EPIDEMIOLOGY FOR THE PART-TIME
OCCUPATIONAL PHYSICIAN

EPIDEMIOLOGY

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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

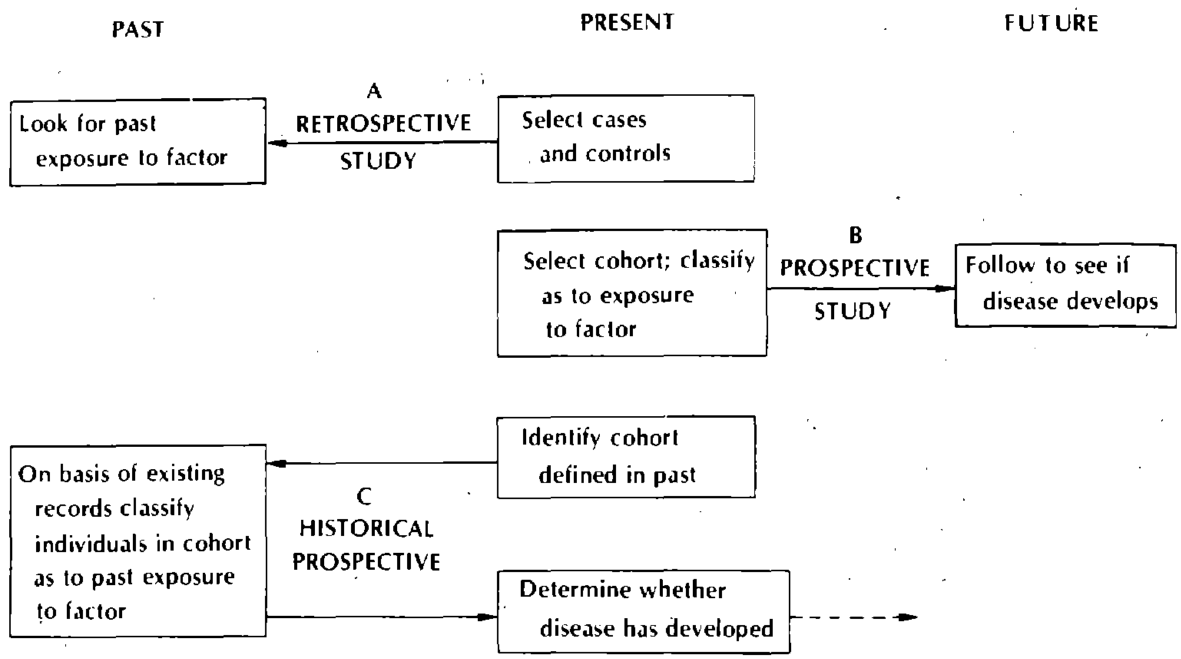

Figure 1. Comparison of retrospective, prospective and historical prospective study designs. (From: J. S. Mausner and A. K. Bahn: Epidemiology: An Introductory Text, Philadelphia: W. B. Saunders Co., 1974.)

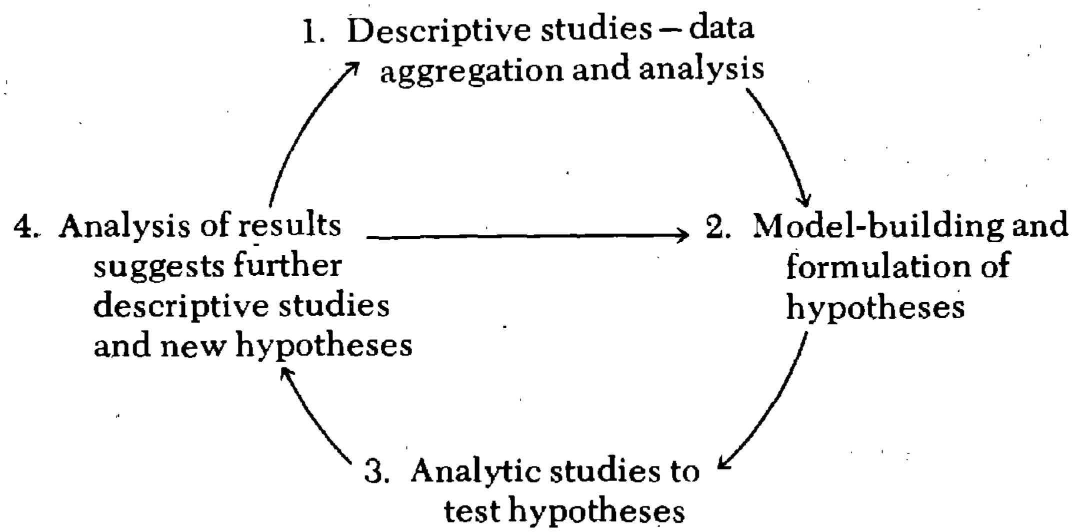

Figure 2. Scheme for an epidemiologic study cycle. (From: J. S. Mausner and A. K. Bahn: Epidemiology: An Introductory Text, Philadelphia: W. B. Saunders Co., 1974.)

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

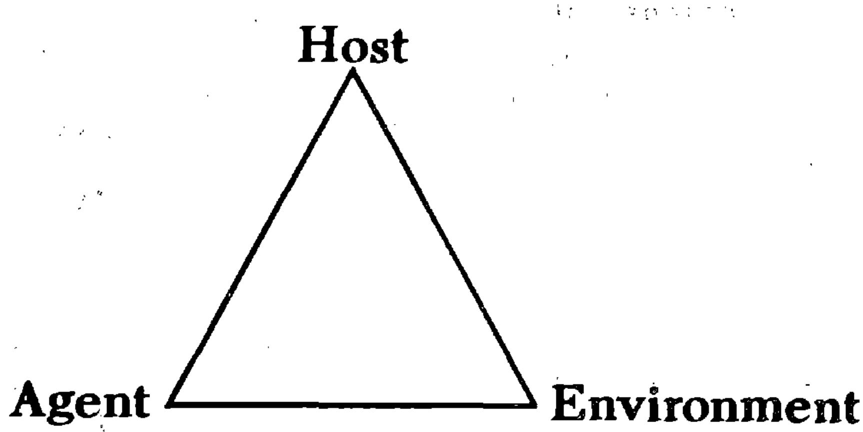

Figure 3. The epidemiologic triangle model of man-environment interactions. (From: J. S. Mausner and A. K. Bahn: Epidemiology: An Introductory Text, Philadelphia: W. B. Saunders Co., 1974.)

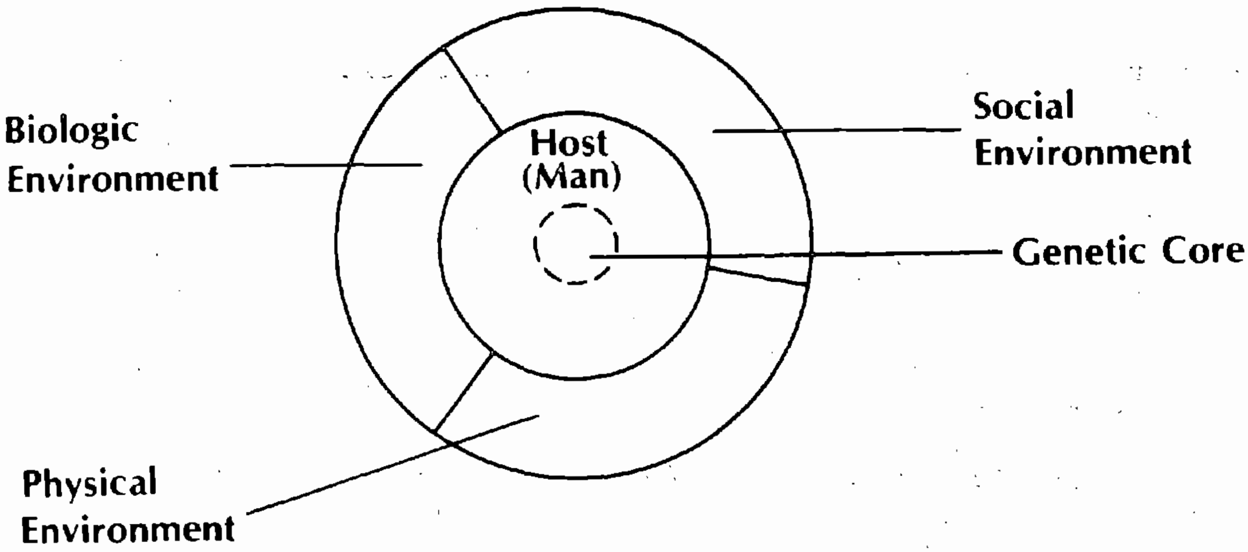

Figure 4. Wheel model of man-environment interactions. (From: J. S. Mausner and A. K. Bahn: Epidemiology: An Introductory Text, Philadelphia: W. B. Saunders Co., 1974)

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	~~04~~
00	98	48	18	97	91	51	63	27	~~00~~
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	~~00~~
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

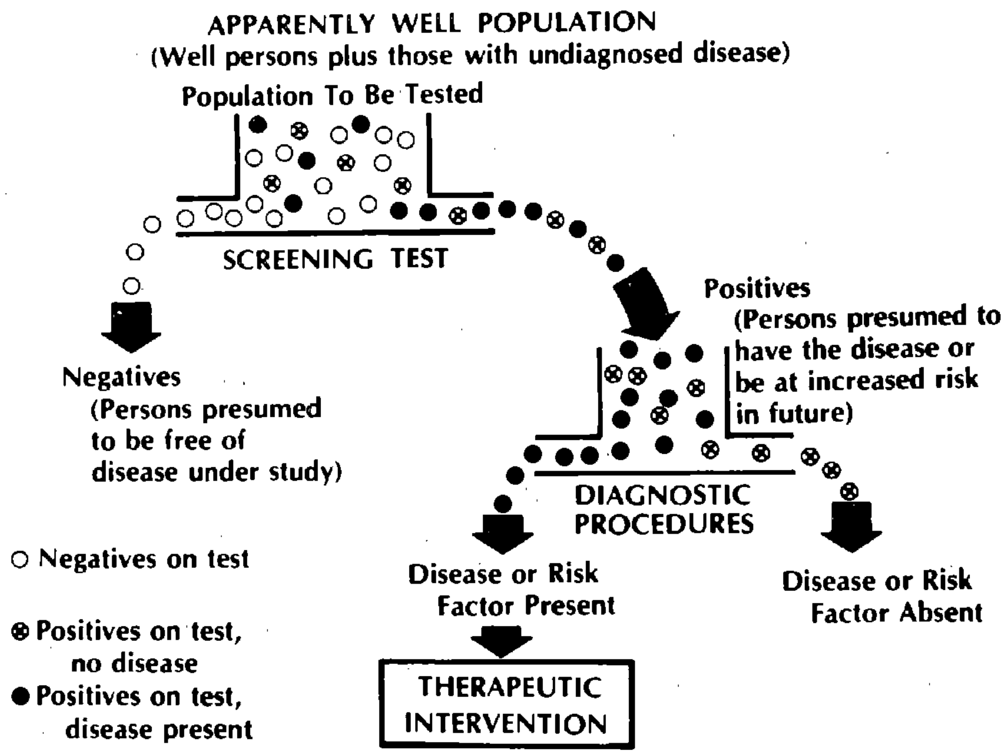

Figure 5. Scheme for mass screening program. (From: J. S. Mausner and A. K. Bahn: Epidemiology: An Introductory Text, Philadelphia: W. B. Saunders Co., 1974)

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.)

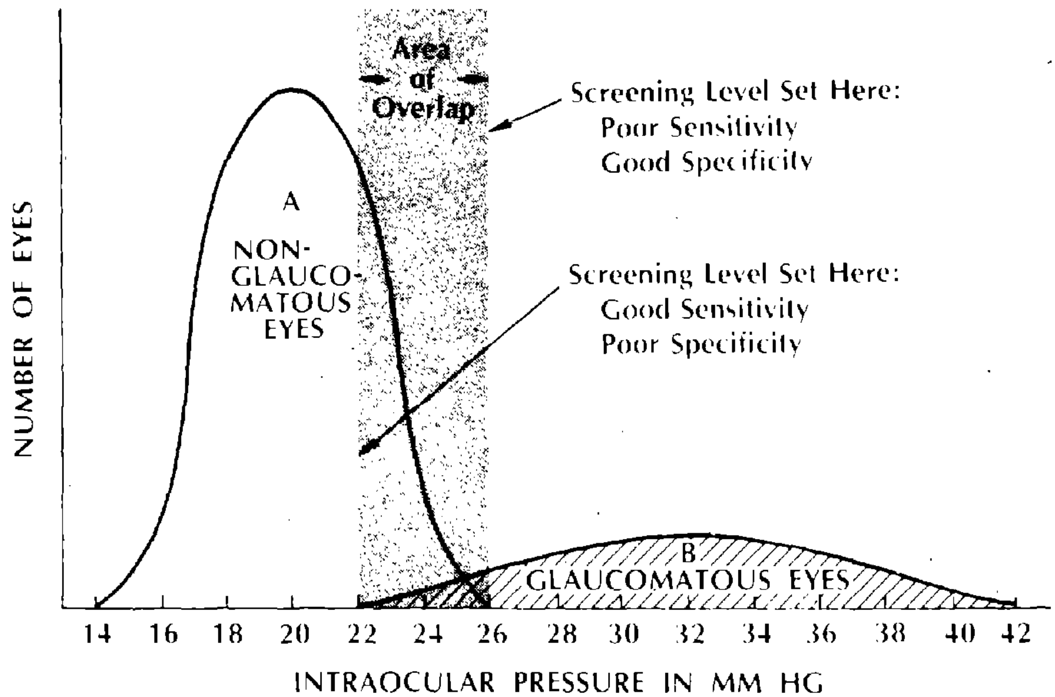

Figure 8 Hypothetical distribution of intraocular pressures in glaucomatous and nonglaucomatous eyes, measured by tonometer. (Adapted from Thorner, R. M., and Remein, Q. R.: Principles and procedures in the evaluation of screening for disease. USPHS Pub. No. 846, U.S. Govt. Printing Office, Washington,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

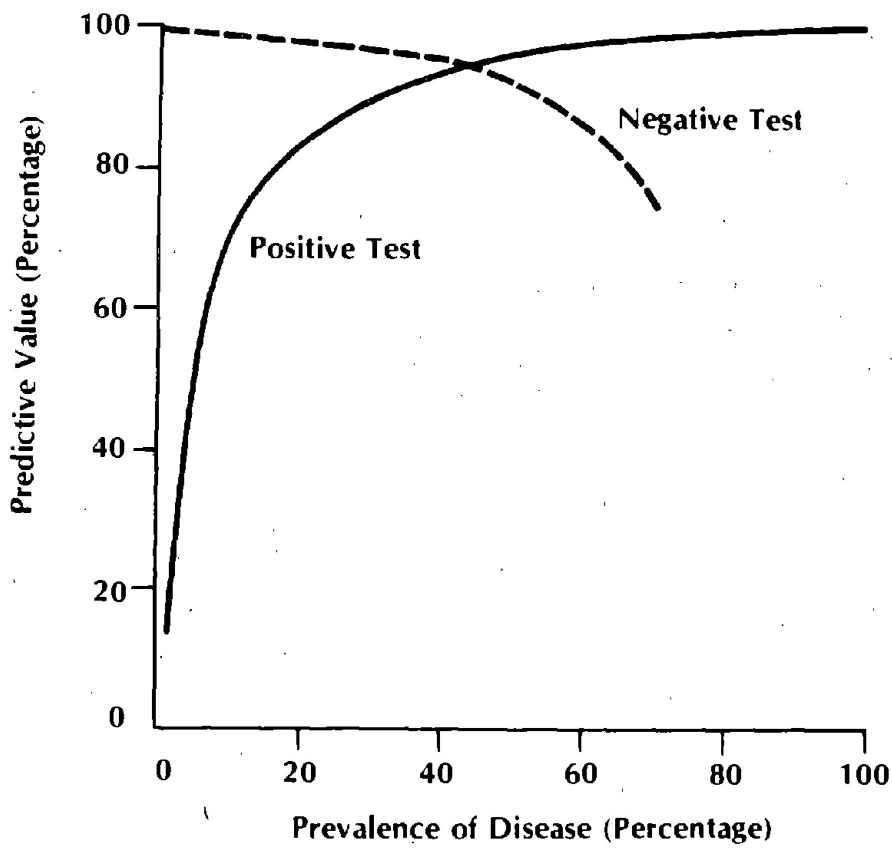

Figure 9 Relationship between prevalence of disease and predictive value, with sensitivity and specificity held constant at 95 per cent. (Adapted from Vecchio, T. J.: Predictive value of a single diagnostic test in unselected populations. N. Engl. J. Med., *274*:1171 1966.)

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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