, hazards in the workplace can be reduced considerably so that every worker may have, as far as possible, "...employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm...".

It is to that end that the NIOSH Division of Training presents this program today.

HAZARDOUS PARTICULATES AND NOISE

HAZARDOUS PARTICULATES

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THE RESPIRATORY SYSTEM AND PARTICLE SIZE

One of the most serious consequences of atmospheric pollution is the health hazard resulting from the inhalation of the respirable particles. Pollutants usually enter the body through the respiratory system, where some are retained, and from there they may be transported to a reactive site in the lung, or through the blood stream to a remote susceptible organ. Particle size, together with specific gravity, largely determines where the particles are deposited in the respiratory system and the fate of the particles after deposition.

1. The Human Respiratory Tract. Because of the delicacy and complicated structure of their surface, the lungs are extremely vulnerable to airborne substances. The total surface area of the lungs is about 300 square feet, and the structures which separate the alveoli from the blood stream are extremely thin. Fortunately, the cilia and the winding passages through which the air must pass remove most airborne particles before they can penetrate the delicate tissues of the alveoli. Occasionally these defenses are overrun, in which case the particles may be deposited in the alveoli and cause trouble.

Three mechanisms are of importance in the deposition of the particulate matter in the respiratory tract:

1. Gravitational Settling
2. Diffusion (Brownian Motion) and
3. Inertial Impaction.

2. Kinetic Behavior of Particles

a. Gravitational Settling - Terminal Velocity. A freely falling particle within the size range found in dusts, smokes, and mists, for example, will accelerate until the aerodynamic drag force on the particle just balances gravitational force. After this, the particle will continue to fall at a constant velocity known as the terminal or free-settling velocity. The terminal velocity of a particle falling under the influence of gravity may be calculated; some of these rates for spherical particles are given in Table I. In general, heavy industrial dusts contain

TERMINAL VELOCITIES AND DIFFUSION COEFFICIENTS OF RIGID SPHERES OF UNIT DENSITY IN AIR AT 760 MM HG PRESSURE AND 20°C.

DIAMETER μm	ν CM/SEC	D CM^2/SEC
0.1	8.71×10^{-5}	6.84×10^{-6}
0.2	2.27×10^{-4}	2.02×10^{-6}
0.4	6.85×10^{-4}	8.42×10^{-7}
1.0	3.49×10^{-3}	2.76×10^{-7}
2	1.29×10^{-2}	1.28×10^{-7}
4	5.00×10^{-2}	6.16×10^{-8}
10	3.03×10^{-1}	2.41×10^{-8}
20	1.20	---
40	4.71	---
100	24.7	---

TABLE 1

particles up to 100 μm in diameter. Permanently airborne particles are below about 2 μm in diameter. Examples of sizes of commonly encountered particulate matter are shown in Table II.

Particulate Matter	Particle Size in Micrometers	
Viruses	0.02	- 0.1
Bacteria (Cocci)	0.8	- 1.0
Industrial Airborne Dust	0.1	-10.0
Spores	3.0	-10.0
Face Powder	1.0	-10.0
Water Droplets in Fog	5.0	-40.0
Pollens	10.0	-80.0

Table II

b. Diffusion - Brownian Movement. The constant motion of a particle about a point is known as Brownian movement. This occurs when a particle is of a diameter which corresponds with the magnitude of the mean free path of the gas molecules in which it is immersed. Because the particle is being constantly bombarded by molecules of the gas, it takes up a random movement. The algebraic sum of all these collisions is zero, so there is no resultant linear movement of the particle. Hence, the particle moves in constant random fashion about a reference point.

The difficulty in removing some particles from air may be explained by noting the movements caused by Brownian effects and gravity. Brownian movement increases as particle size decreases, while the rate of fall due to gravity increases with increased particle size. There is a point, at the diameter of about 0.25 micrometers, at which the movements are about equal. Here, the particle shows a minimum amount of movement. Consequently this size particle is extremely difficult to remove from air, and is, therefore, a matter of concern when designing dust control equipment. It also represents the most difficult particle size to be removed from air by retention in human lungs. Smaller as well as larger particles are captured more efficiently.

c. Inertial Impaction. Particles collect (impinge) on the surface of an obstruction around which dust-laden air flows when the inertia of the particle is great enough to overcome resistive forces of the medium; when it hits the obstacle, it is retained on the surface of the obstacle. The path of the particle is determined by:

1. Air velocity
2. Mass and resistance of the particle, and
3. Size and shape of the obstacle.

Inertial impaction is of greatest importance in the deposition of large particles of high density. In addition, the finer the obstruction, e.g. a fiber in an air filter, the higher is the collection efficiency. In the respiratory system, collection increases where the direction of flow changes at branching points in the airways.

Particle size affects the deposition of particles in at least two ways:

1. The overall percentage of retention of the particles in the system, and
2. The location of the region within the respiratory system where most of the particles are deposited.

Consider a dust particle the size of a common pollen grain (15 - 25 μm); usually a particle of this size would be caught in the nasal passages or at the back of the throat. However, if the particle should enter the trachea near the center line it stands a good chance of passing all the way down to the bronchi, but is not likely to reach the alveoli. The collection of such a particle is the sole result of chance impact against the moist walls of the respiratory tubes.

THE EFFECT OF PARTICLE SIZE ON DEPOSITION AND RETENTION

Experimental studies have demonstrated that there is a particle size corresponding to minimum retention of particles in the lungs. For most substances this is about 0.5 μm diameter. Particles larger than this are deposited by gravitational settling, while smaller particles reach the lower respiratory surfaces mainly by diffusion, as a result of Brownian motion. Larger particles are also removed by interception and impaction.

The upper respiratory tract is capable of capturing inhaled mineral particles larger than 5 to 10 μm. Most of these particles are deposited on ciliary surfaces, located from the end of the terminal Bronchioles up through the trachea. Particles caught on the mucous membranes are transported to the throat by the constantly moving cilia and swallowed. The efficiency of the upper respiratory tract in preventing penetration of particles into the lower respiratory tract decreases rapidly for particles smaller than 5 μm, and for practical purposes, reaches zero for particles of about 1 μm.

Particles smaller than about 1 m diameter (but larger than 0.03 μm) are more likely to be deposited in the alveolar sacs and alveoli than in the bronchial tubes of the upper respiratory tract. The walls of the alveoli are closer together than those of the bronchial tubes, so that the likelihood that particles will reach a surface by diffusion is greater.

The dust-laden cells, which have the power of independent motion, are removed from the respiratory tract by one of two possible pathways.

1. Cells may pass through the walls of the lung tissue into the lymph and, from there, into the blood capillaries surrounding the lungs, or

2. They may pass to the finer bronchioles, from which they are removed by ciliary action.

Eventually the cells reach the mouth and are swallowed. Since the digestive system is much more capable of coping with foreign particulate matter than the respiratory system, the swallowed particles seldom do any harm. The effect of size on deposition in the lungs is shown in the following figure.

Most of the dust-laden cells migrate into the lymphatic system; a great deal of particulate matter is deposited by the phagocytic cells at the tracheobronchial lymph nodes; it is here that fibrosis of healthy lung tissue often starts.

DUST-PRODUCED DISEASES

Particulate contaminated air may impair or injure the respiratory system if:

1. The dust concentration is so high that it exceeds the body's ability to eliminate the dust,

2. The dust is a chemically, physically or mineralogically damaging substance

3. The dust initiates an allergic response

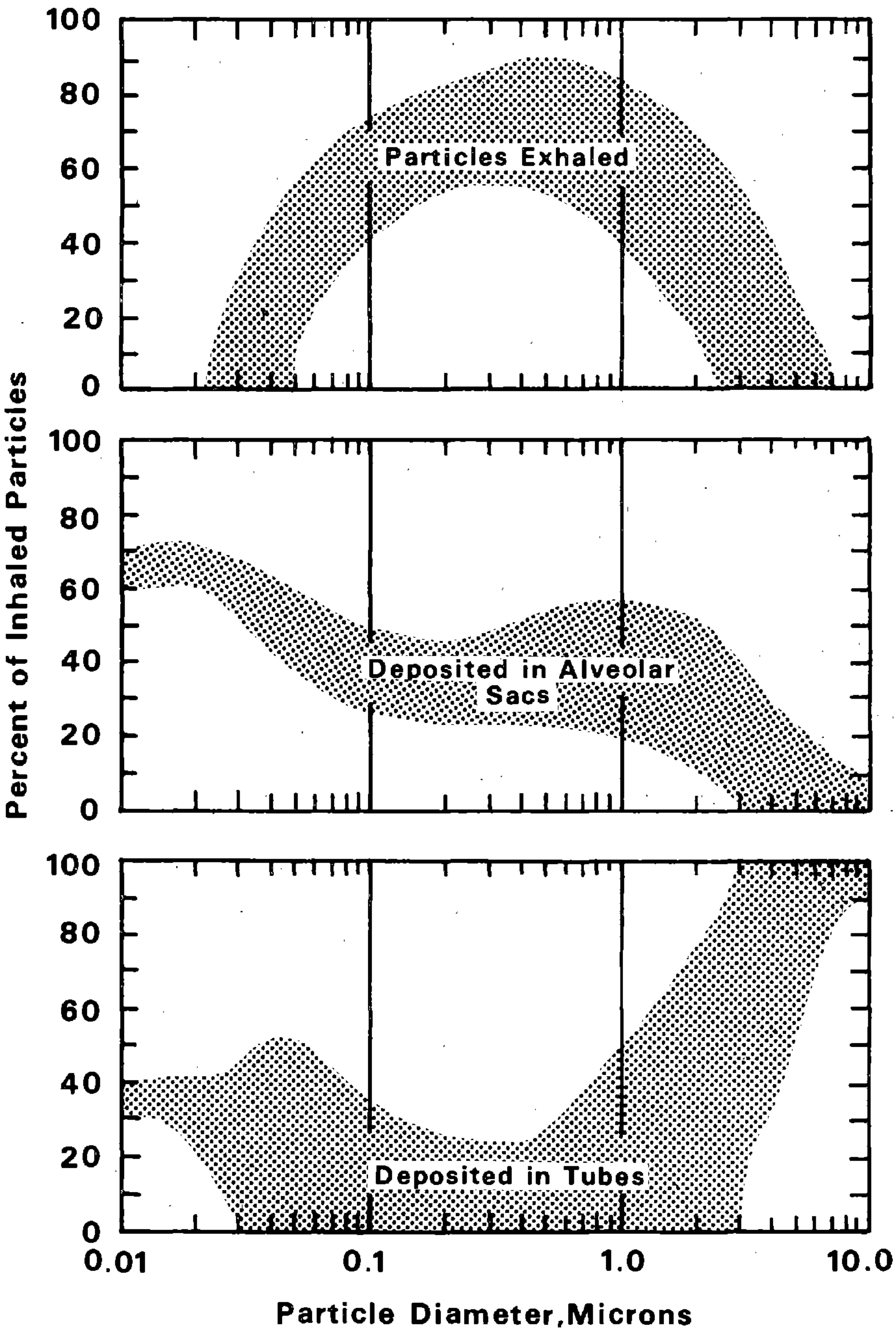
4. The dust is inhaled by an impaired or diseased respiratory system.

The system's physiological reaction to the inhalation of the damaging particulate will depend directly on the size, form, concentration and chemical composition of the aerosol. At least seven classes of reactions are possible: pneumoconioses, systemic reaction, metal fume fever, irritation of the nose and throat; allergic reactions, radioactive damage and carcinogenic damage.

1. Pneumoconioses. The term "pneumoconioses" (from the Greek "dusty lung") is used to describe fibroses resulting from inorganic dusts. There are several dusts which can produce this condition with specific physiological action related to each source.

a. Silicisos. Silicosis is the most important of the

PARTICLE SIZE



pneumoconioses. The causative agent, crystalline free silica dust, produces a progressive fibrosis characterized by miliary nodulation of the lungs. Clinical symptoms of silicosis include: shortness of breath, fatigue, reduced chest expansion, and increased susceptibility to tuberculosis.

Recent theories on the mode of action of silica dust in the lungs favor an immunological effect coupled with a physiochemical effect but the exact mechanism is not known. One of the most striking findings in silicosis research is the small amount of silica retained in the lungs, even in advanced cases. No more than 1% of the total inhaled dust is accumulated after a life-time exposure.

b. Asbestosis. Asbestosis is caused by the action of asbestos dust on the lower parts of the lungs. An asbestos fiber is a needle-sharp crystal up to 100 micrometers long, but less than a few micrometers thick. The fiber can pass through the upper respiratory tract but becomes lodged in the small passages of the lungs. The irritation caused by the fiber results in encapsulation to form an "asbestos body".

The symptoms of asbestosis are similar to those of silicosis; they may be observed after a few (2-3) years of heavy exposure, but normally not until after at least 10 years of exposure.

c. Byssinosis. Byssinosis is caused by prolonged exposure to heavy air concentrations of cotton dust. Although the exact mode of action of the cotton dust is unknown, one or more of the following factors may be important in the pathogenesis of the disease: (1) toxic action of micro-organisms adherent to the inhaled fibers, (2) mechanical irritation from the fibers and (3) allergic stimulation by the inhaled cotton fibers or adherent materials.

The symptoms of byssinosis are dyspnea and tightness of the chest. These symptoms usually become noticeable only after several years of exposure to cotton dust. Characteristically, they initially occur on Monday mornings or on days immediately following holidays or absences and last only a day or two. As exposure to the dust continues, or increases, these symptoms are evident over more and more days of the week until they become permanent. Permanent disabilities which may result from byssinosis are chronic bronchitis and generalized, nonspecific pulmonary emphysema.

d. Bagassosis. Bagasse is the fibrous material remaining after the sugar-containing juice has been expressed from sugar cane. Although the specific etiologic mechanism involved in bagassosis in unknown, several explanations have been suggested. One possibility is that the disease constitutes an allergic reaction to micro-organisms released when the dry bagasse bales are opened. Another theory is that inhalation of the fibrous bagasse causes irritation of the pulmonary tissues and resultant pathologic changes.

First symptoms of bagassosis may appear after exposure to the dust for several weeks. Cough, exertional dyspnea, and low grade fever are usually the initial complaints. As the disease progresses, dyspnea becomes more severe, and the patient may soon become incapacitated.

e. Berylliosis. Beryllium is an important example of an inorganic dust capable of causing disease. The principal damage from berylliosis occurs in the lungs following dust inhalation. Symptoms range from dyspnea and fatigue to loss of weight and intractable cough. The acute bronchitis may occur shortly after exposure to the soluble salts; it may clear up completely or progress to chronic granulomatosis and even death from pulmonary edema.

f. Miscellaneous Pneumoconioses. Other pneumoconioses, some of which are benign, can develop from inhalation of specific dusts. Mica, Kaolin, talc and aluminum dust all can produce pneumoconioses similar to silicosis. Even "harmless dusts" can cause pneumoconioses if the concentration and exposure period are sufficiently high to overload the cleansing mechanisms of the lungs.

2. Systemic Reaction. Systemic reaction of the body to such elements as lead, manganese, cadmium, mercury and certain toxic organic compounds can be transmitted through the respiratory system. The intimacy of contact between the air and blood in the lungs provides an effective portal of entry to the systemic circulation and internal organs of the body. Due to the greater magnitude of transfer of these poisons through the respiratory system as compared to the gastrointestinal tract inhalation thus represents a greater health risk than direct ingestion. The inhaled particles must be small enough, however, to penetrate into the pulmonary air spaces.

3. Metal fume fever. Metal fume fever results from the inhalation of finely divided and freshly generated fume of zinc or magnesium metal and oxide. The health effect is transient; complete recovery usually occurs within 24 to 48 hours.

4. Irritation of the Nose and Throat. Irritation develops from the reaction of acids and alkalis or other irritants on the nasal passages. Chromate dusts can cause ulceration of the nasal septum, or "chrome holes". Similar developments may occur as a result of breathing other metallic oxides, especially those of arsenic.

5. Allergic Reactions. Allergy is the enhanced reactivity of sensitized tissue to the presence of a specific sensitizing substance. Because these substances may be inhaled and deposited upon a surface of the respiratory tract, they can cause temporary impairment of the respiratory system.

If the tissue involved in the allergy is the air passages, then the resulting spasm of the bronchi and bronchioles is called asthma. Involvement of the deep lung tissue, by an allergic reaction, creates a form of chronic interstitial pneumonitis.

6. Radioactive Damage. Inhalation of radioactive particles can eventually lead to lung cancer. It must be emphasized that similar effects can result from the inhalation of any particulate matter on which radioactive gases have been adsorbed. The lung's retention of these particles makes it hard to calculate permissible exposure concentrations. The accepted practice of controlling radiation is to keep exposures as low as possible through "Radioactive Concentration Guides" as recommended for various materials by the Federal Radiation Council.

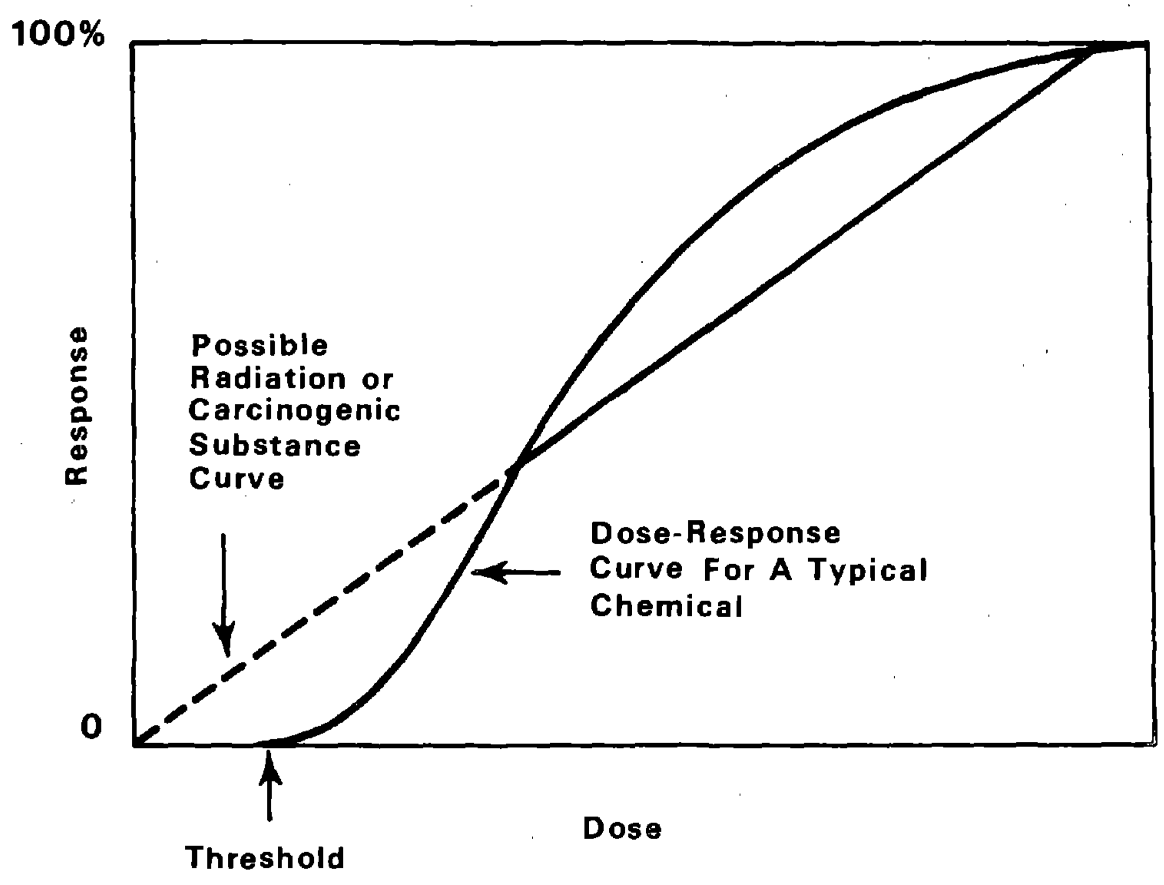
7. Carcinogenic Damage. Several metal dusts and fumes have been proven experimentally to be carcinogenic. Chromate compounds are carcinogenic in tissue fluids. Industrial metal fumes and dusts which may produce cancer include: nickel compounds such as nickel carbonyl, asbestos, and coal tar pitch volatiles adsorbed onto particulate matter.

THRESHOLD LIMIT VALUES

The term "threshold limits" originated over twenty-five years ago with the late Doctor Fairhall of the U.S. Public Health Service. He regarded "threshold limits" as a preferred alternative to the inexactly descriptive "maximum allowable concentrations". The concept of threshold rests on the observed fact that all chemical substances produce a physiological response (toxicity, irritation, narcosis, and so forth) to an increasing number of persons as the exposure dose increases. It therefore follows that there must be a limiting concentration at which no response exists. Stated mathematically, the threshold concept declares that the dose-response function is non-linear at low levels of concentration as seen on the following chart.

There are two situations, however, where the concept of threshold may not be applicable. These include radiation biology and carcinogenesis. Thus any dose over an extended period of time may produce a response in the individual.

In the determination of threshold limits a safety factor is usually incorporated into the experimentally determined values. The size of this factor is determined by the relative toxicity of the chemical and the quality and source of experimental data. For example, the safety factor for an acutely lethal chemical may be larger (by at least ten-fold) than that of a narcosis producing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chemical. The experimentally determined threshold value allows for protection of the majority of individuals but does not cover the hypersusceptible individual.

Threshold limit values usually refer to time-weighted concentrations for a 7 or 8 hour workday and 40 hour workweek. Excursions above the threshold limit are permitted provided they are compensated for by equivalent excursions below the limit during the workday. To use this approach in determining workers' exposure requires that there be a detailed job analysis for each classification studied and that a comprehensive program of sampling, sufficient to establish average airborne concentration at each work site, has been conducted. When two or more hazardous substances are presented in a working environment, their combined effect must be given consideration.

This paper has discussed the physical characteristics of particle size, diffusion, deposition and retention which affect the physiology and pathology of occupational pneumoconioses in human workers exposed to hazardous dusts. A few of the resulting diseases are briefly described, and the concepts of threshold limit exposure values and dose response relationships are defined.

For a description of sampling methods and dust measurement instrumentation, the reader is referred to "Measurements of Particulates," by this author, in Occupational Medicine Symposia, HEW Publication No. (NIOSH) 75-189, Rockville, Maryland May 1975.

HAZARDOUS PARTICULATES AND NOISE

NOISE

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NOISE INSTRUMENTATION SYSTEMS

Many types of instrumentation systems can be utilized for the measurement of sound depending on the characteristics of sound involved; extent of information that is desired about the sound; and the amount of time available.

The various elements of an instrumentation system are:

A. transducer (microphone or vibration pickup);
B. electronic amplifier and calibration attenuator (gain control);
C. data storage system;
D. frequency analyzer, and
E. read out (meter, chart, tape)

Not all elements are used in every instrumentation system. The microphone is connected either to a sound level meter or to a magnetic-tape recorder. The sound level meter is used if the sound pressure level is to be measured directly, and magnetic tape recorder if the sound signal is to be stored for future measurement or reference.

Although these components of a measuring system are shown as separate units, a number of their functions may be combined into one instrument. Even in these combined instruments, provision is commonly made for the use of different types of microphones, and input and output terminals are often included so that other instrumentation can be connected to yield complementary information about a sound.

There are two basic functions of an instrumentation system.

a. to obtain sound or vibration data in the field, and
b. to reduce measured data to a meaningful form, e.g. to weighted values of a sound pressure level, or jerk.

Much of the reliability of a measurement depends on how the instruments are used and set up. One must be thoroughly familiar with an instrument to make full use of its capabilities. The material covered here will help the reader become familiar with the capabilities of various instruments but a thorough study of the handbook supplied by the manufacturer of a particular instrument is also essential.

A. Transducers. A transducer is any device capable of converting power of one kind into power of another kind. In acoustics, transducers are used to convert sound power into electrical power.

Transducers used to convert changes in pressure variations of a sound wave to an electrical signal are called pressure transducers or microphones. Transducers used to convert the acceleration of a vibrating body into an electrical signal are called vibration transducers or accelerometers.

The measurement of the transducer movement can be in terms of displacement, velocity, acceleration and jerk. With pressure transducers the resultant electrical power relates to the rms square of the sound pressure. By using a log circuit a sound pressure level can be determined directly. Vibration transducers are similar but the initial electrical power relates to the acceleration and is passed into an integrator circuit which integrates (summation) for velocity and displacement but differentiates (gradient) for jerk.

a. Pressure Transducer (Microphone). To convert sound fluctuations into electrical variations one commonly uses one of three major types, the piezoelectric (ceramic), condenser and the dynamic.

Desirable microphone characteristics are:

- reliability,
- smooth frequency response,
- minimum phase distortion,
- high sensitivity,
- small size (to minimize disturbance of the sound field),
- simplicity,
- minimal effects to environmental changes, and
- reasonable price.

b. Piezoelectric Transducer (ceramic microphone). The piezoelectric (ceramic) principle is a ceramic (leadtitonate, lead zirconate) which has the property of producing electrical charges on the surface when the material is strained. These microphones are regularly supplied with sound level meters and are available for use with other measuring instruments. They can be mounted directly on the instrument or separately with cable connections.

c. Condenser Transducer (microphone). A condenser microphone is essentially an electrical capacitor formed by a thin metallic diaphragm which is exposed to sound waves by a back plate or perforated electrode. Condenser microphones are more stable with time and temperature than either the ceramic or the dynamic microphones, have excellent responses for various frequencies. Condenser microphones generate more self-noise than other types from air eddies within the microphone head.

d. Vibration Transducer (accelerometer).

i. Piezoelectric vibration transducer (accelerometer). In the simplest form, a mass is mounted on one side of a piezoelectric material, and the other side is cemented to the accelerometer base. The accelerometer base is then rigidly affixed to the sample whose vibration is under study. Movement of the accelerometer base generates an inertial force in the dynamic mass, which then strains the crystal, generating voltage.

ii. Electrodynamic vibration transducer (accelerometer). A transducer similar in principle to the dynamic microphone provides an output proportional to velocity. A dynamic mass as a permanent magnet, is mounted so as to form a spring mass system with a damp resonance at a frequency below the operating range of frequencies. A stationary coil is mounted near the moving mass to detect its relative motion.

B. Sound Level Meter. The most common instrument to measure sound levels in air is the sound-level meter, a sensitive electronic voltmeter used to measure the electrical signal from a transducer, which is usually mounted on the instrument for portability.

The electrical signal from the transducer is fed to the pre-amplifier where the cables may be long. The input is then amplified. The amplified signal is weighted according to the ABCD or flat scales and filtered (or not filtered) over a specific range of frequencies. Further amplification prepares the signal as an output to other instruments or for rectification and direct reading on a meter.

The needle of the indicating meter has two speeds of indication: "fast" and "slow". On the fast setting, the needle gives true indication of the level within 200 to 250 milliseconds after a 1,000 hz tone has been fed into the preamplifier. The overshoot before that time is not greater than 1 dB. The slow setting averages the level for a greater time period.

a. Weighting network criterion. The sensitivity of a sound level meter for any range of frequencies is controlled by the electrical weighting networks according to response curves. A, B, C, weightings have been standardized in the United States in ANSI S1.4-1971 for the sound level meter. Measurement results are designated as dBA, dBB, dBC.

Originally these networks were designed to simulate the loudness level sensitivity of the human ear when listening to pure tones. Today the B weighting network is rarely used. D and E scales have been proposed in connection with noisiness problems. The C weighting (or flat response) is generally used when the problem is of a physical nature such as recording sounds or analyzing data. The A weighting selectively discriminates against low frequency sound and filters out as much as 20 to 40 dB. It is used to estimate hearing damage in industry in the OSHA regulations for measurement of sound levels. A semantic difficulty arises in the literature where unweighted measures are "sound pressure levels" and weighted are "sound levels". To avoid ambiguity the term should state if the measure is weighted. Most commercially available sound level meters meet the ANSI 1.4-1971 specification for precision, general purpose, survey and special purpose sound level meters.

b. Precision Sound Level Meter. Precision Sound Level Meter provides greater accuracy and meets stringent requirements. They provide lower internal noise level and higher gain for measurements of lower sound levels; wider dynamic range, better frequency response characteristics and a low distortion output for driving analyzers or tape recorder. Certain precision sound level meters also impulse (impact) sounds.

C. Vibration Meter. For measurements of displacement, velocity acceleration and jerk a vibration meter is used. A typical unit consists of a vibration transducer (accelerometer), integrator, adjustable attenuator, an amplifier, rectifier, and a direct reading meter. Connections are provided for earphones, sound and vibration analyzer, impact sound analyzer or an oscilloscope. Generally the meter is calibrated directly in terms of peak, peak-to-peak and average displacement, velocity, acceleration and jerk; these are indicated in mils, inches/sec, inches/sec^2, and inches/sec^3 respectively.

D. Frequency Analyzer. Broad band measurements are often inadequate. Full understanding can be gained only when distribution of energy over the frequency spectrum is known. The process of determining this distribution is called "analysis" or "spectrum analysis", and the instruments used are called "spectrum analyzers" or "frequency analyzers". These analyzers vary in cost, complexity and ease of operation. Choice between them is generally determined by their availability and the amount of detailed information needed to solve a particular problem.

a. Octave Band Analyzer. Octave band analyzers make it possible to perform a simple and rapid analysis of sound spectra. The battery operated analyzer consists of a set of band pass filters, attenuator and an amplifier which drives both an indicating meter and a monitoring instrument. Octave band analyzers generally use octave bands centered on the following preferred frequencies, 31.5, 63, 125, 250, 500, 1000, 2000, 4000, 8000, and 16000 Hz. (ANSI S1.6, 1967). The actual nominal frequency range of any one of these bands is 2 - to - 1. Octave band analyzers operate directly from the output of a microphone, a sound level meter, vibration transducer, or a vibration meter.

i. One-third & one-tenth octave Bandwidth Analyzer. When an octave band analysis of sound is not sufficient, a third or a one-tenth octave band analyzer is used. This yields an instrument especially useful in complex sound and vibration problems where machinery diagnosis is important.

E. Impulse (impact) Sound Analyzer. The impact sound analyzer helps evaluate impulsive or impact sounds such as those of pile drivers and punch presses which cannot be properly evaluated by a sound level meter, a vibration meter, or a spectrum analyzer because of rapidity of the sound level changes.

In the measurement of impulsive sounds the criteria are the unfiltered peak pressure value, the pulse rise time, the duration of the pressure wave and the frequency spectrum of the pulse. The indicating meter must have a rise time not greater than 50 sec. for a response within 1dB of the peak value.

F. Graphic Level Recorder. Frequently the sound in an industrial environment varies so much so quickly that it is difficult to measure. Under such conditions a graphic recorder can be used to obtain a permanent record of the sound level.

The graphic level recorder is essentially a recording voltmeter with a logarithmic scale. The input signal voltage connects to a potentiometer, and the voltage from it is amplified and converted to a DC voltage which is amplified and used to drive a movable coil in a strong magnetic field. The coil is mechanically coupled to the movable arm on the potentiometer and also to a pointer which traces a record on paper, divided for levels in decibels. This continuous recording conveys more information about a varying sound than a few selected readings.

G. Magnetic Tape Recorder. The magnetic tape recorder is an instrument which amplifies the signals from a microphone, sound level meter or analyzer and records them on a continuously moving magnetic tape. The modulation of a signal by the recording amplifier can be in terms of the amplitude (AM) or the frequency (FM). Most recording are AM or a particular recording tape speed. However, FM recording has decided frequency analysis advantages. Loop recorders are also available for repeating a portion of the tape continuously.

Calibration and setting the recorder gain are vital issues in tape recording. Tape recording is ideal for documenting the nature of the sound sequence but does not replace the sound level meter measurements.

H. Calibrator. All measuring instruments require calibration and this is normally accomplished by placing a standard source, the calibrator, over the transducer head.

a. Pressure transducer (microphone) calibrator. Two forms are available, a pistonphone which is a motor driven piston and an oscillator calibrator which is an oscillator driven transducer. A piston phone calibrator has the disadvantage of being limited to a 250Hz narrow band signal and needs a correction added for the barometric pressure. An oscillator calibrator often has calibrator points for four octave intervals from 125 Hz. 500 Hz is an important frequency.

b. Vibration Transducer (accelerometer) calibrator. Basically the calibrator is a shaking system of specified narrow band frequency, acceleration, loading and displacement. The vibratory movement is perpendicular to the transducer head which is applied to the vibrating surface.

I. Sound Exposure Monitor. The legislation for work environment requires that we know the duration of sound levels in dBa above prescribed values. Doing this manually can be tedious and thus the sound exposure meter does this automatically.

Various manufacturers have now developed exposure monitoring instruments with measuring circuits which meet OSHA criteria and ANSI Standard S1.4-1971 for a weighted slow response circuit. The General Radio Unit accepts sound information from a microphone or sound level meter, samples, categorizes and weighs it and displays digitally percent of sound exposure or percent of test time as selected. A pocket size battery operated sound exposure monitor is also now available from General Radio.

J. Oscilloscope. A sound level meter shows one characteristic of a sound wave - the rms sound pressure level, but it gives no information about the sound wave form. For this purpose a cathode ray oscilloscope is used. The electron beam in the tube is ordinarily deflected by a sweeping signal so that the trace on the screen moves at a uniform rate horizontally along the x axis, quickly returns it to the beginning, and the pattern is repeated. The combined motion results in a display of the instantaneous amplitude of the wave as a function of time. This display can be photographed to yield permanent records.

Oscilloscopes are particularly helpful in analysis of impact (impulse) sounds.

K. Real Time Analyzer. A real time analyzer displays the spectral distribution of sound pressure levels for an instance in time, by a very rapid electronic switching arrangement which sweeps across the filters in rapid succession. The values appear on a cathode ray tube as a storage display or digitized for computer analysis and storage.

L. Audiometer. The Audiometer is an instrument used in determining the hearing threshold level of an individual in comparison with a chosen standard reference threshold level, primarily for the purpose of identification of hearing deficiencies. Audiometric measurements may be made by pure tone or speech audiometers. Performance requirements for each are specified in ANSI S3.6-1969. Therefore generally for determining the hearing threshold level of an individual a pure tone manual or automatic (self recorder) audiometer is used.

Essential components of such an audiometer include:

1. An electronic sine wave oscillator - which produces "pure" tones of 125, 250, 500, 1000, 2000, 3000, 4000, 6000 and 8000 Hz. At each test frequency an audiometer zero (standard reference threshold) has been established. The oscillator output is adjusted at the factory so that at any frequency, when the attenuator dial reads "0 dB" the acoustic output of the earphone corresponds to the ANSI Specification for the standard reference sound pressure levels.

2. Attenuator, or the hearing threshold level dial - which permits dial readings of hearing threshold level from minimum of 0 dB, to a maximum of 100 dB depending upon frequency, by intervals of 5 dB or less.

3. Tone switch - which permits an audiometer operator to initiate or terminate the tone at will.

4. Earphone - which is necessary for tests by air conduction. Ear audiometer is usually calibrated at the factory to a particular earphone. If a different earphone is substituted, the acoustic output may no longer meet the specification. Each earphone is equipped with an air cushion for contact with the head of the subject and is provided with a spring headband.

The results of hearing threshold measurements made with pure tone audiometer can be recorded as a numerical tabulation or in the graphical form of an audiogram.

Commercial audiometers present serious calibration problems. The ANSI specification provides guidelines for audiometer manufacturers regarding frequencies to include, intensity ranges, test tone purity, attenuator and so forth which must be met. The audiometric technician must insure that this equipment is in good working order before testing. Each time the equipment is turned on the technician, after giving the equipment several minutes to warm up, (as recommended by the manufacturer) puts the earphones on his head and rotates the attenuator through its range for each frequency in each phone.

An acoustic output check on an audiometer, with its associated earphone, is another important test, with the use of a sound level meter and earphone coupler. An independent check should be made on the microphone sensitivity and stability using the sound level calibrator.

In addition, periodic exhaustive calibrations of the equipment are generally recommended every 6 to 12 months, done at the manufacturers service facility or an independent laboratory. Calibration checks and audiometric testing must be performed by trained technicians who are thoroughly familiar with the test procedures and methods. Knowledge of test procedures and methods may be gained by reading individual instruction manuals and by attending training programs offered at universities, colleges, hospitals and certain learning centers and associations.

TYPES OF FIELD NOISE MEASUREMENTS

The previous discussions have dealt with measurements to simulate human responses and measurement to predict the distribution of sound in an environment. In the field, the primary interest is monitoring sound in a space to determine if it is compatible with the activity involved and if it is distributed according to the predicted design.

Several types of field measurement surveys are listed below:

1. General sound survey. Record the weighted sound pressure levels using a general survey sound level meter manually. dBA relates to many loudness problems and dbD to noisiness problems and a difference between dBC and dBA indicates low frequency components. Most surveys will be of this nature in order to identify problems. If sound pressure levels continuously exceed 90dBA, it is certain that the legislated sound exposure criterion would not be met.

2. Sound exposure survey. A continuous storage of dBA weighted sound level exposure is made to check for compliance with legislative acts. Either a personally worn or fixed station sound exposure monitoring instrument may be used. This type of survey is necessary, especially with fluctuating and intermittent sounds in order to simplify their measurement and analysis.

3. Sound survey. Record weighted sound pressure level in octave bands using a precision sound level meter and octave band analyzer manually. In case of impulse sounds record peak and time averaged values in octave bands using a sound impulse (impact noise) analyzer as an accessory to the precision sound level meter. The objective of this type of survey is to establish the nature and sources of the problems. Vibration measurements should be made on problem surfaces to define the nature and scope of the sound problem.

4. Recorded sound survey. Record accurately the actual sounds and vibrations in a space for later measurement and analysis. It could be of a typical sound for the activity, sampled in a particular pattern over a period of time, or continually recorded. Frequency modulation (FM) is often used for frequency analysis but amplitude modulation (AM) is the common method of recording.

5. Recorded interview survey. Record accurately the actual sounds people experience in order to relate these sounds to their assessments during an interview or psychophysical experiment for later analysis.

6. Measurement for reverberation time. Record the sound level decay with a graphical sound level recorder either directly or from a recorded sound. Relate to reverberation response problems and the mean sound absorption efficiency.

7. Survey for transmission loss determination. Measure the sound pressure levels between the spaces in question. Flanking sound and leakage are problems to account for.

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THREE CHALLENGES FOR OCCUPATIONAL MEDICINE

John F. Finklea, M.D.

It is gratifying to note that a number of NIOSH physicians and other scientists are taking an active part in the program of this Congress on occupational health. This participation reflects the mutual concerns and interests of the National Institute for Occupational Safety and Health and the American Medical Association in occupational medicine and in its practitioners. We appreciate the constructive comments and the support received from your professional organizations and from you as individuals, and we look forward to continuing this close relationship.

In these days of accelerating knowledge about occuapational hazards, and of expanded efforts by health and safety professionals to prevent disease and injury, we are making progress in our national effort to protect our working men and women. But progress and problems seem to go hand in hand. We tend to view problems as obstacles, but today let us focus on three of these problem areas and consider them not as problems but as challenges for action, with the aim of spurring serious thought and constructive suggestions. These three challenges are: credibility, professional health manpower, and institutional issues.

CREDIBILITY

The Occupational Safety and Health Act of 1970 requires the establishment of health and safety standards. Included in this requirement is the provision that all sides of the issues involved should be openly examined through a clearly defined series of procedural steps.

An adversary relationship has dominated many of these procedural steps. As a rule, industry has favored less stringent standards than those recommended by Government or by labor. Since the overwhelming majority of occupational health physicians and nurses are employed by industry, it has been too easy for some to assume that these professionals uniformly oppose the stringent regulation of occupational hazards. This feeling has been voiced despite the fact that occupational physicians and nurses labored for many years to focus the attention of management, labor, and Government on occupational safety and health problems and to urge that substantial effort be directed toward solving these problems. For a number of reasons there seems to be much less of an undercurrent in regard to the roles of safety professionals and industrial hygienists.

Because of our dependence on the adversary process to reach the goals of occupational laws, there is every likelihood that even the most responsible segments of American industry will be viewed as having a negative attitude toward any national effort to achieve a safer and more healthful work place. This issue of credibility is very important to us. It is important that occupational physicians and American industry should pause and carefully consider how Government, labor, and industry can build both credibility and a greater degree of mutual respect.

Here are five suggestions for action on which your comments or further suggestions would be welcomed by the Institute:

1. Occupational physicians in American industry should emphasize the positive steps which they are taking to solve occupational health problems and to meet other occupational challenges. The reductions in exposure to vinyl chloride monomer, for example, constitutes a real success story. Today's presentation of the Physician's Award by a representative of the President points up the tremendous contribution made by occupational physicians in matching the persons that are handicapped to available and appropriate jobs. These are achievements that the public does not generally hear about.

2. Occupational physicians, Government, industry, and labor must develop a variety of cooperative relationships. Personnel exchanges involving labor, universities, Government, and industry would be one approach. Each of these sectors has expertise needed by others. In NIOSH, for example, we need to utilize the skills of people who have had actual experience with in-plant occupational problems, particularly in the areas of occupational medicine and occupational nursing. These professionals that spend a period of time in such a Governmental setting will, in turn, gain an understanding of the factors involved in setting priorities for our limited manpower and dollars; in developing health and safety standards; and in identifying trends and needs in occupational health and safety. Establishing these cooperative arrangements may present some obstacles and would require considerable effort to establish but, once started and shown to be successful, the system would undoubtedly continue because such an exchange of expertise can be beneficial to all sectors.

In another type of cooperative relationship, joint labor-management committees to plan and review research projects have proven their worth. The establishment of triparite groups including Government, industry, and labor could provide an excellent mechanism for planning and review of Federal research efforts and for assuring that our inputs into the regulatory programs are people-oriented, not agency-oriented.

Such committees are now active in the rubber, painting, and grocery industries. Each committee started from the joint interest of labor and management and not as a result of governmental urging. They all appear to be doing a fine job. They can help us remember that the important thing is not to achieve a certain, perhaps arbitrary, reduction in exposure but to protect employees and to see that workers have productive jobs.

3. Occupational health professionals and American industry can and should assume a lead role in developing options to stimulate both the entry of new professionals into occupational health practice and the training of health professionals. If our occupational physicians and nurses would carefully evaluate the available options and give us the benefit of their considered opinions and recommendations, we would be in a position to take a positive stance on many controversial educational issues and we would present a united front to the public in helping people understand the problems and the actions planned.

4. Health professionals in industry must work together with labor and government to assure the availability of unreported or proprietary information that bears directly on a health problem. A few American industries do a good job in making such information available. Frequently, however, important data comes to light after proposed health standards have been developed. In some sections, there is a tendency to withhold pertinent information until the public hearings so that it will have more impact on decision-making. This has the effect of creating a number of legal difficulties, delaying the standard setting procedures, and may result in reducing the protection afforded to employees.

5. Occupational health and safety professionals should take a more active role in suggesting and demonstrating ways to provide occupational health and safety services to employees of smaller companies. We continue to have problems with classical safety issues and occupational diseases in small industries throughout this country, and reliance on standards and inspections is just not going to solve these problems. Many large establishments have occupational safety and health programs of recognized excellence, yet there is no organized effort to utilize some of this expertise to chart paths that could be followed by smaller plants and businesses in providing such services to their employees. Here, too, we would like to see a triumvirate of industry, government, and the private sector working together to develop and promote effective health and safety services for all workers.

OCCUPATIONAL HEALTH MANPOWER

The National Institute for Occupational Safety and Health has the legal obligation to train occupational health professionals, and the Department of Labor has a similar legal obligation for the training of employees and employers. The Institute has expended most of its limited resources for manpower on the education of industrial hygienists and safety engineers. We recognize that much less than a fair share has been devoted to solve manpower problems involving physicians and nurses, and we do intend to have a better balance in our training efforts for these disciplines in the future. This will undoubtedly help. However, despite the full utilization of Federal resources, there will continue to be a serious shortage of qualified professionals available in occupational medicine and nursing. Such a shortage will severely weaken the regulatory efforts proposed by the Government. Recently, Dr. Theodore Cooper, Assistant Secretary for Health, testified on health manpower issues before the Health Subcommittee on Labor and Public Welfare of the United States Senate. He pointed out that our problem is not the total number of physicians available but rather a shortage in certain types of physicians and in certain geographical areas. A major Federal investment in medical schools has increased the physician supply but has not remedied these defects. Clearly, financial suppport is not the whole answer. Dr. Cooper, did, however, specifically advocate continued Federal support for occupational medicine training programs and for other occupational health disciplines.

A major problem in occupational health manpower is the recruitment, training and retaining of physicians and nurses. Occupational medicine, like other aspects of preventive medicine, usually receives little emphasis in medical schools and little more in schools of nursing and public health. Our Institute will be working with the Health Resources Administration to seek remedies for this, but this will be a lengthy process. Professional schools are usually modestly funded and occupational medicine sections lack the service income generated by most specialty departments. Stipends for training also tend to be lower, so that a physician entering a formal training program often finds himself faced with a substantial reduction in salary. This is certainly not an inducement to enter the field of occupational health via this route.

NIOSH is strengthening its efforts to generate educational and training materials in occupational medicine and nursing and we will be working with professional societies to explore ways in which we can work together to do a better job, including the difficult task of revising the curriculum of professional schools. Assuredly, we need more post-graduate training programs that lead to board certification. In a recent graduating class of 10,000 physicians, less than a dozen went into occupational medicine. We must improve this figure.

We need to encourage more programs of continuing education for health professionals in the field. One approach is the direct Federal funding of Regional manpower training programs, in which a major university might work closely with other educational institutions to provide training to health professionals and serve as a central training resources for the region.

Another option might be Federal regulations requiring accreditation of occupational health programs, thus stimulating free market forces to meet the required demand. As many of you are aware, there are controversies surrounding efforts of NIOSH and OSHA to develop guidelines for the accreditation of occupational health and safety programs. However, voluntary accreditation remains a viable option.

The Standards Completion Program of NIOSH and OSHA will require monitoring and medical resources that are now available This regulatory route, with or without the accreditation provision, may come about much sooner than many people realize.

Manpower development could be supported in yet another way, and that is by a "tap" on compensation premiums or on health insurance premiums. The equity of this is appealing because the provision of adequate occupational health services should eventually lower compensation premiums. Finally consideration should be given to joint funding by labor and management. It is often difficult for an individual industry or company to support a physician or nurse for long term training. One problem is that there is no assurance that the professional will return to the company that has invested in him or her. Furthermore, there are many demands on corporate management. This is also true in government. NIOSH will be glad to work with the AMA, professional societies, the insurance industry, trade associations, labor, and other responsible groups to consider some options in this area.

INSTITUTIONAL ISSUES

Today's institutional problems will spawn most of the thorny technical issues of tomorrow. Let us consider how we are going to answer the following questions.

1. How can we build a community of mutual respect where the boundaries of scientific uncertainty limit industry, labor, and government to actions that allow adversary proceedings to develop in ways that truly serve the public interest? We must somehow isolate and focus upon substantive issues. We may have the legal manpower to do otherwise, but we certainly do not have the technical manpower. Inefficient use of technical manpower can be a powerful brake on the regulatory process. This should not be allowed to happen.

2. What will be our risk philosphy when we are confronted with the need to regulate several hundred carcinogens in the work place? NIOSH recently published a list of more than 1,500 suspected carcinogens. The International Agency for Research in Cancer has proposed a shorter but still lengthy list that should be regulated. It is important for American industry to think about this "sea of agents" that we are exposed to at varying levels, and think about the impact, not of any single agent, but of the cumulative effect of all of them. Can we continue to say that there is no safe dosage for industrial carcinogens? This is our position now. Can we afford to take a dose-response approach to single carcinogens without considering the aggregate effect of low level doses to many carcinogens? This is advocated by others now.

3. Will we be able to regulate occupational and environmental exposures on an industry-wide basis, rather than on an individual agent basis? In the long run, an industry-by-industry approach has

greater utility. Can we avoid regulating the wrong problems? Have we really appraised the total effect of regulations on the availability of jobs in industry? These are very difficult problems, but they cannot be ignored.

4. Will we recognize the long term implications of new industrial facilities? Today's new plant may contribute to chronic diseases in our grandchildren. Long plant life and extended latency periods lead us to believe that new plants may affect health for a period of 50 to 75 years. Would it not be more appropriate to find mechanisms that stimulate the development and deployment of safer, contained industrial processes? This is easier to day than to do.

5. Will we be able to overcome the problem of "future discounting"? Future discounting leads us to greatly discount events likely to happen in the future and to lightly bypass adverse effects occurring two or three decades in the future.

6. How can we take "credit" now for preventing chronic disease in future generations? Perhaps the trend toward large suits above workers' compensation awardd might hasten the process. In other words, if we pay for our past maybe we will balance the tendency to discount future risks. There are several class action suits now that can threaten the capital structure of several industries. Surely these industries are even now taking a very serious view of any new health risks.

7. Can we to some extent use our past mistakes to motivate us to protect our future?

8. How will we meld occupational health and safety programs into our national health care system? There is a great need to plan for this during the next few months, and waiting until a national health plan is enacted means a loss of input at a time when it can affect national policy.

In many ways, the leadership that you as physicians can demonstrate and that your professional organizations can deploy are our most

important assets in meeting these three challenges. Your contributions as health professionals to develop consensus standards, to advocate legislation, and to promote educational efforts are good models for effective action.

Let us work together, so that tomorrow we will face a different set of problems with a confidence arising out of our successful solutions to the problems we perceive today.

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