CHAPTER 15

Measles

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1. Introduction

In 1948, Kenneth Maxcy(69) wrote in a chapter on epidemiology, "The simplest of all infectious diseases is measles." That was before the virus had been isolated or any serological test had become available. Several complicating situations have been found in the intervening years, but they are rare, and Maxcy's statement is true now, more than 30 years later, as it was then. This relative simplicity makes measles an ideal model for the study of infectious-disease epidemiology. Babbott and Gordon(5) reviewed our knowledge of measles epidemiology as of 1954. Much has been clarified since.

Measles is a relatively distinct disease both clinically and etiologically. The confusion that has sometimes occurred between measles and other exanthems, especially rubella and scarlatina, can usually be avoided except in sporadic atypical cases. A macular exanthem is the most prominent sign of measles in the Caucasian race, but the enanthem, referred to as Koplik spots, is more specifically characteristic. Respiratory-tract involvement that peaks with the onset of rash, but that may be complicated by secondary invaders, probably causes most of the mortality. The central nervous system is regularly involved to a minor degree, and frank encephalitis, which is usually immunologically mediated, occasionally follows as a delayed manifestation of the disease. Mortality is low when the underlying health is good, but it may reach 10% or more in unfavorable circumstances, and worldwide it is estimated(41) that measles accounted for 1% of all deaths in a typical prevaccine year.

2. Historical Background

The writings of Abu Becri(1), known by his hometown name of Rhazes, provide our earliest description of measles. Rhazes lived in the 10th century, but he quoted other authors on measles from as far back as Al Yehudi, who lived in the 7th century.* Rhazes looked on measles as a relatively severe disease and considered it "more to be dreaded than smallpox." It is curious, then, that measles had not been described earlier; smallpox had been accurately described by Galen in the 2nd century A.D.

Hasbah, the Arabic word for measles, which Rhazes used, seems to be reasonably specific, although other exanthems were doubtless confused. This word carries much the same connotation as the English word "eruption." The precision of this name in Arabic is in contrast to classic Greek, which had no specific word, and Latin, which came to use the descriptive terms rubeola and morbilli only during the Middle Ages. The Teutonic languages have a common root word, mazer, which became Masern

* Some confusion has appeared in recent literature through the fact that the 1st century after the Hegira has been mistaken for the 1st century of the Christian era in dating Al Yehudi's life.
in German and mislingar in Icelandic, as well as "measles" in English. The divergence of the Teutonic words suggests considerable antiquity for the original recognition of the disease in northern Europe.

Measles requires a human population of several hundred thousand persons if it is to find a sufficient supply of new susceptibles to permit continuance of the virus. Populations of this size did not exist prior to development of the Middle Eastern river-valley civilizations. Therefore, measles, as we now know it, must have arisen since that time, possibly by adaptation of rinderpest or canine distemper virus to man. This puts the appearance of the disease after 2500 B.C. The linguistic evidence suggests that it was much later than that. There were massive epidemics in the Roman Empire starting in 165 and in 251 A.D. and two similar epidemics in China in 162 and 310. McNeil(20) suggests that each of these represented virgin-soil outbreaks of smallpox and measles. Historical records suggest that smallpox came first in the West and measles first in the East.

Rhazes recognized the seasonal nature of measles epidemics, but seems not to have considered the disease infectious. Rather, he believed it a necessary part of growing up. Sydenham, the first to describe measles in northern Europe, appears to have considered it infectious, but the first clear demonstration of this may be attributed to Home, who, in 1758, attempted a procedure with measles analogous to variolation with smallpox.

In 1846, Peter Panum went to the Faroe Islands to give help during a measles epidemic. While there, he carried out an extraordinarily fruitful investigation that led him to conclude that the source of this disease was solely through contagion. He was also able to define the 14-day incubation period and to show that infection conveyed lifetime immunity. Hirsch(55) then built on Panum's work to reach the conclusion that an epidemic persisted "so long as there are found susceptible individuals affording the poison a soil adapted to its reproduction, whilst it perishes if there be no ground to reproduce itself." A very modern concept of the epidemic cycle involving input of new births and output of immunes to maintain a fluctuating population of susceptibles within stable limits was formulated by Hamer(52) in 1906.

Work on the epidemiology of measles continued in the 20th century because this was obviously a good model for the development of epidemic theory, but there were more false starts than constructive discoveries, and the picture became quite confused until 1954. In that year, Enders and Peebles(40) isolated the virus and demonstrated immune reactions by neutralization and complement-fixation tests. The serological tests proved to be of immense value in delineating the epidemiology of natural measles. The isolated virus was attenuated to provide a vaccine the use of which fundamentally changed the epidemiological pattern of this disease wherever it has been extensively used. These products of Enders's and Peebles's work are part of our modern understanding of this disease and will be described in subsequent sections.

3. Methodology Involved in Epidemiological Analysis

3.1. Sources of Mortality Data

Measles mortality rates are tabulated in the World Health Statistics Annual WHO, Geneva, and by various national vital statistics publications as, for instance, the Vital and Health Statistics published by the National Center for Disease Control (CDC) of the United States. Mortality rates are affected by intercurrent problems such as malnutrition and the age at which measles is contracted, so they do not give an accurate picture of measles incidence. Sometimes, however, where case reporting is very poor, mortality data may offer a better picture of changes in incidence within one political jurisdiction than those available from reported cases.

3.2. Sources of Morbidity Data

The reporting of measles cases to public-health authorities is mandatory in most sociologically advanced countries. However, measles is so commonly regarded as a routine part of childhood that reporting is notoriously incomplete. National statistics for the United States before 1967 probably included only 10-15% of the actual cases. Recognition of infection has also been inhibited by modification by γ-globulin injection in the prevaccine years and by atypical measles in inadequately immunized persons more recently. Confusion with other exanthems is also a problem in interepidemic periods,