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SURVEILLANCE REPORT

The epidemiology of meningococcal disease in New Zealand

2010

Prepared as part of a Ministry of Health contract for scientific services by the Health Intelligence Team, Institute of Environmental Science and Research Limited

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THE EPIDEMIOLOGY OF MENINGOCOCCAL DISEASE IN NEW ZEALAND IN 2010

Prepared as part of a Ministry of Health
contract for scientific services

by

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Introduction

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. An epidemic-strain-specific meningococcal vaccine was introduced in 2004 then removed from the immunisation schedule in 2008. This report provides 2010 data and some comparative historic data.

Meningococcal disease 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.

Key findings from meningococcal disease surveillance in 2010

- Ninety-six cases of meningococcal disease were notified in 2010, which equates to a rate of 2.4 per 100 000 population. The number of confirmed cases was 84, giving a confirmation rate of 87.5%.
- The rate of disease of 2.4 per 100 000 in 2010 was still significantly higher ($p<0.0001$) 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.
- In 2010, the highest District Health Board (DHB) rates were recorded in Hutt Valley (5.9 per 100 000 population, 8 cases) and Hawke's Bay (4.7 per 100 000, 7 cases) DHBs. No cases were reported from Whanganui, Wairarapa and South Canterbury DHBs.
- The highest age-specific rates of disease continued to occur in children younger than 5 years of age in 2010: 47.7 per 100 000 for those aged less than 1 year old and 10.5 per 100 000 for those aged 1–4 years. The 2010 rate of disease for those children aged less than 1 year was the same as in 2009 (47.7 per 100 000), while the 2010 rate of disease for children aged 1–4 years was lower than in 2009 (16.0 per 100 000).
- Ethnicity was recorded for all of the 2010 cases. Māori represented 43.8% of cases (42 cases), Europeans represented 36.5% of cases (35 cases), Pacific Peoples represented 17.7% of cases (17 cases) and Other ethnicity represented 2.1% of cases (2 cases). Although age-standardised rates have decreased significantly for all ethnic groups, Māori and Pacific Peoples continue to experience higher rates of disease than the European population.
- In 2010, 30.9% (25/81) of confirmed cases able to be typed were due to the epidemic strain type defined as group B or non-groupable meningococci with the P1.7-2,4 PorA type. In contrast, 80.1% (370/462) of confirmed cases able to be typed in 2001 were due to the epidemic strain.
- Six deaths occurred in 2010, giving a case-fatality rate of 6.3%.
- Of the 62 meningococcal isolates recovered from cases in 2010, 29% (18/62) had reduced susceptibility to penicillin, but all were susceptible to ceftriaxone and rifampicin. Ciprofloxacin resistance was identified among invasive meningococci in New Zealand for the first time in 2010 in one group C isolate.

INTRODUCTION

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], leading 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 intensifying epidemiologic surveillance, promoting 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. These cases were mostly due to the 'epidemic strain type', which is defined for the purposes of rapid identification and antigenic importance, and in this report, 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 sequencing, both the P1.7-2 and P1.4 epitopes are detectable.

With the continued rise in case numbers, a strategy to control New Zealand's epidemic by developing and using 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}, to control 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]. 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 immunisation of young infants aged 6 weeks to 5 months. MeNZB^{TM} was removed from the immunisation schedule in 2008, with routine administration of MeNZB^{TM} to children under the age of 5 years stopping from 1 June 2008.

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 in peer-reviewed external publications [1-5, 8-10]. This report summarises the epidemiology of meningococcal disease in 2010 and reviews the trends in disease patterns that have occurred since the 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 can be measured. In this report, the 2010 case numbers and rates are often compared with those for 2001, the year in which the meningococcal disease epidemic peaked. In addition, case numbers and rates before and after 2004 are compared to assess the impact of the MeNZB^{TM} vaccination campaign that began in 2004.

METHODS

METHODS

Surveillance methods

Surveillance of meningococcal disease in New Zealand is based on a combination of notification and laboratory-based surveillance. 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 EpiSurv, a computerised database. 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 and DNA extracted from clinical specimens from meningococcal disease cases are referred to ESR for strain typing. Additionally, results from any diagnostic testing undertaken in clinical laboratories are actively sought for all notified cases.

Notification data in this report are based on information recorded on EpiSurv as at 18 February 2011. 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 1990–1993 period, 1996 census data for the 1994–1998 period, 2001 census data for the 1999–2003 period, and 2006 census data for the 2004–2010 period. Shifts in the demographics of the New Zealand population mean the accuracy of these data in representing the true population rates lessens 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 Māori, Pacific Peoples, Other (other groups except European) and European.

This report analyses the distribution of meningococcal disease by deprivation using the New Zealand Deprivation Index 2006 for the 2001–2010 data as published by Statistics New Zealand. 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 10 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
- a 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.

Laboratory methods

Diagnostic laboratories routinely refer the following specimens from cases of meningococcal disease to ESR for characterisation to determine the strain type:

- *N. meningitidis* isolates from CSF, blood, or other normally sterile sites
- meningococcal DNA detected in CSF, blood, or other normally sterile sites.

Some laboratories are also requested to send isolates from non-invasive sites to help monitor strains circulating in the community.

Routine characterisation involves determining the group, serotype (PorB, for isolates only) and subtype (PorA), as follows:

- the capsular group is identified either serologically, using antisera specific for serogroups A, B, C, W135, X, Y and Z , or by PCR for groups B, C, W135, Y and 29E [14]
- the PorA and PorB outer membrane protein types of meningococcal isolates are determined by a whole-cell enzyme-linked immunosorbent assay (ELISA) using monoclonal antibodies for 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 PorB antigens 1, 2a, 2b, 4, 14 and 15. DNA sequence analysis is used to further characterise the PorA types. Sequencing of the PorB gene is not routinely undertaken
- the strain type is defined using the group, PorB and PorA types. Using the New Zealand 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 (VR1 and VR2). In the epidemic strain, the VR1 epitope is P1.7-2 and the VR2 epitope is P1.4. The ‘7-2’ indicates there is a variation in the VR1 P1.7 epitope. Monoclonal antibodies do not necessarily recognise epitopes with such variations, 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 of the meningococcus, it was expected to be effective against all meningococci with this PorA type. Therefore, in the analyses described in this report, all group B or non-groupable meningococci with the P1.7-2,4 PorA type have been designated as the ‘epidemic strain’, irrespective of their PorB type.

Data analysis

Excel 2007 was used for data analysis. The Mantel-Haenszel chi-square test was used to determine statistical significance. P-values less than 0.05 are considered to be significant at the 95% level of confidence.

RESULTS

RESULTS

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

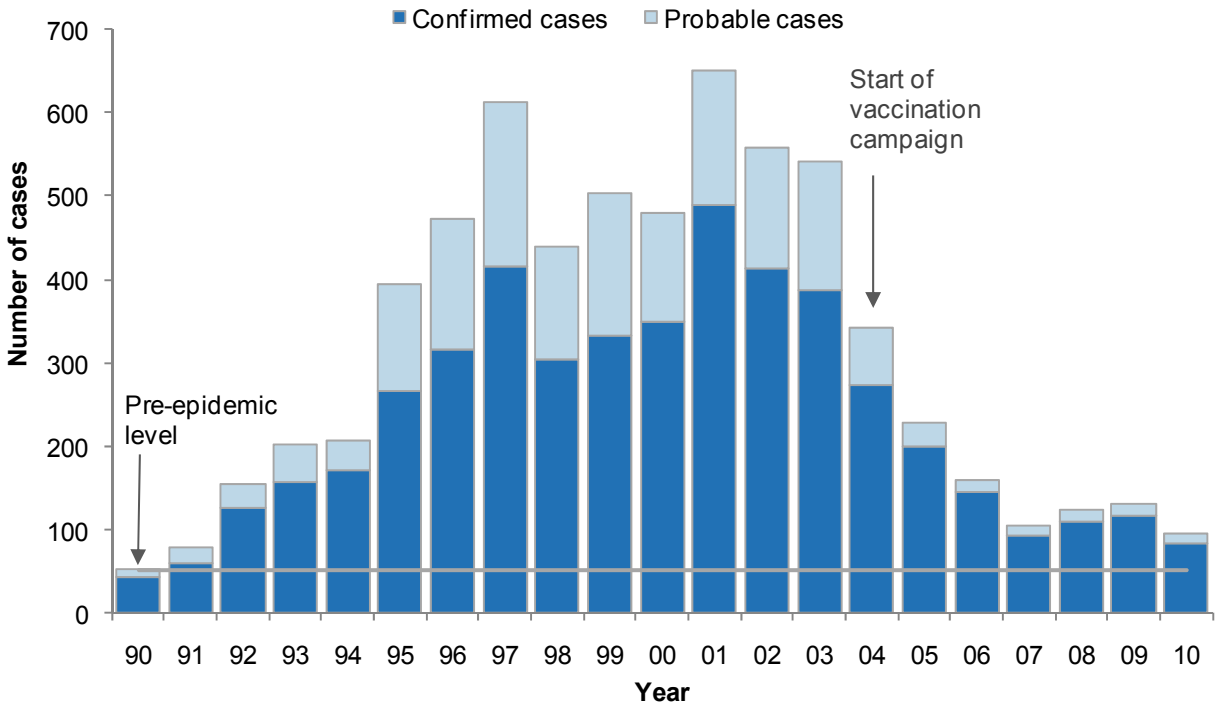
Incidence and distribution

Incidence and rates by year

Ninety-six cases of meningococcal disease were notified in 2010, which equates to a rate of 2.4 per 100 000 population (Appendix: Table 3). Eighty-four (87.5%) of the cases were confirmed (Figure 1), giving a rate of confirmed disease of 2.1 per 100 000.

The highest rate of disease was recorded in 2001 (17.4 per 100 000) (Table 3). The 2010 rate of disease of 2.4 per 100 000 population was significantly higher ($p<0.0001$) than the pre-epidemic rate of 1.5 per 100 000 that occurred during 1989 and 1990.

Figure 1. Total cases (confirmed and probable) notified meningococcal cases, 1990–2010

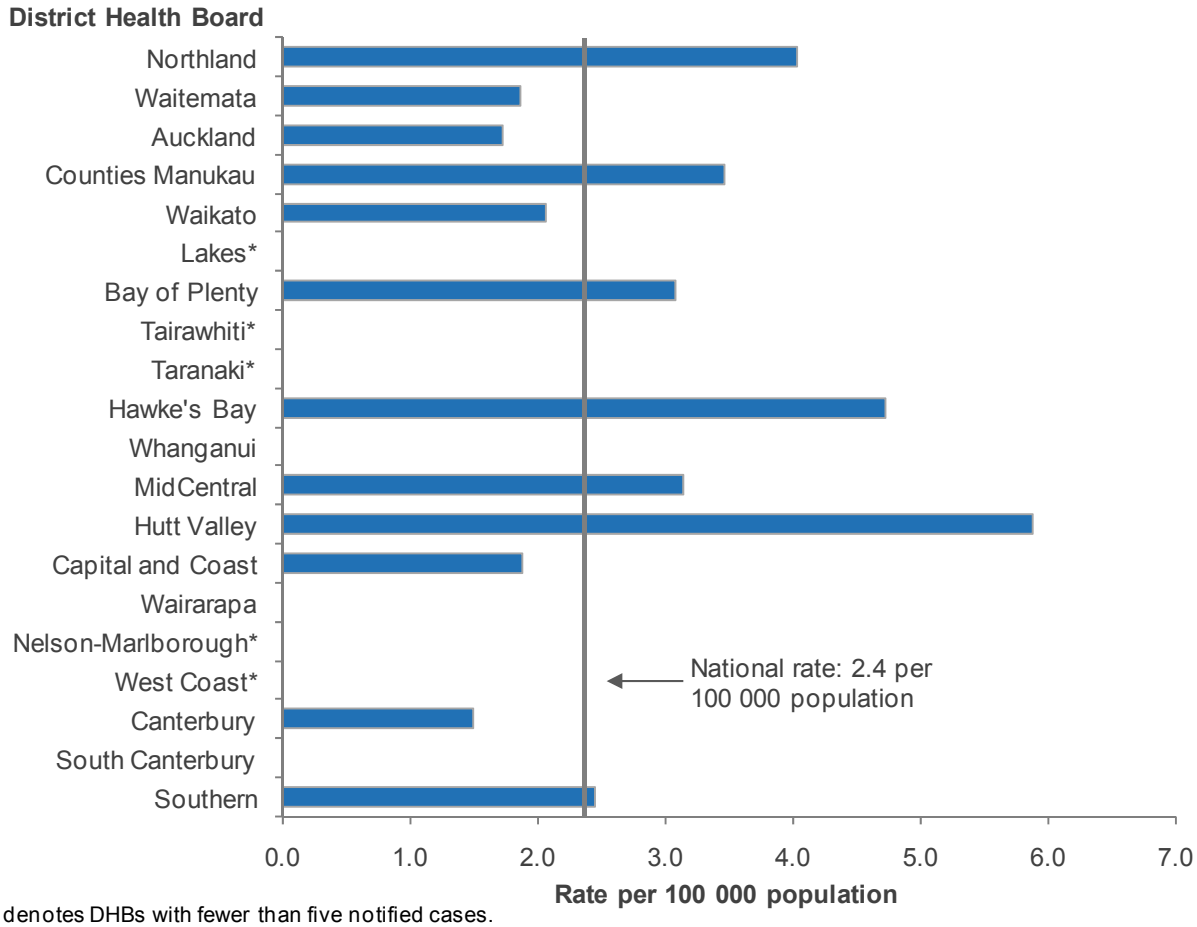


Geographic variation

A marked geographic variation in the number of notified cases and rates of meningococcal disease has occurred since 1991, and 2010 was no exception.

In 2010, Counties Manukau District Health Board (DHB) had the highest number of cases (15), followed by Waitemata (9) and Hutt Valley (8) DHBs. However, the highest rate of disease was reported in Hutt Valley DHB (5.9 per 100 000 population, 8 cases), followed by Hawke's Bay (4.7 per 100 000, 7 cases) and Northland (4.0 per 100 000, 6 cases) DHBs (Figure 2).

Figure 2. Meningococcal disease rates by DHB, 2010



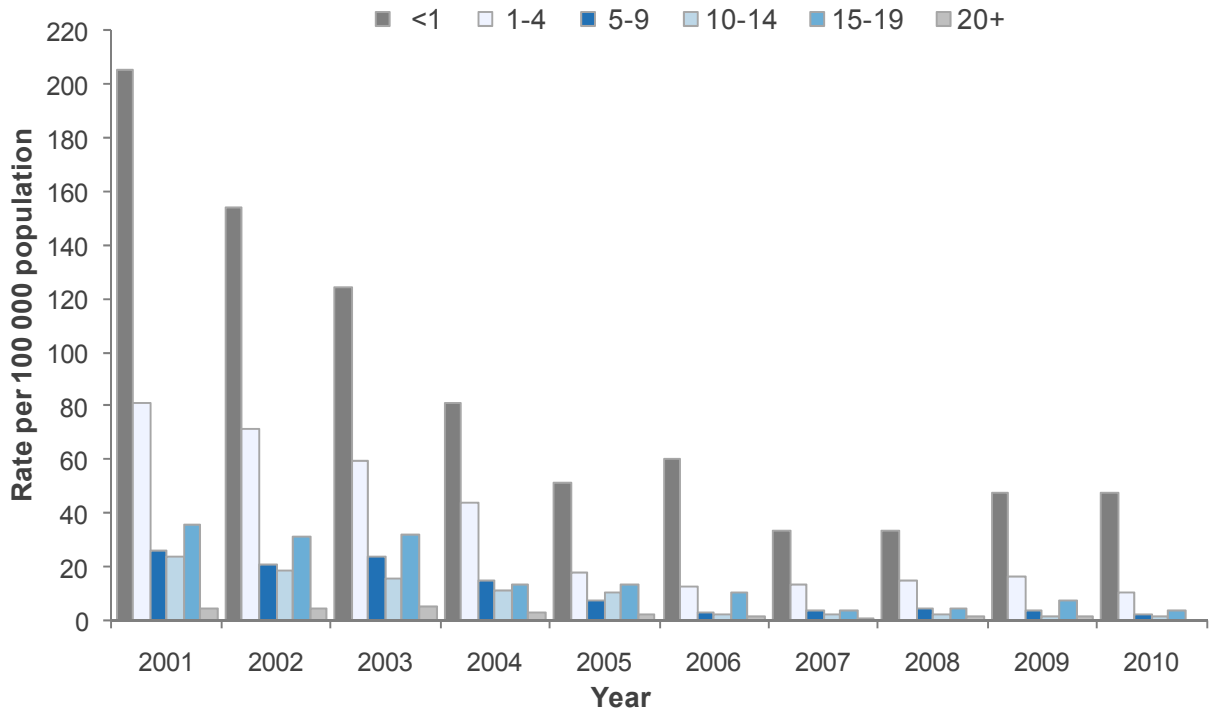
* denotes DHBs with fewer than five notified cases.

"An asterisk alongside the DHB name denotes there were fewer than five cases in the DHB. Rates have not been calculated for these DHBs as such small numbers of cases produce unstable rates."

Incidence by age

In 2010, the highest age-specific disease rates were observed among those aged less than 1 year (47.7 per 100 000 population, 27 cases) and 1–4 years (10.5 per 100 000, 23 cases) (Figure 3 and Appendix: Table 4), which was consistent with previous years. As in previous years, there was a secondary peak in the rate of disease by age group in the 15–19 years age group (3.7 per 100 000 population, 11 cases). Since 2001, the incidence rate in the less than 1 year age group has decreased by almost 77% (from 205.0 to 47.7 per 100 000), and since 2004 the incidence rate in this age group has declined by about 41% (from 81.2 to 47.7 per 100 000). The rate for the less than 1 year age group was higher in 2010 than in 2007 and 2008 (33.6 per 100 000 each). Larger reductions in the disease incidence rate have occurred in the other dominant age groups from 2001 to 2010. In the 1–4 years age group there has been an 87% reduction since 2001 and a 76% reduction since 2004. In the 15–19 years age group the reductions were 90% and 72%, respectively, since 2001 and 2004.

Figure 3. Meningococcal disease rates by age group, 2001–2010



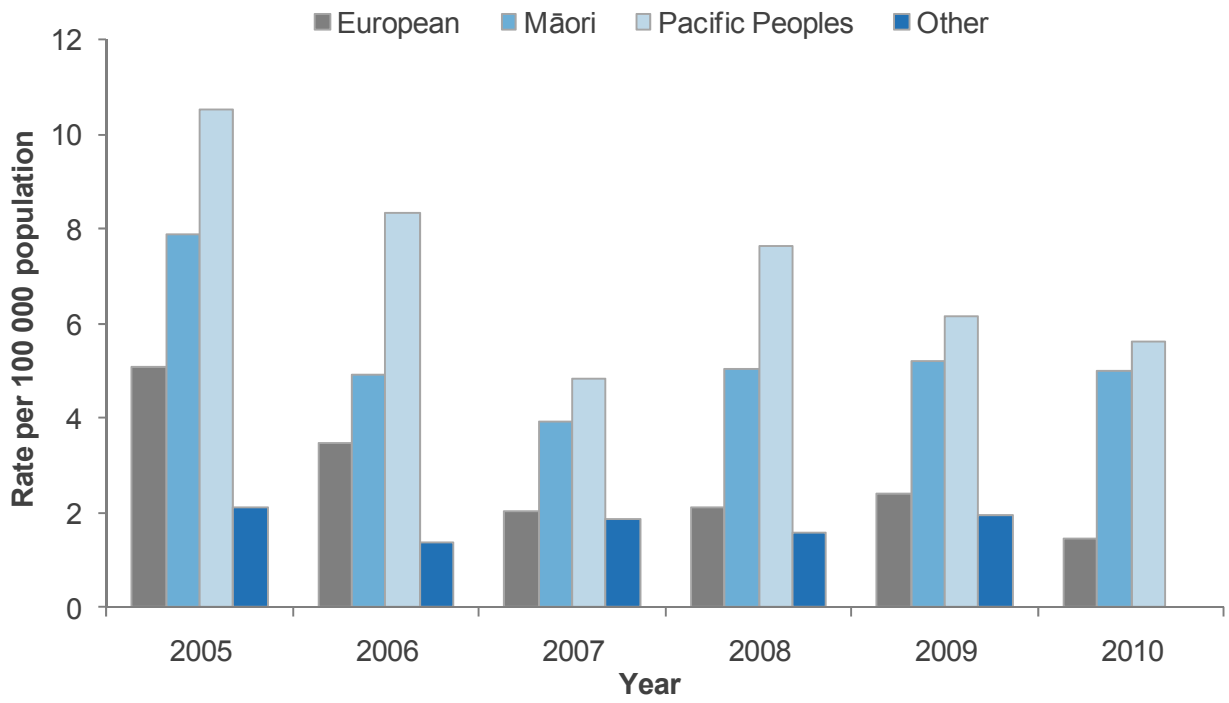
Incidence by ethnicity

In 2010, the age-standardised disease rates for Pacific Peoples (5.6 per 100 000, 17 cases) and Māori (5.0 per 100 000 population, 42 cases) continued to be higher than the rate in Europeans (1.5 per 100 000, 35 cases) (Figure 4 and Appendix: Table 5).The age-standardised disease rate for Pacific Peoples in 2010 was only 10.5% of that in 2001 (53.1 per 100 000). Similarly for Māori, the 2010 disease rate was only 19.5% of that in 2001 (25.7 per 100 000). In 2010, the disease rate differences for Pacific Peoples and Māori compared with Europeans were 4.1 and 3.5 per 100 000, respectively, compared with peak rate differences in 1997 of 58.7 for Pacific Peoples and 15.3 for Māori.

The highest disease rate by age group and ethnicity in 2010 was observed in Pacific Peoples aged less than 1 year (136.7 per 100 000 population, 7 cases) (Figure 5 and Appendix: Table 6). This is the highest rate in this population group since 2006 (195.3 per 100 000, 10 cases). Prior to 2004, the highest rate was always observed in Pacific Peoples in the less than 1 year age group. Since then, Māori aged less than 1 year have sometimes had the highest rate. This was the case in 2009, when the disease rate in Māori aged less than 1 year was 135.4 per 100 000 (19 cases). In 2010, the rate in this population group decreased to 99.8 per 100 000 (14 cases). In comparison, the rate for Europeans aged less than 1 year in 2010 was 20.2 per 100 000 (6 cases).

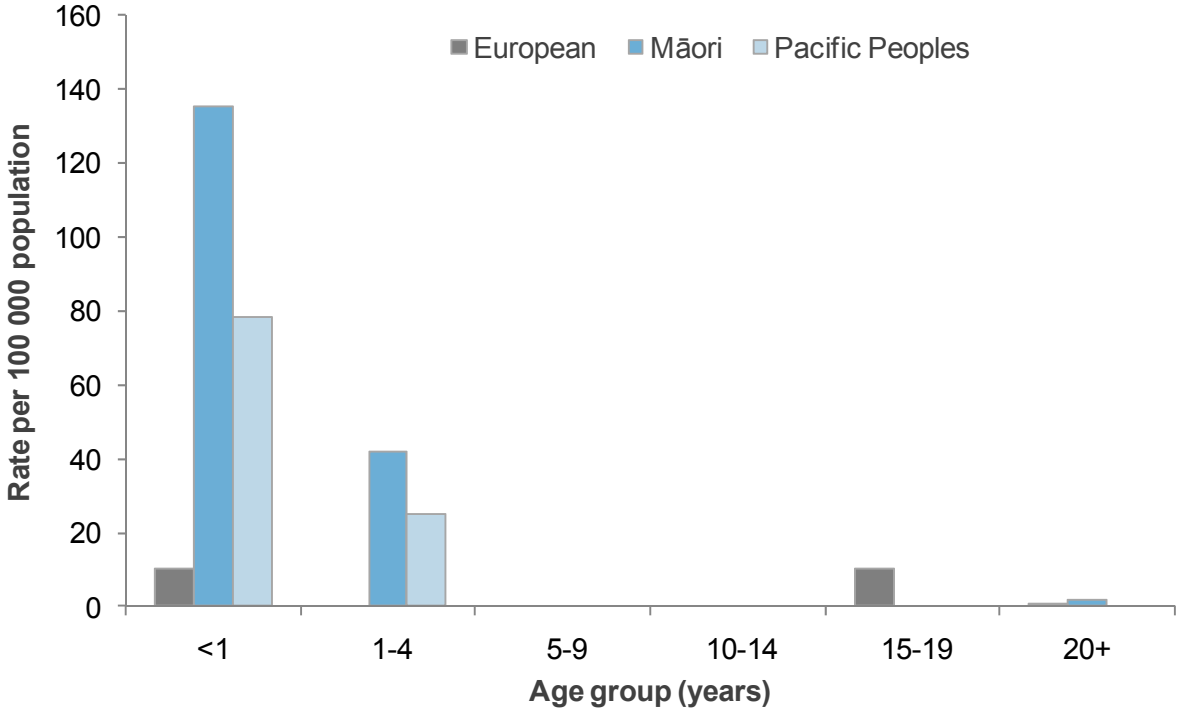
The median age for meningococcal disease cases was markedly different in 2010 for the different ethnicities, and was 1.5 year for Māori and Pacific Peoples, compared with 18.0 years among the European cases.

Figure 4. Age-standardised meningococcal disease rates by ethnicity, 2005–2010



Note: Rates have not been calculated where there are fewer than five notified cases in any category.

Figure 5. Meningococcal disease rates by age group and ethnicity, 2010

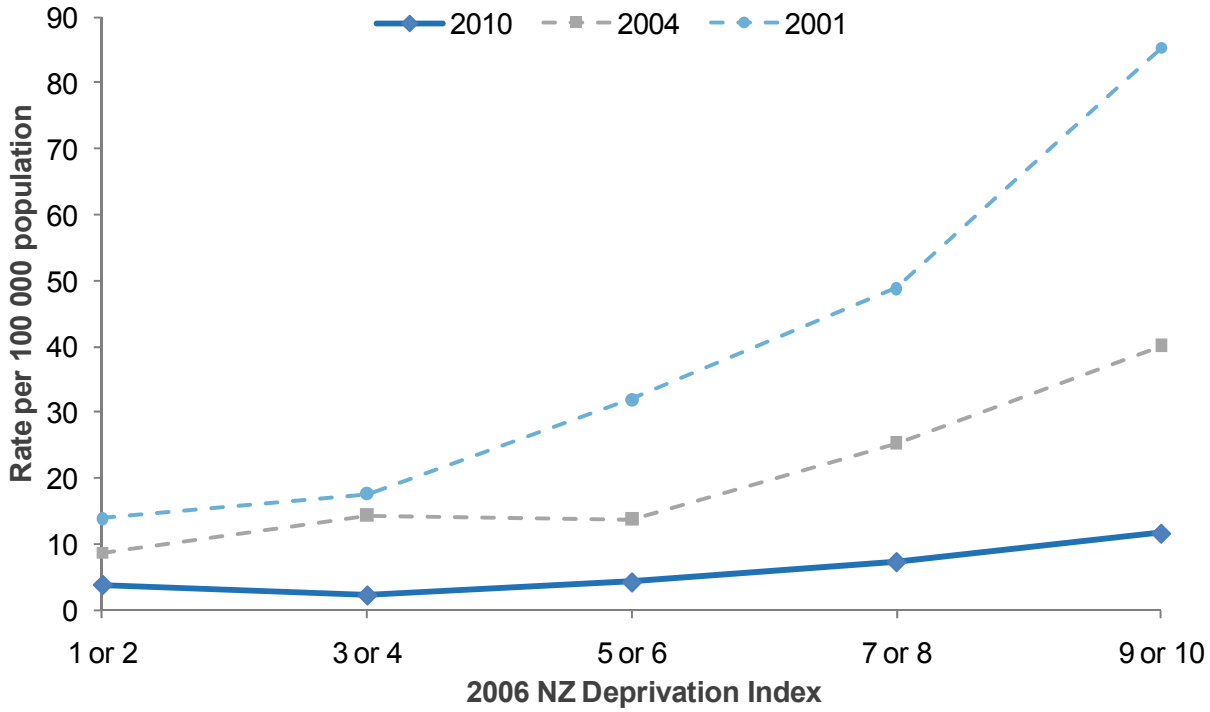


Note: Rates have not been calculated where there are fewer than five notified cases in any category.

Incidence by deprivation for cases aged less than 20 years

Inequalities in meningococcal disease rates by socio-economic status have decreased between 2001 and 2010 (Figure 6). The rate of meningococcal disease has dropped significantly ($p<0.001$) for each quintile of the New Zealand Deprivation Index 2006 compared with 2001, and the relative burden of disease experienced by more deprived groups has decreased. In 2001, those individuals aged less than 20 years and from the most deprived quintile, had over six-times the rate of meningococcal disease (85.3 per 100 000 population) compared with individuals from the least deprived quintile (13.9 per 100 000).

Figure 6. Meningococcal disease rates by quintiles of NZDep06 for cases aged less than 20 years, 2001, 2004 and 2010



Confirmation of disease based on laboratory testing

In 2010, 84 (87.5%) meningococcal disease cases were laboratory confirmed by the isolation of *N. meningitidis* (59) or by PCR (25).

Strain types among confirmed cases

In 2010, the strain type was determined for 81 (96.4%) of the 84 confirmed cases: 25 were the epidemic strain (ie, group B or non-groupable with P1.7-2,4 PorA protein), 21 other group B strains, 22 group C strains, six group W135 strains, five group Y strains, and two non-groupable strains (Table 1).

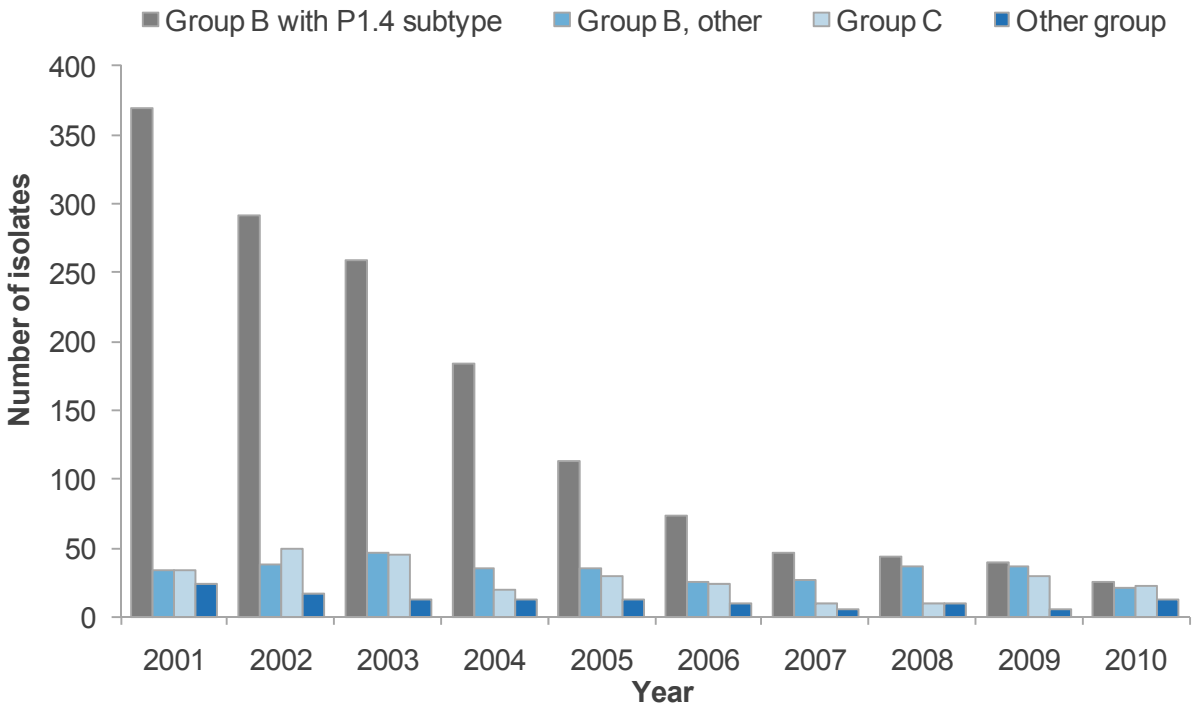
Table 1. Distribution of strain types among meningococcal disease cases, 2010[1]

Group	PorA type	Number	Percentage of group B	Percentage of total
Total B		**46**	**100.0**	**56.8**
B	P1.4	25	54.3	30.9
B	Other PorA	21	45.7	25.9
Total non-B		**35**		**43.2**
C		22		27.2
W135		6		7.4
Y		5		6.2
Non-groupable[1]		2		2.5
Total		**81**		**100.0**

[1] Strain type determined for 81 of the 84 confirmed cases.

The number of cases caused by the epidemic strain, other group B strains and group C strains between 2001 and 2010 is shown in Figure 7. Trends in the number of epidemic strain cases are described in the following section. The numbers of other group B strains and C strains have varied considerably from one year to the next, but have been trending downwards. The number of other group B strains in 2010 (21 cases) was the lowest reported in the last 10 years. Cases due to groups W135 and Y have been consistently uncommon.

Figure 7. Group and dominant subtype among culture and PCR-positive meningococcal disease cases, 2001–2010



Epidemic strain analysis

In 2001, the peak year for disease incidence, 80.1% (370/462) of typed confirmed cases that could 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 MeNZB™ vaccination was introduced in 2004, the percentage of typed confirmed cases with the epidemic strain has fallen significantly ($p<0.001$) from 73.0% (184/252) in 2004 to 30.9% (25/81) in 2010. The rate of disease caused by the epidemic strain in 2010 (0.6 per 100 000 population) was significantly lower than the peak rate of 9.9 per 100 000 in 2001 ($p<0.001$).

The rate of epidemic strain disease has consistently been highest in those individuals aged less than 5 years, particularly in those aged less than 1 year old. For those aged less than 1 year, the 2010 rate of 26.5 per 100 000 population (15 cases) was higher than the 2009 rate (17.7 per 100 000, 10 cases), but lower than the rates in 2004 (33.6 per 100 000, 19 cases) and 2001 (100.6 per 100 000, 55 cases) (Appendix: Table 8).

Epidemic strain case numbers have generally decreased annually for those aged less than 20 years. In 2001, the peak year, there were 296 cases confirmed as the epidemic strain in those aged less than 20 years. This decreased to 129 in 2004 and to 24 in 2010. The crude rate of epidemic strain cases for those aged less than 20 years old has decreased for all ethnic groups since the peak year in 2001. The rate for Pacific Peoples decreased from 75.2 per 100 000 population in 2001 to 17.3 per 100 000 in 2004, and was 8.1 per 100 000 in 2010. The rate for Māori decreased from 46.7 per 100 000 in 2001 to 16.6 per 100 000 in 2004, and was 5.4 per 100 000 in 2010. The rate for those of European ethnicity decreased from 16.4 per 100 000 in 2001 to 10.1 per 100 000 in 2004, and was 0.3 per 100 000 (based on 2 cases only) in 2010.

Antimicrobial susceptibility

The antimicrobial susceptibility of all 62 viable meningococcal isolates received at ESR from cases of invasive disease in 2010 was tested (Table 2).

All isolates were susceptible to ceftriaxone and rifampicin. Eighteen (29.0%) of the 62 isolates had reduced penicillin susceptibility (MIC ≥0.12 mg/L): 66.7% (4/6) of group W135 isolates; 33.3% (10/30) of all group B isolates; 21.4% (3/14) of isolates of group B, subtype P1.4; 10.5% (2/19) of group C isolates; and two isolates that could not be grouped. Infections due to isolates with reduced susceptibility are still treatable with penicillin.

One isolate, a group C meningococcus (C:ns:P1.20,23-7), was ciprofloxacin resistant (MIC 0.12 mg/L). This isolate represents the first case of ciprofloxacin resistance identified among invasive meningococci in New Zealand.

Table 2. MIC range and MIC_{90} of isolates, 2010

Antimicrobial	MIC[1] range (mg/L)	MIC_{90}[2] (mg/L)
Penicillin	0.016–0.25	0.25
Ceftriaxone	0.002–0.004	0.002
Rifampicin	0.002–0.25	0.06
Ciprofloxacin	0.002–0.12	0.004

[1] Minimum inhibitory concentration

[2] Concentration that inhibits at least 90% of the isolates

Clinical outcome

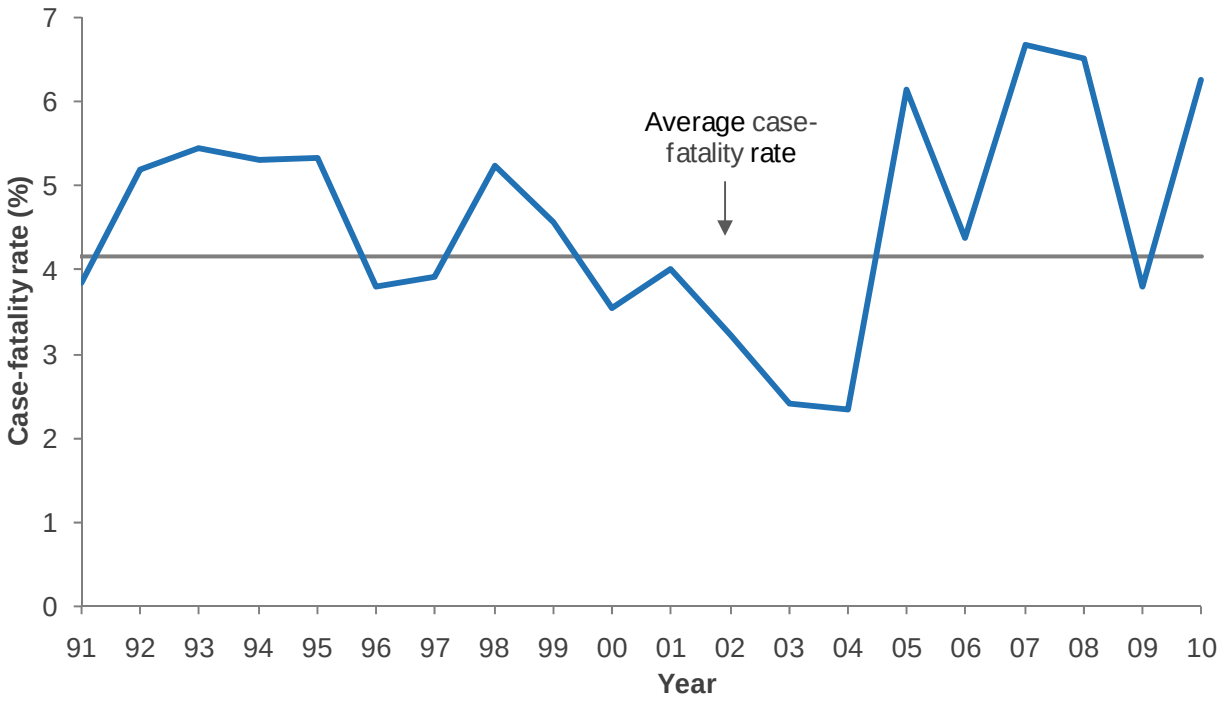
There were six deaths due to meningococcal disease in 2010, with a case-fatality rate of 6.3% (Figure 8).

Of the six fatalities in 2010, three were confirmed cases. Two deaths were due to the epidemic strain and one death was due to a group C strain. Over the last 10 years from 2001 to 2010, the case-fatality rate for group C disease was 10.5% (29 deaths), compared with 4.0% (58 deaths) for the epidemic strain (Appendix: Table 9).

Since 2004, there have been 26 deaths across all age groups due to the epidemic strain, five in 2004, six in 2005, four in 2006, three in 2007, four in 2008, and two each in 2009 and 2010. Of the 26 deaths, 17 (65.4%) were younger than 20 years of age, seven were 40 years of age and older and two were 30–39 years of age.

The case-fatality rate over the last 10 years was highest for those aged 40 years and older (9.1%, 29 deaths) and lowest for those aged 5–9 years (1.3%, 4 deaths). By ethnicity, the case-fatality rate during the last 10 years was greatest for those of Other ethnicity (14.0%, 13 deaths), followed by European (3.8%, 52 deaths), Māori (3.3%, 30 deaths) and Pacific Peoples (3.1%, 17 deaths) ethnicities (see Appendix: Table 9).

Figure 8. Meningococcal disease case-fatality rates, 1991–2010



Case management

Information on hospitalisation was recorded for all 96 cases of meningococcal disease reported in 2010. Of these, 95 (99.0%) cases were hospitalised. This is similar to the 2009 rate of 99.2%.

Data on pre-hospital management were recorded for 97.9% (94/96) of cases. These data show that 48.9% (46/94) of cases were seen by a general practitioner (or other primary care doctor) prior to hospital admission. Of these, only 30.4% (14/46) of cases received antibiotic treatment before being admitted to hospital. In 2010, there were no fatalities among cases seen by a doctor prior to hospital admission and given antibiotics.

DISCUSSION

DISCUSSION

It is 20 years since the initial identification of a strain of *N. meningitidis* that would cause an unprecedented number of meningococcal infections in New Zealand and eventually lead to the introduction of a strain-specific vaccine, MeNZB^{TM}, to combat the epidemic. The epidemic strain was characterised using serological and subsequently molecular techniques and found to be a specific subtype of the group B meningococcus, B:4:P1.7-2,4. At the height of the epidemic in 2001, this strain was responsible for over 80% of the confirmed cases that could be strain typed and a case rate of 9.9 per 100 000 population. After the introduction of the MeNZB^{TM} vaccine in 2004, the number of cases due to the epidemic strain fell significantly. In 2010, the epidemic strain was still responsible for 31% of meningococcal infections indicating its continued circulation within the population and ability to cause a significant number of infections. The continued monitoring of strains causing meningococcal disease is important to identify changes in infection patterns within the population, especially now that the MeNZB^{TM} vaccine has been withdrawn.

The rate of meningococcal disease in 2010 remains significantly above the pre-epidemic rate. As happened throughout the epidemic, the highest age-specific disease rate was in those children aged less than 1 year age, and this was particularly marked in Pacific Peoples and Māori where the rates in this age group were five- to six- times higher than in the equivalent age group of the European population. Infection rates across the deprivation quintiles indicate a fall in rates across all quintiles and also a decrease in the difference between the highest and lowest quintiles over the last 10 years. The significant improvements in health inequalities associated with the burden of meningococcal disease among Pacific Peoples and Māori and also in socio-economically deprived populations may be attributed to a number of factors, including the MeNZB^{TM} vaccination campaign.

The case-fatality rate in 2010 was higher than in most years, although the number of deaths due to meningococcal disease was low. Almost half of the hospitalised cases were seen in primary care prior to hospital admission, but only 30% of these were given antibiotics in primary care. Although, it is difficult to determine the impact of pre-hospital antibiotics on disease severity and death due to small numbers and confounding factors, it would be prudent to increase this practice.

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APPENDIX

APPENDIX

Table 3. Numbers, rates and proportion of confirmed cases of meningococcal disease, 1990–2010

Year	Cases	Rate[1]	% conf[2]
1990	53	1.6	83.0
1991	78	2.3	78.2
1992	154	4.6	82.5
1993	202	6.0	77.7
1994	207	5.7	83.1
1995	394	10.9	67.8
1996	473	13.1	67.0
1997	613	16.9	67.9
1998	440	12.2	69.1
1999	504	13.9	66.1
2000	480	12.8	72.5
2001	650	17.4	75.2
2002	557	14.9	74.1
2003	541	14.5	71.7
2004	342	8.5	79.8
2005	228	5.7	87.7
2006	160	4.0	90.6
2007	105	2.6	88.6
2008	123	3.1	89.4
2009	132	3.3	88.6
2010	96	2.4	87.5

[1] 1990-1993 crude rates based on 1991 census data
1994-1998 crude rates based on 1996 census data
1999-2003 crude rates based on 2001 census data
2004-2010 crude rates based on 2006 census data
[2] Proportion (%) of total cases which were confirmed

Table 4. Age distribution of meningococcal disease cases in 2001, and 2004–2010

Age group (years)	2001		2004		2005		2006		2007		2008		2009		2010	
	No.	Rate[1]	No.	Rate[2]	No.	Rate[2]	No.	Rate[2]	No.	Rate[2]	No.	Rate[2]	No.	Rate[2]	No.	Rate[2]
<5	**288**	**106.3**	**142**	**51.6**	**68**	**24.7**	**62**	**22.5**	**48**	**17.4**	**52**	**18.9**	**62**	**22.5**	**50**	**18.2**
<1	112	205.0	46	81.2	29	51.2	34	60.0	19	33.6	19	33.6	27	47.7	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	23	10.5
≥5	**362**	**10.4**	**200**	**5.3**	**160**	**4.3**	**98**	**2.6**	**57**	**1.5**	**71**	**1.9**	**70**	**1.9**	**46**	**1.2**
5-9	75	26.2	43	15.0	21	7.3	8	2.8	10	3.5	13	4.5	10	3.5	7	2.4
10-14	70	24.1	35	11.4	31	10.1	6	2.0	8	2.6	8	2.6	4	-	5	1.6
15-19	95	35.8	40	13.3	41	13.7	32	10.7	11	3.7	13	4.3	22	7.3	11	3.7
20-29	57	11.7	31	6.0	27	5.3	17	3.3	9	1.8	7	1.4	8	1.6	8	1.6
30-39	25	4.3	12	2.1	10	1.7	4	-	6	1.0	4	-	4	-	3	-
40+	40	2.6	39	2.2	30	1.7	31	1.8	13	0.7	26	1.5	22	1.2	12	0.7
Total	**650**	**17.4**	**342**	**8.5**	**228**	**5.7**	**160**	**4.0**	**105**	**2.6**	**123**	**3.1**	**132**	**3.3**	**96**	**2.4**

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

Table 5. Numbers and age-standardised incidence rates by ethnicity for cases of meningococcal disease in 2001, and 2004–2010

Ethnicity	2001		2004		2005		2006		2007		2008		2009		2010	
	No.	Rate[1]	No.	Rate[2]	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	35	1.5
Māori[3]	211	25.7	104	11.2	63	7.9	44	4.9	35	3.9	41	5.1	48	5.2	42	5.0
Pacific Peoples[4]	155	53.1	61	19.7	34	10.5	24	8.3	15	4.8	21	7.6	17	6.2	17	5.6
Other	13	4.9	14	3.7	9	2.1	6	1.4	6	1.9	6	1.6	6	1.9	2	-
Unknown	7	-	1	-	0	-	0	-	1	-	3	-	2	-	0	-
Total	**650**	**17.4**	**342**	**8.5**	**228**	**5.7**	**160**	**4.0**	**105**	**2.6**	**123**	**3.1**	**132**	**3.3**	**96**	**2.4**

[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 Māori ethnicity.
[4] Rate is calculated using mixed Pacific Peoples ethnicity (excluding Māori).

Table 6. Numbers and crude incidence rates for cases of meningococcal disease by age group and ethnicity, 2010

Age group (years)	European		Māori		Pacific Peoples		Other		Unknown	Total	
	No.	Rate[1]	No.	Rate[1]	No.	Rate[1]	No.	Rate[1]	No.	No.	Rate[1]
<1	6	20.2	14	99.8	7	136.7	0	-	0	27	47.7
1-4	3	-	14	26.7	6	29.9	0	-	0	23	10.5
5-9	3	-	3	-	1	-	0	-	0	7	2.4
10-14	1	-	3	-	1	-	0	-	0	5	1.6
15-19	9	5.2	2	-	0	-	0	-	0	11	3.7
20-29	5	1.7	3	-	0	-	0	-	0	8	1.6
30-39	2	-	1	-	0	-	0	-	0	3	-
40+	6	0.4	2	-	2	-	2	-	0	12	0.7
Total	**35**	**1.3**	**42**	**7.4**	**17**	**7.5**	**2**	**0.5**	**0**	**96**	**2.4**

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

Table 7. Distribution of strain types among meningococcal disease cases and total cases by District Health Board, 2010

District health board	Epidemic strain (B or NG[1]:P1.4)		B other		C		W135		Y		Total	
	No.	%	No.	%	No.	%	No.	No.	%	No.	%	No.
Northland	3	12.0	1	4.8	0	0.0	1	16.7	0	0.0	6	6.3
Waitemata	3	12.0	4	19.0	0	0.0	0	0.0	1	20.0	9	9.4
Auckland	1	4.0	3	14.3	2	9.1	0	0.0	0	0.0	7	7.3
Counties Manukau	8	32.0	2	9.5	2	9.1	1	16.7	1	20.0	15	15.6
Waikato	1	4.0	3	14.3	2	9.1	0	0.0	0	0.0	7	7.3
Lakes	2	8.0	1	4.8	0	0.0	0	0.0	0	0.0	3	3.1
Bay of Plenty	1	4.0	1	4.8	1	4.5	0	0.0	1	20.0	6	6.3
Tairawhiti	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0
Taranaki	0	0.0	1	4.8	0	0.0	0	0.0	0	0.0	1	1.0
Hawke's Bay	1	4.0	1	4.8	2	9.1	1	16.7	0	0.0	7	7.3
Whanganui	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
MidCentral	0	0.0	0	0.0	5	22.7	0	0.0	0	0.0	5	5.2
Hutt Valley	3	12.0	1	4.8	2	9.1	1	16.7	0	0.0	8	8.3
Capital and Coast	1	4.0	1	4.8	0	0.0	0	0.0	1	20.0	5	5.2
Wairarapa	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Nelson Marlborough	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0
West Coast	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1.0
Canterbury	1	4.0	1	4.8	2	9.1	0	0.0	1	20.0	7	7.3
South Canterbury	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Southern	0	0.0	1	4.8	4	18.2	2	33.3	0	0.0	7	7.3
Total	**25**	**100.0**	**21**	**100.0**	**22**	**100.0**	**6**	**100.0**	**5**	**100.0**	**96**	**100.0**

[1] NG = non-groupable.

Table 8. Number of epidemic strain (B or NG[1]:P1.4) cases by year, 2001 and 2004–2010

	2001		2004		2005		2006		2007		2008		2009		2010	
	No.	Rate[2]	No.	Rate[3]	No.	Rate[3]	No.	Rate[3]	No.	Rate[3]	No.	Rate[3]	No.	Rate[3]	No.	Rate[3]
Age group																
<1 year	55	100.6	19	33.6	11	19.4	15	26.5	7	12.4	10	17.7	10	17.7	15	26.5
1-4 years	100	46.3	46	21.1	24	11.0	15	6.9	18	8.2	13	6.0	12	5.5	7	3.2
5-9 years	43	15.0	24	8.4	10	3.5	4	-	4	-	3	-	4	-	2	-
10-14 years	40	13.8	20	6.5	15	4.9	2	-	2	-	4	-	2	-	0	-
15-19 years	58	21.9	20	6.7	21	7.0	11	3.7	7	2.3	1	-	3	-	0	-
20-29 years	35	7.2	21	4.1	13	2.5	10	1.9	4	-	3	-	2	-	0	-
30-39 years	18	3.1	9	1.6	5	0.9	1	-	4	-	1	-	2	-	0	-
40+ years	21	1.3	25	1.4	14	0.8	16	0.9	1	-	9	0.5	5	0.3	1	-
Sex																
Male	197	10.8	100	5.1	58	3.0	33	1.7	27	1.4	26	1.3	21	1.1	14	0.7
Female	173	9.0	82	4.0	54	2.6	40	1.9	20	1.0	18	0.9	19	0.9	11	0.5
Unknown	0	-	2	-	1	-	1	-	0	-	0	-	0	-	0	-
Ethnicity																
European	157	6.0	111	4.1	60	2.2	37	1.4	15	0.6	14	0.5	14	0.5	2	-
Māori	131	24.9	43	7.6	30	5.3	23	4.1	19	3.4	16	2.8	19	3.4	14	2.5
Pacific Peoples	74	36.9	23	10.2	19	8.4	12	5.3	10	4.4	9	4.0	5	2.2	8	3.5
Other	6	2.4	7	1.9	4	-	2	-	2	-	3	-	2	-	1	-
Unknown	2	-	0	-	0	-	0	-	1	-	2	-	0	-	0	-
Total	**370**	**9.9**	**184**	**4.6**	**113**	**2.8**	**74**	**1.8**	**47**	**1.2**	**44**	**1.1**	**40**	**1.0**	**25**	**0.6**

[1] NG = non-groupable.

[2] Rate per 100 000 population based on 2001 census data.

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

Table 9. Case-fatality rates for meningococcal disease cases by age, sex, ethnicity and serogroup, 2001–2010

Features of case and infecting organism	Number of fatalities										Total fatalities 01-10	Total cases 01-10	Case-fatality rate (%)
	01	02	03	04	05	06	07	08	09	10			
Age group													
<1 year	3	3	2	3	2	1	2	3	2	1	22	465	4.7
1-4 years	7	3	2	1	0	1	1	4	0	3	22	743	3.0
5-9 years	0	1	0	1	1	0	1	0	0	0	4	315	1.3
10-14 years	2	0	1	0	0	0	0	0	1	0	4	267	1.5
15-19 years	5	5	3	0	0	1	0	1	1	1	17	432	3.9
20-29 years	4	0	2	0	1	0	1	0	1	0	9	280	3.2
30-39 years	1	0	0	1	3	0	0	0	0	0	5	114	4.4
40+ years	4	6	3	2	7	4	2	0	0	1	29	318	9.1
Sex													
Male	16	8	5	6	5	3	4	6	4	0	57	1591	3.6
Female	10	10	8	2	9	4	3	2	1	6	55	1326	4.1
Ethnicity													
European	12	10	5	2	8	3	4	3	3	2	52	1353	3.8
Māori	9	5	2	3	1	1	1	4	2	2	30	919	3.3
Pacific Peoples	4	2	3	3	1	2	1	0	0	1	17	547	3.1
Other	1	1	3	0	4	1	1	1	0	1	13	93	14.0
Unknown	0	0	0	0	0	0	0	0	0	0	0	22	0.0
Serogroup													
Group A	0	0	0	0	0	0	0	0	0	0	0	0	-
Epidemic strain	18	9	5	5	6	4	3	4	2	2	58	1447	4.0
Group B other	2	1	2	0	1	0	0	2	0	0	8	335	2.4
Group C	3	6	6	2	4	1	2	1	3	1	29	275	10.5
Group W135	0	0	0	0	2	0	1	0	0	0	3	47	6.4
Group Y	1	0	0	0	0	0	0	0	0	0	1	30	3.3
Group Z	0	0	0	0	0	0	0	0	0	0	0	5	0.0
Other[1]	0	0	0	0	1	2	0	0	0	0	3	173	1.7
Probable	2	2	0	1	0	0	1	1	0	3	10	622	1.6
Total	**26**	**18**	**13**	**8**	**14**	**7**	**7**	**8**	**5**	**6**	**112**	**2934**	**3.8**

[1] Includes isolates belonging to other groups, isolates for which the group was not determined and non-groupable isolates.