6 The benefits and disadvantages

The benefits of immunisation

We heard about the many benefits that immunisation brings to individuals, and to the New Zealand population, which include

- individual immunity
- herd immunity
- lower healthcare costs.

We learnt that immunisation is one of the most cost-effective public health interventions.

Immunisation against specific diseases

Measles

We understand that if immunisation against measles ceased, measles infection would be expected to increase to pre-vaccine levels. The Immunisation Advisory Centre estimates that this would result in between 5,000 and 6,000 hospitalisations for measles, and 20 to 60 deaths annually.

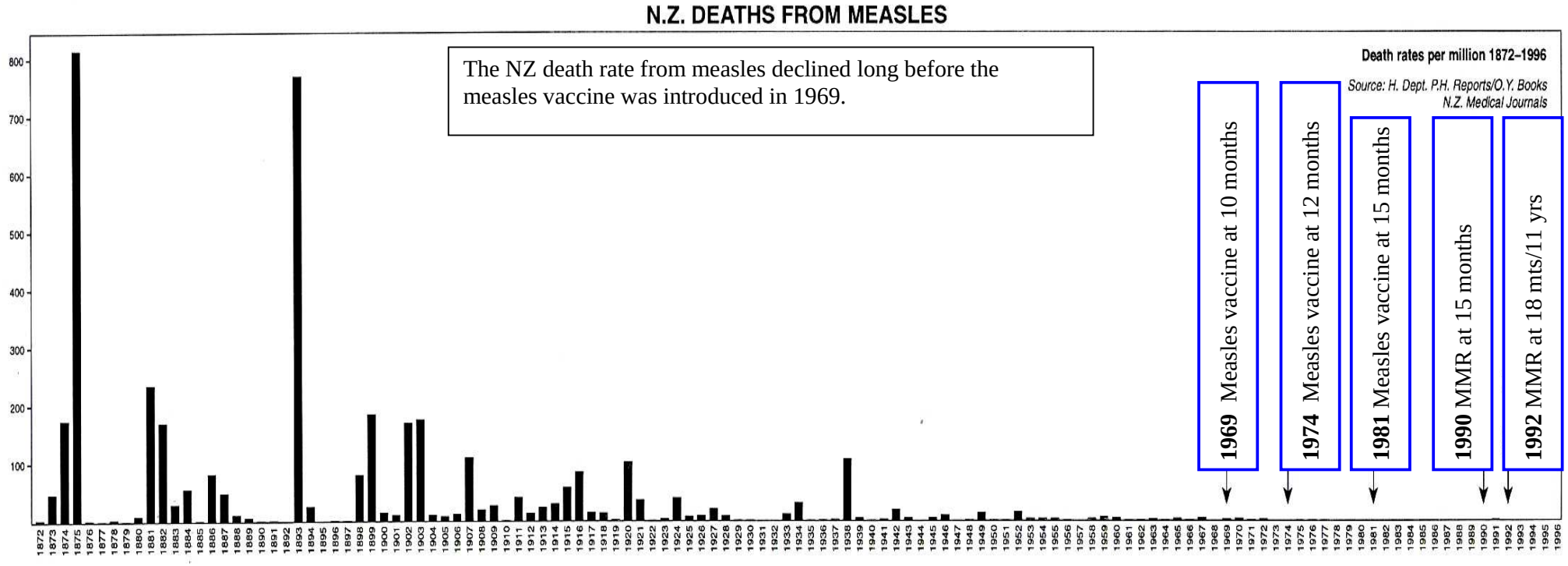
Table 1: Measles disease and vaccine risks

Disease	Risks of disease	Risks of vaccine
A highly contagious viral illness causing fever, cough, and rash	Otitis media (7 percent) Pneumonia (6 percent) Acute encephalitis (0.1 percent) Subacute sclerosing panencephalitis (one per 100,000) Case fatality rate of one to two per 1,000 Maternal measles associated with an increased risk of premature labour, miscarriage, and low-birth-weight infants	Mild local or systemic reaction (14.2 percent) Aseptic meningitis (one per 100,000) Encephalitis (one per million) Anaphylaxis (<1 per million)

Rubella

We were told that stopping rubella vaccination in New Zealand would reduce the population's immunity. Pregnant women would then be at risk of contracting rubella and passing congenital rubella syndrome on to their infants.

N.Z. DEATHS FROM MEASLES
Death rates per million 1872-1996



Source: Health Dept. P.H Reports/O.Y. Books N.Z. Medical Journals

For several years now the principal causes of death have been thus tabulated. The year 1931, compared with 1930, gave in round numbers 150 fewer deaths in a population increased by 20,000. This reduction is accounted for mainly by a lowered infantile mortality and in respect of older persons a lower rate from chest diseases and from all forms of tuberculosis, whereas there was an increased rate from influenza, accident, and suicide.

An outstanding feature noteworthy over many years is that the death-rates from the common infectious diseases appear to show a steady and definite reduction. The greatest example is typhoid fever. A five-year average taken fifty years ago gave a mortality more than forty times that for the five years ending in 1931. We still experience epidemics of scarlet fever, diphtheria, measles, and whooping-cough, but these epidemics give an annual death-rate very much lower than that experienced in former epidemics, while in the intervening non-epidemic years the sporadic cases have assumed a milder type and give a reduced death-rate. Tuberculosis also displays this very markedly over a fifty-year period, the death-rate per 10,000 of mean population in 1881 having been 13·8 compared with 4·27 in 1931, a threefold reduction. In the last six years the death-rate from this disease per 10,000 of mean population has been reduced from 5·37 to 4·27.

As is well known, the infantile death-rate of New Zealand (made up of infant deaths from all causes) has been very greatly reduced, and during recent years infants under one month of age are sharing in this lessened mortality.

These reductions are so great and so sustained that one is forced to the conclusion that good environment (to use a comprehensive term which includes measures taken to improve diet and hygiene) is steadily removing these diseases. This same tendency in lesser degree is noticeable in the vital statistics of closely populated England and is coincident in both countries with improving nutritional and hygienic conditions, including welfare measures directed mainly to those in special need of guidance or protection. The thought then arises, despite the prophesies of certain epidemiologists who, on historical grounds, predict a recurrence of high infectious disease virulence and mortality and perhaps undervalue the influence of improved environment, and those of immunologists who regard the subject as essentially one of acquired immunity, whether or not New Zealand and even closely populated England can by the maintenance or even the improvement of a good environment retain the *natural resistance of their peoples to these diseases.*

The Dominion is now unfortunately experiencing a period of want and poverty, and, pending necessary adjustments, there will be some overcrowding of persons in dwellings. Doubtless this will in some measure mar our vital statistics, but such effect is not yet noticeable. It is to be hoped that restoration of the economic balance can be achieved in order that the beneficient influence over many years of steady improvement in the nutrition and the hygienic environment of the poorer people will not be greatly lessened.

Particularly noteworthy milestones included Walter Carr's 1912 presidential address that reported a 71% decline in extrapulmonary tuberculosis, the 1927 report by the Parisian Armand-de Lille of the diagnostic value of gastric aspirates in infants, the 1930 report by Bela Schick and colleagues on the BCG vaccination introduced three years earlier in France, Detroit's Joseph Johnston's discussion in 1936 of the evolution of pediatric TB to the adult type by endogenous reactivation, and the exciting initial report in 1947 by John Lyttle and colleagues from Los Angeles of the recovery of a patient with miliary TB after streptomycin treatment (7).

Meningitis, including the invariably fatal tuberculous meningitis, was also a common affliction of children in the late 19th Century. Abraham Jacobi wrote about meningitis that the U.S. "more than any other country has been invaded by this plague" (26). At the 1896 meeting of APS, August Caillé (1854–1935) presented a paper on "Tapping the vertebral canal in the lumbar region" and the following year a paper on "Local treatment for tubercular meningitis" (19). These were the first reports to the APS of diagnostic lumbar puncture, after it had been introduced by Quincke in 1891 as a treatment modality (2, 7). Two additional papers presented in 1896 discussed lumbar puncture in the subarachnoid space, which provided a scientific basis for studying meningitis, with measurement of sugar and protein, and a potential route of administering therapy, such as it was in the late 19th and early 20th Centuries (7).

Summer Diarrhea and the Milk Supply. In addition to the introduction of intubation techniques and diphtheria antitoxin, an exceptionally important advance during the late 19th Century and early 20th Century was the result of efforts by concerned pediatricians and others to secure a safe and sanitary milk supply for infants (5). Nonbreast-fed infants experienced particularly high mortality rates, because much of the cow milk supply was "swill milk," which came from cows fed only distiller's mash, housed in incredibly filthy conditions, without fresh air, exercise or hay, many of which were also infected by bovine tuberculosis (2, 5, 7, 22).

Job Lewis Smith, who was one of the first to differentiate rubella from rubeola and wrote several papers on neonatal tetanus, served as the second APS President in 1890, 18 years after he had written in his textbook that more than half of New York's infants who were spoon-fed (*i.e.* not nursed or wet-nursed) in the summer, died before fall (27). He strongly urged milk sterilization and wrote and spoke about the dangers of artificial infant feeding. Bacteriologic studies of milk began to establish a scientific basis for the association of impure milk with infant diarrheal illnesses, including the work of the pediatrician Escherich in 1886, Shiga in 1898, and Flexner in 1900. The genera Escherichia and Shigella (as well as the species *Shigella flexneri*) honor these pioneer bacteriologists. William D. Booker's major area of interest was summer diarrhea of infancy. He presented a paper at the first APS scientific meeting in 1889 on that topic (7), and he devoted his presidential address in 1901 to the early history of summer diarrhea in America from colonial times (21).

The problem of summer diarrhea and its increasingly clear relationship to contaminated milk in the urban poor was highlighted by the report of 1500 infant deaths per week in New York City during the hot weather summer months that were associated particularly with bottle feeding (28). Considerable attention of organized pediatrics was focused on this issue, particularly by Henry L. Coit (1854–1917), Smith, Rotch, Isaac Abt, Schick, and others, who advocated movement toward certified safe milk (5, 11). Coit began as early as 1887 to work tirelessly to ensure a safe milk supply for infants, after the death of his young son, by educating the public, lawmakers, and the medical community (5). He coined the term "Certified Milk" and established the first Medical Milk Commission in New Jersey (19). Henry Koplik (President of APS in 1900) established the first American clean milk depot in New York in 1889 (called Gouttes de Lait), and Thomas Morgan Rotch (a Founder of APS and President in 1891) organized the Walker-Gordon farms that led to the first milk laboratory for preparing safe milk formulas.

Pasteurization of milk by heating was introduced in Europe before 1890 (and had been used for wine since 1864!), and it was promoted particularly by Jacobi in the U.S. during the 1890s for its ability to prevent milk-borne infections. Many other academics preferred certification as an alternative to pasteurization, fearing that the latter would alter the chemical composition of milk and promote gastroenteritis. This proved wrong (29). Jacobi collaborated with the philanthropist Nathan Straus to establish pasteurization plants and milk stations for poor infants in New York beginning in 1893. A reduction in infant mortality of 65% was observed in just one year in the foundling hospital on Randall's Island after a pasteurization plant was established there by Straus (2, 5). However, it was not until 1908 that Chicago became the first city in the world to require pasteurization of milk, with many cities following thereafter (5). Controversy in this area was apparent early on, best exemplified perhaps by the resignation from the APS in 1892 of Arthur V. Meigs of Philadelphia, who argued vehemently against milk sterilization and who continued to reject the germ theory of disease until his death in 1912 (6, 21).

Thomas M. Rotch (1849–1914) was America's first full Professor of Pediatrics, appointed at Harvard in 1893. Rotch published a major textbook of pediatrics in 1896 as well as early reports of the value of the roentgen ray in pediatrics, in addition to his detailed studies of milk. Although extremely focused on the biochemical composition of milk, calculating in minute detail the precise amounts of protein, fat and sugar content of milk for infants, he also recognized the importance of a safe milk supply and worked to achieve that goal. The improved milk supply was complemented by studies, primarily at Johns Hopkins, by Holt, James Gamble, W. McKim Marriott, John Howland, and others, that led to understanding the roles of acidosis and dehydration in contributing to the mortality of infants and children with acute diarrhea. This led directly to effective rehydration and correction of electrolyte imbalances in such children with improved outcomes (25).

Scarlet Fever. In the latter decades of the 19th Century, case-fatality rates for scarlet fever were very high, particularly in the youngest children. Holt's 1897 textbook, The Diseases of Infancy and Childhood, indicated the case-fatality rate to be as high as 55% in those under one year and 7% to 22% in those under three years (30). Wide year-year fluctuations were some-

times observed, with annual death rates during the decade of the 1850's, for example, from as low as 6/100,000 to a high of 272/100,000 population. Representative case-fatality rates during the latter years of the 19th Century were 12.3% in New York in 1889, 20% in 1886–1888 in Providence, RI, and 11.8% in Philadelphia in 1897 (21.8% for those 1–5 years old) (5). In addition to person-person spread of streptococcal infections including scarlet fever, contaminated milk was also shown to produce explosive epidemics of very acute streptococcal pharyngitis with high mortality. This provided an additional reason to support pasteurization of milk (7).

By the close of the 19th Century, scarlet fever had overtaken diphtheria as a cause of death, occurring with great frequency and often with high case-fatality rates. The 1894 pediatric text of Louis Starr (1849–1925) described scarlet fever as the most widely disseminated of the childhood exanthems and "the most dreaded of all the diseases of children." (31)

Poliomyelitis. Poliomyelitis, which was initially described in Underwood's first edition in 1784, was brought to general medical attention by Jacob von Heine (German). von Heine was a pioneer of orthopedics who published a classic monograph on infantile paralysis and its resultant deformities in 1840, and he recognized the spinal cord localization of the pathology (3). The classic French pediatric text of Rilliet and Barthez (1838–1843) provided an early account of polio, and Guillaume-Benjamin-Amand Duchenne (French) localized the lesion in polio to the anterior horn cells in 1855 (18). Later in the 19th Century, Oscar Medin (Swedish) first noted the epidemic character of polio when he observed an outbreak of 44 cases in Stockholm in 1887 (18). In 1894 a larger epidemic of 132 cases occurred in Rutland County, VT (5).

EARLY TWENTIETH CENTURY

From the turn of the century until about 1915, the pediatric community focused particularly upon major public health and welfare issues that adversely affected children, working particularly hard to improve the milk supply. Walter L. Carr's 1912 presidential address to the APS very clearly spelled out the impressive improvements in the health of children that had occurred during the early years of the 20th Century (7). Infant mortality in greater New York City declined 40% from 203/1000 live births in 1898 to 120 in 1911. As a consequence of the efforts to improve the milk supply, diarrheal deaths had declined 43%. Mortality from measles, scarlet fever, pertussis, and diphtheria had declined 54%, while that from acute respiratory disease including pneumonia fell 32% (7).

During the period from 1881 to 1914, the etiologic agents of more than 30 infectious diseases were identified (32). As microbiologic advances were made, American Pediatric Society meetings continued to include many papers related to epidemic infectious diseases including summer diarrhea, poliomyelitis, typhoid fever, gonococcal infection, and meningococcal meningitis. Increasingly large U.S. poliomyelitis epidemics occurred, primarily affecting children, for example in New York City in 1907, with almost 3000 cases and up to 12% mortality (7). This peaked in a 1916 epidemic in the Northeast with almost 30,000 cases and 6,000 deaths, many in the New York City area, leading to massive public anxiety and aggressive public health measures including quarantine and travel restrictions (5). Progress in understanding the etiology and pathogenesis of polio was made early in the 20th Century. In Vienna in 1909 Landsteiner and Popper transmitted polio to monkeys by intraperitoneal injection of spinal cord material from a child who died early in the course of polio. Also in 1909 Simon Flexner (of *Shigella flexneri* fame) and Paul Lewis in New York extended those studies to show transmission to monkeys also after s.c., i.v., or intracerebral routes of inoculation and produced disease using filtrates of nasopharyngeal washes from polio patients (5). Additional Flexner studies from 1910–1917 showed that sera from monkeys that recovered neutralized the infectivity of polio material, that intrathecal injection of convalescent sera within 24 h of inoculation prevented paralysis, that recovered monkeys were protected against subsequent inoculation, and that recovered human patient sera contained antibodies to the infectious agent (5). Great effort was devoted by several groups to use intrathecal administration of convalescent polio sera to treat children with acute poliomyelitis but this proved unhelpful (5). The development of the iron lung by Philip Drinker in the late 1920s was a noteworthy therapeutic advance for affected patients.

During the period from 1900 to 1915, the application of serum therapy to the management of diphtheria, meningococcal and streptococcal infections served as topics for many APS presentations (19). Jacobi's second presidential address, in 1906, was entitled "The Tonsil as a Portal for Microbic and Toxic Invasion," while that of J. L. Morse in 1913 reviewed the high mortality of pertussis, especially in infants, and proposed stringent isolation (21). Specific therapy for congenital syphilis with salvarsan, introduced by Ehrlich two years earlier, was reported by LaFétra in 1912, with dramatic benefit (7). In his APS presidential address in 1923, L. Emmett Holt summarized the dramatic improvement in mortality in those less than five years old from infectious diseases in Manhattan and The Bronx from 1896–1897 to 1921–1922, with approximately an 80% decline in diarrheal deaths, diphtheria and croup, and 60% for pneumonia (33).

Over the next 2 decades (~1915–1938), academic pediatricians and their research were focused particularly upon nutrition and the biochemistry of health and disease, which during this time somewhat eclipsed infectious disease concerns (21). Nevertheless, syphilis, tuberculosis, pertussis, measles, rheumatic fever, streptococcal infections, polio, and meningitis continued to interest those caring for children, as reflected by papers presented at the annual APS meetings. Active immunization against diphtheria using toxin and antitoxin was introduced by Alfred Hess in the U.S. in 1916 (7). At the end of this era, a particularly interesting paper was presented in 1937 by Francis Schwentker, who reported the treatment of meningococcal meningitis with s.c. and intrathecal para-aminobenzenesulfonamide (sulfanilamide) (7). The first use of an antimicrobial agent in the U.S. was by future APS President A. Ashley Weech, whose unsuccessful treatment of a physician's child with *H. influenzae* meningitis with the sulfanilamide-containing compound sulfachrysoidine in 1935 has been well documented (34, 35). The actual administration of this agent was by the Chief Resident at Babies Hospital in New York, F.