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Epidemiology in progress: thoughts, tensions and targets

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Essays and debates about the future, not in short supply at the turn of the millennium, are primarily pictures of the passing present. The following six articles, prologue and epilogue in this issue of the journal are no exception in this respect. Presented at the Panum symposium on *The Future of Epidemiology* held in Copenhagen on 25 January 1999, they portray the unfolding of epidemiology as currently created, perceived, desired (or for some aspects undesired) by leaders in our field of work. In addition to the pleasure of reading these papers, epidemiologists will find plenty of challenges for reflection, both in the overall trends and at the detailed level of the thoughts exposed.

At the former level, four major tensions between opposite poles are at work, generating the dynamics of today's epidemiology.

First there is the tension between methods and substantive problems in biology, medicine, and population health. As has been pointed out[1] epidemiology, an essentially applied discipline, is 'atheoretical': it cannot develop into an internally structured body of theory as does theoretical physics. Its only theoretical component, which is critically important, is the complex of methods. Here all authors at the Panum symposium are conscious, albeit with differences in emphasis, of how crucially advances in epidemiology depend on advances in methodology: none of them, however, confuses epidemiology with methodology. This is an attitude not uniformly shared within epidemiological circles where overindulgence in refinements of little practical impact and semantic quibbles—a challenge to John Last's endurance in assembling the 'Dictionary of Epidemiology'[2]—may take place over imaginative and rigorous development of new study designs and incisive methods of analysis. For epidemiology, as for living organisms, the spirit of epidemiological methods and way of thinking can be separated from the substantive issues only at the price of extinction. It is encouraging that advances in methods capable of increasing the ability of epidemiological investigations to disentangle causal webs are steadily emerging. By way of example the crossover design for isolating precipitating factors of acute events, such as myocardial infarction,[3] can be cited, or the multilevel analysis of causal factors operating at the community level (neighbourhood socioeconomic characteristics) and at the individual level (weight, smoking habits).[4] Also the variety of statistical methods for epidemiology gains in coherence, clarity and versatility in applications when seen under the unifying principle of likelihood.[5] In recent years the whole field of genetic epidemiology has been opened to innovations in study design and analysis to investigating genes and gene-environment interactions in the aetiology of a multitude of diseases. This is particularly so in view of the potential for association studies[6] made feasible by assays of thousands of single nucleotides, each present in variant forms among individuals.

This leads to the second major tension, reflected in all papers, between two poles within epidemiology, the biological and the social. The former is bound to exert an enormous power on how aetiological, preventive and therapeutic hypotheses are conceived, studies carried out and resources allocated to different kinds of investigators. When I started as a student at medical school I learnt that as a 'normal' human being I had 48 chromosomes: just 2 years later (in 1956) I had lost 2. The first direct and correct count had shown that humans have only 46 chromosomes. Chromosome research predominated but human genes remained inaccessible for two or more decades until the power of molecular genetics started the anatomic 'neo-Vesalian' revolution.[7] Through the human genome project this provides, as Vesalius first did for the human phenotype,[8] the knowledge of the anatomy of the genotype. This is followed by the neo-Harveian, physiological, revolution of genomics exploring the links between genes and their functions at molecular, cellular, organ and system levels. A major avenue for epidemiological research to maintain momentum in the midst of this epoch-making revolution in biology is to incorporate concepts and techniques evolving from molecular biology, genetics, immunology and the neurosciences. Biomarkers of exposure, external and internal (genes), of individual susceptibility, hereditary or acquired, and of early effects are already commonly used—sometimes without sound rationale—in epidemiological studies:[9] their principal role is to help identify controllable causal factors, for instance a specific asthma-inducing pollutant recognized through its immunological footprints, rather than in unravelling pathogenesis. An important point is that epidemiological studies are, in general, only auxiliary tools for pathogenesis studies, not so much for lack of relevant biomarkers as for their observational nature. Mechanistic insights are gained, for example, by analysing, in human tissue specimens the genetic changes characteristic of the different histological conditions of the colonic mucosa (normal tissue, adenoma, carcinoma). However to elucidate and demonstrate the causal sequence and interconnection of genetic and non-genetic events requires exploration and testing in systems accessible to direct experiment within simplified and controlled settings, with animal models such as transgenic and knockout mice. Similarly, as descriptive epidemiological data provide aetiological insights and suggestions to be investigated and tested in 'ad hoc' analytical studies, the whole of epidemiology can provide mechanistic insights and suggestions to be fully analysed and established in experimental studies, including possible laboratory studies and trials in humans. In this respect epidemiologists face two main tasks. First, not to be inadvertently sidelined into the role of second line molecular

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biologists but to develop epidemiological research specifically aimed at making biological knowledge relevant in terms of aetiology and prevention at population level; second to regard these populations not only as a tool for studying health and diseases, as other investigators use cells or animals, but as targets for achievements in health.

The third major tension is between specialization and integration, evident from the variety of angles from which each of the authors in the Panum symposium regard epidemiology. Claude Bernard, the founder of experimental medicine, maintained that specialization is at the same time an ill due to the limitation of the human mind and a necessity for successful scientific research.[10] As of necessity, contemporary technoscience undergoes an endless process of split into specialties and subspecialties, leading to serious problems of knowledge accessibility.[11] In epidemiology one can easily name several dozen specialties, in which an epidemiologist can only keep up to date in one, or at most, a few. This somewhat perversely combines with the need for recognition, vital for project peer review and funding, by specialist colleagues such as cardiac specialists for cardiovascular epidemiologists: as a consequence the key professional reference and communication milieu becomes the circle of specialists rather than one of fellow epidemiologists. Still, when it comes to population health, communication and integration is imperative: healthy people eat only one diet, however varied the dietary pattern may be, and it is obviously nonsense to give disjointed, maybe even contradictory, advice to prevent different diseases. Reinforcing communication and integration is a major area for development, which is still inadequately pursued. It relates to how research and advisory teams are formed and operate, how educational programmes train epidemiologists and how generalist associations such as the International Epidemiological Association enable interchange between their members.

The fourth tension, detectable in the papers, is between freedom of research, largely curiosity driven, and orientation of research, driven by the health needs of populations and by resource allocation. Epidemiologists are only one of the players, often marginal, in the allocation process. It has been argued that resources, notably public, should be seen in relation to some measure of ill health burden.[12] Apart from the fact that different measures (current or projected incidence or prevalence, lost years of life) may lead to materially different views,[13,14] this criterion provides a valuable guide for allocation to broad classes of problems rather than to strictly defined and exhaustively enumerated objectives. The latter use would serve to impose, particularly for an applied science such as epidemiology, a counterproductive straitjacket on researchers. However socially minded one likes to be there is no way that ground-breaking scientific results, including in fields immediately impacting on health, can be obtained without the talent and free moving curiosity of researchers. In addition in the not uncommon situation in which public funds are scarce, resource-driven epidemiological research drifts heavily towards studies evaluating drugs (where funds from firms are usually available) whatever the relevance of these to the health of the population.

The poles sustaining these four tensions appear sufficiently well established to generate a vigorous dynamics for epidemiology: this means more and better quality epidemiological studies, more pervasiveness of the epidemiological way of thinking within clinical medicine, occupational and environmental sciences, more epidemiologists and more varieties of them, hopefully with greater ability to exchange experiences. On this basis I join the speakers at the Panum symposium in a reasoned optimism. I am however cautious about how much this activity will approach, in a decade or two, the target of creating better health for all people worldwide. It is well recognized, and documented by a growing body of literature, that the lives and the health of people are unequally affected by ongoing socioeconomic and environmental changes, between and within countries.[15] It is also virtually certain that progress in biomedicine and expanded application of its results will occur over the coming decades allowing health improvements for at least some members of the population. These two premisses are commonly accepted, yet the inescapable consequence is much less emphasized even within epidemiological circles: that the key issue for public health, which deals with the totality of population (not with some members or groups) is, even more than for the past, how health improvements become distributed in the population, i.e. equity in health. This is the central target of all efforts and should be, in my view, an obligatory passage in the education of future epidemiologists. Before they move ahead to their chosen work and specialty they should be thoroughly exposed to the problems of inequity of health and their human, policy and political implications. In the same way future clinicians, however destined to high-tech careers, can benefit from practising, for at least a while, in underprivileged areas getting first hand knowledge of the misery caused by the cumulative effect of physical ailments, psychological distress, and economic and social deprivation. For all the extraordinary advances in health achieved in this century there is still too much suffering around.

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