1. Introduction

Surveillance has been described as the systematic collection of data pertaining to the occurrence of specific diseases, the analysis and interpretation of these data, and the dissemination of consolidated and processed information to contributors to the program and other interested persons. The principles have been well set forth by Langmuir for the United States Center for Disease Control (CDC) and by Raška for the World Health Organization (WHO), and were a major focus of discussion at the Twenty-first World Health Assembly in 1968. The techniques of surveillance have become a part of national and international programs of disease control. This chapter will discuss the background and elements of traditional surveillance, the concept and uses of serological epidemiology, and their application to the control of infectious diseases.

2. Surveillance

The traditional methods of reporting and surveillance are based on the occurrence of a case of clinical disease or of a death from clinical disease. They form the basis of public health control and immunization programs throughout the world.

2.1. Historical Background

The use of mortality and morbidity data as a basis for public-health action goes back for centuries. The occurrence of the "Black Death" or pneumonic plague in Europe about 1348 resulted in the appointment of three guardians of public health by the Venetian Republic to exclude ships with affected persons aboard. The detention of travelers from plague-infected areas for 40 days in Marseilles (1377) and in Venice (1403) led to our current concept of quarantine.

The term surveillance has been employed for years in the restrictive sense of follow-up of persons who have had contact with plague or of infectious syphilis patients to determine whether disease developed within the limits of the incubation period. The dictionary defines the word in terms of police surveillance as meaning to "watch or guard over a person, especially a suspected person, a prisoner, or the like." In public health practice, the suspect is the disease.

The principles of surveillance were first exemplified by William Farr, Superintendent of the Statistical Department of the General Registry in London.
in a series of classic letters on the causes of death in England appearing from 1839 to 1870 and through a collection of papers on "Vital Statistics" published in 1885. The WHO Influenza Centers for recognition of influenza outbreaks and new viral strains were established in 1948 prior to the introduction and general use of the term. Formal development of the concept of surveillance is of more recent origin and was in response to national needs for disease surveillance or to major new epidemic problems. These needs involved the requirement for a nationally centralized clearinghouse of essential information in order to define the magnitude of the problem, to inform the appropriate authorities on whom responsibility fell for public-health control measures, and as a means of evaluating the effectiveness of such measures. Use of the term in the United States began in 1949 with the development of a modified program at the CDC called "Surveillance and Appraisal of Malaria." In 1951, the concept was applied to the residual smallpox cases in the United States.

Surveillance really became an established concept and public-health practice on April 28, 1955, when the Surgeon General directed the establishment of a "National Poliomyelitis Surveillance Program" in response to paralytic polio cases following the use of Salk vaccine (the "Cutter incident"). This program was set up at the CDC. The technique became an effective tool in following trends in the disease, in measuring the effectiveness of polio immunization programs, and in detecting suspected vaccine-associated cases.

On July 5, 1957, the Asian influenza surveillance program was initiated and consisted of bimonthly reports from the CDC to keep everyone informed of the progress of the outbreak, including the public press. It served as an essential system tying together the massive national program to control the pandemic. Influenza surveillance has continued at the CDC in conjunction with the WHO ever since and has provided critical data on the occurrence of influenza outbreaks throughout the world.

The surveillance of hepatitis similarly followed an epidemic in 1961 in which shellfish from contaminated waters were identified as the source of an outbreak. Salmonella surveillance was initiated in 1962 following 18 hospital outbreaks. Many other diseases were added to this list over time, and now the CDC publishes special surveillance reports on about 20 categories of infectious disease. In Europe, Dr. Karel Raska was an enthusiastic supporter of the surveillance concept, initiated both traditional and serological surveillance in his own country, Czechoslovakia, and promoted the principles as Director, Division of Communicable Disease, WHO. A special unit called "Epidemiological Surveillance of Communicable Diseases" was established in the WHO by Dr. A. M.-M. Payne to coordinate and extend this program; three WHO Serum Reference Banks that are currently concerned with serological surveys and serological surveillance are under the jurisdiction of this unit.* Currently, only three diseases are under International Sanitary Regulation: plague, yellow fever, and smallpox; other important communicable diseases are kept under surveillance. (58)

2.2. Elements of Surveillance

As applied to communicable diseases, surveillance has been defined as "the exercise of continuous scrutiny of, and watchfulness over, the distribution and spread of infections and factors related thereto, of sufficient accuracy and completeness to be pertinent to effective control." (70) A wide variety of sources of data on disease occurrence and on the characteristics of the populations at risk contribute to surveillance. These sources vary from country to country depending on the stage of development and sophistication of the public health services, the quality and extent of laboratory facilities, the available funds, and the characteristics of the indigenous diseases. The major features have been summarized in ten "elements of surveillance" by the WHO (1968) and are listed in Table 1.

2.2.1. Mortality Registration. Mortality registration is the oldest form of disease reporting and has the advantage of being legally required and of a high order of completeness in most countries. Since a physician or other health practitioner is usually in attendance, there is a reasonable expectation that

* The WHO Serum Reference Banks are located at the Institute of Epidemiology and Microbiology, Prague, Czechoslovakia; Department of Epidemiology and Public Health, Yale University School of Medicine, New Haven, Connecticut; and the National Institutes of Health, Tokyo, Japan. A fourth established at the South African Institute of Medical Research, Johannesburg, South Africa, is no longer an official WHO unit.