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Positioning Epidemiology in a Changing Environment Over the Next 25 Years: Introduction

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A panel of former presidents of the American College of Epidemiology has been convened to reflect on future challenges in epidemiology and public health and how epidemiologists may be best prepared to meet these challenges. The evolving priorities in the allocation of resources, recruitment and training of health professionals, and the orientation of future intervention programs in disease prevention and control require a global perspective. We cannot afford to view a future that is limited to fulfilling only national priorities. Public health emergencies (e.g., pandemics of infectious diseases) transcend national boundaries and require international collaboration. Another compelling example would be preparedness for bioterrorism, which encompasses the intentional release of bacteria, viruses, or toxins for the purpose of harming or killing civilians (1).

The Centers for Disease Control and Prevention (CDC) highlighted “ten great public health achievements” during 1900–1999: vaccines to prevent childhood communicable diseases; measures to ensure motor vehicle safety; establishing guidelines for safety in the workplace; national morbidity and mortality surveillance of acute and chronic diseases; declining coronary heart disease and stroke mortality; increasing safety and nutritional assessment of marketed foods; improving maternal and infant health; assistance in family planning; fluoridation of drinking water; and the recognition of tobacco use as a major health hazard (2). In the latter half of the 20th century, the emergence of chronic diseases provided a stimulus for enhancing the capacity of the public health infrastructure. Epidemiologists, in recognizing the complexity of the etiology and prevention of emerging chronic diseases, developed an increasing capacity for conducting population-based studies that examined health determinants in relationship to molecular and genetic mechanisms as well as social epidemiologic studies that assessed the contextual significance of social class, neighborhood, and ethnicity (3). It is also apparent that the public health infrastructure comprises a partnership of federal, state, and municipal governmental agencies, nongovernmental organizations, academic research and training institutions, and community-based “stakeholders.”

Let us consider the current global burden of diseases. The emphasis will be on cause-specific mortality. Despite advances in developing vaccines, antimicrobials, and the utilization of molecular diagnostic technology, one third of global deaths are caused by infectious diseases. New infectious diseases have achieved public health prominence (e.g., West Nile virus, severe acute respiratory syndrome [SARS], avian influenza) and, because of greater population mobility, have the potential to spread globally. Recall the outbreak of SARS that spread from mainland China to Hong Kong, then Singapore and to Canada (4). Thirty-nine new human pathogenic organisms have been identified since 1969, including HIV/AIDS, Marburg, Ebola, and other hemorrhagic viruses; hantaviruses; poxviruses; human herpesviruses, and Asian encephalitis viruses. Many of the emerging infectious diseases are naturally resident in animal populations. Zoonoses often exhibit complex life cycle and transmission dynamics and may result in human-to-human transmission. Understanding the sequence of epidemiologic and pathogenic events will be crucial in preventing and controlling future outbreaks. Human immunodeficiency virus (HIV) has infected a cumulative total exceeding 60 million persons, and more than 90% of those infected reside in developing countries of Africa and Asia (5). According to the World Health Organization (WHO), about 2 billion are infected with Mycobacterium tuberculosis; concurrent infection with HIV/AIDS is frequently associated with drug-resistant tuberculosis (6). Malaria is responsible for more than one million deaths that occur each year, mostly in infants, young children, and pregnant women in sub-Saharan Africa. A preliminary report from Mozambique has described the development of an immunogenic recombinant vaccine that was tested in infants (7). The future utility and deployment of the vaccine will be evaluated in the context of a comprehensive malaria control program.

In a recent review article, the authors referred to 13 major neglected and disabling tropical diseases that cause an estimated 534,000 deaths each year in a population of 2.7 billion who earn, on average, less than two dollars per day (8). The parasitic and bacterial diseases include helminth infections, filariasis, onchocerciasis, dracunculiasis, schistosomiasis, Chagas disease, African trypanosomiasis, leishmaniasis, Buruli ulcer, leprosy, and trachoma. These diseases occur primarily in low-income countries of sub-Saharan Africa, Asia, and Latin America. The interactions of poverty, malnutrition, and debilitating tropical diseases
has been documented in the Millennium Declaration of the United Nations (9). The United Nations Millennium Declaration was signed by 189 countries in the year 2000 and translated into goals to be achieved by the year 2015, including alleviation of global poverty, malnutrition, and rising maternal and infant mortality. The infrastructure of such programs will require surveillance registries and the applications of methodologies that assess the multiple factors that influence disease prevalence and vital outcomes.

The WHO has estimated that the chronic degenerative diseases account for 60% of global deaths. By the year 2020, the chronic degenerative diseases are projected to account for 7 out of every 10 deaths in developing countries (10). In the United States during the past decade, heart disease mortality declined, on average, 6.4% per year, whereas cancer mortality declined about 1.1% per year, or about 5000 cancer deaths per year. Although there have been dramatic declines in mortality in the United States since 1950 attributed to heart disease and stroke combined, the vascular diseases cause about one third of global deaths. The dramatic reductions in vascular mortality in the United States may be explained by population shifts in the distribution of established risk factors and by increasing availability of evidence-based medical and surgical therapies (11).

It is estimated that by the year 2020, in a projected population of 7.5 billion, cancer will cause more than 10 million deaths per year worldwide, with about 7 million occurring in developing countries with limited infrastructure for surveillance and integrated preventive medical and diagnostic and therapeutic services (12).

Populations in developing countries are disproportionately susceptible to cancers in which infectious agents are causal. These organ sites include uterine cervical and anogenital cancers (human papillomavirus), hepatocellular carcinoma (hepatitis viruses B and C), gastric carcinoma of the corpus and antrum (Helicobacter pylori), endemic Burkitt lymphoma and other types of non-Hodgkin lymphoma (Epstein-Barr virus), nasopharynx (Epstein-Barr virus), urinary bladder (schistosoma haematobium) and biliary tract (opisthorchis viverrini and clonorchis sinensis). The public health impact of these infections is substantial. The proportion of cancer deaths attributable to infectious agents is about 20% to 25% in developing countries and 7% to 10% in more industrialized countries (13). Approximately 35% of patients with HIV infection are likely to develop a neoplasm of lymphatic tissue (activation of latent Epstein-Barr virus infection), Kaposi sarcoma (human herpesvirus 8), or a neoplasm of the anogenital tract (human papillomavirus) (14).

By the mid-1980’s, cancer epidemiologists had established the causal significance of exposures to tobacco smoke, ethyl alcohol, industrial chemical exposures by workers, ionizing radiation, ultraviolet radiation, exogenous sex steroid hormones, and other pharmaceuticals. In a review of salient developments in cancer epidemiology, Linet (15) commented on the “expanding purview of cancer epidemiology” and the profound influence of methodological and conceptual advances in molecular biology, immunology, virology, pathology, toxicology, and biostatistics. An illustrative example is the etiology of malignant melanoma in relation to patterns of lifetime exposure to ultraviolet radiation and interactions with host susceptibility factors that influence skin pigmentation, immunologic capacity, cell proliferation, and the fidelity of DNA repair (16).

A recent publication (17), Food, Nutrition and the Prevention of Cancer: A Global Perspective, has been issued by the World Cancer Research Fund and the American Institute for Cancer Research. An international panel was convened to review a vast epidemiological, biochemical, and experimental literature concerning associations of specific cancer sites with macronutrient and micronutrient deficiencies and excesses, obesity, and physical activity. The report will serve to guide future scientific research, and population-based interventions in cancer prevention and control.

Molecular epidemiology refers to the application of molecular biologic technology in the conduct of epidemiologic research. The methodology has been used to identify subtypes of infectious disease organisms as a means of tracking epidemic transmission and predicting virulence and resistance to antimicrobials (18). Schulte (19) has defined molecular epidemiology as the “incorporation of molecular, cellular and other biologic measurements into epidemiologic research methodology.” The methodology has also been incorporated into the design and conduct of epidemiologic studies of chronic diseases. For example, epidemiologic studies described associations between various microbial agents and specific types of cancer, but the use of molecular biologic methods demonstrated the intimate presence of an infectious organism in neoplastic tissue and elucidated various pathogenic mechanisms (20). Future challenges in epidemiology, with implications for graduate student and postdoctoral fellowship training and for developing infrastructure resources, will be the development of biomarkers that enhance the valid measurement of human exposures, the demonstration of variability in susceptibility in population subgroups, and the characterization of the heterogeneity of causal agents and disease entities (21).

A national survey conducted in 2006 by the Council of State and Territorial Epidemiologists addressed priority areas and recommendations in building workforce capacity, establishing training standards, certifying competencies, and allocating funds to insure stability of employment (22). The respondents in the survey identified a total workforce in state and territorial health departments of 2,502. Of the employed, 47% had received an MPH degree. Most health departments had resources to enable on-the-job
extramural training. While most health departments described adequate capacity to conduct field studies that identified emerging public health problems, the survey documented insufficient capacity to evaluate the effectiveness, accessibility, and quality of population-based health services as well as to conduct research that would provide new insights and innovative solutions to environmental hazards, new infectious disease outbreaks, or to enhance the utilization of cost-effective preventive services.

In a Shattuck lecture, Schroeder (23) focused on the apparent paradox of the United States spending more on health care than any other economically developed nation, yet ranking poorly on most measures of vital status (e.g., infant mortality, maternal mortality, life expectancy from birth). He listed the major determinants of premature mortality as consisting of “behavioral patterns, genetic predisposition, social circumstances, environmental exposures and health care.” He urged interventional efforts that will serve to ameliorate health outcome disparities among the socioeconomically disadvantaged, who are uninsured and medically underserved, and to focus on population-based cessation of use of tobacco and controlling the epidemic of obesity. As a core component of the public health system, epidemiology must be responsive to national and global challenges in disease control and prevention, and to the requisite capacity of its trained workforce.

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