1. Introduction

Nontyphoidal salmonellosis refers to disease caused by any serotype of the genus *Salmonella* with the exception of *Salmonella typhi* (see Chapter 36). There are approximately 1700 serotypes and variants that are potentially pathogenic for animals and man. Recently, the *Salmonellae* have been classified into three primary species: *Salmonella typhi*, *Sal. choleraesuis*, and *Sal. enteritidis*. The first two species have only one serotype each, leaving the other 1700 serotypes in the species *Sal. enteritidis*. Thus, using formal taxonomic classification, one would designate serotypes as follows: *Sal. enteritidis* serotype *enteritidis* or *Sal. enteritidis* serotype *agna*. For convenience, we will bypass this awkward formality in favor of using the more familiar convention of designating an organism by the genus and serotype, such as *Sal. enteritidis* or *Sal. agona*.

Nontyphoidal salmonellosis is a disease of great public health importance. Approximately 20,000 isolations of these organisms from humans are reported in the United States each year; when large epidemics have been investigated, this reported incidence has been documented to represent only about 1% of the actual number of infections. Therefore, it can be estimated that 1% of the United States population is infected annually. It is the dramatic, nationwide, common-source outbreaks that raise the level of conciousness concerning the public-health importance of this organism, but sporadic cases are much more common, and many mechanisms of transmission are overlooked.

Most nontyphoidal *Salmonellae* are highly adapted to both animals and man and are therefore ubiquitous in nature. There are, however, several serotypes that, like *Sal. typhi*, are particularly well adapted to man, including *Sal. paratyphi* (formerly *Sal. paratyphi A*), *Sal. schottmulleri* (formerly *Sal. paratyphi B*), *Sal. hirschfeldii* (formerly *Sal. paratyphi C*), and *Sal. sendai*. Animal infection is very unusual with these serotypes, and, as with *Sal. typhi*, human-to-human transmission is the predominant mechanism of infection. As outlined below, the other forms of nontyphoidal salmonellosis are transmitted from animals to humans as well as from human to human.

“Enteric fever” or typhoid fever is usually caused by *Sal. typhi*, but it should be noted that typhoidal disease can be caused by many other *Salmonella* species (see Chapter 36). The most common manifestation of disease with nontyphoidal *Salmonellae* is gastroenteritis. In addition, bacteremia, focal infection, or the asymptomatic carrier state may occur.
Their ubiquity in nature, genetic plasticity with multiple serotypes, and ability to mutate and to acquire antibiotic resistance, as well as their wealth of clinical presentations, make these organisms fascinating human pathogens.

2. Historical Background

The name *Salmonella* was derived from D. E. Salmon, who, along with Theobald Smith, first described an organism of this group in 1885. The first recorded outbreak of *Salmonella* occurred in Germany in 1888; in this outbreak, a young man consumed raw meat and died from acute gastroenteritis. Gartner isolated the organism from both the meat and the patient and termed the organism *Bacillus enteritidis*. Another outbreak ascribed to salmonellosis was documented in 1895 by Van Ermegen. Interestingly, a famous veterinarian-cum-meat inspector refused to believe that certain sausages could be unfit for consumption and, to prove his point, consumed a portion himself. Thereupon, he became violently ill and expired; *Sal. enteritidis* was isolated from the late incredulous inspector and the suspicious sausages.

Efforts at control of this infection in the United States were undertaken in 1906 when the Federal meat-inspection act was passed. The purpose of this legislation was to prevent the sale and consumption of diseased meat, in an attempt to prevent outbreaks such as the one described by Gartner.

The history of nontyphoidal salmonellosis is replete with interesting outbreaks that have illustrated new and unrecognized reservoirs of infection or novel routes of transmission. Recognition of the multifaceted routes of transmission paved the way for the enactment of a succession of new control measures. For example, the occurrence of salmonellosis in association with cake mixes, cream pies, and products containing dried or frozen eggs enabled health officials to force passage of laws requiring pasteurization of liquid eggs that are to be dried or frozen for interstate shipment. When dry milk became associated with human salmonellosis, operations in dry-milk plants were changed so that pasteurization of milk took place prior to drying. Another example of a recently enacted control measure was prompted by the observation that rare, precooked roast beef was associated with *Sal. newport*; regulations have been changed to assure more adequate cooking. Control measures have also been applied to pet animals. After the finding that pet turtles were vehicles for as much as 20% of sporadic cases of salmonellosis, laws were passed to control the manner in which these pets are handled in interstate commerce.

Many of these control measures were enacted as a result of outbreaks being recognized. The Centers for Disease Control (CDC) of the U.S. Public Health Service undertook nationwide surveillance activities in 1962 to determine the distribution of cases associated with commercial cake mixes contaminated by *Sal. thompson*. These activities have expanded, and they now provide much of the data on which the following discussion of nontyphoidal salmonellosis is based.

3. Methodology

3.1. Sources of Mortality Data

Reporting of mortality data is an inaccurate reflection of the true incidence of salmonellosis, since infection is usually mild and there are many asymptomatic cases. Mortality information on a nationwide scale is available only from epidemic investigations. Since these investigations also represent a small percentage of both recognized cases and recognized outbreaks, mortality information cannot reflect the true incidence of the disease.

Epidemiological investigations in both New York City and the Commonwealth of Massachusetts have examined mortality information. Insofar as all reported cases are investigated, these data probably give the best general estimates of mortality from this disease.

3.2. Sources of Morbidity Data

As mentioned in Section 2, salmonellosis surveillance activity was initiated at the CDC in 1962 in cooperation with a few states, following a report from Canada concerning *Sal. thompson* gastroenteritis associated with commercial cake mixes. In 1963, these activities were expanded to include the entire United States.

Nationwide surveillance in the United States is based on a weekly reporting system of isolations of *Salmonella* by the 50 states, the District of Columbia, the U.S. Dept. of Agriculture, and the U.S. Food