The Epidemiology of Meningococcal Disease in New Zealand in 2009

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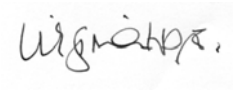

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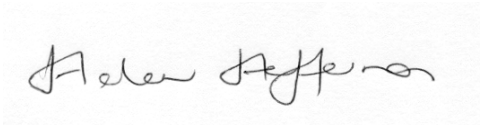

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- An epidemic of meningococcal disease began in New Zealand in mid-1991. Group B meningococci, with a P1.7-2,4 PorA type, caused the majority of the excess cases throughout the epidemic. Reviews of meningococcal disease epidemiology in New Zealand have variously been published since 1991. Information from these reports is available on request. This report provides 2009 data and some comparative historic data.

Surveillance Methods

- Surveillance of meningococcal disease is based on a combination of information from disease notifications and laboratory-based surveillance. Meningococcal isolates or DNA recovered from cases of disease are characterised to identify the strains causing disease.

Incidence and Distribution

- There were 132 cases of meningococcal disease notified in 2009, which equates to a rate of 3.3 per 100 000 population. The number of confirmed cases was 117, giving a confirmation rate of 88.6% which is the third equal highest confirmation rate since 1991.

- The rate of disease of 3.3 per 100 000 in 2009 was still higher (2.1 times) than the pre-epidemic rate of 1.5 per 100 000 (1989-1990). The highest rate of disease of 17.4 per 100 000 was recorded in 2001.

- The highest age-specific rates of disease continued to occur in children <5 years of age in 2009: 47.7 per 100 000 for those <1 year old and 16.0 per 100 000 for 1-4 year olds. The 2009 rates for these age groups were slightly higher than those of 2008.

- Although age-standardised rates have decreased significantly for all ethnic groups, Maori and Pacific Peoples continue to experience higher rates of disease than the European population.

- Between 1991 and 2009, 43.8% of the cases were European, 31.2% Maori, 19.7% Pacific Peoples, 2.9% Other ethnicity, and the remaining 2.5% were of unknown ethnicity.

- Throughout the period from 1991 through 2009 highest case numbers have consistently occurred in the upper North Island, particularly in the Counties Manukau, Auckland, Waikato and Waitemata District Health Boards (DHBs). The West Coast and South Canterbury DHBs have experienced the lowest case numbers.

- In 2009, 30.3% (40/132) of the total cases were due to the epidemic strain type defined as group B isolates with the P1.7-2,4 PorA type. The proportion of cases due to this strain in 2001, the peak year of the epidemic, was 56.9%.

- Five deaths occurred in 2009 giving a case-fatality rate of 3.8%. Since 1991 a total of 265 deaths have been recorded, an overall case-fatality rate of 4.2%. The policy of giving antibiotics prior to hospital admission, implemented in 1995, reduced the case-fatality rate for those receiving antibiotics.

1. INTRODUCTION

An epidemic of group B meningococcal disease began in New Zealand in mid-1991. Most disease was caused by a single group B meningococcal strain type defined as B:4:P1.7-2,4[1]. This led to the development of a national plan for the control and prevention of meningococcal disease[2, 3]. Initially the plan focused on the passive management of meningococcal disease through secondary prevention measures that included intensified epidemiologic surveillance, promotion of public awareness to encourage early diagnosis and treatment, notification of disease, and contact tracing to prevent secondary cases and to provide prophylactic antibiotics.

However, the plan had minimal impact on case numbers which continued to rise mostly due to the 'epidemic strain type', defined for the purposes of rapid identification and antigenic importance as B:P1.7-2,4, where the capsule group is determined as B and the PorA type as P1.7-2,4[1]. When the strain type is determined serologically, the PorA element P1.7-2 cannot be detected due to a deletion in the P1.7 epitope. The PorA strain type is therefore defined serologically as only P1.4, not P1.7-2,4. With DNA technology, both the P1.7-2 and P1.4 epitopes are detectable.

With the continuation of case numbers, a strategy to control New Zealand's epidemic through the development and use of a vaccine was formulated[4, 5]. In 2001, the year with the highest incidence rate, the Ministry of Health contracted Chiron Corporation, in collaboration with the Norwegian Institute of Public Health, to develop a strain-specific vaccine, MeNZB^{TM}, for the control of New Zealand's epidemic[4].

Following trials and regulatory approval, the Meningococcal B Immunisation Programme for those aged 6 months to 19 years began in July 2004 in Counties Manukau District Health Board (DHB) and some eastern suburbs of Auckland DHB[6, 7]. Then in November 2004, the Programme began to be progressively implemented in the remainder of the country. In February 2005, regulatory approval was extended to include young infants aged 6 weeks to 5 months.

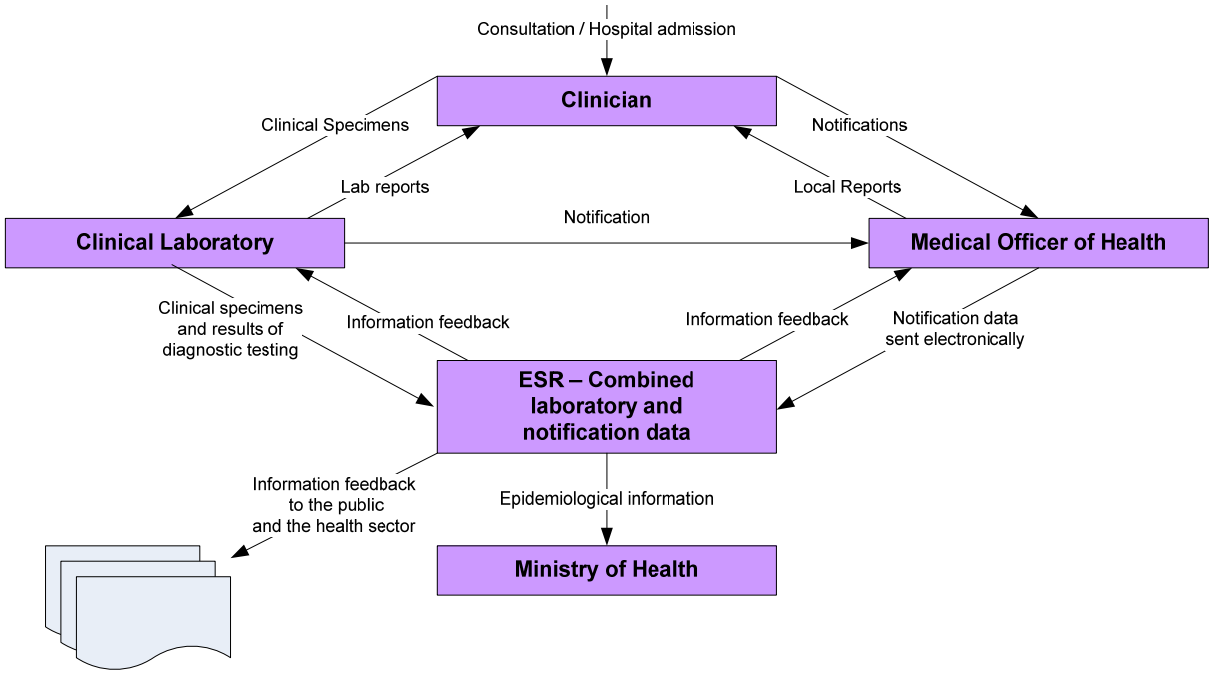
The epidemiology of meningococcal disease in New Zealand has been summarised annually as unpublished reports to the Ministry of Health accessible on the website http://www.moh.govt.nz and variously in peer-reviewed external publications[1-5, 8-10]. This report summarises the epidemiology of meningococcal disease in 2009 and reviews the trends in disease patterns that have occurred since the recognised start of the epidemic in 1991. The report aims to provide historic and recent data against which the success of the Meningococcal B Immunisation Programme to control the epidemic strain of group B meningococcal disease can be measured. In this report, the 2009 case numbers and rates are often compared with those for 2001, the peak year of the meningococcal disease epidemic. In addition, case numbers and rates before and after 2004 are compared to assess the impact of the MeNZB^{TM} vaccination campaign which commenced in 2004.

2. METHODS

2.1. Surveillance Methods

Surveillance of meningococcal disease in New Zealand is based on a combination of notification and laboratory-based surveillance (Figure 1). Meningococcal disease is notifiable to Medical Officers of Health under the Health Act 1956. Data on each case are entered at each public health unit (PHU) via a secure web-based portal onto a computerised database (EpiSurv). The real-time data are collated and analysed on behalf of the Ministry of Health by the Institute of Environmental Science and Research Ltd (ESR). Meningococcal isolates, clinical specimens, and DNA extracted from clinical specimens from meningococcal disease cases are referred to ESR for confirmation of identify and for strain typing. Additionally, results from any diagnostic testing undertaken in clinical laboratories are actively sought for all notified cases.

Figure 1: New Zealand meningococcal disease surveillance system, showing main information flows and integration of laboratory and notification information sources



Notification data in this report are based on information recorded on EpiSurv as at 18 February 2010. Any changes made to EpiSurv data by PHU staff after this date are not reflected in this report. Disease rates were calculated using 1991 population census data as the denominator for the 1990-93 period, 1996 census data for the 1994-2000 period, 2001 census data for 2001-2003, and 2006 census data for 2004-2009. Shifts in the demographics of the New Zealand population mean the accuracy of these data in representing the true population rates lessen as the years become more distant from the census year. Ethnicity-specific rates have been generated for this report using a prioritised approach[11]. The order of prioritisation used was: Maori, Pacific Peoples, Other (other groups except European), and European.

This report analyses the distribution of meningococcal disease by deprivation using the NZDep2006 index for 2001-2009 data. The index, measuring relative socioeconomic deprivation, is derived from a weighted combination of nine variables, each reflecting a different aspect of material and social deprivation. The deprivation score, which ranges from 1 (least deprived) to 10 (most deprived), is calculated for each geographical meshblock in New Zealand. Approximately equal numbers of people reside in areas associated with each of the ten deprivation levels[12].

Case Definition

The case definition in the Ministry of Health's Communicable Disease Control Manual[13] is 'Meningococcal disease presents as meningitis or meningococcal septicaemia. The disease presents as an acute fever, nausea, vomiting, and headache and may rapidly progress to shock and death. Petechial rash is seen in about 50 percent'. Cases with a clinically compatible illness are classified as confirmed or probable as follows:

Confirmed case: A clinically compatible illness with at least one of the following:

- isolation of *Neisseria meningitidis* from an otherwise sterile body site [cerebrospinal fluid (CSF), blood, aspirate or skin biopsy]; or
- a positive nucleic acid test (NAT) using polymerase chain reaction (PCR) on CSF, blood, serum or aspirate; or
- detection of Gram-negative intracellular diplococci in CSF, blood, aspirate or skin biopsy; or
- positive meningococcal antigen test on CSF.

Probable case:

- a clinically compatible illness and isolation of *N. meningitidis* from the throat; or
- a clinically compatible illness.

2.2. Laboratory Methods

Diagnostic laboratories routinely refer the following isolates and specimens from cases of meningococcal disease to ESR:

1. *N. meningitidis* isolates from CSF, blood or other normally sterile site
2. Meningococcal DNA detected in CSF, blood or other normally sterile site
3. CSF, blood or other normal sterile site specimen.

At ESR, isolates are confirmed as *N. meningitidis.* The presence of meningococcal DNA in DNA specimens and clinical specimens is confirmed. Both meningococcal isolates and DNA are further tested to determine the strain type. This testing includes identification of the capsule group, PorA and PorB types.

Strain typing: The capsular group is identified either serologically, by the slide agglutination technique using antisera specific for serogroups A, B, C, D, W135, X, Y, Z and 29E, or by PCR testing for groups B, C, W135, Y and 29E[14].

The PorA and PorB outer membrane protein (OMP) types are determined for meningococcal isolates by the whole-cell ELISA method of serotyping[15]. For whole-cell ELISA serotyping, monoclonal antibodies (RIVM, The Netherlands, and NIBSC, England) are used

to detect the following PorA antigens: P1.1, P1.2, P1.4, P1.5, P1.6, P1.7, P1.9, P1.10, P1.12, P1.13, P1.14, P1.15 and P1.16; and the following PorB antigens: 1, 2a, 2b, 4, 14 and 15. DNA sequence analysis is used to determine the PorA type when only meningococcal DNA, rather than an isolate, is available[16]. DNA sequencing is also performed on all meningococcal isolates to determine the PorA variable region epitope, which cannot be determined by whole-cell ELISA serotyping. Sequencing of the PorB gene is not routinely undertaken.

The strain type is defined using the group, PorB and PorA types. Using the epidemic strain B:4:P1.7-2,4 as an example, 'B' is the group, '4' is the PorB type and 'P1.7-2,4' is the PorA type. The PorA type has two epitopes known as variable regions (VR). In the epidemic strain, the VR1 epitope is P1.7-2 and the VR2 epitope is P1.4. The '7-2' in P1.7-2 indicates there is a specific deletion in the VR1 epitope, otherwise defined as P1.7. Monoclonal antibodies do not necessarily recognise epitopes with such deletions in the variable regions. Hence the epidemic strain is serologically defined as B:4:P1.4.

As the MeNZB^{TM} vaccine targeted the P1.7-2,4 PorA protein or antigen of the meningococcus, it was expected to be effective again all meningococci with this PorA type. Therefore, in the analyses in this report, all group B (or non-groupable) meningococci with P1.7-2,4 PorA type have been designated as the 'epidemic strain', irrespective of their PorB type.

Multi-locus sequence typing[17] may be used to further characterise isolates of interest and, when needed, restriction fragment length polymorphism (RFLP) analysis of isolates[18] is carried out for the purpose of defining clusters.

Antimicrobial susceptibility testing: The ceftriaxone, ciprofloxacin, penicillin and rifampicin susceptibilities of isolates from culture-positive cases are determined by Etest. Minimum inhibitory concentrations (MICs) are interpreted according to Clinical and Laboratory Standard Institute criteria[19].

2.3. Data Analysis

Excel 2003 was used for data analysis. The Mantel-Haenszel chi-square test was used to determine statistical significance. P-values ≤ 0.05 are considered to be significant at the 95% level of confidence.

In this report, the 2009 case numbers and rates are often compared with those for 2001, the peak year of the meningococcal disease epidemic. In addition, case numbers and rates before and after 2004 are compared to assess the impact of the MeNZB^{TM} vaccination campaign which commenced in 2004.

3. RESULTS

The analyses include all notified cases of meningococcal disease (confirmed and probable), except in the sections specified as only including confirmed cases.

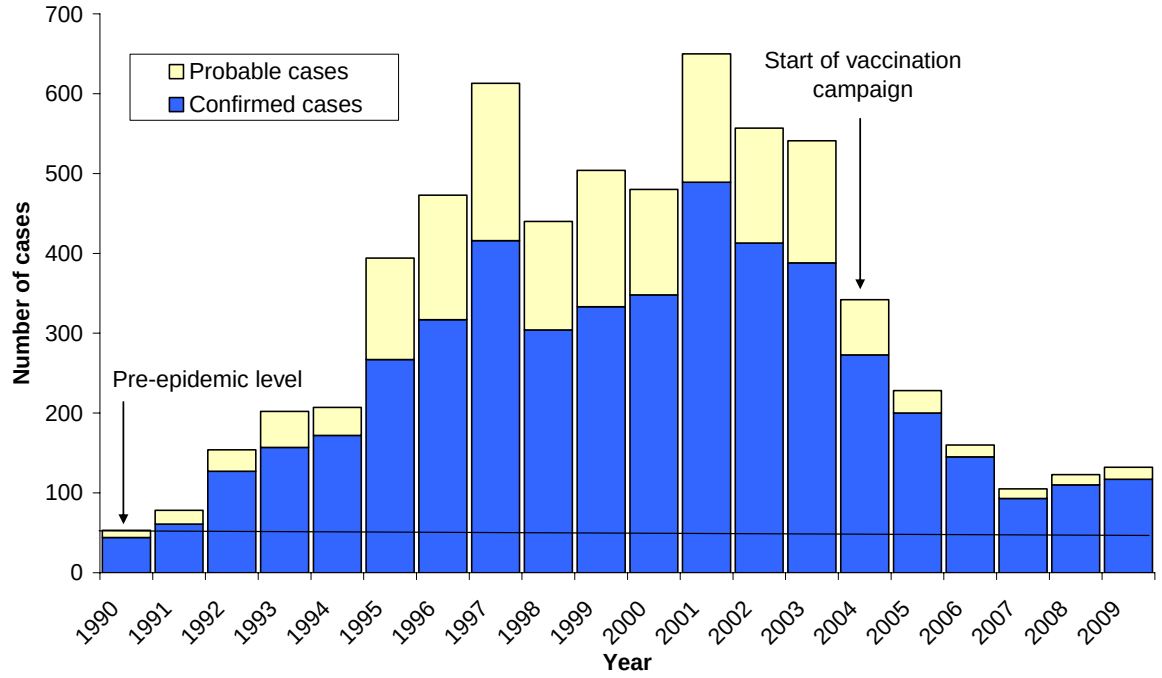
3.1. Incidence and Distribution

3.1.1. Incidence and Rates by Year

There were 132 cases of meningococcal disease notified in 2009, which equates to a rate of 3.3 per 100 000 population. 117 (88.6%) of the cases were confirmed, giving a rate of confirmed disease of 2.9 per 100 000. This proportion of confirmed cases is the third equal highest since 1991 when 90.6% of cases were confirmed.

The total number of cases reported between 1991 and 2009 was 6383 (Figure 2). The highest rate of disease was recorded in 2001 (17.4 per 100 000). The 2009 rate of disease of 3.3 per 100 000 was significantly higher ($p<0.0001$) than the pre-epidemic rate of 1.5 per 100 000 that occurred during the years 1989 and 1990, and is the fourth lowest since 1991 (2.3 per 100 000, 78 cases).

Figure 2: Total cases (confirmed and probable) notified meningococcal cases, 1990-2009

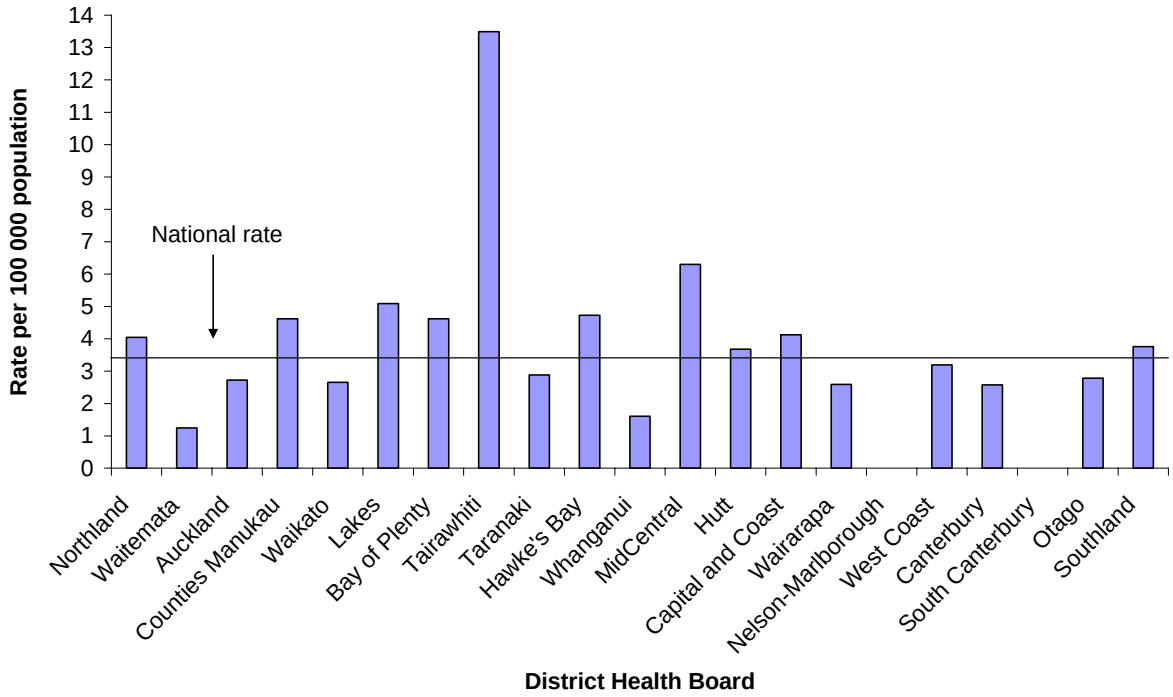


3.1.2. Incidence by Place

A marked geographic variation in the number of notified cases and rates of meningococcal disease has occurred since 1991, and 2009 was no exception. A comparison of DHB rates in 2001 and 2004-2009 is shown in Table 3 of the Appendix.

In 2009, Counties Manukau District Health Board (DHB) had the highest number of cases (20), followed by Canterbury (12), Auckland (11) and Capital and Coast (11) DHBs. However, the highest rate of disease was in Tairawhiti (13.5 per 100 000 population, 6 cases), followed by MidCentral (6.3 per 100 000, 10 cases) and Lakes (5.1 per 100 000, 5 cases) DHBs.

Figure 3: Meningococcal disease rates by District Health Board, 2009

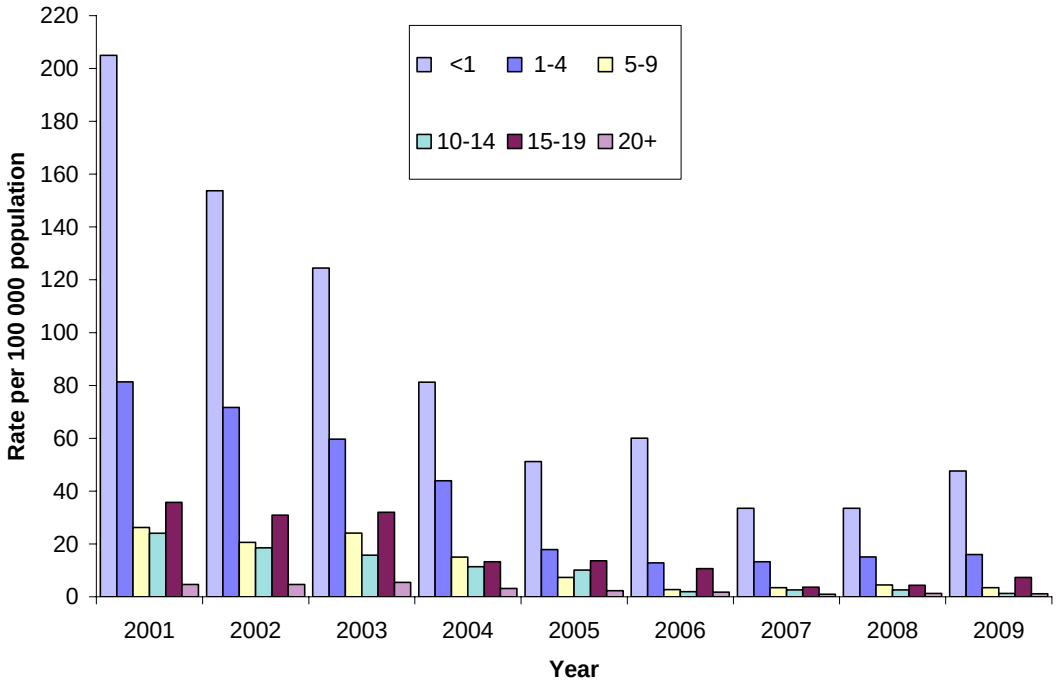


3.1.3. Incidence by Age

Consistent with previous years, in 2009 the highest age-specific rates were in those aged <1 year (47.7 per 100 000 population) and 1-4 years (16.0 per 100 000) (Figure 4 and Appendix: Table 4). As in previous years, there was a secondary peak in the rate of disease by age group, with the rate in the 15-19 years age group (7.3 per 100 000) higher than for both the 5-9 and 10-14 years age groups (3.5 and 1.3, respectively). The 2009 age-specific rates were significantly lower across all of the reported age groups ($p<0.001$) compared with the age-specific rates in the peak epidemic year of 2001.

In 2009, the percentage of cases aged <5 years was 47.0% which was lower than the peak of 56.7% in 1999 but higher than in 2004 (41.5%) (Appendix: Table 6). In 2009, 66.7% (18/27) of infants <1 year old were <6 months old at the time of their disease. This was higher than the average 50.7% (379/747) of cases occurring in the period 2001-2008.

Figure 4: Meningococcal disease rates by age group, 2001- 2009



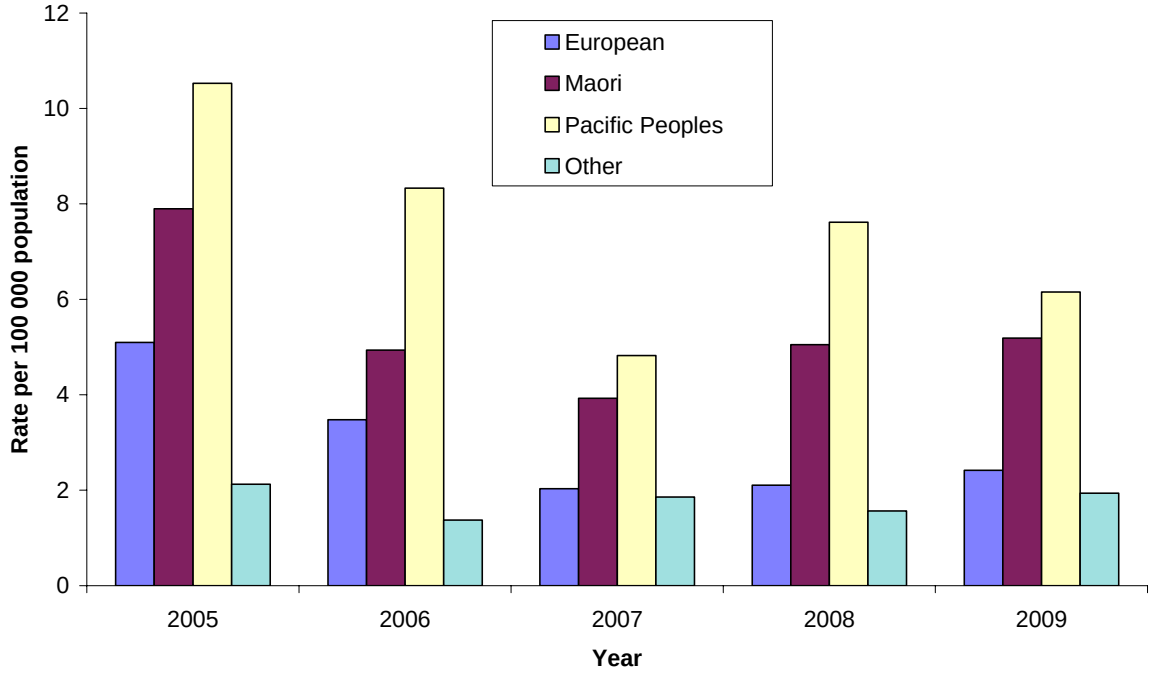
3.1.4. Incidence by Ethnicity

In 2009, the age-standardised rates for Maori (5.2 per 100 000 population) and Pacific Peoples (6.2 per 100 000) continued to be higher than the rate in the European population (2.4 per 100 000). Over the last nine years, age-standardised rates by ethnicity for meningococcal disease have been consistently higher in Maori and Pacific Peoples compared with the European population, with the highest rates observed for Pacific Peoples (Figure 5 and Appendix: Table 8).

The age-standardised rate for Pacific Peoples in 2009 was only 11.7% of that in 2001 (53.1 per 100 000). Similarly for Maori, the 2009 rate was only 20.2% of that in 2001 (25.7 per 100 000). In 2009, the rate differences for Maori and Pacific Peoples compared with Europeans were 2.8 and 3.7 per 100 000, respectively, compared with peak rate differences in 1997 of 15.3 for Maori and 58.7 for Pacific Peoples.

Although, relatively speaking, Maori and Pacific Peoples bear a disproportionate burden of meningococcal disease, due to its size, the European population has experienced a greater number of cases. Between 1991 and 2009, 43.8% of the cases were European, 31.2% Maori, 19.7% Pacific Peoples, 2.9% Other ethnicity, and the remaining 2.5% were of unknown ethnicity.

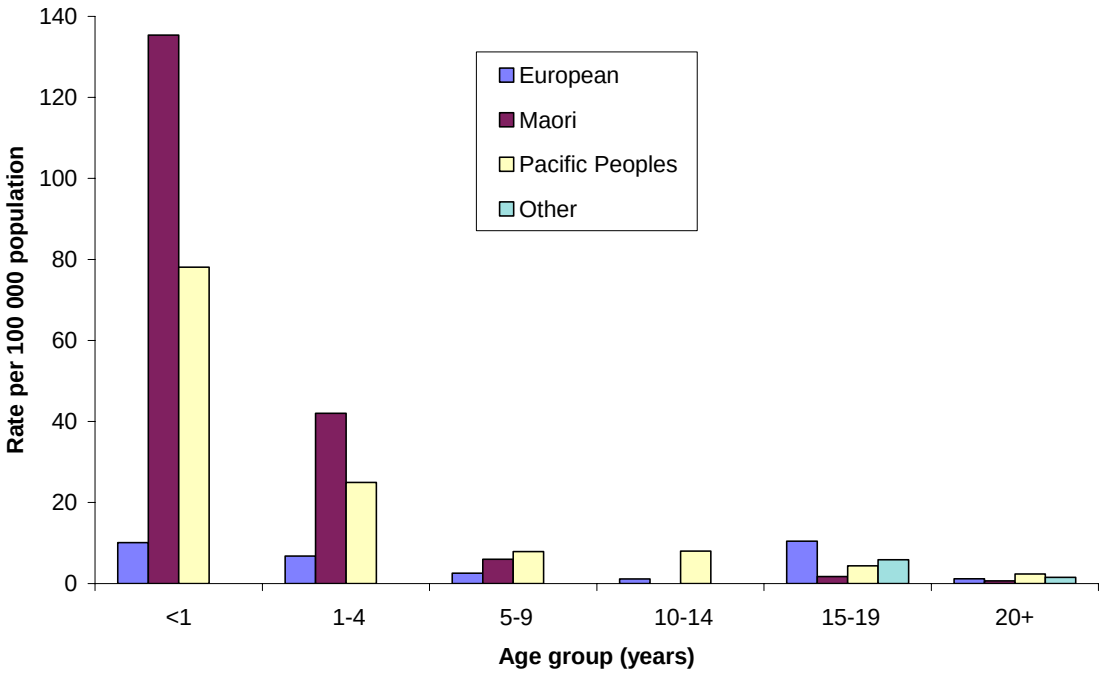
Figure 5: Age-standardised meningococcal disease rates by ethnicity, 2005-2009



Since 1991, in all ethnic groups, rates of disease were consistently highest among those <1 year of age, other than in 2008 when the rates in Pacific Peoples aged <1 year and 1-4 years were similar and in 2009 when the rates in Europeans and Other ethnicity were highest in 15-19 year olds. The highest rate in 2009 was observed in Maori aged <1 year (135.4 per 100 000, 19 cases) (Figure 6 and Appendix: Table 9). This rate is higher than the rate of 92.7 in 2008 (13 cases). In 2009, the rate for children of Pacific Peoples ethnicity aged <1 year was 78.1 per 100 000 (4 cases), higher than the 2008 rate of 39.1 (2 cases). In comparison, the rate for Europeans aged <1 year in both 2009 and 2008 was 10.1 per 100 000 (3 cases).

The median age for meningococcal disease cases was markedly different in 2009 for the different ethnicities: 1.0 year for Maori and 2.5 years for Pacific Peoples, compared with 18.0 years among the European population.

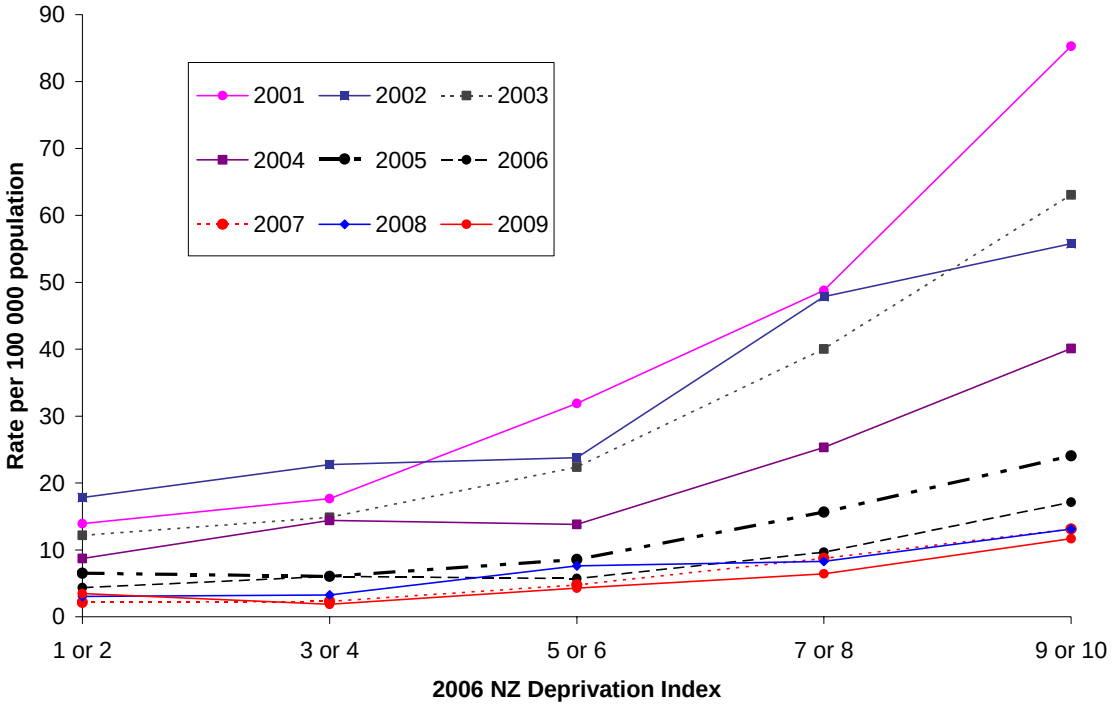
Figure 6: Meningococcal disease rates by age group and ethnicity, 2009



3.1.5. Incidence by Deprivation for Cases Aged <20 years

Inequalities in meningococcal disease rates by socio-economic status have decreased between 2001 and 2009 (Figure 7). Compared with 2001, the rate of meningococcal disease has dropped significantly ($p<0.001$) for each quintile of NZDep06, and the relative burden experienced by more deprived groups has decreased. In 2001 for those aged <20 years, individuals from the most deprived quintile had over six times the rate of meningococcal disease (85.3 per 100 000) compared with individuals from the least deprived quintile (13.9 per 100 000). From 2001 to 2008, the ratio of these two rates fluctuated between 3.1:1 and 6.0:1, and in 2009 was 3.4:1. Although, the rate of disease for <20 year olds in the most deprived quintile in 2009 was slightly lower (11.7 per 100 000) than that experienced by the least deprived quintile in 2001 (13.9 per 100 000), between 2001 and 2009 the difference in rates between these quintiles has decreased from 71.4 to 8.2 per 100 000.

Figure 7: Meningococcal disease rates by quintiles of NZDep06 for cases aged <20 years, 2001-2009



3.1.6. Confirmation of Disease Based on Laboratory Testing

Confirmation of disease is based on a hierarchical system where each case is represented in the following table (Table 1) only once, starting with the isolation of *N. meningitidis* from CSF, blood or other sterile site, followed by detection of meningococcal DNA in CSF, blood or other sterile site. In addition, if *N. meningitidis* is recovered from the eye, and a clinician notifies the case, then the case is categorised as confirmed. However, recovery of *N. meningitidis* from the throat provides presumptive evidence only, and such a case is categorised as probable.

Following intensified efforts by the Ministry of Health from 1995 to encourage general practitioner administration of pre-hospital antibiotics, the proportion of cases confirmed by isolation decreased from 83.1% in 1994 to a low of 41.1% in 2002 but has averaged around 56.2% over the last seven years (2003-2009). PCR technology to confirm the existence of meningococcal DNA in patient specimens as an alternative to culture has increased the disease confirmation rate. An average of 73.7% of cases was confirmed in the years 2001 through 2003, with an increase to 79.8% in 2004 (when the Ministry of Health encouraged laboratory confirmation of cases to assist with the monitoring of MeNZB^{TM} vaccine breakthroughs), and an average increase to 89.0% in 2005-2009. In the five years 2005-2009, just one case (2008) has been notified with a throat isolate as the basis of suspected meningococcal disease (probable category).

Table 1: Meningococcal disease, basis for diagnosis, 2005-2009[1]

Basis for diagnosis[2]	2005		2006		2007		2008		2009	
	No.	%	No.	%	No.	%	No.	%	No.	%
Isolation of *N. meningitidis* from CSF and/or blood or any other sterile site	130	57.0	86	53.8	66	62.9	78	63.4	78	59.1
Detection of meningococcal DNA in CSF and/or blood or any other sterile site by PCR	70	30.7	59	36.9	27	25.7	32	26.0	39	29.5
Confirmed – subtotal	**200**	**87.7**	**145**	**90.6**	**93**	**88.6**	**110**	**89.4**	**117**	**88.6**
Clinical criteria and a positive throat swab	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0
Clinical criteria	28	12.3	15	9.4	12	11.4	12	9.8	15	11.4
Probable – subtotal	**28**	**12.3**	**15**	**9.4**	**12**	**11.4**	**13**	**10.6**	**15**	**11.4**
Total	**228**	**100**	**160**	**100**	**105**	**100**	**123**	**100**	**132**	**100**

1 Each case is represented only once in the table.
2 No cases were confirmed on the basis of identification of Gram-negative diplococci in CSF, blood or other normally sterile site, or a positive antigen test on CSF.

3.2. Characteristics of Meningococci Causing New Zealand's Disease

3.2.1. Meningococcal Disease Cases by Strain Type

In 2009, the strain type causing 111 of the 117 confirmed cases was determined: 40 were the epidemic strain (ie, group B with P1.7-2,4 PorA protein), 37 other group B strains, 29 group C strains, three group Y strains and two group W135 strains (Appendix: Table 11).

The relative number of cases caused by the epidemic strain, other group B strains and group C strains between 2001 and 2009 is shown in Figure 8. Groups W135 and Y have been consistently uncommon.

3.2.2. Epidemic Strain Analysis

Data prior to 2004 may under-represent the number of epidemic strain cases due to changes in laboratory practices over the course of the epidemic. In the early 1990s strain typing was only performed on meningococcal isolates. The administration of antibiotics prior to hospitalisation, advocated from 1995, reduced the likelihood of isolation. From 2004 DNA analysis was introduced to enable identification of strain types when cultures were unavailable. Care is therefore required in the use of these data as it may under-estimate the actual number of cases caused by the epidemic strain.

In 2001, the peak year for disease incidence, 80.1% (370/462) of confirmed cases able to be strain typed were caused by the epidemic strain. An even higher proportion was reported in 2000 when 84.3% (269/319) of the typed confirmed cases were caused by the epidemic strain. Since the introduction of MeNZB^{TM}, the percentage of typed confirmed cases with the epidemic strain has fallen significantly ($p<0.001$) from 73.0% (184/252) in 2004 to 36.0% (40/111) in 2009. The rate of disease caused by the epidemic strain in 2009 (1.0 per 100 000 population) was significantly lower than the peak rate of 9.9 in 2001 ($p<0.001$).

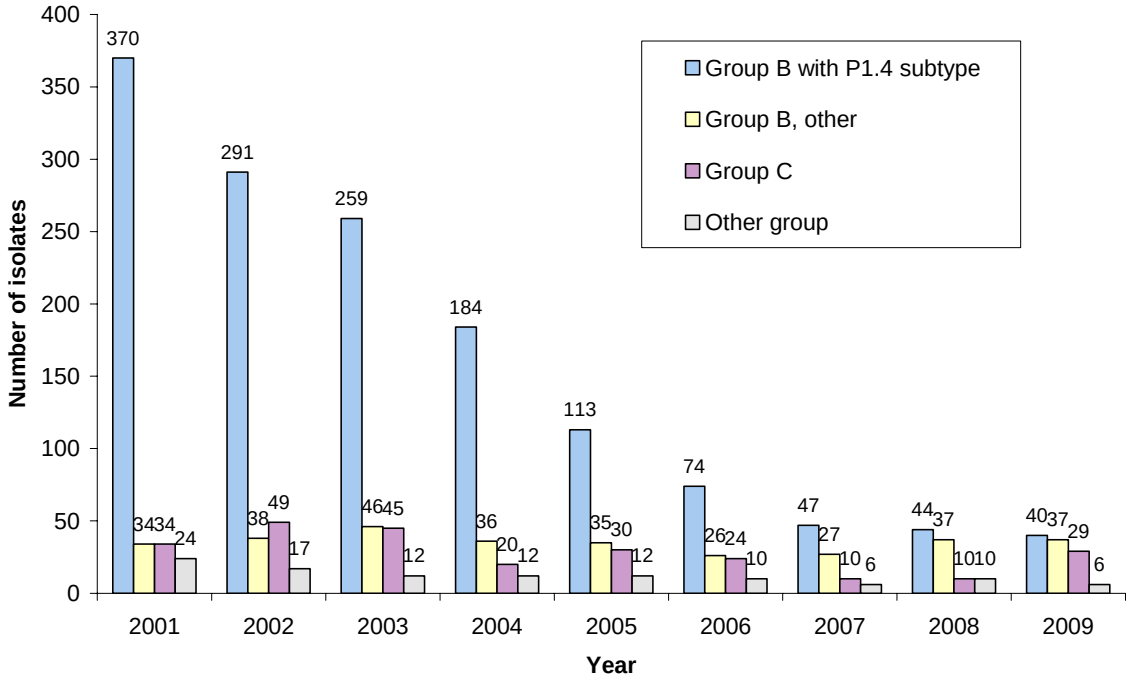
The rate of epidemic strain disease has consistently been highest in those aged <5 years, particularly in those <1 year old. For this youngest <1 year age group, the 2009 rate of 17.7 per 100 000 population (10 cases) was the same as in 2008 and lower than the rates in 2004 (33.6 per 100 000, 19 cases) and 2001 (100.6 per 100 000, 55 cases) (Appendix: Table 13).

Epidemic strain case numbers have generally decreased annually for those aged <20 years: 129 in 2004, 81 in 2005, 47 in 2006, 38 in 2007, and 31 in both 2008 and 2009. In 2001, the peak year, there were 296 cases confirmed as the epidemic strain in those aged <20 years. The crude rate of epidemic strain cases for those aged <20 years old has decreased for all ethnic groups from the peak year in 2001. The rate for Pacific Peoples was 4.1 per 100 000 population in 2009 (17.3 per 100 000 in 2004 and 75.2 per 100 000 in 2001). The rate for Maori was 7.4 per 100 000 in 2009 (16.6 per 100 000 in 2004 and 46.7 per 100 000 in 2001). The rate for European was 1.1 per 100 000 in 2009 (10.1 per 100 000 in 2004 and 16.4 per 100 000 in 2001).

Since 2004, across all age groups there have been 24 deaths due to the epidemic strain: 5 in 2004, 6 in 2005, 4 in 2006, 3 in 2007, 4 in 2008 and 2 in 2009. Of the 24 deaths, 16 (66.7%) were in <20 years old, six were ≥40 years old and two were 30-39 years old.

The impact of MeNZB™ on the numbers of cases occurring is shown in Figure 8. Although epidemic strain case numbers decreased annually from 2001, the greatest decrease occurred between 2004 and 2005 (38.5%) compared to 2001-2002 (21.4%), 2002-2003 (11.0%), 2003-2004 (29.0%), 2005-2006 (34.5%), 2006-2007 (36.5%), 2007-2008 (6.4%) and 2008-2009 (9.1%).

Figure 8: Group and dominant subtype among culture- and PCR-positive meningococcal disease cases, 2001-2009



3.2.3. Antimicrobial Susceptibility

The antimicrobial susceptibility of all 76 viable meningococcal isolates received at ESR from cases of invasive disease in 2009 was tested (Table 2).

All isolates were susceptible to ceftriaxone and ciprofloxacin. 22.4% (17/76) of isolates had reduced penicillin susceptibility (MIC ≥0.12 mg/L): 34.8% (8/23) of group C isolates, 33.3% (1/3) of group Y isolates, 16.7% (8/48) of all group B isolates and 19.2% (5/26) of isolates of the epidemic strain. Infections due to isolates with reduced susceptibility are still treatable with penicillin.

2.6% (2/76) of isolates were rifampicin resistant. These two rifampicin-resistant meningococci came from the same geographic area, but were different types: one was group B (strain B:4:P1.19,15) and the other was group C (C:2a:P1.5-1,10-8). Rifampicin resistance is rare among meningococci from invasive disease in New Zealand, with only four isolates having been identified prior to 2009.

Table 2: MIC range and MIC_{90} of isolates, 2009

Antimicrobial	MIC[1] range (mg/L)	MIC_{90}[2] (mg/L)
Penicillin	0.016-0.5	0.25
Ceftriaxone	0.002-0.004	0.002
Rifampicin	0.004-32	0.12
Ciprofloxacin	0.002-0.008	0.004

1 Minimum inhibitory concentration
2 Concentration that inhibits at least 90% of the isolates

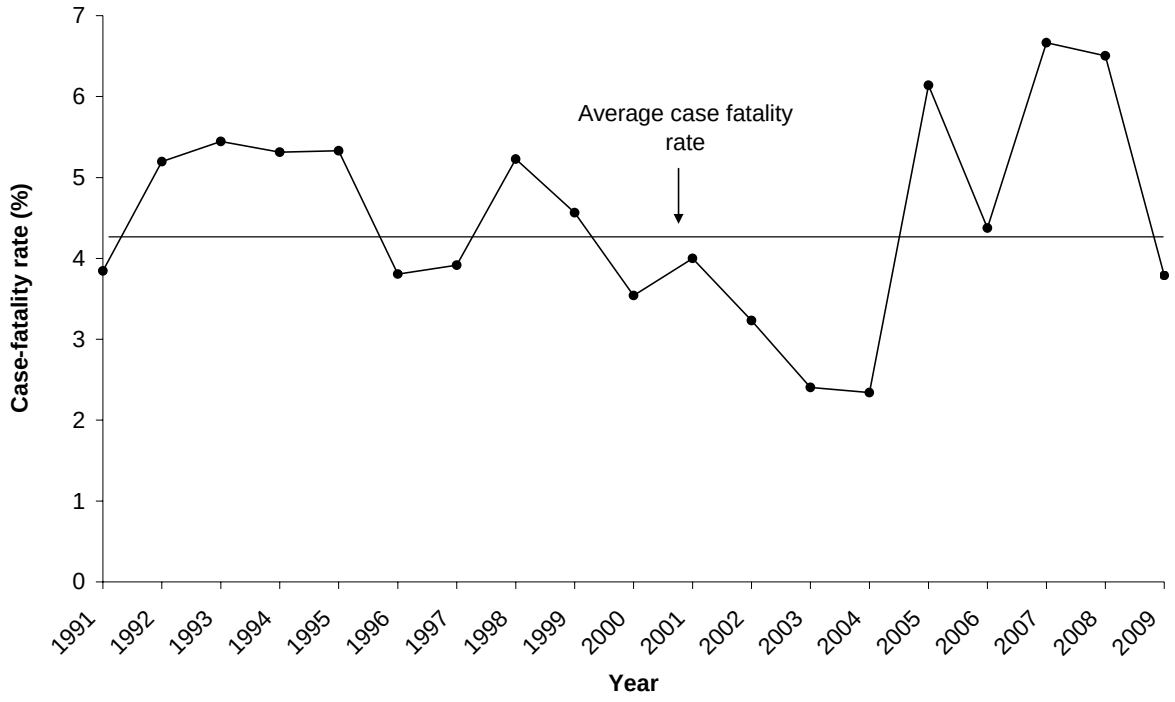
3.3. Clinical Outcome

There were five deaths due to meningococcal disease in 2009 and a case-fatality rate of 3.8% (Figure 9). The total number of fatalities since the epidemic began in 1991 is 265, giving an average case-fatality rate for the epidemic of 4.2%. This total is an excess of 205 deaths over the number that would have occurred had the pre-epidemic incidence and case-fatality (3.1%) rates continued during this 19-year period.

Of the five fatalities in 2009, three were cases due to group C strains and two were due to the epidemic strain. During the last nine years (2001-2009) the case-fatality rate for group C disease was 11.1% (28 deaths), compared to 3.9% (56 deaths) for the epidemic strain (Appendix: Table 14).

The case-fatality rate during the last nine years was greatest for those aged ≥40 years (9.2%, 28 deaths) and least for those aged 5-9 years (1.3%, 4 deaths). By ethnicity, the case-fatality rate during the last nine years was greatest for 'Other' ethnicity (13.2%, 12 deaths), followed by Europeans (3.8%, 50 deaths), Maori (3.2%, 28 deaths) and Pacific Peoples (3.0%, 16 deaths) (Appendix: Table 14).

Figure 9: Meningococcal disease case-fatality rates, 1991-2009



3.4. Case Management

Information on hospitalisation was recorded for 99.2% (131/132) of meningococcal disease cases reported in 2009. Of these 131 cases, 130 (99.2%) were hospitalised. This is similar to the 2008 rate of 97.5%.

Data on pre-hospital management were recorded for 95.5% (126/132) of cases. These data show that only 15.9% (20/126) of cases received antibiotic treatment prior to hospital admission. In 2009, there was one fatality among cases seen by a doctor prior to hospital admission and given antibiotics. In comparison there were three fatalities in those cases seen by a doctor prior to admission and not given pre-hospital antibiotics. One case was not seen by a doctor or given antibiotics.

DISCUSSION

Prior to 1991 around 50 cases of meningococcal disease were identified annually, a case rate of 1.5 per 100 000[1], a rate consistent with most industrialised countries[20, 21]. Case numbers only were notified and strain typing beyond serogroup identification was not undertaken. This changed in 1991 when a sudden increase in case numbers of meningococcal disease cases was observed. Investigation of strain types showed that the increase was due to one specific strain type defined as B:4:P1.7-2,4. Case numbers rose to a peak in 1997 with 613 cases and a rate of 16.9 per 100 000 population[22] followed by a decrease in case numbers. Then in 2001, a total of 650 cases were recorded, a rate of 17.4 per 100 000[22]. This led to the Ministry of Health fronting a campaign aimed at public awareness of the symptoms of meningococcal disease, encouraging early treatment of cases, notification of disease, and contact tracing to prevent secondary cases. The total number of cases reported from the start of the epidemic in 1991 until the end of 2009 was 6383.

The introduction of the MeNZB^{TM} strain-specific vaccine in July 2004 resulted in a statistically significant decrease in the overall meningococcal disease rate ($p<0.01$). In 2004, 342 cases regardless of strain type were reported, reducing to 228 in 2005, 160 in 2006, 105 in 2007, 123 in 2008, and 132 in 2009. The vaccination programme, except for infants <6 months of age, finished at the end of 2006. The infant programme involved a fourth dose of vaccine. Vaccination of these infants ceased in 2008.

The decline post-vaccination in epidemic strain cases has also been demonstrated by vaccine effectiveness measurements. A statistical model was developed to estimate vaccine effectiveness while controlling for confounding variables, such as disease progression over time, age, ethnicity, socioeconomic status, seasonality and geographic region. Using data from January 2001 to June 2006, the model demonstrated a statistically significant ($p<0.0001$) vaccine effect with estimated disease rates 3.7 times higher in the unvaccinated group than the vaccinated group (95% CI: 2.1, 6.8) and a vaccine effectiveness of 73% (95% CI: 52%, 85%)[23].

An improvement in health inequalities in the burden of meningococcal disease experienced by Maori and Pacific Peoples, and in individuals living in more socio-economically deprived areas was also observed during the vaccination programme. The continued monitoring of the epidemic strain is vital, particularly since the MeNZB^{TM} vaccination programme has ceased and the epidemic strain continues to cause disease.

APPENDIX

Table 3: Numbers, rates and proportion of confirmed cases of meningococcal disease by District Health Board, 2001 and 2004-2009

District Health Board	2001			2004			2005			2006			2007			2008			2009		
	No.	Rate[1]	% conf[3]	No.	Rate[2]	% conf[3]	No.	Rate[2]	% conf[3]	No.	Rate[2]	% conf[3]	No.	Rate[2]	% conf[3]	No.	Rate[2]	% conf[3]	No.	Rate[2]	% conf[3]
Northland	37	26.4	73.0	21	14.1	71.4	5	3.4	80.0	9	6.1	77.8	5	3.4	100	8	5.4	75.0	6	4.0	83.3
Waitemata	37	8.6	48.6	45	9.3	75.6	21	4.4	76.2	6	1.2	66.7	6	1.2	100	7	1.5	85.7	6	1.2	100
Auckland	79	21.5	57.0	38	9.4	55.3	16	4.0	81.3	15	3.7	86.7	8	2.0	100	10	2.5	100	11	2.7	100
Counties Manukau	126	33.6	61.1	49	11.3	83.7	30	6.9	100	25	5.8	96.0	16	3.7	93.8	16	3.7	100	20	4.6	90.0
Waikato	72	22.7	86.1	23	6.8	95.7	33	9.7	93.9	27	8.0	92.6	12	3.5	100	11	3.2	90.9	9	2.7	100
Lakes	39	40.6	100	16	16.3	87.5	7	7.1	71.4	2	2.0	100	1	1.0	100	0	0.0	-	5	5.1	100
Bay of Plenty	32	18.0	84.4	12	6.2	83.3	12	6.2	66.7	3	1.5	100	4	2.1	75.0	3	1.5	100	9	4.6	100
Tairawhiti	11	25.0	72.7	13	29.2	92.3	1	2.2	100	3	6.7	100	4	9.0	75.0	2	4.5	50.0	6	13.5	83.3
Taranaki	10	9.7	90.0	7	6.7	100	3	2.9	100	3	2.9	100	4	3.8	100	4	3.8	100	3	2.9	100
Hawke's Bay	29	20.2	65.5	15	10.1	66.7	13	8.8	69.2	4	2.7	75.0	10	6.7	60.0	12	8.1	91.7	7	4.7	85.7
Whanganui	7	11.0	100	6	9.6	83.3	0	0.0	-	0	0.0	-	0	0.0	-	5	8.0	80.0	1	1.6	100
MidCentral	20	12.9	80.0	16	10.1	75.0	15	9.4	100	7	4.4	100	2	1.3	100	2	1.3	100	10	6.3	100
Hutt	16	12.1	75.0	5	3.7	100	1	0.7	100	6	4.4	100	6	4.4	100	5	3.7	80.0	5	3.7	80.0
Capital and Coast	24	9.8	87.5	17	6.4	88.2	10	3.8	80.0	7	2.6	100	6	2.3	83.3	8	3.0	100	11	4.1	90.9
Wairarapa	11	28.8	100	1	2.6	100	5	13.0	80.0	2	5.2	50.0	1	2.6	100	2	5.2	50.0	1	2.6	100
Nelson Marlborough	12	9.8	83.3	3	2.3	100	6	4.6	83.3	5	3.8	80.0	1	0.8	100	6	4.6	83.3	0	0.0	-
West Coast	3	9.9	66.7	2	6.4	100	2	6.4	50.0	0	0.0	-	1	3.2	100	1	3.2	100	1	3.2	100
Canterbury	18	4.2	88.9	27	5.8	88.9	25	5.4	96.0	18	3.9	83.3	11	2.4	72.7	9	1.9	66.7	12	2.6	41.7
South Canterbury	3	5.7	100	2	3.7	100	3	5.6	100	1	1.9	100	0	0.0	-	2	3.7	100	0	0.0	-
Otago	54	31.6	92.6	18	10.0	72.2	15	8.3	93.3	11	6.1	100	5	2.8	80.0	5	2.8	100	5	2.8	100
Southland	10	9.7	100	6	5.6	83.3	5	4.7	100	6	5.6	100	2	1.9	100	5	4.7	100	4	3.8	75.0
Total	**650**	**17.4**	**75.2**	**342**	**8.5**	**79.8**	**228**	**5.7**	**87.7**	**160**	**4.0**	**90.6**	**105**	**2.6**	**88.6**	**123**	**3.1**	**89.4**	**132**	**3.3**	**88.6**

1 Rate per 100 000 population based on 2001 census data.
2 Rate per 100 000 population based on 2006 census data.
3 Proportion (%) of total cases which were confirmed.

Table 4: Age distribution of meningococcal disease cases, 2001 and 2004-2009

Age group (years)	2001		2004		2005		2006		2007		2008		2009	
	No.	Rate[1]	No.	Rate[2]	No.	Rate[2]	No.	Rate[2]	No.	Rate[2]	No.	Rate[2]	No.	Rate[2]
<1	112	205.0	46	81.2	29	51.2	34	60.0	19	33.6	19	33.6	27	47.7
1-4	176	81.4	96	43.9	39	17.9	28	12.8	29	13.3	33	15.1	35	16.0
5-9	75	26.2	43	15.0	21	7.3	8	2.8	10	3.5	13	4.5	10	3.5
10-14	70	24.1	35	11.4	31	10.1	6	2.0	8	2.6	8	2.6	4	1.3
15-19	95	35.8	40	13.3	41	13.7	32	10.7	11	3.7	13	4.3	22	7.3
20-29	57	11.7	31	6.0	27	5.3	17	3.3	9	1.8	7	1.4	8	1.6
30-39	25	4.3	12	2.1	10	1.7	4	0.7	6	1.0	4	0.7	4	0.7
40+	40	2.6	39	2.2	30	1.7	31	1.8	13	0.7	26	1.5	22	1.2
Total	**650**	**17.4**	**342**	**8.5**	**228**	**5.7**	**160**	**4.0**	**105**	**2.6**	**123**	**3.1**	**132**	**3.3**
<5	288	106.3	142	51.6	68	24.7	62	22.5	48	17.4	52	18.9	62	22.5
≥5	362	10.4	200	5.3	160	4.3	98	2.6	57	1.5	71	1.9	70	1.9

1 Rate per 100 000 population based on 2001 census data.
2 Rate per 100 000 population based on 2006 census data.

Table 5: Age distribution for confirmed cases of meningococcal disease and proportion of confirmed to total cases, 2001 and 2004-2009

Age group (years)	2001			2004			2005			2006			2007			2008			2009		
	No.	Rate[1]	% conf[3]	No.	Rate[2]	% conf[3]	No.	Rate[2]	% conf[3]	No.	Rate[2]	% conf[3]	No.	Rate[2]	% conf[3]	No.	Rate[2]	% conf[3]	No.	Rate[2]	% conf[3]
<1	75	137.2	67.0	34	60.0	73.9	24	42.4	82.8	34	60.0	100	17	30.0	89.5	16	28.3	84.2	24	42.4	88.9
1-4	127	58.7	72.2	74	33.9	77.1	38	17.4	97.4	23	10.5	82.1	24	11.0	82.8	30	13.7	90.9	32	14.6	91.4
5-9	48	16.8	64.0	33	11.5	76.7	16	5.6	76.2	7	2.4	87.5	8	2.8	80.0	13	4.5	100	10	3.5	100
10-14	54	18.6	77.1	31	10.1	88.6	25	8.2	80.6	5	1.6	83.3	6	2.0	75.0	8	2.6	100	4	1.3	100
15-19	78	29.4	82.1	34	11.3	85.0	40	13.3	97.6	30	10.0	93.8	11	3.7	100	12	4.0	92.3	19	6.3	86.4
20-29	47	9.7	82.5	23	4.5	74.2	25	4.9	92.6	14	2.7	82.4	9	1.8	100	5	1.0	71.4	8	1.6	100
30-39	23	4.0	92.0	9	1.6	75.0	8	1.4	80.0	2	0.3	50.0	6	1.0	100	2	0.3	50.0	4	0.7	100
40+	37	2.4	92.5	35	2.0	89.7	24	1.4	80.0	30	1.7	96.8	12	0.7	92.3	24	1.4	92.3	16	0.9	72.7
Total	**489**	**13.1**	**75.2**	**273**	**6.8**	**79.8**	**200**	**5.0**	**87.7**	**145**	**3.6**	**90.6**	**93**	**2.3**	**88.6**	**110**	**2.7**	**89.4**	**117**	**2.9**	**88.6**
<5	202	74.6	70.1	108	39.3	76.1	62	22.5	91.2	57	20.7	91.9	41	14.9	85.4	46	16.7	88.5	56	20.4	90.3
≥5	287	8.3	79.3	165	4.4	82.5	138	3.7	86.3	88	2.3	89.8	52	1.4	91.2	64	1.7	90.1	61	1.6	87.1

1 Rate per 100 000 population based on 2001 census data.
2 Rate per 100 000 population based on 2006 census data.
3 Proportion (%) of cases which were confirmed.

Table 6: Meningococcal disease cases, <5 year olds versus those ≥5 years, 1990-2009

Year	Age group		Total	% <5 years
	<5 years	≥5 years		
1990	27	26	53	**50.9**
1991	34	44	78	**43.6**
1992	62	93	155	**40.0**
1993	98	104	202	**48.5**
1994	96	112	208	**46.2**
1995	180	214	394	**45.7**
1996	242	231	473	**51.2**
1997	334	279	613	**54.5**
1998	217	223	440	**49.3**
1999	286	218	504	**56.7**
2000	239	241	480	**49.8**
2001	288	362	650	**44.3**
2002	239	318	557	**42.9**
2003	197	344	541	**36.4**
2004	142	200	342	**41.5**
2005	68	160	228	**29.8**
2006	62	98	160	**38.8**
2007	48	57	105	**45.7**
2008	52	71	123	**42.3**
2009	62	70	132	**47.0**

Table 7: Numbers and rates for cases of meningococcal disease by age group and District Health Board, 2009

District Health Board	0-4 years		5-19 years		20+ years	
	No.	Rate[1]	No.	Rate[1]	No.	Rate[1]
Northland	4	38.9	1	2.9	1	1.0
Waitemata	3	9.1	1	0.9	2	0.6
Auckland	1	3.8	2	2.6	8	2.7
Counties Manukau	14	38.6	5	4.5	1	0.4
Waikato	3	12.3	3	3.8	3	1.3
Lakes	2	26.5	3	12.8	0	0.0
Bay of Plenty	6	45.1	2	4.6	1	0.7
Tairawhiti	3	82.2	2	17.4	1	3.4
Taranaki	2	29.1	1	4.3	0	0.0
Hawke's Bay	5	47.7	1	2.9	1	1.0
Whanganui	1	24.9	0	0.0	0	0.0
MidCentral	4	38.2	4	11.1	2	1.8
Hutt	4	40.0	0	0.0	1	1.1
Capital and Coast	3	17.1	2	3.7	6	3.1
Wairarapa	1	41.2	0	0.0	0	0.0
Nelson Marlborough	0	0.0	0	0.0	0	0.0
West Coast	1	52.7	0	0.0	0	0.0
Canterbury	3	10.2	3	3.1	6	1.8
South Canterbury	0	0.0	0	0.0	0	0.0
Otago	1	10.2	4	10.6	0	0.0
Southland	1	14.4	2	9.1	1	1.3
Total	**62**	**22.5**	**36**	**4.0**	**34**	**1.2**

1 Rate per 100 000 population based on 2006 census data.

Table 8: Numbers and age-standardised incidence rates by ethnicity for cases of meningococcal disease, 2001 and 2004-2009

Ethnicity	2001		2004		2005		2006		2007		2008		2009	
	No.	Rate[1]	No.	Rate[2]	No.	Rate[2]	No.	Rate[2]	No.	Rate[2]	No.	Rate[2]	No.	Rate[2]
European	264	11.5	162	6.8	122	5.1	86	3.5	48	2.0	52	2.1	59	2.4
Maori[3]	211	25.7	104	11.2	63	7.9	44	4.9	35	3.9	41	5.1	48	5.2
Pacific Peoples[4]	155	53.1	61	19.7	34	10.5	24	8.3	15	4.8	21	7.6	17	6.2
Other	13	4.9	14	3.7	9	2.1	6	1.4	6	1.9	6	1.6	6	1.9
Unknown	7	-	1	-	0	-	0	-	1	-	3	-	2	-
Total	**650**	**17.4**	**342**	**8.5**	**228**	**5.7**	**160**	**4.0**	**105**	**2.6**	**123**	**3.1**	**132**	**3.3**

1 Rate per 100 000 direct standardised to age distribution of the total NZ population (based on 2001 census data).
2 Rate per 100 000 direct standardised to age distribution of the total NZ population (based on 2006 census data).
3 Rate is calculated using mixed Maori ethnicity.
4 Rate is calculated using mixed Pacific people ethnicity (excluding Maori).

Table 9: Numbers and crude incidence rates for cases of meningococcal disease by age group and ethnicity, 2009

Age group (years)	European		Maori		Pacific Peoples		Other		Unknown	Total	
	No.	Rate[1]	No.	Rate[1]	No.	Rate[1]	No.	Rate[1]	No.	No.	Rate[1]
<1	3	10.1	19	135.4	4	78.1	0	0.0	1	27	47.7
1-4	8	6.8	22	42.0	5	24.9	0	0.0	0	35	16.0
5-9	4	2.5	4	6.0	2	7.9	0	0.0	0	10	3.5
10-14	2	1.1	0	0.0	2	8.0	0	0.0	0	4	1.3
15-19	18	10.4	1	1.7	1	4.4	2	5.9	0	22	7.3
20-29	6	2.1	1	1.2	0	0.0	0	0.0	1	8	1.6
30-39	4	1.1	0	0.0	0	0.0	0	0.0	0	4	0.7
40+	14	1.0	1	0.7	3	5.0	4	3.4	0	22	1.2
Total	**59**	**2.2**	**48**	**8.5**	**17**	**7.5**	**6**	**1.6**	**2**	**132**	**3.3**

1 Crude rate per 100 000 population based on 2006 census data.

Table 10: Proportion of meningococcal disease cases in each District Health Board confirmed by PCR and other means, 2009

District Health Board	2009							
	No. total cases	No. confirmed cases	% total cases confirmed	No. cases confirmed by PCR	% of total cases confirmed by PCR	No. cases confirmed by means other than PCR	% of total cases confirmed by means other than PCR	No. probable cases
Northland	6	5	83.3	0	0.0	5	83.3	1
Waitemata	6	6	100	4	66.7	2	33.3	0
Auckland	11	11	100	3	27.3	8	72.7	0
Counties Manukau	20	18	90.0	8	40.0	10	50.0	2
Waikato	9	9	100	2	22.2	7	77.8	0
Lakes	5	5	100	1	20.0	4	80.0	0
Bay of Plenty	9	9	100	0	0.0	9	100	0
Tairawhiti	6	5	83.3	3	50.0	2	33.3	1
Taranaki	3	3	100	0	0.0	3	100	0
Hawke's Bay	7	6	85.7	3	42.9	3	42.9	1
Whanganui	1	1	100	0	0.0	1	100	0
MidCentral	10	10	100	3	30.0	7	70.0	0
Hutt	5	4	80.0	0	0.0	4	80.0	1
Capital and Coast	11	10	90.9	5	45.5	5	45.5	1
Wairarapa	1	1	100	0	0.0	1	100	0
Nelson Marlborough	0	0	-	0	-	0	-	0
West Coast	1	1	100	0	0.0	1	100	0
Canterbury	12	5	41.7	3	25.0	2	16.7	7
South Canterbury	0	0	-	0	-	0	-	0
Otago	5	5	100	3	60.0	2	40.0	0
Southland	4	3	75.0	1	25.0	2	50.0	1
Total	**132**	**117**	**88.6**	**39**	**29.5**	**78**	**59.1**	**15**

Table 11: Distribution of strain types among meningococcal disease cases, 2009

Group	PorA type	Number	Percentage of Group B	Percentage of total
B	P1.4	40	51.9	36.0
B	Other PorA	37	48.1	33.3
Total B		**77**	**100**	**69.4**
C		29		26.1
W135		2		1.8
Y		3		2.7
Z		0		0.0
Total		**111**[1]		**100**

1 Strain type determined for 111 of the 117 confirmed cases.

Table 12: Distribution of strain types among meningococcal disease cases by District Health Board, 2009

District Health Board	Epidemic strain (B:P1.4)		B other		C		W		Y		Total	
	No.	%	No.	%	No.	%	No.	No.	%	%	No.	%
Northland	3	7.5	1	2.7	1	3.4	0	0.0	0	0.0	5	4.5
Waitemata	3	7.5	2	5.4	1	3.4	0	0.0	0	0.0	6	5.4
Auckland	4	10.0	3	8.1	2	6.9	1	50.0	0	0.0	10	9.0
Counties Manukau	3	7.5	7	18.9	4	13.8	1	50.0	0	0.0	15	13.5
Waikato	3	7.5	4	10.8	2	6.9	0	0.0	0	0.0	9	8.1
Lakes	5	12.5	0	0.0	0	0.0	0	0.0	0	0.0	5	4.5
Bay of Plenty	3	7.5	3	8.1	3	10.3	0	0.0	0	0.0	9	8.1
Tairawhiti	2	5.0	3	8.1	0	0.0	0	0.0	0	0.0	5	4.5
Taranaki	2	5.0	0	0.0	1	3.4	0	0.0	0	0.0	3	2.7
Hawke's Bay	3	7.5	3	8.1	0	0.0	0	0.0	0	0.0	6	5.4
Whanganui	0	0.0	0	0.0	1	3.4	0	0.0	0	0.0	1	0.9
MidCentral	0	0.0	2	5.4	6	20.7	0	0.0	0	0.0	8	7.2
Hutt	0	0.0	3	8.1	0	0.0	0	0.0	1	33.3	4	3.6
Capital and Coast	6	15.0	2	5.4	1	3.4	0	0.0	1	33.3	10	9.0
Wairarapa	0	0.0	0	0.0	1	3.4	0	0.0	0	0.0	1	0.9
Nelson Marlborough	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
West Coast	0	0.0	1	2.7	0	0.0	0	0.0	0	0.0	1	0.9
Canterbury	1	2.5	1	2.7	2	6.9	0	0.0	1	33.3	5	4.5
South Canterbury	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Otago	2	5.0	0	0.0	3	10.3	0	0.0	0	0.0	5	4.5
Southland	0	0.0	2	5.4	1	3.4	0	0.0	0	0.0	3	2.7
Total	**40**	**100**	**37**	**100**	**29**	**100**	**2**	**100**	**3**	**100**	**111**	**100**

Table 13: Number of epidemic strain (B:P1.4) cases by year, 2001and 2004-2009

	2001		2004		2005		2006		2007		2008		2009	
	No.	**Rate[1]**	**No.**	**Rate[2]**	**No.**	**Rate[2]**	**No.**	**Rate[2]**	**No.**	**Rate[2]**	**No.**	**Rate[2]**	**No.**	**Rate[2]**
<1 year	55	100.6	19	33.6	11	19.4	15	26.5	7	12.4	10	17.7	10	17.7
1-4 years	100	46.3	46	21.1	24	11.0	15	6.9	18	8.2	13	6.0	12	5.5
5-9 years	43	15.0	24	8.4	10	3.5	4	1.4	4	1.4	3	1.0	4	1.4
10-14 years	40	13.8	20	6.5	15	4.9	2	0.7	2	0.7	4	1.3	2	0.7
15-19 years	58	21.9	20	6.7	21	7.0	11	3.7	7	2.3	1	0.3	3	1.0
20-29 years	35	7.2	21	4.1	13	2.5	10	1.9	4	0.8	3	0.6	2	0.4
30-39 years	18	3.1	9	1.6	5	0.9	1	0.2	4	0.7	1	0.2	2	0.3
40+ years	21	1.3	25	1.4	14	0.8	16	0.9	1	0.1	9	0.5	5	0.3
Total	**370**	**9.9**	**184**	**4.6**	**113**	**2.8**	**74**	**1.8**	**47**	**1.2**	**44**	**1.1**	**40**	**1.0**
Male	197	10.8	100	5.1	58	3.0	33	1.7	27	1.4	26	1.3	21	1.1
Female	173	9.0	82	4.0	54	2.6	40	1.9	20	1.0	18	0.9	19	0.9
Unknown	0	-	2	-	1	-	1	-	0	-	0	-	0	-
European	157	6.0	111	4.1	60	2.2	37	1.4	15	0.6	14	0.5	14	0.5
Maori	131	24.9	43	7.6	30	5.3	23	4.1	19	3.4	16	2.8	19	3.4
Pacific Peoples	74	36.9	23	10.2	19	8.4	12	5.3	10	4.4	9	4.0	5	2.2
Other	6	2.4	7	1.9	4	1.1	2	0.5	2	0.5	3	0.8	2	0.5
Unknown	2	-	0	-	0	-	0	-	1	-	2	-	0	-

1 Rate per 100 000 population based on 2001 census data.
2 Rate per 100 000 population based on 2006 census data.

Table 14: Case-fatality rates for meningococcal disease cases by age, sex, ethnicity and serogroup, 2001-2009

Features of case and infecting organism	Number of fatalities									Total fatalities 01-09	Total cases 01-09	Case-fatality rate (%)
	01	02	03	04	05	06	07	08	09			
<1 year	3	3	2	3	2	1	2	3	2	21	438	4.8
1-4 years	7	3	2	1	0	1	1	4	0	19	720	2.6
5-9 years	0	1	0	1	1	0	1	0	0	4	308	1.3
10-14 years	2	0	1	0	0	0	0	0	1	4	262	1.5
15-19 years	5	5	3	0	0	1	0	1	1	16	421	3.8
20-29 years	4	0	2	0	1	0	1	0	1	9	272	3.3
30-39 years	1	0	0	1	3	0	0	0	0	5	111	4.5
40+ years	4	6	3	2	7	4	2	0	0	28	306	9.2
Male	16	8	5	6	5	3	4	6	4	57	1543	3.7
Female	10	10	8	2	9	4	3	2	1	49	1278	3.8
European	12	10	5	2	8	3	4	3	3	50	1318	3.8
Maori	9	5	2	3	1	1	1	4	2	28	877	3.2
Pacific	4	2	3	3	1	2	1	0	0	16	530	3.0
Other	1	1	3	0	4	1	1	1	0	12	91	13.2
Unknown	0	0	0	0	0	0	0	0	0	0	22	0.0
Group A	0	0	0	0	0	0	0	0	0	0	0	-
Epidemic strain	18	9	5	5	6	4	3	4	2	56	1422	3.9
Group B other	2	1	2	0	1	0	0	2	0	8	314	2.5
Group C	3	6	6	2	4	1	2	1	3	28	253	11.1
Group W	0	0	0	0	2	0	1	0	0	3	41	7.3
Group Y	1	0	0	0	0	0	0	0	0	1	25	4.0
Group Z	0	0	0	0	0	0	0	0	0	0	5	0.0
Serogroup not determined*	0	0	0	0	1	2	0	0	0	3	168	1.8
Probable	2	2	0	1	0	0	1	1	0	7	610	1.1
Total	**26**	**18**	**13**	**8**	**14**	**7**	**7**	**8**	**5**	**106**	**2838**	**3.7**

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