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INVITED ADDRESSES

The Society for Epidemiologic Research (SER) and the Future of Epidemiology

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I appreciate very much this opportunity to help celebrate the 25th Anniversary of the Society for Epidemiologic Research (SER). I think it will be useful to present the historical background to the Society's formation as a necessary prelude for discussing SER and the future of epidemiology.

I was a student in 1943 at the Johns Hopkins School of Hygiene and Public Health, where Wade Hampton Frost had served as the first Professor of Epidemiology. Frost had defined epidemiology as "the science of the mass-phenomena of infectious diseases" (1), and the epidemiology courses at Hopkins were limited entirely to infectious diseases. We studied *Panum on Measles* (2) and *Snow on Cholera* (3), but the great American classic of epidemiology, *Goldberger on Pellagra* (4), was not mentioned.

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SOCIAL MEDICINE IN GREAT BRITAIN

In that same year, 1943, John A. Ryle, the Regius Professor of Medicine at Cambridge, resigned his position to become the first Professor of Social Medicine in Great Britain, accepting the Chair which had just been established at Oxford University. This dramatic event signalized the leap from infectious disease to noninfectious disease epidemiology. As Ryle stated, "Public health ... has been largely preoccupied with the communicable diseases, their causes, distribution, and prevention. Social medicine is concerned with all diseases of prevalence, including rheumatic heart disease, peptic ulcer, the chronic rheumatic diseases, cardiovascular disease, cancer, the psychoneuroses, and accidental injuries—which also have their epidemiologies and their correlations with social and occupational conditions and must eventually be considered to be in greater or less degree preventable" (5). The British movement toward social medicine which Ryle symbolized was essentially a movement toward noninfectious disease epidemiology.

The connecting link between infectious and noninfectious disease epidemiology in Great Britain was Major Greenwood, Professor of Epidemiology and Vital Statistics at the London School of Hygiene; President of the Royal Statistical Society; primary author, with Bradford Hill, Topley, and Wilson, of the pioneering work on the *Experimental Epidemiology* (6) of infectious diseases; and author of *Epidemiology and Crowd Diseases, An Introduction to the Study of Epidemiology*, the first textbook to include cancer in its scope (7).

Major Greenwood combined the two disciplines, epidemiology and biostatistics, in his own person. The tradition of interdisciplinary collaboration at the London School of Hygiene was carried forward by Greenwood's colleagues, the epidemiologist Richard Doll and the statistician A. Bradford Hill. In 1950, Doll and Hill shared honors with two American groups, Wynder and Graham, and Levin, Goldstein, and Gerhardt, in publishing the results of the first major retrospective studies linking cigarette smoking and lung cancer (8–10). And it was Doll and Hill who carried out the first prospective study confirming this relation (11–13). They and their colleagues at the London School of Hygiene—including Donald Reid, Peter Armitage, and Jerry Morris—provided the most important center for the development of noninfectious disease epidemiology in Great Britain.

PUBLIC HEALTH IN THE UNITED STATES

Research in noninfectious disease epidemiology in Great Britain developed primarily as an academic discipline. This was quite different from the situation in the United States, where epidemiologic research had developed primarily as a function of federal, state, and local health departments. In 1891, the Hygienic Laboratory was organized by the US Public Health Service (then the Marine Hospital Service), and rapidly became the focal point for epidemiologic research in the United States. It was the training ground for many of the country's most eminent epidemiologists, including Milton J. Rosenau, author of the first comprehensive American textbook on public health (14), who was Director of the Hygienic Laboratory from 1899 to 1909, then Professor of Preventive Medicine at Harvard Medical School, Professor of Epidemiology at the Harvard School of Public Health, and finally Dean of the University of North Carolina School of Public Health; and Wade Hampton Frost, who was assigned by the US Public Health Service to the Johns Hopkins School of Hygiene and Public Health in 1919 to develop the first university department of epidemiology (15).

The Hygienic Laboratory did not limit itself to infectious diseases. One of its officers, Dr. Joseph Goldberger, solved the problem of pellagra through investigations conducted from 1914 to 1930; these stand with John Snow's work on cholera as a classic of epidemiologic research (4). In 1931, a year after the Hygienic Laboratory was renamed the National Institute of Health, Dr. H. Trendley Dean began his important epidemiologic studies of fluorine and dental caries; these culminated in the Grand Rapids-Muskegon fluoridation experiment conducted by the US Public Health Service. And, beginning in 1910, the Service carried out numerous studies in occupational epidemiology, including investigations of silicosis, lead poisoning, industrial dermatoses, radiation, pneumoconiosis, and mercury poisoning (15).

After World War II, there was further expansion of federal leadership in epidemiologic research. The Communicable Disease Center was founded in 1946 by conversion of the wartime agency for Malaria Control in War Areas; it is now the Centers for Disease Control, which is concerned with a wide variety of infectious and noninfectious diseases. Perhaps one of the most important federal actions was the establishment of a statistical unit in the National Cancer Institute under the leadership of a sociologist, Harold Dorn. This unit, which included such outstanding statisticians as Jerome Cornfield and Nathan Mantel, made major contributions to the methodology of nonin-

fectious disease epidemiology; it became, in a sense, the statistical nerve-center of the entire movement. During this period, also, the Framingham studies were begun by the National Heart Institute. These turned out to be perhaps the most important investigations ever carried out in the field of cardiovascular epidemiology; they opened up an entirely new area of public health, pointing the way toward the conquest of the pandemic of coronary heart disease.

A number of the more advanced state health departments also played important roles in the development of noninfectious disease epidemiology. The people of Massachusetts, for example, alarmed by the growing problem of cancer and other chronic diseases, "had demanded with increasing insistence that action be taken, and through a legislative resolve passed in 1926 the Massachusetts Department of Public Health was committed to a program of cancer control" (16). George H. Bigelow and Herbert L. Lombard of that Department carried out intensive investigations, both descriptive and analytic, of cancer epidemiology. Their pioneering work, *Cancer and Other Chronic Diseases in Massachusetts*, published in 1933, includes one of the first case-control studies to demonstrate the relation of tobacco use to cancer of the buccal cavity (16). This study was later extended to include lung cancer, for which the same relation was reported in 1945 (17). It was these findings that prompted Morton Levin and his colleagues in the Division of Cancer Control of the New York State Department of Health to undertake their landmark study of the relation of tobacco to lung and other cancers, which, published in 1950 in the *Journal of the American Medical Association* (9) with a similar paper by Wynder and Graham (8), signaled the beginning of the first great scientific breakthrough resulting from the new epidemiology.

Several other states made outstanding contributions to the development of noninfectious disease epidemiology: the New York State Department of Health, particularly in cancer, heart disease, and dental caries; the California and Connecticut State Health Departments in cancer epidemiology; and the Ohio State Health Department in the epidemiology of occupational diseases. And local health departments in New York City, Chicago, and Los Angeles produced important findings in the epidemiology of cardiovascular disease.

ORIGINS OF THE SOCIETY FOR EPIDEMIOLOGIC RESEARCH

The role of epidemiology in achieving major scientific breakthroughs received national and international attention in the decades following World War II. Funds were made available for epidemiologic training and research. In the schools of public health, the replacement of the infectious disease-oriented chairs of epidemiology with representatives of the new approach—a process which took several decades to complete—was begun at Harvard in 1958 with the appointment of Brian MacMahon, an import from England who had been a fellow in social medicine with Thomas McKeown in Birmingham. The first textbooks of epidemiology based primarily on noninfectious disease appeared: Morris's *Uses of Epidemiology* (18) in Great Britain in 1957, and MacMahon, Pugh, and Ipsen's *Epidemiologic Methods* (19) in the United States in 1960.

Young people flocked to the field, responding to the increased opportunities for training and research and to the excitement of the rapidly growing list of accomplishments of this new area of epidemiology. The professional epidemiologists were joined by pathologists, physiologists, chemists, internists, and other specialists. The verve and spirit of these epidemiologists, whatever their background, was reminiscent of William Henry Welch's description of the scientific explosion that ushered in the first epidemiologic revolution: "At the end of that wonderful decade, 1880–1890, perhaps the most wonderful decade in the history of medicine, there had been a revolution in medical thought through the discovery of the agents causing infectious disease—such discoveries as the bacillus of tuberculosis, of

Asiatic cholera, of diphtheria, of typhoid fever, and other infectious diseases. Those living today can hardly realize the enthusiasm and youthful spirit which was stirred not only among medical men, but in the general public by these discoveries" (20).

During the 1950s, associations devoted primarily to noninfectious disease epidemiology were organized: the Society for Social Medicine in Great Britain, and the International Epidemiological Association. In the United States, the American Epidemiological Society, concerned primarily with infectious diseases, was unable to include the large number of new recruits to epidemiology because it had limited capacity for expansion: only those nominated by existing members could be considered, and their qualifications and scientific contributions had to be evaluated and approved by a membership committee.

This is why, in 1967, we wrote the letter to epidemiologists which was republished in the Fall 1991 SER Newsletter with the announcement of this 25th Anniversary meeting. It stated that "We have been concerned for some time with the need for an organization of epidemiologists which would include all those who are active in this field. Such an organization would provide a common meeting ground for stimulation and encouragement of the different generations of epidemiologists and the various categories of specialists in infectious, chronic and mental disease epidemiology" (21). We had hoped to have an eminent infectious disease epidemiologist join us in signing the letter, but he declined. Undoubtedly, this was because of his many years of membership in the American Epidemiological Society and the possible embarrassment resulting from sponsorship of what appeared to be a rival organization.

THE FUNCTIONS OF EPIDEMIOLOGY

This, then, is the background for the formation of SER. Let me now turn to a discussion of the future of epidemiology, based on consideration of its fundamental tasks. I define the field broadly, as follows:

> Epidemiology is the study of the health of human populations. Its functions are:
>
> 1. To discover the agent, host, and environmental factors which affect health, in order to provide the scientific basis for the prevention of disease and injury and the promotion of health.
>
> 2. To determine the relative importance of causes of illness, disability, and death, in order to establish priorities for research and action.
>
> 3. To identify those sections of the population which have the greatest risk from specific causes of ill health, in order that the indicated action may be directed appropriately.
>
> 4. To evaluate the effectiveness of health programs and services in improving the health of the population.

It should be noted that all four of these research functions are described in terms of their specific relations to public health, their contributions to the social goal of improving the health of the population. That goal is now being achieved by the public health movement, which, despite many obstacles, is applying the results of epidemiologic research with increasing success. This is already evident in US mortality data. From 1970 to 1987, the age-adjusted death rate declined by 33 percent for heart disease, 55 percent for cerebrovascular disease, 35 percent for accidents, and 40 percent for chronic liver disease and cirrhosis. As a result, the overall death rate fell by 25 percent, a remarkable achievement (22).

TRENDS IN ORIENTATION

The future of epidemiologic research depends on many factors, including the state of the US economy, the willingness of legislators to provide the necessary funds, and the degree of understanding and support by the public at large. But it also depends on factors related to the background and orientation of epidemiologists themselves.

One such factor is the shift of epidemiologic research from health departments to the schools of public health as a major locus. As a result, some of the intrinsic tendencies of academic life have become increasingly evident: a greater concern with the methodology of data manipulation than with the solution of disease problems; a withdrawal from the community, from field studies in which the investigator knows the data and their limitations, and the increased use of someone else's data regardless of their value; an orientation geared more to the goal of "publish or perish" than to the goal of preventing disease and death; and, finally, an arrogant and elitist attitude toward the health officer that is similar to the academic clinician's attitude toward the medical practitioner.

Another factor is the widespread overemphasis on statistical approaches, with the concomitant tendency to neglect the fact that epidemiology is a biologic science concerned with disease in human beings. This lack of a biologic orientation has led a number of eminent statisticians into serious error. Joseph Berkson, J. Yerushalmy, R. A. Fisher, and others took a negative position in the lung cancer controversy because they had a purely statistical view of the problem; they failed to recognize the important fact that the smoking hypothesis was physiologically reasonable and sound.

The clinical disciplines are a major component of the biologic side of epidemiology. They not only help determine whether hypotheses are biologically reasonable, but they also identify the specific cases that require epidemiologic investigation. Most important, the clinical disciplines provide a major source of epidemiologic hypotheses. For example, it was chest surgeons such as Evarts Graham (8) who first noted the association of cigarette smoking and lung cancer in their patients. The epidemiologists came later, carrying out the numerous investigations which tested and eventually proved the truth of the surgeons' hypothesis. And it was an Australian ophthalmologist, N. McAlister Gregg, who, on the basis of observations made originally in his practice, developed and tested the hypothesis that rubella early in pregnancy causes congenital malformations (23). It would be valuable, also, for epidemiologists to work closely with laboratory scientists who could help deepen their understanding of disease processes.

There are still many areas of epidemiologic research in which we have come to dead ends because of the lack of suitable hypotheses. Perhaps we should change the current situation in our teaching programs, in which the formulation of hypotheses receives little or no attention, while most of the time and effort is spent on teaching how to test hypotheses. All of us need to learn, not only how to formulate hypotheses, but how to formulate productive hypotheses that will break through the dead ends and move the field forward.

Unlike doing tests of hypotheses, the formulae for which can be learned by most people, the ability to develop a good hypothesis is a creative act, one that requires the ability to synthesize available information in an unusual and original manner. Such creativity is relatively rare, and whether we can teach it in our courses is problematical. Nevertheless, we need to try. A part of the time we now give in our courses to painstaking analyses of the methods by which given hypotheses are tested by case-control, cohort, experimental, and other studies, could easily be devoted to similarly painstaking analyses of the laboratory, clinical, epidemiologic and other bases of hypothesis formulation.

There are many instructive examples which provide documentation on both successful and unsuccessful hypotheses for the same disease: pellagra, cholera, retrolental fibroplasia, syphilis, coronary heart disease, yellow fever, etc. The history of the controversy between contagionists and anticontagionists is full of significant lessons on hypothesis formulation. The study of these and other lessons will sharpen our wits, show us the pitfalls, and perhaps even teach us to formulate new and more productive hypotheses. Thereby the past may be used to

help us solve our current problems and strengthen the forward surge of epidemiology.

THE FRONTIERS OF EPIDEMIOLOGY

The concerns of epidemiologic research have broadened considerably in recent years. The resurgence of cholera (now pandemic in the Americas), the increase in sexually transmitted diseases, and the re-emergence of tuberculosis, are regressive phenomena which require further study and explanation as a guide to appropriate action. New diseases have arisen, such as legionellosis, genital herpes, and the most frightening of all modern pandemics, HIV infection and AIDS; these have presented major problems for epidemiologic research.

The recent epidemics of noninfectious diseases, such as the Bhopal and Chernobyl disasters, emphasize the need for much greater attention to research on the occupational and environmental hazards that produce disease and injury. The etiology of many noninfectious diseases is still to be determined; diabetes, arthritis, mental disease, duodenal ulcer, Alzheimer's disease, and various sites of cancer are among the major examples.

In addition, there is greater recognition now of the need to study the epidemiology of health, not only in the sense of well-being, but also in terms of ability to function. Recent investigations of the effect of maternal and child nutrition on physical growth and mental performance provide a case in point.

Finally, epidemiologists need to give much greater attention to research on the effectiveness of health services. These services for prevention, treatment, and rehabilitation are important determinants of health status. It is essential, therefore, for all aspects of current medical therapy to be systematically subjected to the critical tools of epidemiology in order to determine their effect on disease outcomes. The US Public Health Service has already undertaken such research through nationwide trials of alternative treatments for breast cancer and other diseases. We now have the capacity, also, to undertake field experiments designed to subject different methods of organizing medical care personnel and facilities to epidemiologic evaluation, by determining the effect on outcomes, on the health of the people receiving care. And, most important of all, epidemiologists must greatly expand their role in improving preventive programs through experimental studies of alternative strategies and tactics in both infectious and noninfectious diseases. This will require closer working relationships with federal, state, and local health departments.

Your success in addressing this agenda for research will help determine the future of epidemiology and its role in improving the health of the public. However, the future of epidemiology does not depend on the epidemiologists alone. As I stated earlier in this paper, it is influenced by many factors, including the state of the economy, the willingness of legislators to provide the necessary funds, and the degree of understanding and support by the public at large.

Epidemiology is a key component of public health, and epidemiologists constitute an important sector of public health workers. They are employed in federal, state, and local health departments, schools of public health, departments of community and preventive medicine, and voluntary health agencies. The funding for their research comes from these public health agencies, and foremost among them is the federal government through the US Public Health Service.

The support of all public health services, including epidemiology, is being placed in jeopardy by the current pandemic of budget-cutting, which has already affected health departments, universities, and voluntary health agencies. The chronically inadequate funding of epidemiology and other components of public health is being threatened further as expenditures for medical care—for treating the failures of epidemiology and public health—continue to escalate.

Epidemiologists, and other public health workers, cannot stand idly by while their ability to carry on and improve their work is being undermined. The American College

of Epidemiology has responded by making arrangements for information services on legislative developments in the nation's capital. Epidemiologists and other public health workers in the American Public Health Association are urging their association to place greater emphasis on legislative support for preventive services. And SER needs to explore more thoroughly the implications of its statement that "The objective of the Society shall be to foster epidemiologic research" (24).

We cannot remain indefinitely in our ivory towers; they may crumble around us. We need to foster epidemiologic research, not only by improving our methodology and sharing our scientific experience, but by helping to convince the American public and its legislators that prevention is far more important than treatment, that our expanded agenda for research needs full legislative and financial support, and that the application of our findings to improve the health of the public must become the highest priority for health policy in the United States.

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