Commentary

Epidemiology: A Problem-solving Journey

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As a scientific discipline, epidemiology has helped liberate the practice of public health and medicine from dogmatic thinking over the past century. This commentary highlights some integrating principles to explain why epidemiology is a problem-solving discipline. The first of these is that epidemiology is an information science. Epidemiology generates information for decision-making at all levels of the health-care system, including information for both individuals and the general public. Although all scientific disciplines produce data that may be used for decision-making, there is more immediacy for the decisions in epidemiology. The second principle is that epidemiology operates within an environment of complex systems. Etiologic factors operate in complex systems, and the use of a systems analysis approach in investigating health problems must be considered. The third principle is that epidemiology is not just a scientific discipline but a professional practice area as well. Epidemiology has a solid disciplinary scientific base, and its practice requires well-grounded academic preparation. Its objectives are very much within the public–social domain, and a well-defined, outcome-oriented, prevention-based philosophy steers its practice. In a number of universities, epidemiology is taught today as a research discipline rather than as an operational, problem-solving one. In conclusion, this commentary emphasizes the need to accept the fact that epidemiology has as much of a social role as a scientific one. Public health action, problem solving, and a sense of mission are what brings many students to epidemiology. A problem-solving, action-oriented epidemiology is consistent with that sense of mission.

education, professional; epidemiology; information science; problem solving

Abbreviation: DDD, disease, disability, and death.

Epidemiology has been and continues to be a journey through time, place, and with persons. There are different pathways that have led people to choose epidemiology as a career. The initial excitement that draws many to epidemiology is a medical or public health problem that needs to be addressed or solved on a broader level—going beyond the individual person experiencing the problem.

Epidemiology is a wonderful expression of our civilization of the past 2 centuries. Civilizations are in constant flux. The search for solutions that address problems of the past, present, and future marks the most dynamic of societies. As a discipline, epidemiology has faced the problems of the present. It has tried to learn from the past in order to deal with the present but also to redirect the future. Although it deals mainly with the problems of the present, its raison d'être is very much dictated by the positive impact it can make on the future of persons without distinction of geography or demography.

The uses of epidemiology can not be selective, and openness is what helps us to both investigate a problem and look for its solutions. One wonders why epidemiology has really blossomed in countries like the United States and the United Kingdom more than in other countries over the past century. The frame of comparison includes such countries as Germany, the Soviet Union, and Japan—countries where physical and other sciences have done very well. Does it have something to do with the liberal environment of the United States with an intellectual milieu that challenges established schools of thought? As a scientific discipline, epidemiology is liberating because it does not accept dogma. It has helped liberate the practice of public health and medicine from dogmatic thinking over the past century.
One has to get concerned whenever there is a colleague who embraces a finding or method too religiously. The last 2 decades have highlighted the need for Popperian thinking in epidemiology (1). Refutation of the existing way of thinking should very much be in our focus of attention. A hypothesis can never be proven. However, there are hypotheses that have never been rejected—so far. Being inquisitive and challenging existing paradigms have been very much a part of epidemiology.

I have been professing the following integrating principles in my teaching over the years to explain why epidemiology is a problem-solving discipline.

**Epidemiology: An Information Science**

The first integrating principle is that epidemiology is an information science. Epidemiology generates information for decision-making at all levels of the health-care system, including information for both individuals and the general public. Although all scientific disciplines produce data that may be used for decision-making, there is more immediacy for some of the decisions stemming from epidemiologic problem solving. There needs to be some immediate or long-term utility for the data generated in epidemiology. Such a perspective encourages us to target information to the appropriate audience, as well as to present it with a clear definition of the value and potential applications of the data generated. Therefore, *epidemiology is purposeful*. Whether it is prevention of disease, disability, or death, there is a societal responsibility in epidemiology.

Our starting point is the problem, and that is why we need to continue emphasizing the need for the case-control and other case-based methods, because they deal with the problem at hand: people who have disease, disability, or distress. The case-control method is a good starting point; there is immediacy in its approach. We start by identifying the problem; defining it, we investigate it and try to link it to its antecedents. Then hopefully, as a result of our investigation, we can propose some rational solutions to the problem.

Thus, addressing the problem is our number 1 public health and moral responsibility as health professionals working in epidemiology. We need to identify the best tools that help us deal with the problem at hand. There is a continuous evolution of methodologies and approaches that will be integrated in epidemiology, enriching its practice in the process. A few decades ago, medicine and microbiology were very much at the core of epidemiologic investigation, whereas today the presence of statistics in the practice of epidemiology has been overwhelming. We should not allow one set of tools or methods from another disciplinary area to dominate epidemiology. For almost 100 years, that was the case for microbiology, which so dominated epidemiologic investigation that, in many countries and during long decades, one could not differentiate between the epidemiologist and the microbiologist by what they did. We should not let that happen with statistics in epidemiology.

Epidemiology aims at a synthesis of knowledge and a meeting place of multiple scientific disciplines and tools. It is through epidemiology that the clinical disciplines, social sciences, statistics, genetics, microbiology, biochemistry, environmental and management sciences, and so on are brought under the same roof for solving the complex public health and health services problems facing us. Information from a variety of these disciplines needs to be culled together for decision-making.

Thus, it is essential to have good epidemiologic intelligence prior to engaging in the direction of intervention. Epidemiology is about asking the right questions and knowing the different ways by which you can get answers to your questions. Some 30 years ago, as an epidemiologist working in the Ministry of Health of Bahrain at a time when there was active international discussion about implementing primary health care within the framework of Health for All by the Year 2000, I asked myself about what constituted the evidence that primary health care works. The database for such a worldwide policy recommendation was very meager. At the time, an example that documented the effectiveness of primary health care was the Kavar Village Health Worker Project in Iran. In this project, a positive impact on infant mortality and crude death rates was demonstrated in the villages that were recipients of the primary health-care worker program compared with other villages that did not have such a program (2). Thus, in a way, the authors of that report from Iran saved the day for a major international policy decision that was being implemented with little supporting information.

**Epidemiology: Working with Complex Systems**

The second integrating principle is that epidemiology operates within an environment of complex systems. The simple models of one major etiology and one outcome have allowed us to target a number of public health prevention efforts to these specific etiologies. Examples abound of these simple models from infectious diseases and cancer. Our etiologic investigations continue to have the focus of simple models even if we use multivariate analyses. Most multivariate analyses are done for adjustments or control of confounding rather than for how variables interact in more complex models.

Etiologic factors operate in complex systems, and we need to consider the use of a systems-analysis approach in investigating etiology. In such an approach, the focus of attention is sets of interacting entities or subsystems. Over the past few years, there have been a number of attempts at incorporating a systems approach to broader research in epidemiology. One of the most interesting articles I have come across on the subject was published 28 years ago in a phytopathology journal. The paper, entitled “Systems Analysis in Epidemiology” (3), described the use of systems analysis methods to control diseases in plant populations.

Systems are situated within different levels of organization. Epidemiologists, sometimes, need to work at multiple levels to make the appropriate inferences. Epidemiology has worked primarily at the level of comparison between persons and not between populations or within persons. The individual person or case is a level of organization in its own
right, and our investigation of the individual case may also give us leads to new knowledge in epidemiology (4). Epidemiology needs to navigate and operate at multiple systems levels.

The study of problems at the level of the case is very relevant in the context of health services. While working on the development of a primary health-care system through a network of population-based health centers in Bahrain in the 1970s, I learned a number of lessons in integration across systems. We were developing an information system for the health centers with an appropriate reporting schedule. The content of the projected monthly report from the system became the subject of discussion with my colleague John Forbes, Professor of Primary Medical Care at Southampton Medical School in England, who worked with us for a year. As I was extolling the merits of the proposed information system and telling him that, through the system, we would be able to study the time trends of diabetes at the local health center level and a number of other epidemiologic parameters for every important condition, he listened carefully and then said:

As a physician working in this health center, I am not just interested in the trends and distribution of the disease, but I want first to know individually who are my diabetic patients and what is being done to them.

In dealing with these complex systems, we need to innovate our methods. We strive for simple approaches when, in spite of the infinite number of configurations that combinations of time, place, and persons provide us, we continue to be fixated on 1 subgroup of the population for decades to study a problem or sometimes multiple problems within the same data pool. Are we losing something of the richness of expressions of the problems as they are evolving all around us? With the exponential growth of databases at the personal and group levels, are we losing every day and every hour opportunities of problem solving through potential innovation by using alternative methods and databases?

It is not necessary to have the ultimate in technology for us to innovate. Much of the world will continue for decades not to have access to such sophisticated technology. One of the problems in public health program development, planning, and policy setting that we face in many of the areas outside Western Europe and North America is the absence of valid and dependable records that will allow definition of priorities and review of time trends of demographic, mortality, and morbidity indicators. Some alternatives to state-run databases can be identified that could provide such information. One such alternative is the records of church parishes. For example, Armenian churches have recorded information about deaths, marriages, and baptisms in their parishes for over 300 years from about 24 countries of the diaspora.

Beginning in the early 1980s, we conducted a series of studies of patterns of infant mortality, general mortality trends, widowhood and mortality, and epidemics using these parish records as our primary source of data (5–7). The small communities of the diaspora served as a microcosm that reflected what was occurring in the larger societies that surrounded them. Thus, we were able to identify 2 epidemics of what was probably influenza in the small Armenian parish of Belgrade in the early 18th century and 3 epidemics of cholera in the Armenian Catholic parish records of Kutahya, Turkey, in the mid-19th century—the same time period that Snow was investigating for cholera in London. We were able to get an estimate of the speed with which the great influenza pandemic progressed from Dakka, Bengal, to Cairo, Egypt, in 1918 using, again, the Armenian parish records (6).

EPIDEMIOLOGY: A PROFESSIONAL PRACTICE AREA

My third integrating principle is that epidemiology is not just a scientific discipline but a professional practice area. While we philosophize about our discipline in our academic ivory towers, let us remember that our colleagues in various health services positions practice epidemiology on the ground floor.

But what do we mean by “professional practice”? Definitions of the word “profession” emphasize the need for specialized knowledge, academic preparation, and an altruistic spirit. One of my medical school teachers, John Racy, wrote an article on the subject decades later. He defined a profession as “a socially sanctioned activity whose primary object is the well-being of others above the professional’s personal gain” (8, p. 139). A profession is much more than a job; it is an identity where the giving supersedes and precedes the gain. A profession also uses well-defined paradigms or common approaches for practice.

Epidemiology has a solid, disciplinary scientific base, and its practice requires well-grounded academic preparation. Its objectives are very much within the public–social domain, and a well-defined, outcome-oriented, prevention-based philosophy steers its practice. Further, epidemiology uses well-defined paradigms of problem investigation, analysis, and inferences.

This professional practice orientation of epidemiology, which has helped us not just to address real life problems but also to engage in problem solving, has sharpened our tools and helped us develop new methods. There is a lot that can be said as to how the human immunodeficiency virus epidemic helped introduce new methods in infectious disease epidemiology over the past 25 years.

As a rotating intern in pediatrics and as a resident in internal medicine, I had to deal with a recurrent episodic condition that affects primarily people of Middle Eastern origin: familial paroxysmal polyserositis or familial Mediterranean fever. Within a decade of our getting involved in research about familial Mediterranean fever, the genes of the disease were identified. Our knowledge of the genes was really not very helpful to the patients who were suffering from the painful and debilitating episodes of illness. Thus, it was important to consider that, in addition to the genes, one may be able to prevent the attacks if there are external precipitants for these attacks to occur. It was very logical to think of the atopic model for the etiology of this disease where precipitants are needed for the phenotypic expression of the genetic predisposition. In order to investigate such a hypothesis, we worked on a research proposal

in 1975 that would have studied antecedents and exposures in the same patient during the attack and at a random day when the patient was attack free. This was the first time we were thinking of a research design similar to what Malcolm Maclure later described as the case-crossover model (9). Unfortunately, with the eruption of the civil war in Lebanon that same year, we had to abandon that project. This project is currently being pursued by Dr. Gayane Yenokyan in Armenia for her doctoral thesis research at Johns Hopkins University.

The use of epidemiology may help us redirect our problems toward simpler solutions. A lot of effort has been invested over the past 100 years in trying to develop effective interventions against trachoma. We have a clear understanding of the pathobiology of the agent and its transmission. For years, efforts were made to test vaccines against the disease, as well as other medical based interventions. The disease continues to be an endemic, chronic problem for hundreds of millions around the world, causing blindness in thousands. However, the public health problem of trachoma was solved on its own in a number of communities in the Middle East and elsewhere by providing clean running water to everyone and improving sanitary habits. A review of the epidemiology of trachoma could have led epidemiologists to recommend these most effective of public health interventions—clean water and sanitary habits—to yet another major endemic disease several decades ago.

One of the essential characteristics of good professional practice is good management. Epidemiology has relevance beyond disease etiology, and epidemiologic thinking can be critical for good operational management and not just for planning and evaluation (10). Beyond efficacy and effectiveness, epidemiology has a lot to offer for efficient management. The discipline of thinking and analysis that are part of the core of epidemiologic methods can be very useful for professional practice.

CONCLUDING REMARKS

Although, currently, epidemiology has developed into several divisions or specialized areas, there is a definite place for generalists. As a professional, one should not be selective as to what problems we will accept to tackle. The problems dictate what we practice.

Epidemiology is taught today as a research discipline rather than as an active problem-solving one. None of the introductory textbooks of epidemiology spends an adequate amount of space in elaborating on the professional practice areas of epidemiology. Professional practice is no more at the core but at the periphery. If you want to learn about the practice of epidemiology, you need to read some “applied epidemiology” texts rather than the main textbooks or take a course in the applications of epidemiology.

There are relatively fewer young physicians and other health professionals who are joining epidemiology today compared with a couple of decades ago. Is this because the discipline has strayed away from its core practice areas and is presented more and more as a research discipline? Why do a number of our graduates feel the need to spend a few years with the Epidemic Intelligence Service at the Centers for Disease Control and Prevention after spending 4–6 years in our academic departments for a doctoral degree?

Epidemiology cannot exist without being engaged in the broader public health and health services mission. We have to believe in not just the future of epidemiology as a discipline but also our common capacity of achieving our objectives of a humanity living in dignity. When we are inspired and driven by the potential impact of what we can achieve, then we can make a great leap forward for the discipline.

We need to accept and be comfortable with the fact that epidemiology has as much of a social role as a scientific one. The great founder of the Institute of the History of Medicine at Johns Hopkins, Henry Siegerist, has stated that one of the problems of medicine through the ages has been that technology has always outpaced sociology (11). We have new knowledge and technology that take decades and sometimes centuries to make a part of the social fabric of the profession. Is that what is happening in epidemiology? I believe, today, that epidemiology is in need of sociology more than additional technology. Sociology in epidemiology is in the context of its uses and its practice within the framework of health services. This is not a plea for more studies on social factors in health and disease but for a redirection of epidemiology toward its social–professional roles within the health services and at all levels.

We need to define not an overarching set of methods but overarching social impact objectives for the discipline. Without its social dimension, epidemiology loses its soul.

Over the past century or so, we have aimed at preventing disease, disability, and death (DDD), and we have been quite successful in minimizing the load of the DDDs. Whether as individuals or as a society, we need to realize the inevitability of DDD for most people. Our immediate and long-term concern has been the minimizing of pain and suffering for our fellow human beings, because those with pain and suffering lose so much of their integrity and dignity as human beings. Thus, the ultimate objective of our aggregate effort is human dignity. We aim at helping the individual and the group in improving their dignity. Ultimately, this is every profession’s aim.

We agree that human beings are not just a collection of cells or molecules and that they also have spirituality that binds the molecules and cells with an integrative purpose and resultant direction. Thus, in every culture and with every individual, there is this search for dignity that elevates us out of our biologic complexity. Dignity is very much an important dimension of our understanding of health.

Public health action, problem solving, and a sense of mission are what brings many of our students to epidemiology. They come to us in search of that soul of epidemiology, and that soul is where the action is. Today, the best expression of that soul is in the global dimension of epidemiology and the local engagement in our communities. Eliminate these, and epidemiology ends up becoming soulless numbers and technology.

It will be interesting to ask: Who are the heroes of our current students? I have a sense that they are mostly the theoreticians who have had very little to do with the practice of epidemiology. These are also the same people who today dictate the direction in which epidemiology develops and is taught.
I would like to end with the following quotation attributed to Harold S. Kushner (12, p. 197):

In the final analysis, the question of why bad things happen to good people translates itself into some very different questions, no longer asking why something happened, but asking how we will respond, what we intend to do now that it has happened.

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REFERENCES


