

EPIDEMIOLOGY AND SURVEILLANCE

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Summary

As efforts are being made to enhance the well-being of human beings worldwide through control and elimination of infectious diseases, particularly those “old diseases with old problems” for which cost-effective interventions are available, rapid emergence of *new* diseases are occurring with a vengeance in different parts of the world: little knowledge exists of the natural history of these emerging diseases and the factors responsible for them are also not fully understood. During the last decades of the twentieth century, there was also the “reemergence” of diseases that were thought to have been brought under control.

These occurred with changing behavior as well as with rapid spread of pathogens resistant to antibiotics and of disease-carrying insects resistant to insecticides. There is growing concern in the medical and health community over the threat of infectious diseases as options for their control seem to be shrinking. Historical trends indicate that effective surveillance through early identification and confirmation, followed by prompt dissemination of findings to health authorities to enable them to launch prevention and control activities, will contribute substantially to reduction in spread of infection through containment and thus of deaths and disabilities.

Surveillance does not make risk go away but it does help in recognizing it so that appropriate response can be made. This article describes the evolution of surveillance concepts and examines the potential and challenges of monitoring disease trends and detecting threats and ensuring that relevant action is taken at local, national, and global levels to prevent further spread and to ameliorate their impact.

1. Introduction

Never has there been a period in history when the population health and distribution of diseases worldwide has changed so rapidly as since 1950: dramatic improvements in life expectancies have been achieved, large reductions in child and, to a lesser extent, in infant mortality through eradication and elimination of centuries-old infectious diseases have been accomplished, and the number of deaths and disabilities due to some chronic diseases has declined at least in some countries. No one can question epidemiology's remarkable contribution to such changes in people's health, in general, in better understanding of the causes and consequences of illness, disability, and death and, in particular, of surveillance in preventing and controlling the spread of diseases. However, its contribution could have been much more spectacular.

While it can be acknowledged that epidemiology as the study of the distribution and determinants of disease in humans had its roots in the Bible and in the writings of Hippocrates (fourth to fifth centuries B.C.E.), it has only been since the nineteenth century that any serious attempt has been made to apply it for enlarging our understanding of causes and determinants of diseases and disabilities and thus paving the way for preventing and controlling their occurrence and spread. Even thereafter, epidemiology in general and epidemiological research in particular have been focusing invariably more on methodological aspects of refining methods and procedures than on the application of what has been available for ensuring and even accelerating the well-being of humankind. As new and better epidemiological techniques and tools were being developed and disseminated for enhancing the understanding of disease processes and their determinants, medical sciences and biomedical technologies were making available more efficacious immunizing agents, chemotherapy, and antibiotics and were also enlarging the information and knowledge base with evidence on more effective products and devices that could simplify diagnostic, therapeutic, and rehabilitation procedures in appropriate use of these vaccines and drugs.

Interaction, however, between epidemiologists who have knowledge of disease processes, technologists who have new and improved tools and products with the potential for improving peoples' health, and health and medical care providers and policy makers has not been as intense and effective as it could have been. Similarly, the potential of *surveillance* in accelerating health gains has not also been fully exploited. Developments in this area were directed more at conceptual levels for expanding the scope of surveillance and extending its functions to health services as a whole (that is, well beyond specific diseases and illnesses) than at the adaptation, simplification, and application levels for involving different categories of individuals for early recognition, prompting timely response, and thus avoiding panic. Broadening the scope led to a dilution of the effectiveness of surveillance in carrying out its primary tasks of early detection and recognition of infectious cases, timely reporting, and rapid confirmation of outbreaks and prompt and effective response to prevent and control the spread of diseases. Under these circumstances, there has been no substantial reduction in the gap between what *could* be achieved and what *has* been achieved by epidemiology and surveillance in improving health worldwide. Remarkable developments have taken place in the area of surveillance at conceptual and application levels insofar as communicable diseases are concerned and this article summarizes them: it describes

surveillance and its evolution and examines the problems and prospects associated with its effectiveness in improving global health.

2. Evolution of Surveillance

2.1. Historical Trends

The dictionary definition of surveillance as supervision, watch or guard, especially over a suspected person that has existed at least since the seventeenth century has evolved into an epidemiological definition of continued watchfulness over the distribution and trends of incidence of diseases through a systematic collection, consolidation and evaluation of morbidity and mortality reports and other relevant data for the purpose of prevention of disease or injury. Its scope was further expanded beyond its relevance for infectious diseases to include a broad spectrum of public health problems of chronic diseases, occupational health, low birth-weight, malnutrition, disability, accidents, etc., as well as of the environment, personal behavior, and preventive health technologies. In its application, as well, certain clear milestones can be identified, such as the introduction of the practice of quarantine in C.E. 1400; the systematization in eighteenth-century Vienna of personal and communal behavior for achieving better health; the introduction by industrial nations in the late nineteenth century of environmental health measures through legal means; and developments in the twentieth century of innovative approaches to disease prevention and control resulting in health improvements at local, national, and international levels.

The first real public health action that can be considered “surveillance” probably occurred in 1348 during the bubonic plague when public health authorities boarded ships in the port near the then Republic of Venice to prevent people suffering from plague-like illness from disembarking. In the late Middle Ages, governments in western Europe assumed responsibility for health protection and health care of the population of their towns and cities: a rudimentary system of monitoring illness led to regulations against polluting streets and public water, instructions for burial and food handling, and the provision of health care. Evolution of surveillance concepts and procedures thus followed public health activities required to control and prevent diseases in the communities. It soon became clear that effective surveillance required some semblance of an organized health care system in a stable government, which was achieved not earlier than the fifteenth century and a classification system for diseases and illnesses that did not begin until the seventeenth century, with the work of Sydenham as well as mathematical methods for sophisticated statistical measurement that had also not been developed until then.

From the late 1600s and 1700s, death reports formed the basis for measuring population health, a use that continues to be important for assessing the extent and impact of diseases and injuries. In the seventeenth century, Achenwall coined the term “statistics” and Europe made extensive use of vital statistics for describing health trends; in the 1680s von Leibnitz established a health council and demonstrated the use of numerical analysis in mortality statistics for health planning. About the same time, John Grant outlined basic laws of birth and mortality as well as some basic principles of public health surveillance including disease-specific death counts, death rates, and the concept

of disease patterns. As early as 1741, the basic elements of surveillance were in practice in Rhode Island in the USA. The colony passed an act requiring tavern keepers to report contagious diseases among their patrons; this was followed two years later by the enactment of a law requiring the reporting of smallpox, yellow fever, and cholera.

A major breakthrough also occurred during the eighteenth century with Chadwick demonstrating the relationship between poverty, environmental conditions, and disease and Shattuck reporting on the relationship between death rates, infant and maternal mortality, and communicable diseases to living conditions. Shattuck also proposed the standardization of nomenclature for the causes of diseases and deaths and for the collection of health data by age, sex, occupation, socioeconomic level, and locality. All these developments contributed to establishing a basis for surveillance that can provide descriptive information regarding when and where health problems occur and who is affected, thus bringing out the diversity of epidemiological inquiries and resulting in public health responsibilities. In the latter part of the eighteenth century at a time when the health of the people was regarded as the responsibility of the state, a more comprehensive form of surveillance as “police medicine” was introduced. By the late eighteenth century and well into the nineteenth century, this idea of medical police, originally initiated in Germany and then adopted in other countries that had close contact with Germany, influenced developments in countries such as France, Britain, and the USA.

During most of the nineteenth century, surveillance was largely the concern of social reformers who instigated the setting up of systems for monitoring the health of the population by drawing the attention of health authorities to outbreaks of diseases such as cholera, smallpox, plague, etc. This was followed by the introduction in industrialized countries in the late nineteenth century of environmental health measures through “legal means,” a form of police medicine but with people’s participation. Surveillance as a continuous process of collection and dissemination of descriptive information for monitoring health problems was being shaped by concerns for combating infectious diseases and thus depended heavily on reporting of these diseases. Meaningful concepts in surveillance emanating from these concerns went with public health activities designed to control and prevent these diseases in communities.

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Bibliography

Bayer R. and Fairchild A.L. (2000). Public health: surveillance and privacy. *Science* **290**(5498), 1898–1899. [An excellent article dealing with the emerging issue of confidentiality in the dissemination of infectious disease data and implications for disease prevention and control.]

Cash R.A. and Narasimhan V. (2000). Impediments to global surveillance of infectious diseases: consequences of open reporting in a global economy. *Bulletin of the World Health Organization* **78**(11), 1358–1366. [This paper discusses the spread of infectious diseases and the role of early recognition and rapid response in dealing with them in the context of globalization of the world economy.]

Halperin W. and Baker E.L., Jr., eds. (1992). *Public Health Surveillance*, 238 pp. New York: Van Nostrand Reinhold. [An excellent reference text on surveillance, particularly on its relevance and evolution of concepts and methods in the context of epidemiology and public health.]

Heymann D. (2001). *The Fall and Rise of Infectious Diseases*, 10 pp. Geneva: WHO. [A paper on the emerging threat of infectious diseases and on the role of surveillance in dealing with their control.]

Langmuir A.D. (1963). The surveillance of communicable diseases of national importance. *New England Journal of Medicine* **268**, 182–192. [A descriptive paper on the concept and practice of surveillance in the USA.]

Langmuir A.D. (1976). William Farr: founder of modern concepts of surveillance. *International Journal of Epidemiology* **5**(1), 13–18. [An excellent paper elaborating Farr's contribution to modern concepts underlying surveillance.]

Last J.M. (1998). *Public Health and Ecology*, 464 pp. New York: McGraw-Hill Professional. [A textbook on public health problems, including historical background and ecological perspectives.]

Mahler H.T. (1978). *World Health Is Indivisible* (Address to the Thirty-first World Health Assembly, Geneva, May 9, 1978). Geneva: WHO [A thought-provoking address by Dr. H.T. Mahler on globalization of ill-health and on the need for individual and collective responsibility of member states for their control, as WHO launched its Global Strategy for Health for All by the year 2000.]

Rothman K.J. and Greenland S. (1998). *Modern Epidemiology*, 738 pp. Philadelphia: Lippincott-Raven. [An excellent textbook on epidemiology that explains and illustrates the specific role of surveillance in disease control.]

United States. Institute of Medicine (1992). *Emerging Infections*, 294 pp. Washington, D.C.: National Academy Press. [A lucid exposition on emerging diseases, the threat they pose to population health, implications for global trade and travel, and recommendations and guidelines for their control.]

Walford D. and Noah N. (1999). Emerging infectious diseases—United Kingdom. *Emerging Infectious Diseases* **5**(2), 189–194. [A summary paper that illustrates recent trends in emerging and reemerging diseases and the U.K.'s efforts and experience in dealing with them.]

World Health Organization (WHO) (1968). *National and Global Surveillance of Communicable Diseases* (Report of the Technical Discussions at the Twenty-first World Health Assembly, A21/ Technical Discussions/5, May 18, 1968). Geneva: WHO. [A background paper that brings together state-of-the-art surveillance in the mid twentieth century, particularly in relation to global initiatives for smallpox eradication.]

WHO (1996). *The World Health Report 1996*, 137 pp. Geneva: WHO. [An advocacy report giving an assessment of health situations and trends with particular reference to infectious diseases, summarizing global activities and initiatives in dealing with priority issues in disease control and outlining an agenda for further action.]

WHO (1999). *WHO Recommended Surveillance Standards* (WHO/CDS/CSR/IAR/99.2), 157 pp. 2nd ed. Geneva: WHO. [A manual designed for developing a system at national and international levels for integrated surveillance of priority diseases.]

Biographical Sketch

In more than four decades of professional work, **Muthu Subramanian's** interest and focus have been on adaptation and application of modern and state-of-the-art methodologies, techniques, and tools from epidemiology, statistics, mathematics, and management for analyzing and solving issues in social development and public health and on developing needed skills and capabilities at national and international levels. While at the United Nations Research Institute for Social Development (UNRISD) from 1964 to 1969, Subramanian contributed to innovative approaches to analysis and measurement of

development and to social planning methodologies and techniques. In his 30-year career with the World Health Organization (WHO), he advised, directed, and supported several countries—big and small, developing and developed, capitalist and erstwhile communist—in health services research on issues related to health care delivery and its management as well as in information systems; supported senior management of WHO at regional and headquarters levels in identifying and solving issues in international health policy and program strategies; organized and conducted more than 100 workshops and seminars; and carried out pioneering work in applying operations research in hospital care and health services, assessment of health and disease situation and trends, monitoring and evaluation of health strategies, health programs, and interventions and in health management information systems (HMIS). As Director with WHO, Geneva, Subramanian initiated and was responsible for the preparation and launching of the WHO flagship *The World Health Report*, in 1995 (*Bridging the Gaps*), 1996 (*Infectious Diseases*), 1997 (*Chronic Diseases and Disorders*), and in 1998 (*Health in the 21st Century—A Vision for All*). Since his retirement in 1998, his contributions have been directed to intergenerational issues in health, health of aging women, indicators of impact of health research on global health, statistics in human rights, cancer trends in the twenty-first century, etc.