Summary

Through a variety of studies, the Missouri Regional Medical Program hopes to be able to trace a theoretical patient from his home (household survey), through his physician (physician surveys), through the local hospital (Operation Icepick), through the regional hospital (through activities of the University Computer Center), back to his physician, and back into the life of his community.

Dr. Jones's group is searching for ways of measuring the patient's performance and satisfaction with that performance, both before acceptance and after discharge from the formal health care system. With such a measurement, we will have a theoretical end point against which change can be standardized. Correlation studies could then be conducted to show positive or negative impact of each of the elements in the formal health care system to which the patient has been exposed.

Keys to the Missouri Regional Medical Program investigations will include:

1. use of the citizen's evaluation as a standard-setting device
2. design of health care delivery systems with data studies as an integral part of the system, and
3. continual model building, using all of the skills of all of the interested university and health care disciplines.

Certainly a great need exists for effective means of evaluating health care and for replicating studies to validate procedures and data. We who are involved in the delivery portion of the system will be looking to epidemiologists for guidance as we continue to search for solutions to this persistently troubling puzzle. If we are to meet the challenge, all of the ingenuity we can collectively muster will be required.

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IV. EPIDEMIOLOGY AND PLANNING FOR THE NORTH CAROLINA REGIONAL MEDICAL PROGRAM

Herman A. Tyroler, M.D., and Harvey L. Smith, Ph.D.

THE recentness of the creation of Regional Medical Programs, the urgent need to begin operational phases and still have adequate planning preparations, and the explicit national policy not to spell out detailed blueprints and not to attempt to have identical programs in all regions, have produced challenges and new opportunities for the discipline of epidemiology. This presentation will describe some of the current activities of the Department of Epidemiology, University of North Carolina School of Public Health, in relation to our Regional Medical Program, and some of the plans for the future. The major

function to be discussed will be that of consultation with the Planning Division, which has undertaken data-gathering operations to determine the program's needs and resources for North Carolina, the area covered by the region. Although the Planning Division is also engaged in surveys of professions and manpower, services and facilities, and continuation education, our epidemiologic component is focused on population-based disease measurements. In addition to activities in arriving at best possible current estimates, we are also developing plans for the future training of epidemiologists, and the special surveys and new areas of research required by the program. The material presented will be illustrated with examples from cardiovascular epidemiology.

Predictive Epidemiology

Among our major efforts will be attempts at estimates and descriptions for North Carolina of the community dimension of the diseases covered by the program, and the disease manifestations and distribution in segments of the population in the past, at present, and, as best we can project, in the future. It is obvious that estimates of this type are needed for current health services planning: to determine caseloads and the facilities and professional personnel needed for maximally effective care, and to provide quantitative base lines against which to evaluate the impact and efficacy of the program. Projections are required particularly for the development of community health, preventive measures, prior to the emergence of new health problems. An intelligence system which can provide predictions of newly emerging problems has been alluded to as anticipatory epidemiology. Although there are technical difficulties in arriving at estimates of the contemporary community health dimensions of cardiovascular diseases in populations as large and diverse as those in the North Carolina Region, there are no theoretic barriers to obtaining them.

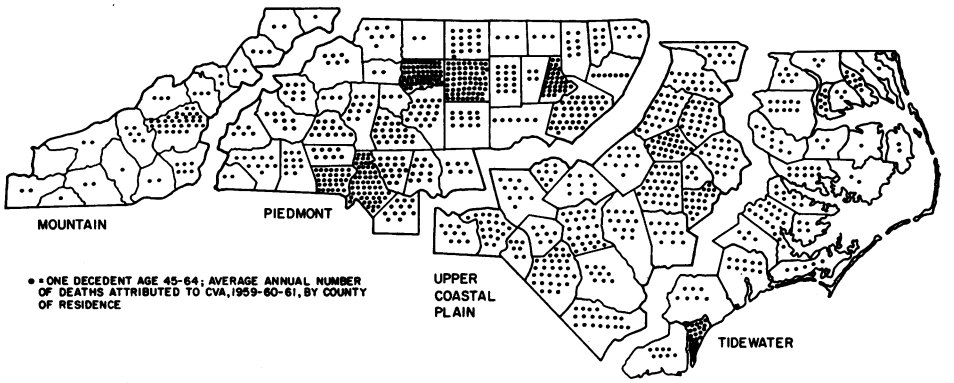
Not equally simple is the method of obtaining future, contrasted with contemporary, estimates. This requires knowledge of the epidemiologic determinants of the disease, and the anticipated changes in the disease-relevant biologic, social, and environmental characteristics of the population of the region, knowledge which may currently be incomplete or erroneous. Clearly, predictive estimates will need revision as our experience increases. However, despite their imprecision it is felt that estimates, even if predominantly comparative and ordinal in identifying high-risk populations, can provide valuable information.

Illustrative of this is the knowledge provided by epidemiologic studies of the relationships between major demographic characteristics and cardiovascular disease. The exponential rise with age, the marked male vulnerability to coronary heart disease, particularly in young adulthood, and the excess of hypertension and cerebrovascular disease in the Negro provide clear examples. Populations within the region, differing in these attributes at present, or predicted to differ in the future, will have differing amounts and manifestations of cardiovascular disease.

Mortality Studies

As an example, we have set out the geographic distribution of deaths attributed to cerebrovascular disease in North Carolina, by the county of residence of decedents age 45-64, for the years 1959-1960-1961 (Figure 1). Gross heterogeneity in the distribution is apparent. For those familiar with the geography and demography of the state, and the epidemiology of strokes, the pattern of distribution of cases is explicable. There are dense clusters of deaths in the

Figure 1—Distribution of deaths attributed to cerebrovascular disease, 1959-1960-1961, by county of residence in North Carolina: deaths of all residents age 45-64



crescent-shaped area of the more highly populated, industrializing counties of the Piedmont area, very few cases in the sparsely populated counties of the western mountain area, and large aggregates of cases in the coastal plains area. There are proportionately more Negroes in the coastal plains counties than in the remainder of the state, and the Negro, as is well documented, is at much higher risk of stroke mortality.

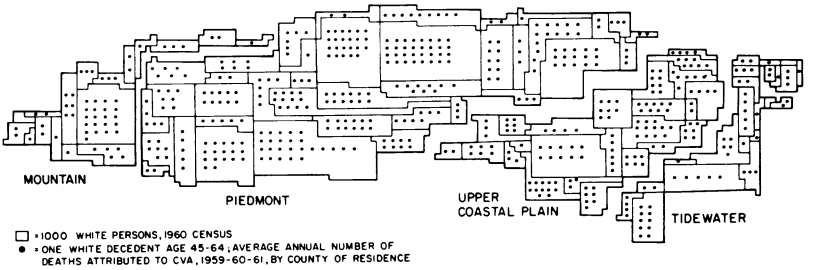
Epidemiologic area adjusted maps were constructed to aid in these evaluations and comparisons. In this technic, the county units have been redrawn with their size proportionate to population rather than area, while preserving spatial relations, that is, county borders, and general north-south and east-west orientation.[1] Epidemiologic area adjusted maps were constructed separately for whites and nonwhites (Figures 2 and 3).

The more striking results of distributing deaths on the epidemiologic area adjusted maps include the disappearance of clustering of cases in the Piedmont —the more highly populous areas now appear larger in scale and, for the white population, do not appear to have disproportionately large numbers of cerebrovascular deaths. The map for nonwhites is smaller than for whites (if drawn to the same scale), and in addition to change in size reflects, by its change in shape, the differential geographic distribution by place of residence of the nonwhite, with few nonwhite residents in the mountain area and proportionately more in the coastal plain. The density of cases relative to population is obviously much higher for nonwhites than whites.

From the perspective of the planner and administrator, the geographic areas with differing numbers of nonwhites, and with high and low fatal caseload, are identified and the known relation of fatal cases to race is confirmed. Combined with age and sex data, the race composition of counties in North Carolina can thus provide rough estimates of expected cerebrovascular deaths, and combined with demographic projections of population growth and migration can permit crude predictions of future rates.

The demographic and epidemiologic area adjusted map provides a useful graphic mechanism, permitting visual study of patterns. The areas with largest numbers of subjects and patients can readily be identified. The areas can also be redrawn proportionate to any appropriate population of interest; for exam-

Figure 2—Distribution of deaths attributed to cerebrovascular disease, 1959-1960-1961, by county of residence in North Carolina: epidemiologic area adjusted map, deaths of white residents age 45-64



ple, number of hospital beds or coronary care units can be represented in area proportionate to their numbers, if patients under treatment in different areas are the denominators for study of case fatality rates.

For the epidemiologist, the visual presentation may suggest patterns of grouping of areas of high and low mortality and their relation to population size, but obviously this need is better served by computing and plotting rates. This has been done in Figures 4 and 5 for death rates attributed to the major cardiovascular disease, for white males separately from nonwhite males.

A rather consistent pattern emerges. For the white male age 45-64, there is a fairly sizable and regular increase in death rates in the counties of the east contrasted with those in the western part of the state, and the area of consistently highest rates is the coastal plains. For the white male there is also a gradient of increased rate by population size within the mountain and Piedmont area. (Although this is not too evident graphically, we have documented it statistically, as reported in a prior study.[2]) However, the maximum rates for the state are not those of the more populous counties, but rather the less

Figure 3—Distribution of deaths attributed to cerebrovascular disease, 1959-1960-1961, by county of residents in North Carolina: epidemiologic area adjusted map, deaths of nonwhite residents age 45-64

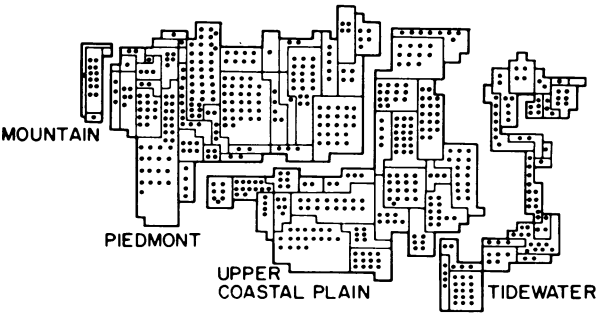
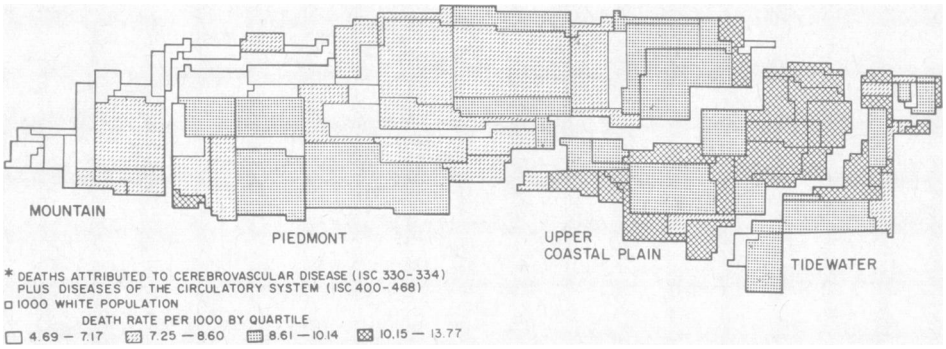


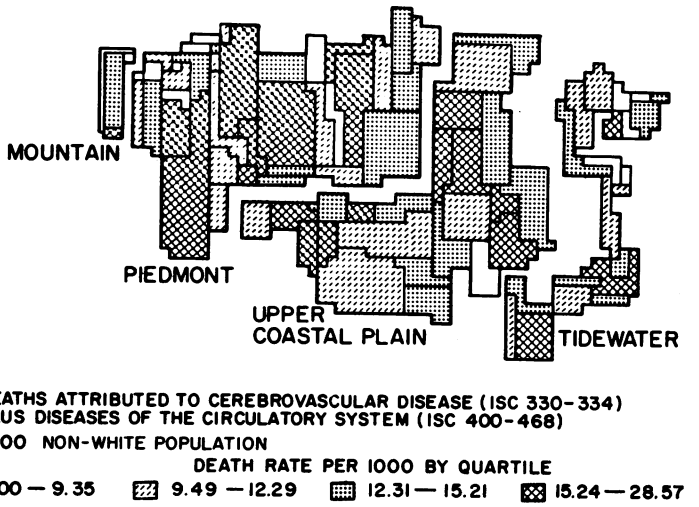
Figure 4—Death rates from major cardiovascular diseases* white males, age 45-64, 1959-1960-1961



populous counties of the coastal plains. The pattern is different for nonwhites. Highest rates are present in the Piedmont, and seem to be present in the more populous counties.

There is evidence that the west-east gradient observed in 1960 is not a chance occurrence; similar results were obtained by Hamilton on analysis of 1950 experience.[3] There is also evidence for stroke deaths that diagnostic custom is not responsible for the high rate areas. This was demonstrated in a national collaborative study of diagnostic custom contrasting high, medium, and low rate counties of the nation, which included some of these high rate counties of North Carolina. Results of the study reported recently at the American Heart Association meeting[4] also document a direct relationship between the total cerebrovascular disease, arteriosclerotic heart disease, and other heart disease death rates, for areas in the national

Figure 5—Death rates from major cardiovascular diseases* nonwhite males age 45-64, 1959-1960-1961



sample, findings which we observed both in 1950 and 1960 for North Carolina.

The high rate counties of North Carolina are part of a large belt of coastal southeastern United States counties which have been identified as having high cardiovascular and cerebrovascular death rates, compared with rates for the remainder of the United States.[5-7] The next procedural step, and one which is under development, is to determine whether the high death rates are due to higher incidence, higher case fatality rates, or combinations of both.

This capsule description highlights the importance of demographic characteristics influencing cardiovascular death rates, and also the heterogeneity of county and area rates within the state, controlling for the major attributes of age, race, and sex. The possible explanations for these differences will be discussed subsequently. However, we would emphasize now the rapid rates of change of major population characteristics. Population growth, aging, rural to urban migration, and industrialization are proceeding rapidly in the state. It can safely be predicted that the absolute number of cardiovascular deaths, particularly coronary heart disease, will increase in response to these changes. We also believe that the cardiovascular disease caseload increase will exceed the age-specific population increase. This is posited as a response to style of life changes, including the trends toward nonmanual occupations, dietary changes, and social dislocations.

Morbidity Studies

Although crude estimates of current and future caseloads of cardiovascular disease can be obtained from mortality statistics plus general knowledge of the natural history of the diseases and their case fatality rates, it is obvious that these must be supplemented with morbidity data. It is practical and feasible at present to enumerate ascertained and treated cases, within a defined geographic area, by use of hospital and physicians' office records. This affords the opportunity for epidemiologic studies of treated disease within the region, through coordinated analysis of standardized input of medical information. For example, efforts are under way to collect and study clinical case data from the coronary care units under development in the state. Another example is provided by hospital data routinely encoded for the Professional Activity Study, an effort within North Carolina which will be aided by a grant from the Duke Endowment Fund supporting the implementation of this standardized, medical records summarization system in all hospitals in the region.

Similar uses can be made of data from patient contacts at physicians' offices. The utility of physicians' records for estimating the community dimensions of cardiovascular disease was investigated by Gibson, et al.,[8] in North Carolina, and they found it possible to obtain reliable estimates of the prevalence of congestive heart failure by this technic. They did note, however, that there would have been gross underenumeration of all cases of heart disease in their defined population, were treated cases their only source of data. Similar results have been reported from the Framingham Study,[9] where approximately half the new cases of coronary heart disease developing in a 12-year period would have been missed, had the investigators relied only on reporting through physicians' offices, hospitals, or death notifications, and had they not had the added information provided by the special epidemiologic follow-up examinations.

There are other major difficulties in the use of secondary sources of morbidity information in addition to underascertainment and underenumeration of cases. When notification of cases is

dependent upon many practitioners, and upon numerous recording and coding clerks, there will be marked variability in completeness, reliability, and validity.

At present there would appear to be an inverse relationship between the ease of obtaining morbidity data and its utility for epidemiologic study. The sources listed above, physician and hospital records, can be supplemented with school, insurance, and industrial data, by computerized record linkage. The limitations in the quality of the data would, however, probably be compounded. In contrast, the most epidemiologically useful data, that issuing from a well-defined cohort under continuous surveillance, is almost prohibitive in terms of the personnel and financing required for a large community. The discussion will return to possible solutions to these problems after consideration of the population laboratory used by our Department of Epidemiology to provide cardiovascular morbidity data.

Under the direction of Dr. Curtis Hames, the total adult community of Evans County, Georgia, is under cardiovascular epidemiologic surveillance. Dr. Hames acts as, and combines the functions of, private medical practitioner, county health officer, survey researcher, and university teacher. His experience in conceptualizing the Evans County study, in designing and executing it collaboratively with public health agencies and universities, and currently with the Planning Commission of the Regional Medical Program of Georgia and consultants to the program in North Carolina, provides a model for other regions.

Evans County, Georgia, is located in the same high cardiovascular mortality rate belt referred to previously for the North Carolina coastal plains. Studies in Evans County relevant to the North Carolina Regional Program have documented the relationship of physiologic (blood pressure, serum cholesterol), genetic (family and population), and psychologic factors to coronary disease. Of perhaps most immediate relevance to the North Carolina program are the studies relating behavioral and social attributes of changing life styles to coronary heart disease. McDonough, Hames, Stulb, and Garrison[10,11] have demonstrated higher coronary heart disease prevalences in whites than in nonwhites, despite epidemic hypertension in the nonwhite, and higher prevalence of coronary disease in upper social class than in lower social class white males, and have posited that differences in occupational physical activity may explain most of the observed differences among the social class strata in coronary heart disease prevalence. Other social and behavioral attributes are also under investigation. Regardless of the specific process responsible, the implications for the North Carolina Regional Program seem clear: as the state is transformed from a rural, predominantly agrarian economy, and continues its trend toward accelerating urbanization and industrialization, it can be predicted that the problem of coronary heart disease, particularly in the middle-aged white male will increase.

Teaching and Research

Epidemiologic surveillance on a continuing basis will be an integral component of regional programs. As we have indicated, there are formidable methodologic and theoretic problems in providing rigorous epidemiologic information for a region such as North Carolina. A coordinated combination of elements in a diverse network of information sources will be required. These include data collected, coordinated, and synthesized from: prospective, community-based surveys; and medical records generated in physicians' offices, clinics, nursing homes, industries, and schools, some of which will be the byproduct of routine service

functions, and some will be data collected explicitly for, and under the direction of, the Regional Program.

The representation of these information sources in the surveillance system, the sampling methods required to obtain them, and the development and implementation of automated medical records data systems providing ease of information transfer, all require research. Similarly, research is required quantitatively to appraise the limitations known to exist in quality and completeness of each source of information, and to experiment with and develop alternative approaches to their improvement. Methodologic research also is required for the epidemiologic analysis of pathways to and through the health services of the region. The natural history and outcome of treated illness in large populations of patients can be described, given information derived with the aid of such technics as record linkage.[12] Problems arise, however, when interest is focused on determining, quantifying, and contrasting the characteristics of ill individuals who do, and those who do not, get into the treatment system. This, once more, requires surveillance technics on community-based samples.

One possible solution to the problems discussed is to select several study areas, simulate approximate solutions to needed epidemiologic information using routinely available data, and then test the predicted outcome of the model against the results of definitive surveys. If there is good agreement between the simulated and observed rates of disease, and this is replicable in study samples including a wide range of experience, the model could be used on a routine service basis, maintaining a few comprehensive epidemiologic community-based surveys for quality control within the region. Preliminary experiments in the simulation of coronary heart disease, presenting in a county of North Carolina, have been performed and reported.[13]

To carry out the service functions and research activities required for epidemiologic consultations and surveillance will demand numbers of trained personnel considerably in excess of those currently available. If, as we believe, an epidemiologic component is to be an integral part of each regional program, hundreds of such professionals will have to be trained in schools of medicine and public health. Prerequisites for admission, the curriculum, and academic and research experience for these epidemiologists have yet to be determined. There is, for example, a growing tendency at present to use either social survey researchers or biostatisticians for epidemiologic surveillance functions. Is it "appropriate" for such individuals to participate in the design of studies of the determinants and natural history of a disease, the biology of which they are ignorant? Similarly, is it "appropriate" for physicians with depth training in cardiovascular epidemiology to design studies of the needs and allocations of resources, studies requiring knowledge of systems analysis, social science and economic theory, of which they may well be ignorant? The very definition of the appropriate domain of interest of the epidemiologist is the subject of controversy.

With recognition that others disagree, we take the position that it is both important and appropriate for epidemiologists to study the influence of social factors, as antecedents of disease, and also as determinants of participation in health care systems. That which is relevant to the determinants and distribution of disease in populations must either be identified from the extant body of biologic and social science theory and fact, or must be researched in the context of epidemiologic interests.[14]

Given these assumptions, we believe that a multidisciplinary approach is required for fruitful epidemiologic investigation, and similarly that research

training should include exposure to, and synthesis of, theoretic and substantive material from more than one epidemiologically relevant discipline. The interrelatedness of the regional program needs and research training can be illustrated by the following example. In North Carolina, the identification of geographic areas of high and low cardiovascular disease rates has been accomplished; this is a first step in descriptive epidemiology. Information regarding differential needs is immediately provided for the administrator. For the epidemiologist, the challenge of explanation is raised: what are the distinguishing attributes of these areas? Are there differences in known genetic, social, or environmental determinants of cardiovascular disease between the high and low rate areas to explain the observations? If not, does this not provide a natural experiment, the setting within which to develop community surveys to generate and test new explanations?

We regard the community survey as the analogue for epidemiology of bedside teaching in clinical medicine. Teaching, research, and research training must proceed concurrently in graduate level education, and the demands for trained personnel created by the Regional Medical Programs can only be met by expansion of the currently available facilities and opportunities for epidemiologic study. The medical schools have provided a successful model in the use of patient care as the vehicle for research and teaching. We see community-wide epidemiologic surveillance, as demanded by the needs of Regional Medical Programs, as providing an analogous population-based research and teaching mechanism.

Epidemiology in Planning

The ultimate goal of the North Carolina Regional Medical Program is the improvement of the health status of the people of North Carolina. Its immediate goals include an evaluation of the current health status, a community diagnosis, and an inventory of the resources available for its improvement. Epidemiology figures importantly in both immediate and final goals. Current tasks of planning in the North Carolina program require data to be used in decisions concerning program development, and as a base line against which to measure the future impact of programs. Epidemiology will contribute both to data for current appraisal and use, and to ultimate program evaluation.

The information which epidemiology will contribute on illness magnitudes, patterning, and populations at risk will be supplemented by studies of facilities, institutions, agencies, and voluntary associations; manpower; and education programs. All such data will contribute to the evaluation of the program. Epidemiology, which provides essential initial data for program development, can also contribute information necessary to determine success or failure of that program, if we wish to measure change in health status and not just provide an inventory of medical activities.

Our apparatus of health care and health education will be mobilized toward improving the health of our population. The approach of epidemiology can contribute to identifying populations at high risk and in determining whether there is improvement in response to programs. Epidemiologic methods also can assist in the next stages of planning: monitoring selected aspects of our health care system, including the careers of patients, and of those ill people whom the network misses. This challenge can provide a growing edge for epidemiological research and training, enlarging functions and responsibilities. Thus, in serving planning for the Regional Medical Program, epidemiology may in turn better serve itself and augment its customary contributions.

Finally, our studies document the well-known inadequacy of existing reporting systems to effectively reveal the full range of disease manifestations and treatment histories, i.e., the biologic gradient of disease, in total communities. Epidemiology is challenged to provide new case-finding and reporting systems. Such surveillance mechanisms, when developed, will provide for the continuous monitoring of the impacts of changing health care upon health status. Health planning is calling upon epidemiology to contribute information, which is required as our health care system is increasingly subject to evaluative control and rational direction.

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