Science for Communities

INVASIVE PNEUMOCOCCAL DISEASE IN NEW ZEALAND, 2017–2019

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

by

Andrew Anglemyer

Kristin Dyet

Julie Morgan

Charlotte Gilkison

Gerard Sonder

Andrea McNeill

Health Group
Institute of Environmental Science and Research Limited

October 2021

This report is available at www.surv.esr.cri.nz

Published 8 October 2021

Suggested citation:

Institute of Environmental Science and Research Ltd (ESR).
Invasive pneumococcal disease in New Zealand, 2017–2019. Porirua: ESR; 2021.

Client Report: FW21033

ACKNOWLEDGEMENTS

This report was prepared by Andrew Anglemyer, Kristin Dyet, Julie Morgan, Charlotte Gilkison, Andrea McNeill, and Gerard Sonder.

Thanks to the following people for their contributions to this report:

- Public Health Unit staff for provision of notification data for their regions.
- Diagnostic microbiology laboratories throughout New Zealand who participate in the national laboratory-based surveillance of invasive pneumococcal disease by referring isolates to ESR.
- Staff in the ESR Invasive Pathogens Laboratory for serotyping data.
- Staff in the ESR Antibiotic Reference Laboratory for antimicrobial susceptibility data.

DISCLAIMER

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	Description
CLD	Chronic Lung Disease
CLSI	Clinical and Laboratory Standards Institute
CSF	Cerebrospinal fluid
DHB	District Health Board
ESR	Institute of Environmental Science and Research Ltd
EUCAST	European Committee on Antimicrobial Susceptibility Testing
I	Intermediate resistance
IPD	Invasive pneumococcal disease
MELAA	Middle Eastern/Latin American/African
MDR	Multidrug resistant
MIC	Minimum inhibitory concentration
NHI	National Health Index
NIR	National Immunisation Register
NT	Non-typeable
NZDep13	2013 New Zealand Index of Deprivation
PCR	Polymerase chain reaction
PCV	Pneumococcal conjugate vaccine
PCV7	7-valent pneumococcal conjugate vaccine
PCV10	10-valent pneumococcal conjugate vaccine
PCV13	13-valent pneumococcal conjugate vaccine
PHU	Public Health Unit
PPV23	23-valent pneumococcal conjugate vaccine
R	Resistant
S	Susceptible

SUMMARY

In June 2008, a 7-valent pneumococcal conjugate vaccine (PCV7), Prevenar®, was added to the New Zealand childhood immunisation schedule. In July 2011, this was replaced with the 10-valent conjugate vaccine (PCV10), Synflorix® and in July 2014, Synflorix® was replaced by the 13-valent conjugate vaccine (PCV13), Prevenar13®. In July 2017, Synflorix® was re-introduced to the childhood immunisation schedule and replaced Prevenar13®. Synflorix® has some reported cross-reactivity to serotype 19A, one of the three additional serotypes included in Prevenar13®.

Since 17 October 2008, invasive pneumococcal disease (IPD) has been a notifiable disease in New Zealand. In this report, the data presented for 2009–2019 is based on IPD case notifications supplemented with serotype and antimicrobial susceptibility data from ESR's national laboratory-based surveillance of invasive *Streptococcus pneumoniae* isolates. Data for earlier years is solely from ESR's laboratory-based surveillance. For the laboratory-based surveillance, diagnostic microbiology laboratories are requested to refer all invasive isolates of *S. pneumoniae* to ESR for serotyping and antimicrobial susceptibility testing.

A *S. pneumoniae* isolate from an invasive site was received at ESR for antimicrobial susceptibility testing for 489 (93.9%) of the notified cases in 2017, 531 (95.3%) of the notified cases in 2018, and 233 (47.0%) of the notified cases in 2019 (in 2019, a purposeful reduction in antimicrobial susceptibility testing to 50% of *S. pneumoniae* isolates was introduced).

Incidence

- There were 521 cases of IPD notified in 2017, yielding an annual incidence of 10.9 cases per 100,000 population.
- There were 557 cases of IPD notified in 2018, which yields an annual incidence of 11.4 cases per 100,000 population.
- There were 495 cases of IPD notified in 2019, resulting in an annual incidence of 10.1 cases per 100,000 population.

In children <5 years, the annual incidence of IPD (i.e., disease due to any serotype) decreased from 32.6 per 100,000 in 2009 (after IPD became notifiable) to 14.7 per 100,000 in 2019. The median annual incidence of IPD from 2009 to 2016 in children <5 years of age was 16.5 per 100,000 (range 7.8 to 32.6 per 100,000). From 2017 to 2019 the annual incidence of IPD in children <5 years of age ranged from 14.7 to 15.0 per 100,000. The PCV10[1] serotype-specific annual incidence of IPD in children <5 years of age (has decreased from 25.4 per 100,000 in 2009 to 3.6 per 100,000 in 2019 (n=11 total cases, of which n=10 were serotype 19A in 2019).

[1] 19A is included as a PCV10 serotype in this report as PCV10 is licensed for effectiveness against serotype 19A disease through serotype 19F eliciting some cross-reactive antibodies against serotype 19A.

Ethnicity

As in previous years, the age-standardised rates of IPD for the Pacific peoples and Māori ethnic groups remained higher than the rate for the European or Other ethnic groups between 2017–2019.

In 2017, 12 (52.2%) of the 23 total cases in the <2 years age group were of Māori (7 cases) or Pacific peoples (5 cases) ethnicity. Similarly, in 2018, 16 (55.2%) of the 29 total cases in the <2 years age group were of Māori (11 cases) or Pacific peoples (5 cases) ethnicity and in 2019, 18 (69.2%) of the 26 total cases in the <2 years age group were of Māori (13 cases) or Pacific peoples (5 cases) ethnicity.

Clinical Outcomes

The all-age annual incidence of pneumococcal meningitis was 1.0 per 100,000 in 2017, 0.8 per 100,000 in 2018, and 1.1 per 100,000 in 2019.

The IPD case-fatality rate has decreased over the last 3 years from 5.4% in 2017, 4.6% in 2018, and 2.5% in 2019. It should be noted, however, that the proportion of deaths in which IPD has not yet been determined to be attributable is higher in more recent years (27% of all deaths among IPD cases in 2017, 33% of all deaths among IPD cases in 2018, and 45% of all deaths among IPD cases in 2019 had no determination on whether IPD was the cause of death).

District Health Boards

- In 2017 the highest all-age annual rate of IPD was in Bay of Plenty District Health Board (DHB) (19.8 per 100,000, 46 cases), followed by Whanganui (18.72 per 100,000, 12 cases), West Coast (18.46 per 100,000, 6 cases) and Wairarapa (17.98 per 100,000, 8 cases) DHBs.
- In 2018 the highest rate of IPD was in Lakes DHB (22.79 per 100,000, 25 cases), followed by Wairarapa (21.98 per 100,000, 10 cases), Whanganui (18.49 per 100,000, 12 cases) and Northland (16.75 per 100,000, 30 cases) DHBs.
- In 2019, the highest rate of IPD was in Whanganui DHB (20.74 per 100,000, 14 cases), followed by Taranaki (17.1 per 100,000, 21 cases), Lakes (16.61 per 100,000, 19 cases), and Hawke's Bay (16.13 per 100,000, 28 cases) DHBs.

From 2017–2019, the Southern Region consistently had the lowest annual incidence rate, while Midland Region consistently had the highest annual incidence rate. The annual incidence rate in Whanganui DHB was consistently one of the three highest each year from 2017–2019, driven almost entirely by adult IPD cases (only one child under 5 was reported 2017–2019 in this DHB). In contrast, the annual incidence rate in Canterbury DHB was consistently one of the three lowest each year from 2017–2019).

Serotypes: Overall incidence

Although the annual incidence of IPD from 2012 has been relatively stable (ranging from 5.7 to 7.2 per 100,000), the annual incidence of IPD in the ≥65 years age group has decreased from a peak of 35.0 per 100,000 in 2012 to 25.0 per 100,000 in 2019.

Due to the indirect or herd immunity effects of routine infant PCV immunisation, there have also been marked reductions in incidence of IPD due to PCV10 plus/including 19A serotypes, in the 5–64 years age group since 2012 (PCV10 was first introduced in mid-

2011). Specifically, since 2012, the incidence of IPD due to PCV10 serotypes peaked in 2013 at 4.1 per 100,000 and has since decreased to 1.5 per 100,000 in 2019. Among ≥65 years age groups, since 2012 the incidence of IPD due to PCV10 serotypes has decreased from a peak of 16.6 cases per 100,000 in 2012 to 4.7 per 100,000 in 2019.

Serotypes: Most prevalent serotypes

- The most prevalent serotypes in 2017 were 19A (60 cases), 8 (49 cases), 22F (35 cases), 3 (33 cases), and 7F (30 cases). These five types collectively accounted for 39% (207/490) of the culture-positive cases typed in 2017.
- The most prevalent serotypes in 2018 were 19A (75 cases), 12F (52 cases), 22F (49 cases), 8 (48 cases), and 3 (33 cases). The top five most prevalent serotypes in 2018 accounted for an increasing proportion of all culture-positive cases typed (48%; 257/533),
- The most prevalent serotypes in 2019 were 19A (65 cases), 8 (64 cases), 22F (53 cases), 12F (39 cases), and 3 (28 cases). In 2019, the top five most prevalent serotypes made up the majority of all culture-positive cases typed (53%; 249/467).

Serotypes: trends in 19A

Serotype 19A has been the most common type among IPD cases since 2011, with increasing reported counts from 2011 to 2015. However, since 2015, the reported cases of 19A in the 5–64 years age group have decreased steadily. Among the ≥65 years age group, the reported cases of 19A increased from 2011 to 2015, but then have steadily decreased since 2016, and in 2019 there was the lowest number of reported cases since 2011 (*n*=24). Since 2017, the number of 19A cases reported in <2 years age group has increased from zero, to one in 2018, to five cases in 2019. Four of these five cases in those <2 years had received 2–3 doses of PCV10 prior to diagnosis.

Serotypes: trends in PCV10 serotypes

The rates of IPD due to the PCV10 serotype 7F increased in the 5–64 years and ≥65 years age groups between 2011 and 2013. However, following the introduction of PCV10 in mid-2011, between 2014–2016, there were successive decreases in the rates of IPD due to type 7F in both these age groups. These decreases are probably an indication that the switch from PCV7 to PCV10 for routine infant immunisation in 2011 is now having an indirect effect on type 7F disease in the older age groups. In fact, the total reported cases of serotype 7F among those 5–64 years of age has continuously decreased since 2013, decreasing from 48 cases to 7 cases in 2019. Among the ≥65 years age group, the total reported cases of serotype 7F have remained low, decreasing to only 1 case reported in 2019, after a slight increase in cases in 2017 and 2018 (n=12 and n=10, respectively).

Serotypes: trends in other PCV13 serotypes

After an increase in 2014 in the prevalence of IPD due to the PCV13 serotype 3 in the <65 years age groups, cases have decreased to three or fewer cases annually in the <2 years age group since 2016. Whether this decrease in disease due to serotype 3 over the last 4 years is the result of increasing coverage of the <2 years age group with PCV13 following the change to this vaccine in 2014 is uncertain given that literature suggests minimal protection against carriage or disease is provided against serotype 3 by PCV13.

Antimicrobial Resistance

The prevalence of antimicrobial resistance (specifically, penicillin resistance) among invasive pneumococcal isolates has been increasing since 2017. Based on the European Committee on Antimicrobial Susceptibility Testing (EUCAST) breakpoints, 21.9% of isolates in 2017 were resistant to penicillin (meningitis breakpoints--the EUCAST and CLSI penicillin meningitis breakpoints are the same (susceptible, MIC ≤0.06 mg/L; resistant, MIC ≥0.12 mg/L)) and 0.4% were cefotaxime resistant. The proportion of isolates that were resistant to penicillin increased to 24.5% in 2018 and 27.5% in 2019; 0.0% of isolates were cefotaxime resistant in 2018 and 2019. The proportion of 19A isolates that were resistant to penicillin has increased from under 20% in 2010 to 62.1% in 2019, peaking at 69.7% in 2018.

INTRODUCTION

Since 17 October 2008, invasive pneumococcal disease (IPD) has been a notifiable disease in New Zealand. Prior to this date, national surveillance of IPD was solely laboratory-based, with diagnostic laboratories voluntarily referring invasive isolates of Streptococcus pneumoniae to the Institute of Environmental Science and Research Ltd (ESR) for serotyping and antimicrobial susceptibility testing.

On 1 June 2008, pneumococcal conjugate vaccine (PCV) was added to the New Zealand childhood immunisation schedule, with a catch-up programme for all children born on or after 1 January 2008. Initially the 7-valent conjugate vaccine (PCV7), Prevenar®, was used. In July 2011, Prevenar® was replaced on the schedule with the 10-valent conjugate vaccine (PCV10), Synflorix®. In July 2014, Synflorix® was replaced by the 13-valent conjugate vaccine (PCV13), Prevenar13® [1]. With both the change to PCV10 in 2011 and the change to PCV13 in 2014, there was no catch-up programme for children fully or partially vaccinated with a lower-valency PCV. Any child who was part-way through their 4-dose PCV course completed the course with the higher-valency vaccine. Although both these schedule changes occurred mid-year, the actual use of the new vaccines did not begin until some months later as supplies of the lower-valency vaccines were depleted. There was a further schedule change in July 2017, when Synflorix® was re-introduced to the childhood immunisation schedule and replaced Prevenar13®. Synflorix® is reported to elicit cross-reactive opsonophagocytic antibodies against serotype 6A and 19A, but at a lower level than Prevenar13® leading to it becoming registered for cross-protection against 19A since 2016.

This series of annual reports on the epidemiology of IPD in New Zealand commenced in 2008. The 2008 annual report was based on data available from ESR's national laboratory-based surveillance of IPD [2]. Subsequent annual reports have been based on IPD notifications, supplemented with serotype and antimicrobial susceptibility data from ESR's laboratory-based surveillance [3–9].

Prior to these annual reports, information from ESR's laboratory-based surveillance of IPD was published periodically [10–14]. In addition, between 2002 and 2007, annual reports on the antimicrobial susceptibility of invasive pneumococcal isolates were published on ESR's Public Health Surveillance website at *http://www.surv.esr.cri.nz/antimicrobial/streptococcus_pneumoniae.php*.

This report presents information on cases of IPD that were notified in 2017–2019, as well as trend data for recent surveillance years.

METHODS

SURVEILLANCE METHODS

In this report, data for 2009 to 2019 is based on IPD case notifications from EpiSurv, supplemented with serotype and antimicrobial susceptibility data from ESR's national laboratory-based surveillance of invasive *S. pneumoniae* isolates. Data for earlier years is solely from ESR's laboratory-based surveillance of IPD. For the purposes of this report, PCV10 is assumed to offer protection against 19A, and 19A is thus grouped with PCV10 serotypes.

Since 17 October 2008, IPD has been notifiable to the local medical officer of health under the Health Act 1956. A case of IPD requires laboratory confirmation by at least one of the following [15]:

- isolation of *S. pneumoniae* from blood, cerebrospinal fluid (CSF) or another normally sterile site (e.g., joint fluid, pleural fluid)
- detection of *S. pneumoniae* nucleic acid from blood, CSF or another normally sterile site
- a positive *S. pneumoniae* antigen test on CSF (since 2009) or pleural fluid (since 2016)

The use of a laboratory-based surveillance system for IPD notification has some limitations. The addition of CSF in 2016 may have slightly increased the total number of IPD cases relative to previous years. This is particularly true for cases that were not detected from isolation of *S. pneumoniae* from blood, CSF, or another normally sterile site, nor from detection of *S. pneumoniae* nucleic acid from blood, CSF or another normally sterile site, nor did they have a positive *S. pneumoniae* antigen test on CSF. The total number of additional cases that may have been identified with this method was less than 10.

The use of surveillance data to identify and accurately quantify risk factors for IPD may be limited due to a lack of completeness of data. Moreover, not only are questions about risks often not answered, but when they are answered they often lack context. For example, a child who has been identified as "immunocompromised" may not necessarily be at an increased risk for IPD. A closer examination of the medical records for these cases would be needed to determine true risk. Additionally, some risk factors are especially susceptible to recall bias. That is, a clinician may report all risks, both large and small, after a case is identified, potentially falsely over-representing some risks relative to non-cases in the community. Lastly, the cause of death is unknown in a large proportion of fatalities, and the proportion where the cause of death is unknown has increased over time.

Notification data is entered at each public health unit (PHU) via a secure web-based portal onto a computerised database (EpiSurv). The data is collated and analysed on behalf of the Ministry of Health by ESR. The case report form is available in the appendix.

For the national laboratory-based surveillance of IPD, diagnostic microbiology laboratories in New Zealand are requested to refer all invasive isolates of *S. pneumoniae* (i.e., isolates from CSF, blood or another normally sterile site) to ESR. At ESR, all invasive isolates are serotyped and tested for susceptibility to a range of antibiotics, though from 2019 only 50%

of isolates are tested for susceptibility. Further details are provided in the section below entitled Laboratory methods.

The notification data in this report is based on the information recorded on EpiSurv as at 1 February 2021. Any changes made to the notification data by PHU staff after this date are not reflected in this report. Serotype and antimicrobial susceptibility data for invasive isolates was matched with the relevant case notification.

The immunisation status of cases age-eligible for PCV (i.e., cases born after 1 January 2008) is based on data from the National Immunisation Register (NIR) rather than the immunisation data reported with the case notification in EpiSurv. Further details are provided in the section below entitled Analytical methods.

LABORATORY METHODS

Strain typing

S. pneumoniae isolates are serotyped by the capsular antigen reaction (Neufeld test) using the Danish system of nomenclature and sera obtained from the Statens Serum Institut [16]. Some serotypes form serogroups and factor antisera is required to identify the serotype within that serogroup. The full complement of factorised antisera is not held by ESR. Consequently, some isolates are described by their serogroup followed by the designation NT (non-typeable).Isolates where the serotype is undetermined are designated ‘Non-typeable’.

Antimicrobial susceptibility testing

Penicillin and cefotaxime susceptibilities were determined by Etest (bioMerieux, France), using EUCAST Mueller-Hinton Fastidious agar and incubation for 20–24 hours in 5% CO_2. Chloramphenicol, clindamycin, co-trimoxazole, erythromycin, moxifloxacin, rifampicin, tetracycline and vancomycin susceptibilities were determined by EUCAST disc susceptibility testing methods [17]. Inducible clindamycin resistance was detected by the D-zone test [17]. All minimum inhibitory concentrations (MICs) and zone of inhibition diameters were interpreted according to the current EUCAST clinical breakpoints [17–20]. The only change to the breakpoints used between 2016 and 2019 were for co-trimoxazole, which changed in January 2019.

The antimicrobial susceptibility data presented in this report for the years prior to 2016 is based on CLSI methods and breakpoints [21,22]. EUCAST breakpoints, where they differ from CLSI breakpoints, have not been retrospectively applied to MICs and zone diameters determined by CLSI methods due to differences between the two methods. In this report, when associations between penicillin resistance and patient demographics, geographical distribution or serotypes are made, penicillin resistance as defined by the meningitis breakpoints have been used. The EUCAST and CLSI penicillin meningitis breakpoints are the same (susceptible, MIC ≤0.06 mg/L; resistant, MIC ≥0.12 mg/L). These penicillin breakpoints are also those commonly used for surveillance purposes. The EUCAST clinical breakpoints for co-trimoxazole changed in 2019 and are noted in the results.

In this report, multidrug resistance (MDR) is defined as resistance to three antibiotics in addition to penicillin. For the purposes of this definition, the meningitis breakpoints for penicillin were used.

ANALYTICAL METHODS

The denominator data used to determine all disease rates, except the rates for ethnic groups and deprivation index, is derived from the mid-year population estimates (2017, 2018, and 2019, respectively) published by Statistics New Zealand. All rates are presented as the number of cases per 100,000 population. Note that rates presented in this report for years prior to 2017 may differ slightly from those published in earlier annual reports as the mid-year population estimates are updated each year. The denominator data used to determine disease rates for ethnic groups is based on the proportion of people in each ethnic group from the resident 2013 census population applied to the mid-year population estimates. The demographic data presented for cases are obtained from the Episurv record. Where ethnicity is reported as unknown in the EpiSurv record (approximately 20% of cases), this information is obtained from the Ministry of Health, through matching to the National Health Index (NHI) database. Any cases that cannot be matched to the NHI database remain unknown. Ethnicity is prioritised in the following order: Māori, Pacific peoples, Asian, Middle Eastern/Latin American/African (MELAA), and European or Other ethnicity (including New Zealander).

Socio-economic deprivation is based on the 2013 New Zealand Index of Deprivation (NZDep13). The index, measuring relative socioeconomic deprivation, is derived from a weighted combination of nine variables from the 2013 census, each reflecting a different aspect of material and social deprivation. The deprivation score is calculated for each geographical meshblock in New Zealand. Quintiles of NZDep13, ranging from 1 (least deprived) to 5 (most deprived), are presented in this report. Approximately equal numbers of people reside in areas associated with each of the five deprivation levels. The deprivation index analysis was confined to those cases for which the accuracy of index designation was recorded as exact or nearest. Rates presented were calculated using population data derived from the usually resident 2013 census population.

Clinical presentation is determined from the EpiSurv record which is completed through the review of available clinical records. Notifiers are advised to report specific clinical presentations over ‘bacteraemia without focus’. More than one clinical presentation may be recorded for some cases of IPD. The clinical presentations are prioritised in the following order: meningitis, empyema, pneumonia, bacteraemia without focus (positive blood culture without a specific clinical site of infection) and ‘Other’. In this report, any cases for which *S. pneumoniae* was identified in CSF (by culture, polymerase chain reaction (PCR) or antigen test) and which were not notified as meningitis cases were considered to be cases of pneumococcal meningitis.

More than one method of laboratory confirmation may be recorded for some cases of IPD. The method of laboratory confirmation is prioritised in the following order: culture of *S. pneumoniae* from CSF, culture of *S. pneumoniae* from blood, detection of *S. pneumoniae* DNA in CSF, positive pneumococcal antigen test on CSF, detection of *S. pneumoniae* DNA in blood, culture of *S. pneumoniae* from pleural fluid, culture of *S. pneumoniae* from joint fluid, culture of *S. pneumoniae* from another normally sterile site, detection of *S. pneumoniae* DNA in pleural fluid, positive pneumococcal antigen test of pleural fluid, detection of *S. pneumoniae* DNA in joint fluid and detection of *S. pneumoniae* DNA in other normally sterile site.

IPD notifications from EpiSurv were matched with relevant data in the NIR for cases born after 1 January 2008 only. The NIR data obtained included the dates of vaccination, the

type of PCV administered (ie, PCV7, PCV10 or PCV13), and the batch number of the vaccine given. The batch numbers of all PCV issued from the former National Vaccine Store at ESR were obtained and were used to cross-check the NIR data on the type of vaccine administered. Any doses of PCV given within 14 days of disease onset were not counted in the analysis.

Data presented for 2009 onwards is based on IPD notifications from EpiSurv and data prior to 2009 is from ESR's national laboratory-based surveillance of IPD. Compared with notifications, laboratory-based surveillance is likely to underestimate the burden of IPD. Data for 2008–2016 can be obtained from earlier annual reports [2–9,23].

VACCINE ABBREVIATIONS

PCV7: 7-valent pneumococcal conjugate vaccine with serotypes 4, 6B, 9V, 14, 18C, 19F and 23F.

PCV10: 10-valent pneumococcal conjugate vaccine with serotypes 1, 4, 5, 6B, 7F, 9V, 14, 18C, 19F (and cross-protection against 19A) and 23F.

PCV13: 13-valent pneumococcal conjugate vaccine with serotypes 1, 3, 4, 5, 6A, 6B, 7F, 9V, 14, 18C, 19A, 19F and 23F.

PPV23: 23-valent pneumococcal polysaccharide vaccine with serotypes 1, 2, 3, 4, 5, 6B, 7F, 8, 9N, 9V, 10A, 11A, 12F, 14, 15B, 17F, 18C, 19A, 19F, 20, 22F, 23F and 33F.

RESULTS

In 2017, 521 cases of IPD were notified. The 2017 annual incidence rate for IPD was 10.9 cases per 100,000 population, similar to the 2016 rate (10.2 per 100,000). *S. pneumoniae* isolates from an invasive site were received by ESR and antimicrobial susceptibility testing was performed on 489 (93.9%) of the 521 cases notified in 2017.

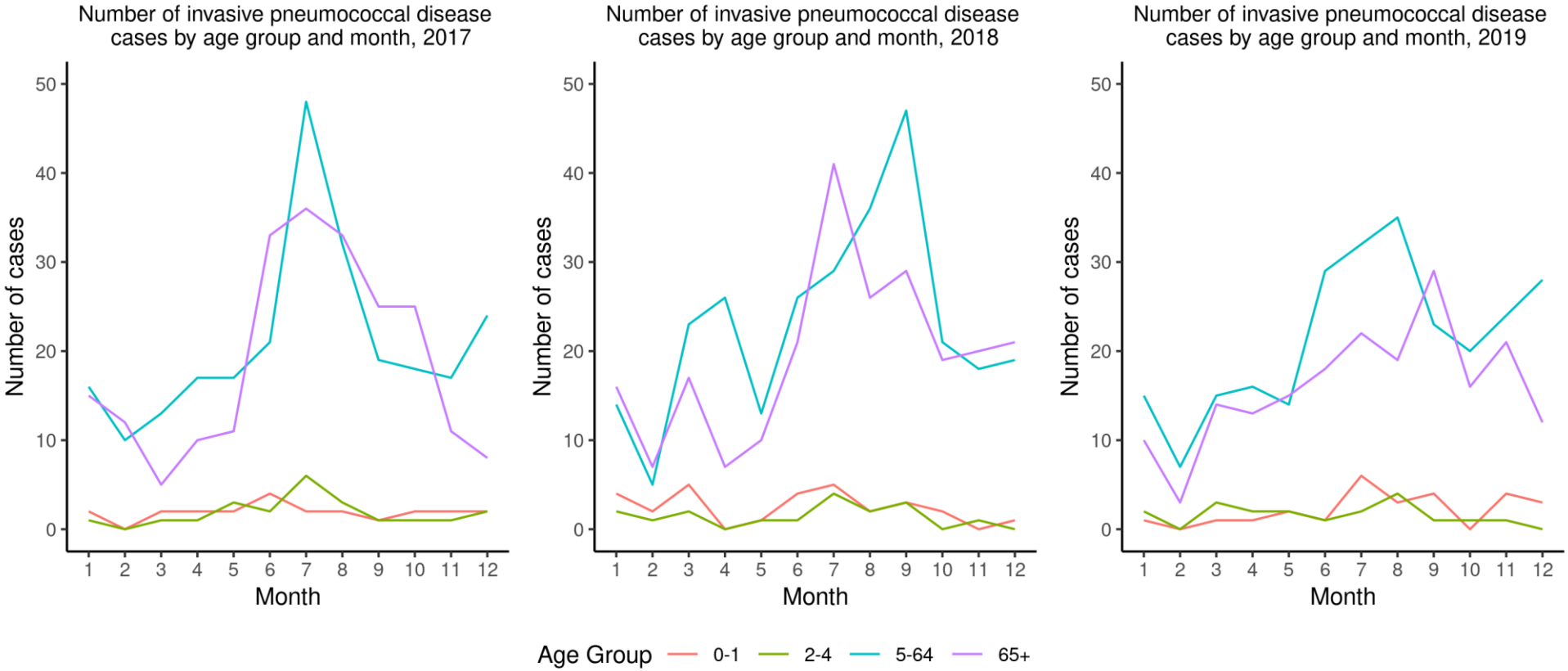
The 2018, 557 cases of IPD were notified. The 2018 annual incidence rate for IPD was 11.4 cases per 100,000 population. *S pneumoniae* isolates from an invasive site were received by ESR and antimicrobial susceptibility testing was performed on 531 (95.3%) of the 557 cases notified in 2018.

In 2019, 495 cases of IPD were notified. The 2019 annual incidence rate for IPD was 10.1 cases per 100,000 population. *S. pneumoniae* isolates from an invasive site were received by ESR and antimicrobial susceptibility testing from 233 (47.1%) of the 495 cases notified in 2019. Note in 2019, a purposeful reduction in antimicrobial susceptibility testing to 50% of *S. pneumoniae* isolates was introduced, accounting for the reduction in isolates received for antimicrobial susceptibility testing.

DISEASE INCIDENCE BY SEASON

During 2017–19 there was the usual marked peak of cases in the winter months among cases aged ≥5 years (Figure 1). Though the number of incident cases during 2018 followed historical trends throughout winter months, the number of cases remained elevated through the end of the year, particularly among cases aged ≥5 years. Again, though the incident cases among those 5 years old and older followed historical trends peaking in winter months, the cases remained high and began increasing again toward the end of 2019 among those 5–64 years of age.

Figure 1. Number of invasive pneumococcal disease cases by age group and month, 2017–2019



DISEASE INCIDENCE BY AGE AND SEX

Age and sex were recorded for all IPD cases between 2017–2019. The distribution of the cases by age group and sex is presented in Table 1. For aggregated age groups, the 5–64 age group consistently had the most incident cases of IPD, and males had higher rates of IPD when compared to females in all three years. While the overall rate of IPD was highest among males when compared to females 2017–2019, the rates of IPD among the <2 year age group and the <5 year age group did not follow a gender-year pattern. The highest rates were in adults aged ≥65 years for all years, followed by infants aged <2 years. Rates of IPD showed an increasing trend with age from 15 years onwards, regardless of gender or year of notification.

Table 1. Number of cases and rate per 100,000 population of invasive pneumococcal disease by age group and sex, 2017–2019

Age group (years)	Female-2017		Male-2017		Female-2018		Male-2018		Female-2019		Male-2019	
	Cases	Rate[a]	Cases	Rate[a]	Cases	Rate[a]	Cases	Rate[a]	Cases	Rate[a]	Cases	Rate[a]
<1	7	23.6	4	--	10	34.1	8	25.9	7	23.9	11	35.7
1	4	--	8	25.7	6	20.0	5	16.0	4	--	4	--
2–4	11	12.2	11	11.6	9	10.0	8	8.4	7	7.8	12	12.6
5–14	8	2.6	16	5	11	3.5	18	5.5	8	2.5	15	4.5
15–24	8	2.5	9	2.6	8	2.5	11	3.2	4	--	14	4.2
25–34	10	2.9	13	3.9	15	4.2	16	4.5	14	4.0	15	4.4
35–44	15	5.0	16	5.7	19	6.2	20	7.0	16	5.1	21	7.1
45–54	25	7.5	34	11.1	31	9.4	29	9.5	19	5.7	41	13.4
55–64	40	13.6	58	21.1	51	16.9	48	17	47	15.3	44	15.3
65–74	52	24.3	56	27.7	55	24.7	45	21.5	46	20.0	48	22.3
75–84	47	39.4	28	27.4	42	34.3	46	43.7	29	22.9	28	25.7
≥85	22	41.9	19	59.4	23	43.2	23	68.7	20	37.2	21	60.7
Aggregated age groups (years)												
<2[c]	11	18.6	12	19.3	16	26.9	13	20.9	11	18.6	15	24.2
<5	22	14.8	23	14.6	25	16.8	21	13.3	18	12.1	27	17.2
5–64	106	5.6	146	7.8	135	7.0	142	7.5	108	5.6	150	7.9
≥65	121	31.3	103	30.6	120	30.1	114	32.7	95	23.2	97	27.0
Total	**249**	**10.2**	**272**	**11.5**	**280**	**11.3**	**277**	**11.5**	**221**	**8.8**	**274**	**11.3**

[a] Where there were fewer than five cases, a rate has not been calculated.

The 55–64 and 65–74 year age groups appear to have decreasing incidence rates from 2017 to 2019, the <1 age group appears to follow an increasing trend in IPD rates, though case numbers are low (Table 2). Most other age groups are stable or do not follow a trend across years.

Table 2. Total Number of cases and rate per 100,000 population of invasive pneumococcal disease by age group, 2017–2019

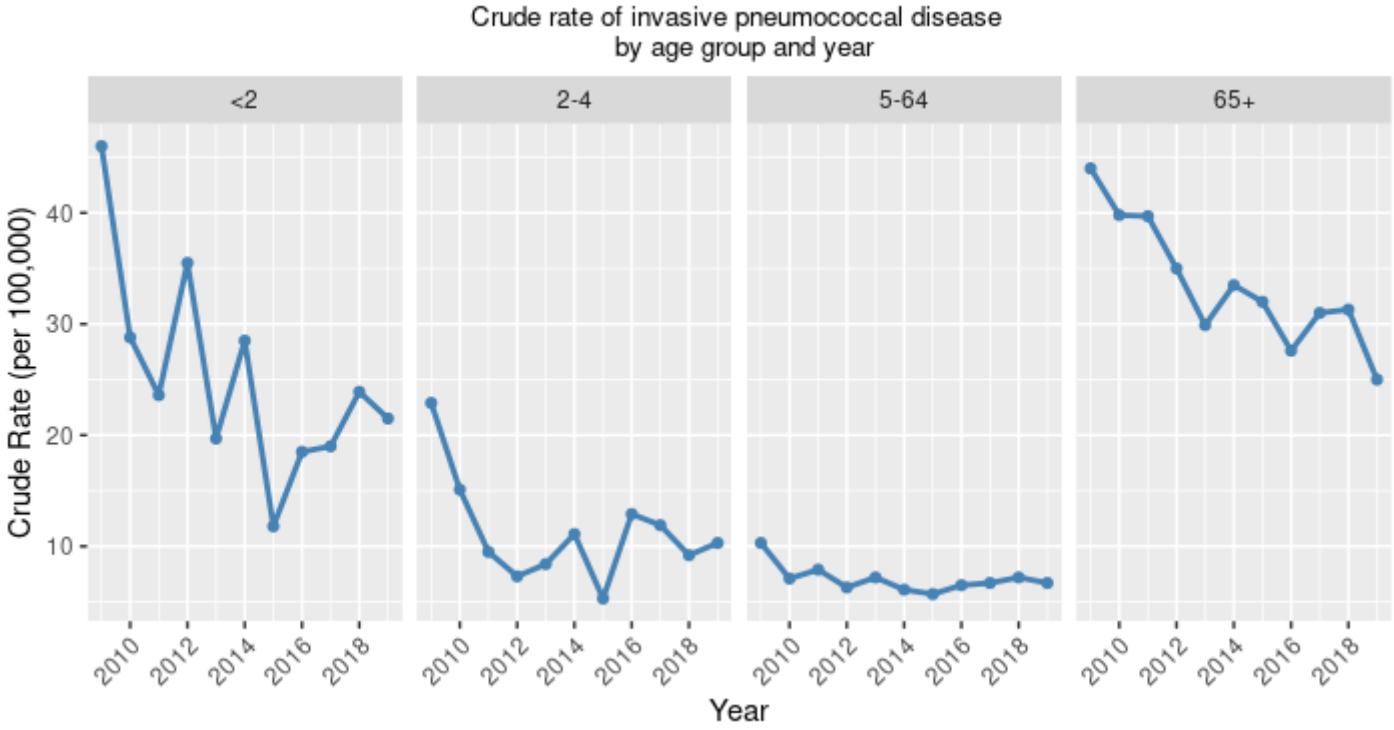
Age group (years)	2017			2018			2019		
	Cases	Rate[a]	Proportion[b]	Cases	Rate[a]	Proportion[b]	Cases	Rate[a]	Proportion[b]
<1	11	18.2	2.1	18	29.9	3.2	18	30.0	3.6
1	12	19.8	2.3	11	18.0	2.0	8	13.1	1.6
2–4	22	11.9	4.2	17	9.2	3.1	19	10.3	3.8
5–14	24	3.8	4.6	29	4.5	5.2	23	3.5	4.6
15–24	17	2.5	3.3	19	2.8	3.4	18	2.8	3.6
25–34	23	3.4	4.4	31	4.4	5.6	29	4.2	5.9
35–44	31	5.3	6.0	39	6.6	7.0	37	6.1	7.5
45–54	59	9.3	11.3	60	9.4	10.8	60	9.4	12.1
55–64	98	17.2	18.8	99	16.9	17.8	91	15.3	18.4
65–74	108	25.9	20.7	100	23.1	18.0	94	21.1	19.0
75–84	75	33.9	14.4	88	38.6	15.8	57	24.2	11.5
≥85	41	48.5	7.9	46	53.0	8.3	41	46.4	8.3
Aggregated age groups (years)									
<2	23	19.0	4.4	29	23.9	5.2	26	21.5	5.3
<5	45	14.7	8.6	46	15	8.3	45	14.7	9.1
5–64	252	6.7	48.4	277	7.2	49.7	258	6.7	52.1
≥65	224	31.0	43.0	234	31.3	42.0	192	25.0	38.8
Total	**521**	**10.9**	**100**	**557**	**11.4**	**100**	**495**	**10.1**	**100**

[a] Where there were fewer than five cases, a rate has not been calculated.
[b] Percentage of cases in each age group.

Between 2009 and 2019, there was an approximate 50% decrease in the annual incidence rate of IPD in the <2 years age group (46 to 21.5 per 100,000), getting as low as 11.8 per 100,000 in 2015 (Figure 2). Similarly, in the 2–4 year age group, the annual incidence rate also decreased by approximately 50% (22.9 to 10.3 per 100,000), reaching a low of 5.3 per 100,000 in 2015. The actual reductions in disease rates in these age groups may be greater than these figures indicate due to the changes in laboratory case definitions to include pleural antigen detection from 2016.

Since 2010, the annual incidence rate of IPD in the 5–64 years age group has remained stable, ranging from 5.7 to7.9 cases per 100,000. Over the same period, the rate in the ≥65 years age group has decreased from 39.8 to 25.0 per 100,000.

Figure 2. Rate per 100,000 population of invasive pneumococcal disease by age group and year, 2009–2019



DISEASE INCIDENCE BY ETHNIC GROUP

Ethnicity was recorded for 512 (98.3%) of the 521 IPD cases in 2017. The age-standardised rates of IPD were highest for the Pacific peoples (37.6 per 100,000, 80 cases) and Māori (27.2 per 100,000, 134 cases) ethnic groups. The rates for these two ethnic groups were, respectively, 4.9 and 3.6 times the rate for the European or Other ethnic group (7.7 per 100,000, 265 cases) (Table 3).

Among the 23 cases aged <2 years, eight cases (34.8%) were European or Other ethnicity, seven cases (30.4%) were of Māori ethnicity, five (21.7%) were of Pacific peoples ethnicity, and three (13.0%) were of Asian ethnicity.

Table 3. Number of cases, and age-specific and age-standardised rate per 100,000 population of invasive pneumococcal disease by ethnic group and age group, 2017

Age group (years)	Māori		Pacific peoples		Asian		MELAA[a]		European or Other	
	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
<1	4	--	2	--	2	--	0	--	3	--
1	3	--	3	--	1	--	0	--	5	15.3
2–4	1	--	7	35.2	7	30.7	0	--	7	6.7
5–14	9	5.7	4	--	3	--	0	--	8	2.3
15–24	6	4.5	2	--	1	--	2	--	6	1.7
25–34	10	9.9	2	--	1	--	1	--	9	2.5
35–44	12	14.5	5	13.6	1	--	0	--	13	3.4
45–54	20	25.4	16	49.1	2	--	1	--	18	4
55–64	23	41.3	11	49.3	6	12.1	0	--	55	12.6
65–74	24	82.5	14	112.5	3	--	0	--	64	18.4
75–84	18	162.4	9	182.9	2	--	0	--	45	23.2
≥85	4	--	5	517.9	0	--	0	--	32	42.4
Aggregated age groups (years)										
<2	7	19.8	5	38.3	3	--	0	--	8	12.7
<5	8	9.7	12	39.9	10	27.5	0	--	15	9.9
5–64	80	13.1	40	15.7	14	2.9	4	--	109	4.7
≥65	46	109.5	28	152.7	5	13.8	0	--	141	22.8
Total cases and crude rate for all ages[b]	**134**	**18.3**	**80**	**26.3**	**29**	**5.2**	**4**	**--**	**265**	**8.5**
Age-standardised rate[c]		**27.2**		**37.6**		**6.1**		**6.6**		**7.7**

[a] Middle Eastern/Latin American/African.
[b] Ethnicity was recorded for 507 (97.3%) of cases notified in 2017.
[c] The age-standardised rates are direct-standardised to the age distribution of the total New Zealand population.
Note: Denominator data used to determine disease rates for ethnic groups is based on the proportion of people in each ethnic group from the usually resident 2013 census population applied to the 2017 mid-year population estimates from Statistics New Zealand. Ethnicity is prioritised in the following order: Māori, Pacific peoples, Asian, MELAA and European or Other ethnicity (including New Zealander). Where there were fewer than five cases in any category, a rate has not been calculated.

Ethnicity was recorded for 539 (96.8%) of the 557 IPD cases in 2018. The age-standardised rates of IPD were highest for the Pacific peoples (39.1 per 100,000, 92 cases) and Māori (23.8 per 100,000, 129 cases) ethnic groups. The rates for these two ethnic groups were, respectively, 4.7 and 2.9 times the rate for the European or Other ethnic group (8.3 per 100,000, 292 cases) (Table 4).

Among the 29 cases aged <2 years, 11 cases (37.9%) were of Māori ethnicity, eight (27.6%) were European or Other ethnicity, five (17.2%) were of Pacific peoples ethnicity , and five (17.2%) were of Asian ethnicity.

Table 4. Number of cases, and age-specific and age-standardised rate per 100,000 population of invasive pneumococcal disease by ethnic group and age group, 2018

Age group (years)	Māori		Pacific peoples		Asian		MELAA[a]		European or Other	
	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
<1	8	44.2	3	--	1	--	0	--	6	19.6
1	3	--	2	--	4	--	0	--	2	--
2–4	3	--	5	24.7	4	--	0	--	5	4.7
5–14	9	5.6	7	11.4	0	--	0	--	13	3.7
15–24	5	3.8	8	14.2	1	--	0	--	4	--
25–34	4	--	9	18.5	1	--	0	--	17	4.5
35–44	11	13.1	7	18.8	2	--	0	--	16	4.1
45–54	21	26.6	12	36.8	3	--	0	--	22	4.9
55–64	28	49.0	14	61.2	4	--	0	--	50	11.1
65–74	21	69.7	16	124.1	2	--	0	--	57	15.8
75–84	13	114.4	7	138.8	3	--	0	--	60	30.1
≥85	3	--	2	--	1	--	0	--	40	52.2
Aggregated age groups (years)										
<2	11	30.6	5	37.7	5	28.8	0	--	8	12.5
<5	14	17.0	10	33.3	9	24.7	0	--	13	8.6
5–64	78	12.6	57	22.0	11	2.2	0	--	122	5.1
≥65	37	85.3	25	132.1	6	16.1	0	--	157	24.7
Total cases and crude rate for all ages[b]	**129**	**17.4**	**92**	**29.9**	**26**	**4.6**	**0**	**--**	**292**	**9.2**
Age-standardised rate[c]		**23.8**		**39.1**		**5.7**		**0**		**8.3**

[a] Middle Eastern/Latin American/African.
[b] Ethnicity was recorded for 536 (96.2%) of cases notified in 2018.
[c] The age-standardised rates are direct-standardised to the age distribution of the total New Zealand population.
Note: Denominator data used to determine disease rates for ethnic groups is based on the proportion of people in each ethnic group from the usually resident 2013 census population applied to the 2018 mid-year population estimates from Statistics New Zealand. Ethnicity is prioritised in the following order: Māori, Pacific peoples, Asian, MELAA and European or Other ethnicity (including New Zealander). Where there were fewer than five cases in any category, a rate has not been calculated.

Ethnicity was recorded for 492 (99.4%) of the 495 IPD cases in 2019. The age-standardised rates of IPD were highest for the Pacific peoples (30.9 per 100,000, 78 cases) and Māori (24.7 per 100,000, 150 cases) ethnic groups. The rates for these two ethnic groups were, respectively, 4.6 and 3.7 times the rate for the European or Other ethnic group (6.7 per 100,000, 242 cases) (Table 5).

Among the 26 cases aged <2 years, thirteen cases (50.0%) were of Māori ethnicity, six (23.1%) were European or Other, five (19.2%) were of Pacific peoples ethnicity, one (3.8%) was of Asian ethnicity, and one (3.8%) was in the MELAA ethnic group.

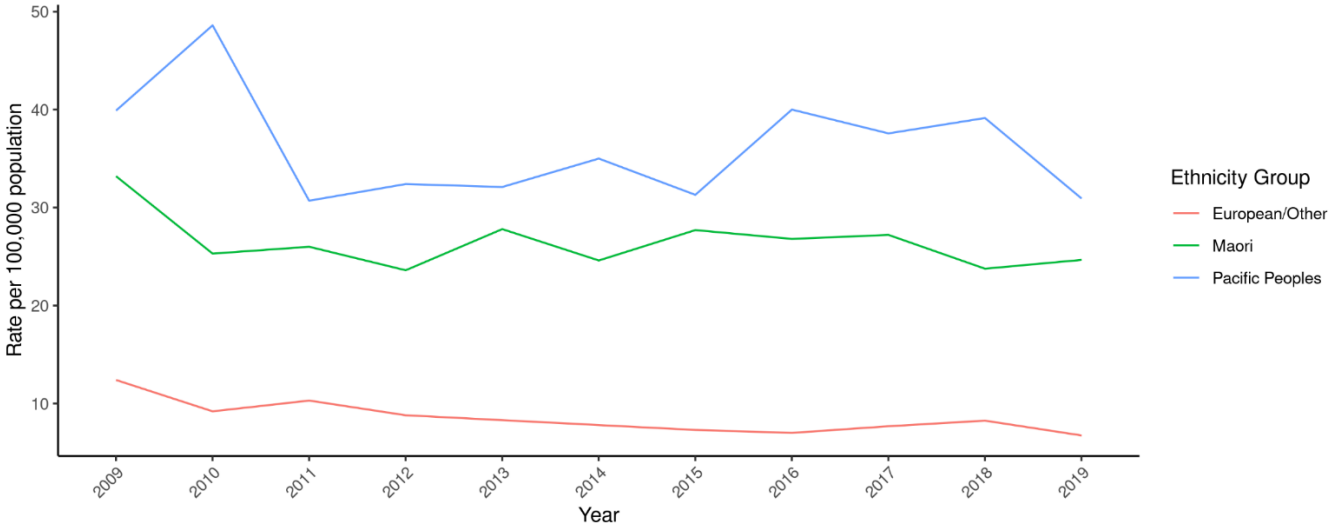
Table 5. Number of cases, and age-specific and age-standardised rate per 100,000 population of invasive pneumococcal disease by ethnic group and age group, 2019

Age group (years)	Māori		Pacific peoples		Asian		MELAA[a]		European or Other	
	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
<1	10	54.5	4	--	1	--	0	--	3	--
1	3	--	1	--	0	--	1	--	3	--
2–4	6	10.6	3	--	3	--	0	--	7	6.5
5–14	4	--	6	9.6	3	--	0	--	8	2.3
15–24	8	6	3	--	2	--	0	--	5	1.4
25–34	12	11.2	7	14.0	0	--	0	--	10	2.6
35–44	15	17.6	9	23.8	2	--	1	--	10	2.5
45–54	26	32.9	13	39.9	1	--	0	--	20	4.4
55–64	35	60.0	15	64.3	3	--	0	--	38	8.3
65–74	19	61.0	11	82.6	5	19.3	0	--	58	15.5
75–84	10	84.7	3	--	0	--	0	--	44	21.3
≥85	2	--	3	--	0	--	0	--	36	46.2
Aggregated age groups (years)										
<2	13	35.6	5	37.1	1	--	1	--	6	9.3
<5	19	23.1	8	26.6	4	--	1	--	13	8.5
5–64	100	16	53	20.2	11	2.2	1	--	91	3.8
≥65	31	69.1	17	86.9	5	12.9	0	--	138	21
Total cases and crude rate for all ages[b]	**150**	**19.9**	**78**	**25**	**20**	**3.5**	**2**	**--**	**242**	**7.5**
Age-standardised rate[c]		**24.7**		**30.9**		**4.4**		**3.0**		**6.7**

[a] Middle Eastern/Latin American/African.
[b] Ethnicity was recorded for 491 (99.2%) of cases notified in 2019.
[c] The age-standardised rates are direct-standardised to the age distribution of the total New Zealand population.
Note: Denominator data used to determine disease rates for ethnic groups is based on the proportion of people in each ethnic group from the usually resident 2013 census population applied to the 2018 mid-year population estimates from Statistics New Zealand. Ethnicity is prioritised in the following order: Māori, Pacific peoples, Asian, MELAA and European or Other ethnicity (including New Zealander). Where there were fewer than five cases in any category, a rate has not been calculated.

Between 2009 and 2019, the age-standardised IPD rates decreased in the European or Other (-45%), Māori (-27%), and Pacific peoples (-22%) ethnic groups (Figure 3).

Figure 3. Age-standardised rate per 100,000 population of invasive pneumococcal disease by ethnic group, 2009–2019



Note: Rates for the Asian and MELAA ethnic groups are not shown due to small numbers.

DISEASE INCIDENCE BY DEPRIVATION

In 2017, 493 (94.6%) of the 521 IPD cases had a residential address recorded that could be assigned an NZDep13 score. In all age groups, at least half the cases resided in NZDep13 quintiles 4 or 5 (Table 6). The difference between higher quintiles becomes less as the age of the cases increases. For example, there are three times more cases in quintile 5 than in quintile 4 among the <2 years age group (36.4% vs 13.64%), though that relative difference decreases substantially among 65 years old or older group (29.67% vs 27.75%). The declining relative difference between quintiles as the age increases is also seen when comparing cases in the lowest quintile (1) with the highest quintile (5), particularly among those 65 years old or older (the proportion in quintile 5 among 65 years old or older is more than two times higher than the proportion in quintile 1 in the oldest age group, but four times higher in every other age group).

Table 6. Number and percentage of invasive pneumococcal disease cases by quintiles of the 2013 New Zealand deprivation index and age group, 2017

NZDep13 quintile[a]	<2 years		2–4 years		5–64 years		≥65 years		Total	
	Cases	%[b]	Cases	%[b]	Cases	%[b]	Cases	%[b]	Cases	%[b]
1	2	9.1	2	9.5	26	10.8	27	12.9	57	11.6
2	3	13.6	3	14.3	30	12.5	24	11.5	60	12.2
3	6	27.3	4	19.1	31	12.9	38	18.2	79	16.0
4	3	13.6	4	19.1	48	19.9	58	27.8	113	23.0
5	8	36.4	8	38.1	106	44.0	62	29.7	184	37.3
Total[d]	**22**	**100**	**21**	**100**	**241**	**100**	**209**	**100**	**493**	**100**

[a] Quintile of the 2013 New Zealand Deprivation Index (1 = least deprived and 5 = most deprived).
[b] Percentage of cases within the age group in the quintile.
[d] Accurate New Zealand Deprivation Index (NZDep13) data was available for 488 (93.7%) cases notified in 2017.

In 2018, 532 (95.5%) of the 557 IPD cases had a residential address recorded that could be assigned an NZDep13 score. In all age groups, at least 55% of the cases resided in NZDep13 quintiles 4 or 5, but more than 70% of the cases <5 years old resided in NZDep quintiles 4 or 5 (Table 7). For 2018, quintile 5 is six times higher than quintile 4 among <2 years age group (60.7% vs 10.7%), though that relative difference decreases to just 1.3 times higher among 65 years old or older group (31.7% vs 24.2%).

There was a declining relative difference between quintiles as age increased in 2018. Comparing the lowest quintile (1) with the highest quintile (5), particularly among those 65 years old or older (the proportion in quintile 5 among 65 years old or older is more than two times higher than the proportion in quintile 1 in the oldest age group, but four to eight times higher in every other age group).

Table 7. Number and percentage of invasive pneumococcal disease cases by quintiles of the 2013 New Zealand deprivation index and age group, 2018

NZDep13 quintile[a]	<2 years		2–4 years		5–64 years		≥65 years		Total	
	Cases	%[b]	Cases	%[b]	Cases	%[b]	Cases	%[b]	Cases	%[b]
1	2	7.1	1	6.3	23	8.8	30	13.2	56	10.5
2	2	7.1	2	12.5	33	12.6	29	12.8	66	12.4
3	4	14.3	2	12.5	38	14.6	41	18.1	85	16.0
4	3	10.7	4	25	59	22.6	55	24.2	121	22.7
5	17	60.7	7	43.8	108	41.4	72	31.7	204	38.4
Total[d]	**28**	**100**	**16**	**100**	**261**	**100**	**227**	**100**	**532**	**100**

[a] Quintile of the 2013 New Zealand Deprivation Index (1 = least deprived and 5 = most deprived).
[b] Percentage of cases within the age group in the quintile.
[d] Accurate New Zealand Deprivation Index (NZDep13) data was available for 529 (95.0%) cases notified in 2018.

In 2019, 468 (94.5%) of the 495 IPD cases had a residential address recorded that could be assigned an NZDep13 score. In all age groups under 65 years of age, at least two-third of the cases resided in NZDep13 quintiles 4 or 5e (Table 8). For 2019, quintile 5 is more than 2 times higher than quintile 4 among <2 years age group (50% vs 21%), though that relative difference decreases to just 1.1 times higher among 65 years old or older group (30.8% vs 28.6%).

There was a declining relative difference between quintiles as the age increased in 2019, as well. Comparing the lowest quintile 1 with the highest quintile 5, particularly among those 65 years old or older (the proportion in quintile 5 among 65 years old or older is more than two times higher than the proportion in quintile 1 in the oldest age group, but four times higher in every other age group).

Table 8. Number and percentage of invasive pneumococcal disease cases by quintiles of the 2013 New Zealand deprivation index and age group, 2019

NZDep13 quintile[a]	<2 years		2–4 years		5–64 years		≥65 years		Total	
	Cases	%[b]	Cases	%[b]	Cases	%[b]	Cases	%[b]	Cases	%[b]
1	3	12.5	0	0	25	10.2	22	12.1	50	10.7
2	1	4.2	1	6.3	28	11.4	26	14.3	56	12.0
3	3	12.5	4	25.0	30	12.2	26	14.3	63	13.5
4	5	20.8	5	31.3	55	22.4	52	28.6	117	25.0
5	12	50.0	6	37.5	108	43.9	56	30.8	182	38.9
Total[d]	**24**	**100**	**16**	**100**	**246**	**100**	**182**	**100**	**468**	**100**

[a] Quintile of the 2013 New Zealand Deprivation Index (1 = least deprived and 5 = most deprived).
[b] Percentage of cases within the age group in the quintile.
[d] Accurate New Zealand Deprivation Index (NZDep13) data was available for 465 (93.9%) cases notified in 2019.

DISEASE PRESENTATION, HOSPITALISATIONS AND FATALITIES

In 2017, 507 (97.3%) of the 521 IPD cases had at least one clinical presentation recorded (Table 9). Among infants aged <1 year, meningitis and bacteraemia without focus were the most common presentations (36.4% each). Pneumonia was the most common presentation among cases aged ≥5 years (69.5%).

The four cases of pneumococcal meningitis aged <1 year were in the Māori (1 case), Asian (1 case), and European or Other (2 cases) ethnic groups.

Table 9. Clinical presentation of invasive pneumococcal disease cases by age group, 2017

Age group (years)	Meningitis		Empyema		Pneumonia		Bacteraemia without focus		Other		Total[c]
	Cases[a]	%[b]	Cases[a]	%[b]	Cases[a]	%[b]	Cases[a]	%[b]	Cases[a]	%[b]	
<1	4	36.4	1	9.1	2	18.2	4	36.4	0	0	11
1	1	8.3	3	25.0	2	16.7	4	33.3	2	16.7	12
2–4	4	18.2	5	22.7	6	27.7	7	31.8	0	0	22
5–14	5	21.7	1	4.4	9	39.1	5	21.7	3	13.0	23
15–64	26	11.9	6	2.7	146	66.7	29	13.2	12	5.5	219
≥65	10	4.6	4	1.8	166	75.5	28	12.7	12	5.5	220
Aggregated age groups (years)											
<2	5	21.7	4	17.4	4	17.4	8	34.8	2	8.7	23
<5	9	20.0	9	20.0	10	22.2	15	33.3	2	4.4	45
≥5	41	8.9	11	2.4	321	69.5	62	13.4	27	5.8	462
Total[d]	50	9.9	20	3.9	331	65.3	77	15.2	29	5.7	507

[a] Number of cases with 'yes' recorded for the clinical presentation. Only one presentation was counted for each case, with presentations prioritised in the following order: meningitis, empyema, pneumonia, bacteraemia without focus and 'Other'. Any cases for which *S. pneumoniae* was identified in CSF were considered to be cases of pneumococcal meningitis.
[b] Percentage of cases within the age group with the clinical presentation.
[c] Number of cases with at least one clinical presentation recorded.
[d] At least one clinical presentation was recorded for 507 (97.3%) of cases notified in 2017.

In 2018, 542 (97.3%) of the 557 IPD cases had at least one clinical presentation recorded (Table 10). Among infants aged <1 year, meningitis, pneumonia, and bacteraemia without focus were the most common presentations (29.4%, 35.3%, and 35.3%, respectively). Pneumonia was the most common presentation among cases aged ≥5 years (71.2%).

The five cases of pneumococcal meningitis aged <1 year were in the Māori (3 cases), Pacific peoples (1 case), and European or Other (1 case) ethnic groups.

Table 10. Clinical presentation of invasive pneumococcal disease cases by age group, 2018

Age group (years)	Meningitis		Empyema		Pneumonia		Bacteraemia without focus		Other		Total[c]
	Cases[a]	%[b]	Cases[a]	%[b]	Cases[a]	%[b]	Cases[a]	%[b]	Cases[a]	%[b]	
<1	5	29.4	0	0	6	35.3	6	35.3	0	0	17
1	0	0	2	18.2	5	45.5	4	36.4	0	0	11
2–4	1	5.9	2	11.8	9	53.0	5	29.4	0	0	17
5–14	5	17.9	0	0	14	50.0	7	25.0	2	7.1	28
15–64	19	7.9	7	2.90	166	69.0	37	15.3	13	5.4	242
≥65	9	4.0	4	1.80	174	77.0	31	13.7	9	4.0	227
Aggregated age groups (years)											
<2	5	17.9	2	7.1	11	39.3	10	35.7	0	0	28
<5	6	13.3	4	8.9	20	44.4	15	33.3	0	0	45
≥5	33	6.6	11	2.2	354	71.2	75	15.1	24	4.8	497
Total[d]	**39**	**7.2**	**15**	**2.8**	**374**	**69.0**	**90**	**16.6**	**24**	**4.4**	**542**

[a] Number of cases with 'yes' recorded for the clinical presentation. Only one presentation was counted for each case, with presentations prioritised in the following order: meningitis, empyema, pneumonia, bacteraemia without focus and 'Other'. Any cases for which *S. pneumoniae* was identified in CSF were considered to be cases of pneumococcal meningitis.
[b] Percentage of cases within the age group with the clinical presentation.
[c] Number of cases with at least one clinical presentation recorded.
[d] At least one clinical presentation was recorded for 542 (97.3%) of cases notified in 2018.

In 2019, 481 (97.2%) of the 495 IPD cases had at least one clinical presentation recorded (Table 11). Among infants aged <1 year, meningitis was the most common presentation (50%). Pneumonia was the most common presentation among cases aged ≥5 years (68.0%). The nine cases of pneumococcal meningitis aged <1 year were in the Māori (6 cases), Asian (1 case), and Pacific (2 cases) ethnic groups.

Table 11. Clinical presentation of invasive pneumococcal disease cases by age group, 2019

Age group (years)	Meningitis		Empyema		Pneumonia		Bacteraemia without focus		Other		Total[c]
	Cases[a]	%[b]	Cases[a]	%[b]	Cases[a]	%[b]	Cases[a]	%[b]	Cases[a]	%[b]	
<1	9	50.0	0	0	3	16.7	3	16.7	3	16.7	18
1	4	57.1	1	14.3	1	14.3	1	14.3	0	-	7
2–4	2	10.5	3	15.8	8	42.1	6	31.6	0	-	19
5–14	1	4.6	4	18.2	9	40.9	6	27.3	2	9.1	22
15–64	25	10.9	4	1.8	154	67.3	36	15.7	10	4.4	229
≥65	12	6.5	5	2.7	134	72.0	26	14.0	9	4.8	186
Aggregated age groups (years)											
<2	13	52.0	1	4.0	4	16.0	4	16.0	3	12.0	25
<5	15	34.1	4	9.1	12	27.3	10	22.7	3	6.8	44
≥5	38	8.7	13	3.0	297	68.0	68	15.6	21	4.8	437
Total[d]	**53**	**11.0**	**17**	**3.5**	**309**	**64.2**	**78**	**16.2**	**24**	**5.0**	**481**

[a] Number of cases with 'yes' recorded for the clinical presentation. Only one presentation was counted for each case, with presentations prioritised in the following order: meningitis, empyema, pneumonia, bacteraemia without focus and 'Other'. Any cases for which *S. pneumoniae* was identified in CSF were considered to be cases of pneumococcal meningitis.
[b] Percentage of cases within the age group with the clinical presentation.
[c] Number of cases with at least one clinical presentation recorded.
[d] At least one clinical presentation was recorded for 481 (97.2%) of cases notified in 2019.

Hospitalisations and Fatalities

Information on whether the patient was hospitalised was recorded for 517 (99.2%) IPD cases in 2017, 553 (99.3%) IPD cases in 2018 and 492 (99.4%) IPD cases in 2019.

The proportion of IPD cases that were hospitalised remained high and stable over the period 2017–2019.

In 2017, 497 (96.1%) cases were hospitalised, in 2018 541 (97.8%) were hospitalised, and in 2019 478 (97.2%) were hospitalised

Information on whether the patient survived or died was recorded for 496 (95.2%) of the IPD cases in 2017, 546 (98.0%) in 2018, and 476 (96.2%) in 2019.

In 2017, IPD was recorded as the primary cause of death for 27 cases (a further 12 had an unknown cause of death and 5 were not attributable), giving a case-fatality rate of 5.4% among the cases for whom this information was reported.

In 2018 25 deaths were attributed to IPD (a further 13 had an unknown cause of death and 2 were not attributable), yielding a case-fatality rate of 4.6%.

In 2019 there 12 deaths were attributed to IPD (a further 14 had an unknown cause of death and 5 were not attributable) (2.5% case-fatality rate).

There was one death due to IPD reported in the <5 years age group in both 2017 and 2018, and 2 deaths due to IPD in the <5 years age group in 2019.

IMMUNISATION STATUS

Immunisation records were identified for IPD cases who were age-eligible for PCV (i.e., cases born after 1 January 2008 and aged ≥6 weeks). The number of doses shown were received prior to 14 days before onset of IPD (determined using the earliest episode date available from onset of illness date, hospitalised date, or date reported to the public health unit). PCV vaccine was defined as PCV7, PCV10, PCV13—the number of doses of covering PCV is specific to the serotype detected and the PCV type received.

In 2017, immunisation records were identified in the NIR for 48 IPD cases (Table 12). An additional 11 IPD cases were age-eligible for PCV but had no data within NIR nor in EpiSurv and are assumed to be unvaccinated. Of the 48 IPD cases in 2017 found within NIR data, 12 were either missing serotype data or were non-typable and 36 had serotype data. Of those 36 cases, 29 had serotypes that were not covered by PCV and seven were diagnosed with a serotype that was contained within PCV7, PCV10, or PCV13. Of these seven, three were serotype 19A (PCV10[b], PCV13), two were serotype 14 (PCV7, PCV10 and PCV 13), and two were serotype 3 (PCV13).

Of note, of the two cases diagnosed with serotype 14, one had four PCV13 doses and one had three PCV7 doses and one PCV10 dose. Of the two cases of serotype 3, both had received four doses of PCV13. Of the three cases of 19A, two had received four doses of PCV10 and one received four doses of PCV13.

Table 12. Immunisation status of the 2017 IPD cases (n=48) who were age-eligible for PCV and have an NIR record

Vaccine Type (doses)	PCV7 Serotypes							PCV10 Serotypes				PCV13 Serotypes		Non-PCV Serotypes or Unknown	Number of People
	4 n=0	6B n=0	9V n=0	14 n=2	18C n=0	19F n=0	23F n=0	1 n=0	5 n=0	7F n=0	{19A} n=3	3 n=2	6A n=0	n=41	
PCV7															
1														0	0
2														0	0
3														0	0
4														2	2
PCV10															
1														0	0
2														2	2
3														1	1
4											2			9	11
PCV13															
1														2	2
2														1	1
3														8	8
4				1							1	2		9	13
Multiple PCVs															
PCV7/ PCV10				1[a]										3[b]	4
PCV7/ PCV13														0	0
PCV10/ PCV13														4[c]	4
	0	0	0	2	0	0	0	0	0	0	3	2	0	41	48

Note: blank cells represent 0 observations.
[a]3 PCV7 doses/1 PCV10 dose.
[b];2 cases received 3 PCV7 doses/1 PCV10 dose and 1 case received 1 PCV7 dose/2 PCV10 doses.
[c];2 cases received 3 PCV10 doses/1 PCV13 dose, 1 case received 1 PCV10 dose/1 PCV13 dose, and 1 case received 1 PCV10 dose/3 PCV13 doses.

In 2018, Immunisation records were identified in the NIR for 61 IPD cases who were age-eligible for PCV (Table 13). An additional 6 IPD cases were age-eligible for PCV but had no data within NIR (though 1 of these had at least 3 doses of an unknown PCV noted in EpiSurv) and are assumed to be unvaccinated. Of the 61 IPD cases in 2018 found within NIR data, nine were either missing or non-typable and 52 had serotype data. Of those 52 cases, 41 had serotypes that were not covered by PCV and 11 were diagnosed with a

serotype that was contained within PCV7, PCV10, or PCV13. Of these 11 cases, nine were serotype 19A (PCV10[b] and PCV13), and two were serotype 3 (PCV13).

We identified two cases of serotype 3, one of which had received three doses of PCV13 and one dose of PCV10. There were nine cases of 19A,four of which had between two and four doses of PCV10, two had had three to four doses of PCV13, one had one dose of PCV13, and three had three to four doses of PCV7.

Table 13. Immunisation status of the 2018 IPD cases (n=61) who were age-eligible for PCV and have an NIR record

Vaccine Type (doses)	PCV7 Serotypes							PCV10 Serotypes				PCV13 Serotypes		Non-PCV Serotypes or Unknown	Number of People
	4 n=0	6B n=0	9V n=0	14 n=0	18C n=0	19F n=0	23F n=0	1 n=0	5 n=0	7F n=0	{19A} n=9	3 n=2	6A n=0	n=50	
PCV7															
1														0	0
2														0	0
3														2	2
4											2			4	6
PCV10															
1														1	1
2											1			5	6
3														3	3
4											2	1		7	10
PCV13															
1														0	0
2														0	0
3														4	4
4											1			8	9
Multiple PCVs															
PCV7/ PCV10											1[a]			2[b]	3
PCV7/ PCV13														1[c]	1
PCV10/ PCV13											2[d]	1[e]		13[f]	16
	0	0	0	0	0	0	0	0	0	0	9	2	0	50	61

Note: blank cells represent 0 observations.

[a] One case received 3 PCV7 doses/1 PCV10 dose.

[b] One case received 2 PCV7 doses/2 PCV10 doses and one case received 3 PCV7 doses/1 PCV10 dose.

[c] One case received 1 PCV7 dose/3 PCV13 doses.

[d] One case received 3 PCV10 doses/1 PCV13 dose and one case received 1 PCV10 dose/3 PCV13 doses.

[e] One case received 1 PCV 10 dose/3 PCV13 doses.

[f] One case received 1 PCV10 dose/2 PCV13 doses, one case received 2 PCV10 doses/1 PCV13 dose, three cases received 3 PCV10 doses/1 PCV13 dose, and eight cases received 1 PCV10 dose/3 PCV13 doses.

In 2019, Immunisation records were identified in the NIR for 53 IPD cases who were age-eligible for PCV (Table 14). An additional 9 IPD cases were age-eligible for PCV but had no data within NIR nor immunisation data within EpiSurv and are assumed to be unvaccinated. Of the 53 IPD cases in 2019 found within NIR data, 12 were either missing or non-typable and 41 had serotype data. Of those 41 cases, 28 had serotypes that were not covered by PCV and 13 were diagnosed with a serotype that was contained within PCV7, PCV10, or PCV13. Of these 13, 11 were serotype 19A (PCV10[b], PCV13), one was serotype 6B (PCV7, PCV10 and PCV13), and one was serotype 3 (PCV13).

There was one case of 6B, and this case had four doses of PCV7. There was also one case of serotype 3, and this case had four doses of PCV10. Additionally, there were 11 cases of 19A, of which five had received at least three doses of PCV10, four had received three to four doses of PCV13, one had one dose of PCV13, and four had one to two doses of PCV10.

Table 14. Immunisation status of the 2019 IPD cases (n=53) who were age-eligible for PCV and have an NIR record

Vaccine Type (doses)	PCV7 Serotypes							PCV10 Serotypes				PCV13 Serotypes		Non-PCV Serotypes or Unknown	Number of People
	4 n=0	6B n=1	9V n=0	14 n=0	18C n=0	19F n=0	23F n=0	1 n=0	5 n=0	7F n=0	{19A} n=11	3 n=1	6A n=0	n=40	
PCV7															
1														0	0
2														0	0
3														0	0
4		1												1	2
PCV10															
1											0			0	0
2											1			3	4
3											3			8	11
4												1		10	11
PCV13															
1											0			1	1
2														0	0
3											0			0	0
4											1			8	9
Multiple PCVs															
PCV7/ PCV10														2[a]	2
PCV7/ PCV13															
PCV10/ PCV13											6[b]			7[c]	13
	0	1	0	0	0	0	0	0	0	0	11	1	0	40	53

Note: blank cells represent 0 observations.

[a] Two cases received 3 PCV7 doses/1 PCV10 dose

[b] One case received 2 PCV10 doses/2 PCV13 doses, two cases received 3 PCV10 doses/1 PCV13 dose, and three cases received 1 PCV10 dose/3 PCV13 doses

[c] Three cases received 1 PCV10 dose/3 PCV13 doses, two cases received 3 PCV10 doses/1 PCV13 dose, one case received 1 PCV10 dose/4 PCV13 doses, and one case received 2 PCV10 doses/1 PCV13 dose.

19A in children under 5 and Immunisation status

In 2017, there were two 19A cases <5 years of age who had received at least one PCV dose before disease onset (Table 15). Both children were 2–4 years old at the time of diagnosis. One was fully vaccinated with PCV10 and one was fully vaccinated with PCV13.

Table 15. Pneumococcal conjugate vaccination history of the serotype 19A invasive pneumococcal disease cases in <5 years age group, 2017

Case number	Age group	Number of PCV7 doses	Number of PCV10 doses	Number of PCV13 doses	Vaccination Status
1	2–4 years			4	Fully vaccinated
2	2–4 years		4		Fully vaccinated

In 2018, there were four 19A cases <5 years of age who received at least one PCV dose before disease onset (Table 16). One child was 5–14 months old and had two doses of PCV10. The other three were 2–4 years old, one had one dose of PCV13 and three doses of PCV10, one had three doses of PCV13 and one dose of PCV10, and one had four doses of PCV13 (Table 16): three of the children were fully vaccinated, and one was on schedule for their age at the time of diagnosis.

Table 16. Pneumococcal conjugate vaccination history of the serotype 19A invasive pneumococcal disease cases in <5 years age group, 2018

Case number	Age group	Number of PCV7 doses	Number of PCV10 doses	Number of PCV13 doses	Vaccination Status
1	5–14 months		2		On schedule
2	2–4 years		1	3	Fully vaccinated
3	2–4 years			4	Fully vaccinated
4	2–4 years		3	1	Fully vaccinated

In 2019, there were nine children < 5 years of age who had received at least one dose of PCV before disease onset (Table 17). Four were 5–14 months old and each had two to three doses of PCV10. And five were 2–4 years old, two had one PCV10 dose together with three PCV13 doses, one had three PCV10 doses together with one PCV13 dose, one had two PCV10 doses together with two PCV13 doses, and one had four doses of PCV13 (Table 17): three of these children were on schedule for their age, five were fully vaccinated at the time of their diagnosis (with a combination of different PCV types), and one child was under vaccinated for their age at the time of their diagnosis.

Table 17. Pneumococcal conjugate vaccination history of the serotype 19A invasive pneumococcal disease cases in <5 years age group, 2019

Case number	Age group	Number of PCV7 doses	Number of PCV10 doses	Number of PCV13 doses	Vaccination Status
1	5–14 months		3		On schedule
2	5–14 months		3		On schedule
3	5–14 months		2		Under vaccinated
4	5–14 months		3		On schedule
5	2–4 years		1	3	Fully vaccinated
6	2–4 years		1	3	Fully vaccinated
7	2–4 years		3	1	Fully vaccinated
8	2–4 years		2	2	Fully vaccinated
9	2–4 years			4	Fully vaccinated

RISK FACTORS

The risk factors reported among IPD cases in 2017–2019 which would have made the case eligible for additional funded vaccines are presented in Table 18–Table 20. An additional three conditions that are associated with the highest risk of IPD are not reported in EpiSurv, these include renal failure (dialysis, or persistent nephrotic syndrome), CSF leak, and intercranial shunts.

The only risk factor reported in 2017 for children <5 years of age was immunocompromised, reported in 11.6% of cases with responses. More than 20% of cases 5 years of age or older were reported to be immunocompromised. No children <5 years of age were asplenic, and only one adult was asplenic. No children <5 years of age had cochlear implants, while two adults had cochlear implants.

Table 18. Conditions reported and associated with highest risk of IPD (2017)**

	<2 Years (n=23)				<5 Years (n=45)				≥5 Years (n=476)			
Risk factor	Cases[a]	Total[b]	%[c]	Unknown	Cases[a]	Total[b]	%[c]	Unknown	Cases[a]	Total[b]	%[c]	Unknown
Anatomical or functional asplenia	0	22	0.0	1	0	43	0.0	2	1	418	<1.0	58
Immuno-compromised	1	21	4.8	2	5	43	11.6	2	94	429	21.9	47
Cochlear implants	0	21	0.0	2	0	41	0.0	4	2	402	<1.0	74
Chronic lung disease, including CLD of prematurity	0	23	0.0	0	0	44	0.0	1	69	444	15.5	32

[a] Number of cases with 'yes' recorded for each risk factor. Some cases reported exposure to more than one risk factor.
[b] Number of cases for which information was recorded for each risk factor.
[c] Percentage of cases with the risk for which the information was supplied.
***Entitled to High Risk vaccine schedule as per immunisation handbook*

The only risk factor reported in 2018 for children <5 years of age was immunocompromised, reported in 12.2% of cases with responses. Nearly 20% of cases 5 years of age or older were reported to be immunocompromised. No children under 5 were asplenic or had cochlear implants. Among individuals 5 years or older, 2% were asplenic and <1.0% had cochlear implants.

Table 19. Conditions reported and associated with highest risk of IPD (2018)**

	<2 Years (n=29)				<5 Years (n=46)				≥5 Years (n=511)			
Risk factor	**Cases[a]**	**Total[b]**	**%[c]**	**Unknown**	**Cases[a]**	**Total[b]**	**%[c]**	**Unknown**	**Cases[a]**	**Total[b]**	**%[c]**	**Unknown**
Anatomical or functional asplenia	0	24	0.0	5	0	40	0.0	6	9	452	2.0	59
Immuno-compromised	0	24	0.0	5	5	41	12.2	5	84	446	18.8	65
Cochlear implants	0	24	0.0	5	0	39	0.0	7	4	439	<1.0	72
Chronic lung disease, including CLD of prematurity	0	25	0.0	4	0	42	0.0	4	92	471	19.7	40

[a] Number of cases with 'yes' recorded for each risk factor. Some cases reported exposure to more than one risk factor.
[b] Number of cases for which information was recorded for each risk factor.
[c] Percentage of cases with the risk for which the information was supplied.

***Entitled to High Risk vaccine schedule as per immunisation handbook*

The only two risk factors reported in 2019 for children <5 years of age were immunocompromised, reported in 9.3% of cases with responses, and CLD, reported in 2.3% of cases with responses. Approximately 17% of cases 5 years of age or older were reported to be immunocompromised.

Table 20. Conditions reported and associated with highest risk of IPD (2019)**

	<2 Years (n=26)				<5 Years (n=45)				≥5 Years (n=450)			
Risk factor	**Cases[a]**	**Total[b]**	**%[c]**	**Unknown**	**Cases[a]**	**Total[b]**	**%[c]**	**Unknown**	**Cases[a]**	**Total[b]**	**%[c]**	**Unknown**
Anatomical or functional asplenia	0	24	0.0	2	0	43	0.0	2	2	391	<1.0	59
Immuno-compromised	1	24	4.2	2	4	43	9.3	2	68	394	17.3	56
Cochlear implants	0	24	0.0	2	0	41	0.0	4	1	360	<1.0	90
Chronic lung disease, including CLD of prematurity	1	24	4.2	2	1	43	2.3	2	68	403	16.9	47

[a] Number of cases with 'yes' recorded for each risk factor. Some cases reported exposure to more than one risk factor.
[b] Number of cases for which information was recorded for each risk factor.
[c] Percentage of cases with the risk for which the information was supplied.

***Entitled to High Risk vaccine schedule as per immunisation handbook*

In addition to risk factors that would make an individual eligible for a high-risk vaccine schedule, there are other chronic conditions that are known to be associated with IPD. The conditions include Down syndrome, chronic cardiac disease, diabetes, alcoholism, chronic liver disease, and preterm birth. Of these, only premature birth is regularly collected in EpiSurv and are reported below for 2017–2019.

In 2017, among cases for which information was recorded, approximately 9% (*n*=2) of children under 5 years of age and 7% (*n*=1) of children under 2 years of age were preterm. In 2018, approximately 12% (*n*=4) of children under 5 years of age and 19% (*n*=4) of children under 2 years of age were preterm. And in 2019, approximately 19% (*n*=6) of children under 5 years of age and 32% (*n*=6) of children under 2 years of age were preterm.

DISEASE INCIDENCE BY DISTRICT HEALTH BOARD

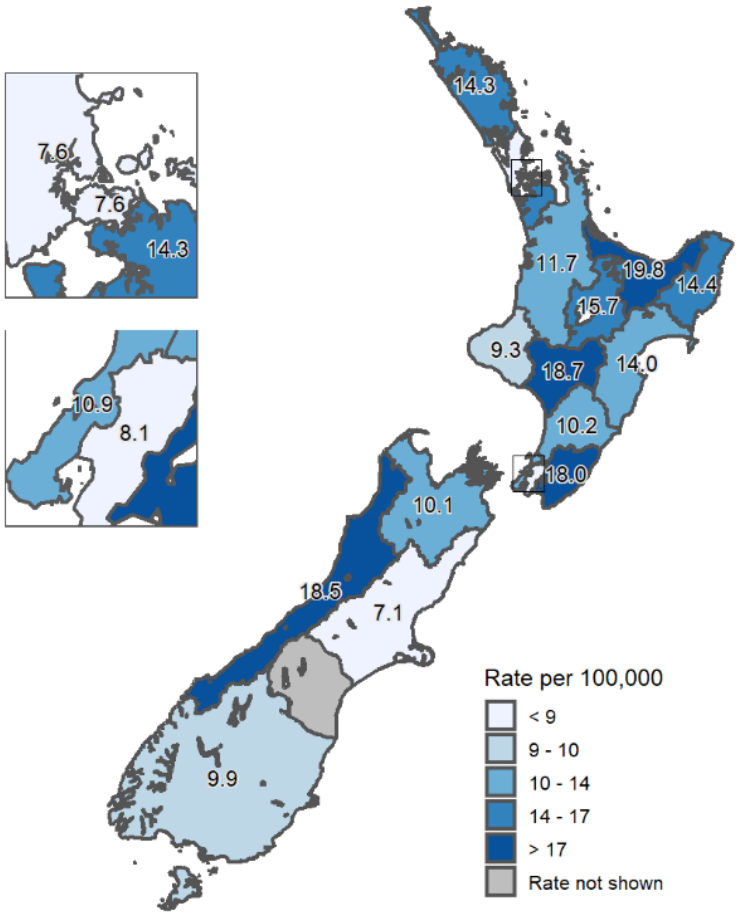
In 2017 the highest rate of IPD was in Bay of Plenty District Health Board (DHB) (19.8 per 100,000, 46 cases), followed by Whanganui (18.7 per 100,000, 12 cases), West Coast (18.5 per 100,000, 6 cases) and Wairarapa (18.0 per 100,000, 8 cases) DHBs (Table 21 and Figure 4). Across the regions, rates ranged from 8.4 in the Southern region to 19.3 per 100,000 in the Midland region (Table 21).

Table 21. Number of cases of invasive pneumococcal disease by age group and rate per 100,000 population for each District Health Board, 2017

District Health Board	Cases by age group (years)					Rate[a] (all ages)
	<2	<5	5–64	≥65	All ages	
Northland	0	1	14	10	25	14.3
Waitemata	2	3	19	24	46	7.5
Auckland	0	3	20	17	40	7.6
Counties Manukau	6	11	47	20	78	14.3
Northern region	8	18	100	71	189	10.2
Waikato	2	4	22	22	48	11.7
Lakes	2	2	7	8	17	15.7
Bay of Plenty	1	4	25	17	46	19.8
Tairawhiti	0	0	4	3	7	14.4
Taranaki	1	2	5	4	11	9.3
Midland region	6	12	63	54	177	19.3
Hawke's Bay	0	0	13	10	23	14.0
Whanganui	0	0	6	6	12	18.7
MidCentral	2	4	5	9	18	10.3
Hutt Valley	0	1	5	6	12	8.1
Capital & Coast	2	3	18	13	34	10.0
Wairarapa	0	0	5	3	8	18.0
Nelson Marlborough	0	0	5	10	15	10.2
Central region	4	8	57	57	122	11.5
West Coast	0	0	5	1	6	18.5
Canterbury	2	3	16	20	39	7.1
South Canterbury	0	0	2	2	4	--
Southern	3	4	9	19	32	9.9
Southern region	5	7	32	42	81	8.4
Total	23	45	252	224	521	10.9

[a] Where there were fewer than five cases, a rate has not been calculated.

Figure 4. Geographic distribution of invasive pneumococcal disease cases, 2017



Numbers represent notification count in DHB region.
Where fewer than five rates are not shown.

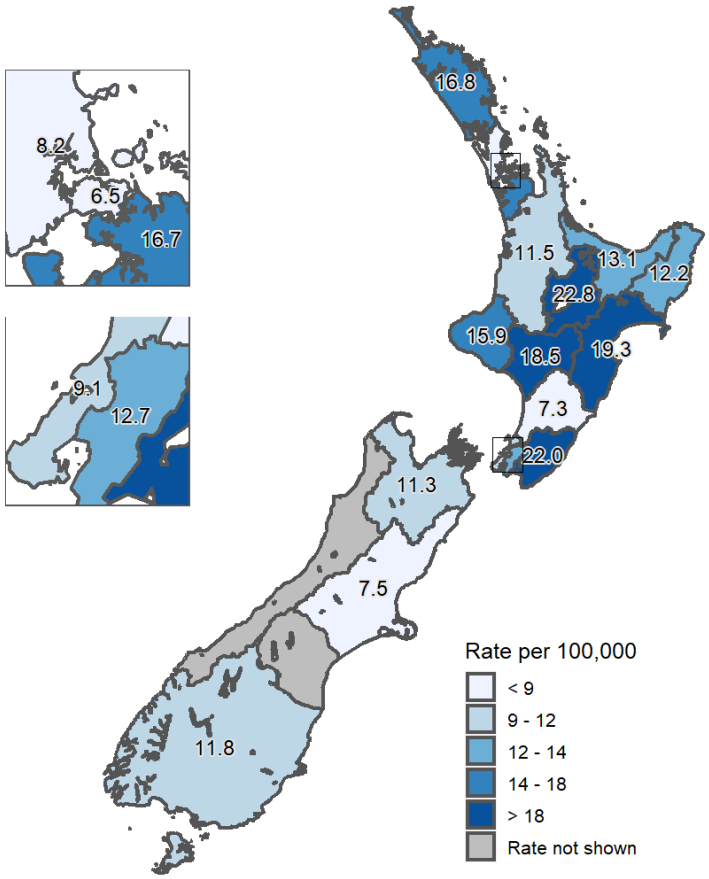
In 2018 the highest rate of IPD was in Lakes DHB (22.8 per 100,000, 25 cases), followed by Wairarapa (22.0 per 100,000, 10 cases), Whanganui (18.5 per 100,000, 12 cases) and Northland (16.8 per 100,000, 30 cases) DHBs (Table 22 and Figure 5). Across the regions, rates ranged from 8.8 in the Southern region to 19.0 per 100,000 in the Midland region (Table 22).

Table 22. Number of cases of invasive pneumococcal disease by age group and rate per 100,000 population for each District Health Board, 2018

District Health Board	Cases by age group (years)					Rate[a] (all ages)
	<2	<5	5–64	≥65	All ages	
Northland	1	1	11	18	30	16.8
Waitemata	1	7	25	19	51	8.2
Auckland	3	6	17	12	35	6.5
Counties Manukau	7	9	57	27	93	16.7
Northern region	12	23	110	76	209	11.0
Waikato	2	3	28	17	48	11.5
Lakes	0	0	16	9	25	22.8
Bay of Plenty	1	1	13	17	31	13.1
Tairawhiti	1	1	2	3	6	12.2
Taranaki	2	4	7	8	19	15.9
Midland region	6	9	66	54	177	19.0
Hawke's Bay	1	1	17	14	32	19.3
Whanganui	1	1	5	6	12	18.5
MidCentral	0	0	8	5	13	7.3
Hutt Valley	1	1	5	13	19	12.7
Capital & Coast	2	3	10	16	29	9.1
Wairarapa	0	0	6	4	10	22.0
Nelson Marlborough	1	1	8	8	17	11.3
Central region	6	7	59	66	132	12.3
West Coast	1	1	3	0	4	--
Canterbury	0	1	23	18	42	7.5
South Canterbury	0	0	1	1	2	--
Southern	4	5	15	19	39	11.8
Southern region	5	7	42	38	87	8.8
Total	29	46	277	234	557	11.4

[a] Where there were fewer than five cases, a rate has not been calculated.

Figure 5. Geographic distribution of invasive pneumococcal disease cases, 2018



Numbers represent notification count in DHB region.
Where fewer than five rates are not shown.

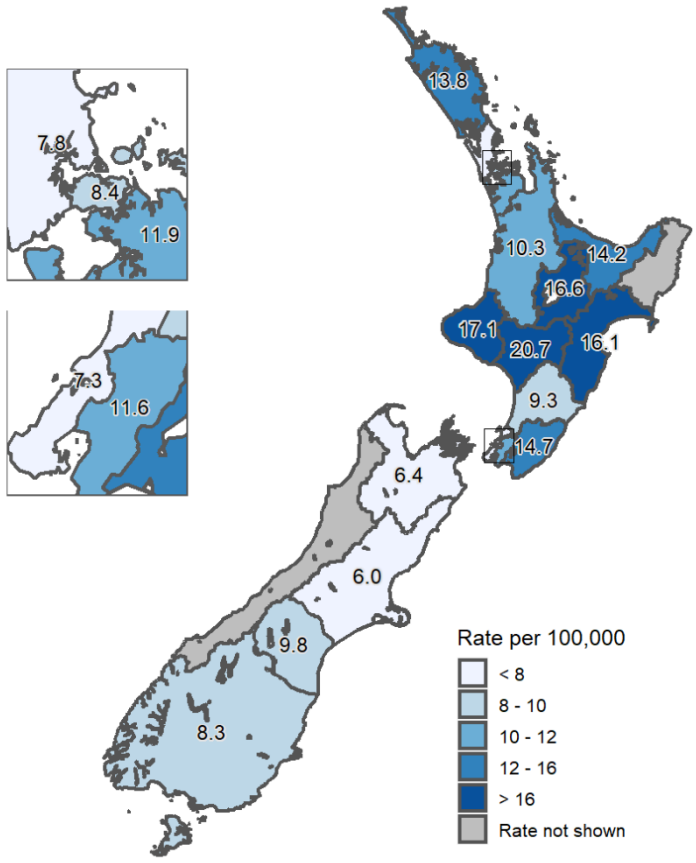
In 2019, the highest rate of IPD was in Whanganui DHB (20.7 per 100,000, 14 cases), followed by Taranaki (17.1 per 100,000, 21 cases), Lakes (16.6 per 100,000, 19 cases), and Hawke's Bay (16.1 per 100,000, 28 cases) DHBs (Table 23 and Figure 6). Across the regions, rates ranged from 7.2 in the Southern region to 17.4 per 100,000 in the Midland region (Table 23).

Table 23. Number of cases of invasive pneumococcal disease by age group and rate per 100,000 population for each District Health Board, 2019

District Health Board	Cases by age group (years)					Rate[a] (all ages)
	<2	<5	5–64	≥65	All ages	
Northland	1	1	9	16	26	13.8
Waitemata	1	3	29	16	48	7.8
Auckland	7	10	22	9	41	8.4
Counties Manukau	6	8	41	18	67	11.9
Northern region	15	22	101	59	182	9.8
Waikato	4	7	14	23	44	10.3
Lakes	0	0	13	6	19	16.6
Bay of Plenty	1	2	17	17	36	14.2
Tairawhiti	0	0	4	0	4	--
Taranaki	1	2	7	12	21	17.1
Midland region	6	11	55	58	168	17.4
Hawke's Bay	0	2	20	6	28	16.1
Whanganui	0	0	8	6	14	20.7
MidCentral	1	1	4	12	17	9.3
Hutt Valley	1	3	11	4	18	11.6
Capital & Coast	0	2	17	4	23	7.3
Wairarapa	0	0	3	4	7	14.7
Nelson Marlborough	1	1	6	3	10	6.4
Central region	3	9	69	39	117	10.6
West Coast	0	0	0	4	4	--
Canterbury	1	1	16	17	34	6
South Canterbury	0	0	3	3	6	9.8
Southern	1	2	14	12	28	8.3
Southern region	2	3	33	36	72	7.2
Total	26	45	258	192	495	10.1

[a] Where there were fewer than five cases, a rate has not been calculated.

Figure 6. Geographic distribution of invasive pneumococcal disease cases, 2019



Numbers represent notification count in DHB region.
Where fewer than five rates are not shown.

Between 2016 and 2017, rates of IPD increased in two regions (Central Region increased from 7.1 to 11.5; Midland Region increased from 10.9 to 19.33), decreased in one (Northern Region from 12.6 to 10.2), and remained the same in one region (Southern: 8.4 in 2016 and 2017, respectively). In 2018, compared to 2016–2017, the annual incidence rate in Southern Region continued to be stable (8.8 per 100,000), while Central and Midland Regions continued to have elevated annual incidence rates (12.3 and 19.0 per 100,000, respectively). Northern Region in 2018 also experienced a small increase in annual incidence rate (11.0 per 100,000), though it is still lower than the annual incidence rate in 2016. Lastly, in 2019 Southern and Northern Regions experienced their lowest recorded annual incidence rates (7.2 and 9.8 per 100,000, respectively), while annual incidence rates in Central and Midland Regions began to again decrease to pre-2017 levels (10.6. and 17.4 per 100,000, respectively).

SEROTYPE DISTRIBUTION

Table 24 shows, by age group, the number and proportion of the 490 isolates from culture-positive IPD cases referred to ESR in 2017 caused by each of the serotypes included in PCV7, PCV10 and PCV13, and any other serotypes.

The most common serotypes in 2017 were 19A (60 cases), 22F (35 cases), and 7F (30 cases). Of these, 7F and 19A are also covered by either PCV10 or PCV13 vaccines.

In the <2 years age group, four cases (20.0%) of IPD were due to a PCV13 serotype (the childhood schedule vaccine changed to re-include PCV10 in mid-2017) (Table 24). Three cases were serotype 3, and one case was serotype 4. See the IMMUNISATION STATUS section for details of their immunisation. Only one case of IPD was due to a PCV10 (serotype 4) in the <2 years age group, and this case is assumed to be unvaccinated.

Among the ≥65 years age group, 65% (n=139) of cases were due to 23PPV serotypes.

Table 24. Number and percentage of invasive pneumococcal disease cases by serotype, serotypes covered by PCV7, PCV10 and PCV13, and age group, 2017

Serotype	<2 years		2–4 years		<5 years[a]		5–64 years		≥65 years[b]		Total	
	Cases	%[c]	Cases	%[c]	Cases	%[c]	Cases	%[c]	Cases	%[c]	Cases	%[c]
4	1	5	0	0	1	2.78	13	5.42	5	2.34	19	3.88
6B	0	0	0	0	0	0	1	0.42	0	0	1	0.2
9V	0	0	1	6.25	1	2.78	3	1.25	0	0	4	0.82
14	0	0	1	6.25	1	2.78	1	0.42	0	0	2	0.41
18C	0	0	0	0	0	0	1	0.42	0	0	1	0.2
19F	0	0	0	0	0	0	5	2.08	9	4.21	14	2.86
23F	0	0	0	0	0	0	0	0	1	0.47	1	0.2
PCV7	1	5	2	12.5	3	8.33	24	10	15	7.01	42	8.57
1	0	0	0	0	0	0	2	0.83	0	0	2	0.41
5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7F	0	0	0	0	0	0	18	7.5	12	5.61	30	6.12
19A[d]	0	0	4	25	4	11.11	23	9.58	33	15.42	60	12.24
PCV10	0	0	4	25	4	11.11	43	17.92	45	21.03	92	18.78
3	3	15	1	6.25	4	11.11	16	6.67	13	6.07	33	6.73
6A	0	0	0	0	0	0	0	0	2	0.93	2	0.41
PCV13	3	15	1	6.25	4	11.11	16	6.67	15	7.01	35	7.14
6C	0	0	1	6.25	1	2.78	5	2.08	6	2.8	12	2.45
7C	0	0	0	0	0	0	0	0	3	1.4	3	0.61
8	1	5	0	0	1	2.78	36	15	12	5.61	49	10
9N	0	0	0	0	0	0	8	3.33	4	1.87	12	2.45
10A	2	10	0	0	2	5.56	6	2.5	3	1.4	11	2.24
10F	0	0	0	0	0	0	0	0	1	0.47	1	0.2
11A	0	0	0	0	0	0	8	3.33	12	5.61	20	4.08
12F	3	15	0	0	3	8.33	17	7.08	2	0.93	22	4.49
13	0	0	0	0	0	0	1	0.42	0	0	1	0.2
15A	0	0	2	12.5	2	5.56	8	3.33	10	4.67	20	4.08
15B	1	5	0	0	1	2.78	8	3.33	6	2.8	15	3.06
15C	1	5	1	6.25	2	5.56	0	0	3	1.4	5	1.02
16F	0	0	0	0	0	0	4	1.67	11	5.14	15	3.06
17F	1	5	0	0	1	2.78	2	0.83	1	0.47	4	0.82
18A	0	0	0	0	0	0	3	1.25	0	0	3	0.61
18F	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
20	0	0	0	0	0	0	0	0	1	0.47	1	0.2
21	0	0	0	0	0	0	2	0.83	1	0.47	3	0.61
22A	0	0	0	0	0	0	1	0.42	0	0	1	0.2
22F	1	5	3	18.75	4	11.11	14	5.83	17	7.94	35	7.14
23A	0	0	1	6.25	1	2.78	4	1.67	7	3.27	12	2.45
23B	1	5	0	0	1	2.78	8	3.33	8	3.74	17	3.47
31	0	0	0	0	0	0	1	0.42	6	2.8	7	1.43
33F	1	5	1	6.25	2	5.56	6	2.5	8	3.74	16	3.27
34	0	0	0	0	0	0	0	0	1	0.47	1	0.2
35B	0	0	0	0	0	0	4	1.67	1	0.47	5	1.02
35F	0	0	0	0	0	0	2	0.83	3	1.4	5	1.02
37	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
38	2	10	0	0	2	5.56	4	1.67	8	3.74	14	2.86
42	0	0	0	0	0	0	0	0	1	0.47	1	0.2
Other[e]	2	10	0	0	2	5.56	5	2.08	3	1.4	10	2.04

Non-PCV	16	80	9	56.25	25	69.44	157	65.42	139	64.95	321	65.51
Total[f]	20	100	16	100	36	100	240	100	214	100	490	100

[a] Aggregated age group.
[b] Among the cases in the ≥65 years age group, 65% were due to PPV23 serotypes. Vaccination with PPV23 is recommended for people in this age group.
[c] Percentage of cases within the age group with the serotype.
[d] PCV10 (Synflorix®) has some unknown level of cross-reactivity to serotype 19A, one of the three additional serotypes included in PCV13 (Prevenar13®).
[e] Includes non-typeable serotypes.
[f] Total number of isolates from culture-positive cases referred to ESR for serotyping for each age group.

Table 25 shows, by age group, the number and proportion of the 533 isolates from culture-positive IPD cases referred to ESR in 2018 caused by each of the serotypes included in PCV7, PCV10 and PCV13, and any other serotypes.

The most common serotypes in 2018 were 19A (76 cases), 12F (52 cases), and 22F (49 cases). Of these, only 19A is also covered by PCV10 or PCV13 vaccines.

In the <2 years age group, five cases (18%) of IPD were due to a PCV13 serotype (Table 25). Two cases were serotype 3, one case was serotype 1, and two cases was serotype 19A. Only one case of IPD was due to a PCV10 (serotype 1) in the <2 years age group and this case was assumed to be unvaccinated. The proportion of IPD due to PCV13 types was lower in the <5 years age groups (17%) compared to the older age groups (Table 9b).

Among the ≥65 years age group, 68% of cases (n=153) were due to 23PPV serotypes.

Table 25. Number and percentage of invasive pneumococcal disease cases by serotype, serotypes covered by PCV7, PCV10 and PCV13, and age group, 2018

Serotype	<2 years		2–4 years		<5 years[a]		5–64 years		≥65 years[b]		Total	
	Cases	%[c]	Cases	%[c]	Cases	%[c]	Cases	%[c]	Cases	%[c]	Cases	%[c]
4	0	0	0	0	0	0	3	1.12	1	0.45	4	0.75
6B	0	0	0	0	0	0	0	0	2	0.89	2	0.38
9V	0	0	0	0	0	0	2	0.75	1	0.45	3	0.56
14	0	0	0	0	0	0	2	0.75	0	0	2	0.38
18C	0	0	0	0	0	0	1	0.37	0	0	1	0.19
19F	0	0	0	0	0	0	5	1.87	1	0.45	6	1.13
23F	0	0	0	0	0	0	1	0.37	1	0.45	2	0.38
PCV7	0	0	0	0	0	0	14	5.24	6	2.68	20	3.75
1	1	3.7	0	0	1	2.38	3	1.12	1	0.45	5	0.94
5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7F	0	0	0	0	0	0	17	6.37	10	4.46	27	5.07
19A[d]	2	7.41	2	13.33	4	9.52	38	14.23	34	15.18	76	14.26
PCV10	3	11.11	2	13.33	5	11.9	58	21.72	45	20.09	108	20.26
3	2	7.41	0	0	2	4.76	16	5.99	15	6.7	33	6.19
6A	0	0	0	0	0	0	1	0.37	2	0.89	3	0.56
PCV13	2	7.41	0	0	2	4.76	17	6.37	17	7.59	36	6.75
6C	0	0	1	6.67	1	2.38	4	1.5	8	3.57	13	2.44
7C	0	0	0	0	0	0	0	0	2	0.89	2	0.38
8	1	3.7	0	0	1	2.38	27	10.11	20	8.93	48	9.01
9N	0	0	0	0	0	0	13	4.87	9	4.02	22	4.13
10A	2	7.41	0	0	2	4.76	10	3.75	4	1.79	16	3
10F	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11A	0	0	0	0	0	0	8	3	4	1.79	12	2.25
12F	3	11.11	2	13.33	5	11.9	38	14.23	9	4.02	52	9.76
13	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15A	3	11.11	2	13.33	5	11.9	4	1.5	8	3.57	17	3.19
15B	1	3.7	1	6.67	2	4.76	6	2.25	7	3.12	15	2.81
15C	0	0	0	0	0	0	0	0	1	0.45	1	0.19
16F	0	0	0	0	0	0	4	1.5	10	4.46	14	2.63
17F	0	0	0	0	0	0	4	1.5	4	1.79	8	1.5
18A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
18F	0	0	0	0	0	0	1	0.37	0	0	0	0
20	0	0	0	0	0	0	0	0	1	0.45	1	0.19
21	0	0	1	6.67	1	2.38	1	0.37	0	0	2	0.38
22A	0	0	1	6.67	1	2.38	0	0	1	0.45	2	0.38
22F	2	7.41	0	0	2	4.76	18	6.74	29	12.95	49	9.19
23A	3	11.11	0	0	3	7.14	10	3.75	3	1.34	16	3
23B	1	3.7	2	13.33	3	7.14	11	4.12	9	4.02	23	4.32
31	0	0	0	0	0	0	2	0.75	3	1.34	5	0.94
33F	0	0	1	6.67	1	2.38	5	1.87	15	6.7	21	3.94
34	2	7.41	0	0	2	4.76	2	0.75	0	0	4	0.75
35B	0	0	0	0	0	0	1	0.37	1	0.45	2	0.38
35F	0	0	0	0	0	0	2	0.75	1	0.45	3	0.56
37	0	0	0	0	0	0	1	0.37	0	0	1	0.19
38	2	7.41	0	0	2	4.76	0	0	3	1.34	5	0.94
42	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other[e]	2	7.41	2	13.33	4	9.52	6	2.25	4	1.79	14	2.63
Non-PCV	22	81.48	13	86.67	35	83.33	178	66.67	156	69.64	368	69.04
Total[f]	27	100	15	100	42	100	267	100	224	100	533	100

[a] Aggregated age group.
[b] Among the cases in the ≥65 years age group,68.3% were due to PPV23 serotypes. Vaccination with PPV23 is recommended for people in this age group.
[c] Percentage of cases within the age group with the serotype.
[d] PCV10 (Synflorix®) has some unknown level of cross-reactivity to serotype 19A, one of the three additional serotypes included in PCV13 (Prevenar13®).
[e] Includes non-typeable serotypes.
[f] Total number of isolates from culture-positive cases referred to ESR for serotyping for each age group.

Table 26 shows, by age group, the number and proportion of the 466 isolates from culture-positive IPD cases referred to ESR in 2019 caused by each of the serotypes included in PCV7, PCV10 and PCV13, and any other serotypes.

The most common serotypes in 2019 were 19A (65 cases), 8 (64 cases), and 22F (53 cases). Of these, only 19A is also covered by PCV10 or PCV13 vaccines.

In the <2 years age group, eight cases (35%) of IPD were due to a PCV13 serotype (Table 26). Two cases were serotype 3, one case was serotype 7F, and five cases were serotype 19A. Only one case of IPD was due to a PCV10 (serotype 7F) in the <2 years age group and this case was assumed to be unvaccinated. The proportion of IPD due to PCV13 types was higher in the <5 years age groups (34%) compared to the older age groups (Table 9c).

Among the ≥65 years age group, 71% of cases (n=134) were due to 23PPV serotypes.

Table 26. Number and percentage of invasive pneumococcal disease cases by serotype, serotypes covered by PCV7, PCV10 and PCV13, and age group, 2019

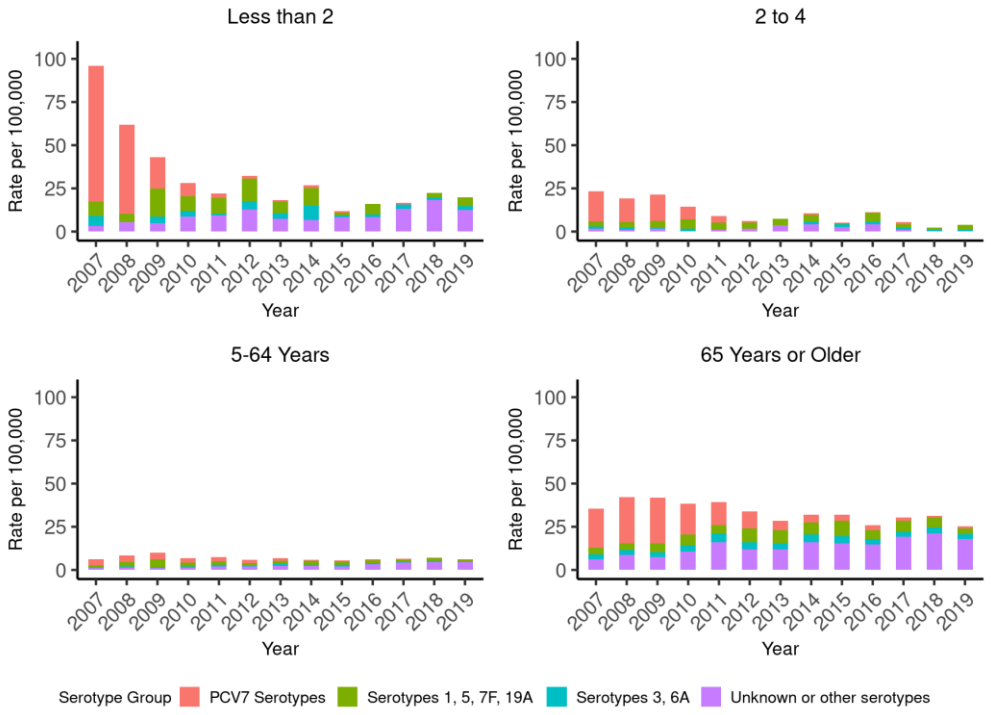
Serotype	<2 years		2–4 years		<5 years[a]		5–64 years		≥65 years[b]		Total	
	Cases	%[c]	Cases	%[c]	Cases	%[c]	Cases	%[c]	Cases	%[c]	Cases	%[c]
4	0	0	0	0	0	0	8	3.33	0	0	8	1.72
6B	0	0	0	0	0	0	3	1.25	1	0.53	4	0.86
9V	0	0	0	0	0	0	1	0.42	0	0	1	0.21
14	0	0	0	0	0	0	1	0.42	2	1.06	3	0.64
18C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
19F	0	0	0	0	0	0	3	1.25	6	3.19	9	1.93
23F	0	0	0	0	0	0	1	0.42	1	0.53	2	0.43
PCV7	0	0	0	0	0	0	17	7.08	10	5.32	27	5.79
1	0	0	0	0	0	0	2	0.83	0	0	2	0.43
5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7F	1	4.35	0	0	1	2.63	7	2.92	1	0.53	9	1.93
19A[d]	5	21.74	5	33.33	10	26.32	31	12.92	24	12.77	65	13.95
PCV10	6	26.09	5	33.33	11	28.95	40	16.67	25	13.3	76	16.31
3	2	8.7	0	0	2	5.26	10	4.17	16	8.51	28	6.01
6A	0	0	0	0	0	0	1	0.42	0	0	1	0.21
PCV13	2	8.7	0	0	2	5.26	11	4.58	16	8.51	29	6.22
6C	1	4.35	1	6.67	2	5.26	3	1.25	6	3.19	11	2.36
7C	0	0	0	0	0	0	1	0.42	1	0.53	2	0.43
8	2	8.7	0	0	2	5.26	45	18.75	17	9.04	64	13.73
9N	1	4.35	0	0	1	2.63	11	4.58	9	4.79	21	4.51
10A	1	4.35	0	0	1	2.63	4	1.67	1	0.53	6	1.29
10F	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11A	0	0	0	0	0	0	6	2.5	6	3.19	12	2.58
12F	1	4.35	1	6.67	2	5.26	25	10.42	12	6.38	39	8.37
13	0	0	0	0	0	0	2	0.83	1	0.53	3	0.64
15A	0	0	0	0	0	0	4	1.67	6	3.19	10	2.15
15B	2	8.7	0	0	2	5.26	4	1.67	6	3.19	12	2.58
15C	0	0	0	0	0	0	1	0.42	0	0	1	0.21
16F	0	0	1	6.67	1	2.63	5	2.08	5	2.66	11	2.36
17F	1	4.35	0	0	1	2.63	2	0.83	3	1.6	6	1.29
18A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
18F	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
20	0	0	0	0	0	0	2	0.83	1	0.53	3	0.64
21	3	13.04	0	0	3	7.89	2	0.83	1	0.53	6	1.29
22A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
22F	1	4.35	2	13.33	3	7.89	24	10	26	13.83	53	11.37
23A	1	4.35	0	0	1	2.63	5	2.08	9	4.79	15	3.22
23B	0	0	5	33.33	5	13.16	8	3.33	6	3.19	19	4.08
31	0	0	0	0	0	0	3	1.25	3	1.6	6	1.29
33F	0	0	0	0	0	0	5	2.08	2	1.06	7	1.5
34	0	0	0	0	0	0	2	0.83	3	1.6	5	1.07
35B	0	0	0	0	0	0	2	0.83	2	1.06	4	0.86
35F	0	0	0	0	0	0	0	0	1	0.53	1	0.21
37	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
38	0	0	0	0	0	0	0	0	1	0.53	1	0.21
42	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other[e]	1	4.35	0	0	1	2.63	6	2.5	9	4.79	16	3.43

Non-PCV	15	65.22	10	66.67	25	65.79	172	71.67	137	72.87	334	71.67
Total[f]	23	100	15	100	38	100	240	100	188	100	466	100

[a] Aggregated age group.
[b] Among the cases in the ≥65 years age group, 71.3% were due to PPV23 serotypes. Vaccination with PPV23 is recommended for people in this age group.
[c] Percentage of cases within the age group with the serotype.
[d] PCV10 (Synflorix®) has some unknown level of cross-reactivity to serotype 19A, one of the three additional serotypes included in PCV13 (Prevenar13®).
[e] Includes non-typeable serotypes.
[f] Total number of isolates from culture-positive cases referred to ESR for serotyping for each age group.

Trends in the rates of disease due to PCV7 serotypes, the additional serotypes covered by PCV10 (1, 5, 7F and cross-reactive 19A) and PCV13 (3 and 6A), and all other serotypes for the different age groups are presented in Figure 7. Since the introduction of PCV7 to the national immunisation schedule in 2008 and the change to PCV10 in 2011, there have been decreases in IPD rates due to PCV10 serotypes in all age groups, with a greater decrease for PCV7 serotypes. The largest decreases for PCV7 serotypes have been in the <2 years and 2–4 years age groups, with no cases due to PCV7 serotypes reported in 2018 and 2019. There have also been reductions in PCV7 serotypes over the same time period in the older age groups. Among the 5–64 years group, the proportion of all isolates that were serotypes contained in PCV7 decreased from 10% in 2017 to 7% in 2019. The proportion of all isolates that were serotypes contained in PCV10 decreased from 8% in 2017 to 4% in 2019 among the 5–64 years group. Among the ≥65 years group, the proportion of all isolates that were serotypes contained in PCV7 decreased from 7% in 2017 to 5% in 2019. Lastly, the proportion of all isolates that were serotypes contained in PCV10 decreased from 6% in 2017 to 1% in 2019 among the ≥65 years group.

Figure 7. Rate per 100,000 population of invasive pneumococcal disease due to PCV7 serotypes, additional PCV10 types, additional PCV13 types and non-PCV13 types, by age group and year, 2006–2019



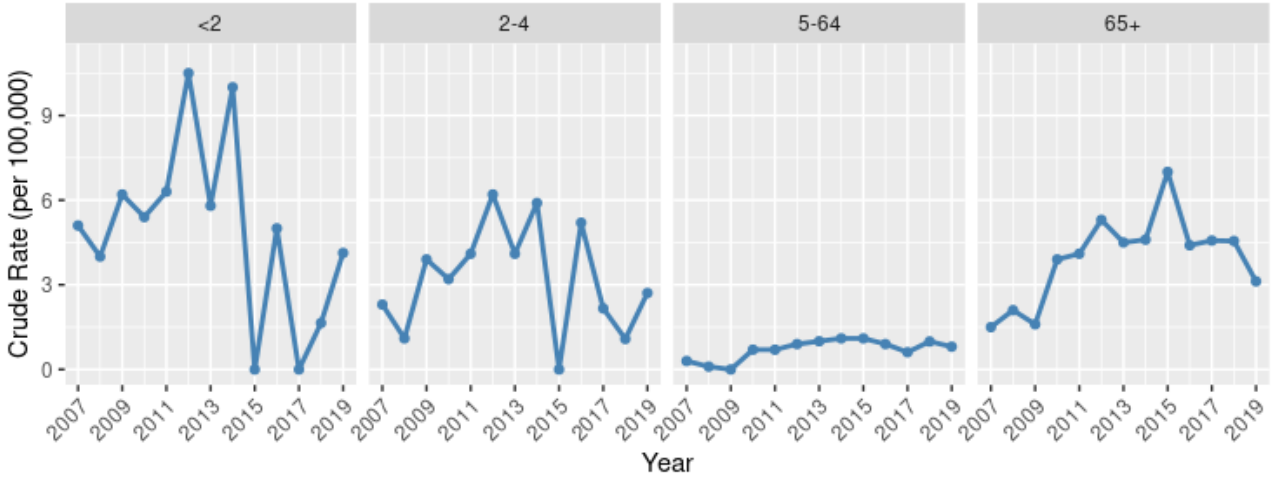
Note: 'PCV7 serotypes' are cases due to serotypes covered by PCV7 (4, 6B, 9V, 14, 18C, 19F and 23F); 'Serotypes 1, 5, 19A, and 7F' are cases due to the additional serotypes covered by PCV10; 'Serotypes 3 and 6A' are cases due to the additional serotypes covered by PCV13; and 'Other serotypes' are all other culture-positive IPD cases that were typed. Data presented from 2009 is based on IPD notifications and data prior to 2009 is from ESR's national laboratory-based surveillance of IPD

PCV13-Specific Serotypes

Though we present serotype 19A as a PCV10-specific serotype due to presumed cross-reactivity with 19F, serotypes 19A, 3, and 6A are contained in PCV13 and outlined below.

In 2017, there were a total of 60 IPD cases due to serotype 19A –the most prevalent serotype. The prominence of 19A continued in 2018 (76 cases) and 2019 (65 cases), though serotype 8, which is not in PCV13, was also identified in 64 cases in 2019. Though from 2007 to 2015 rates of 19A disease in the 65 or older age group have increased (from 1.5 to 7.4 per 100,000), there appear to be decreasing rates from 2016 to 2019 (from 4.5 to 3.0 per 100,000) (Figure 8). From 2015 to 2019 case numbers and rates of 19A IPD cases have continued to fluctuate in the <2 years age group, though still very low. For example, there were 0 cases in 2017, 1 in 2018, and 5 cases (5 per 100,000) in 2019.

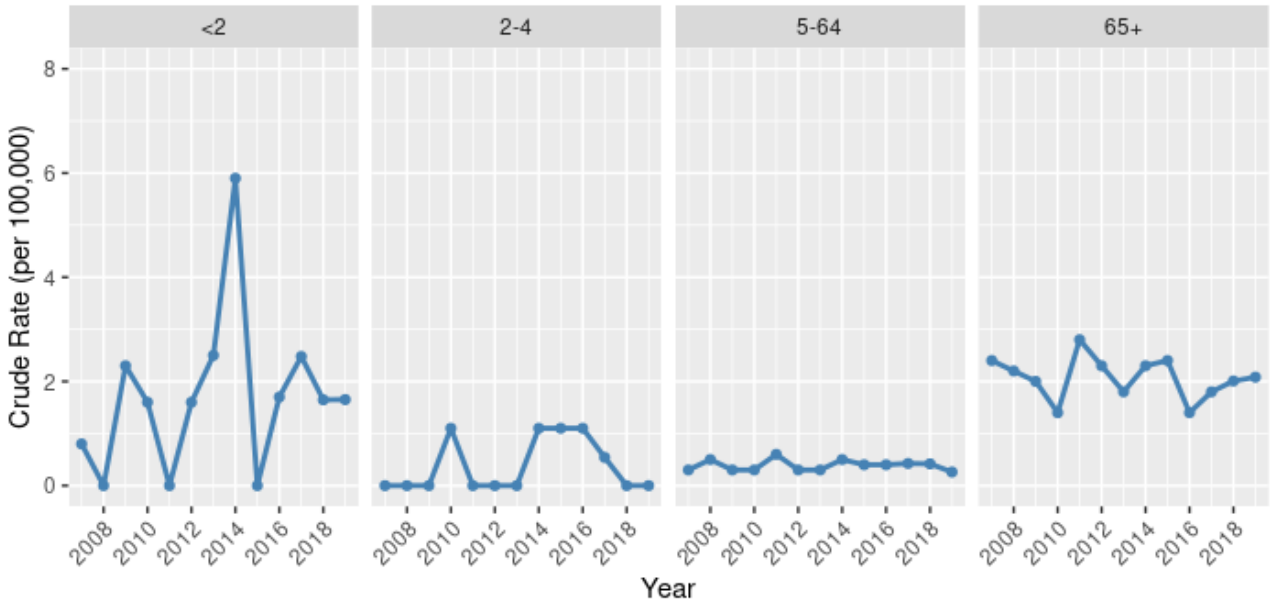
Figure 8. Rate per 100,000 population of invasive pneumococcal disease due to serotype 19A by age group and year, 2007–2019



Note: Data presented from 2009 onwards is based on IPD notifications and data prior to 2009 is from ESR's national laboratory-based surveillance of IPD. Rates for the <2 are based on less than five cases and are considered unstable.

The crude rate for PCV13 serotype 3 has remained relatively low in 2017–2019, with rates under 3 per 100,000 for all age groups (Figure 9). For those 65 years or older, the crude rate has increased slightly, though it's still lower than 2 cases per 100,000.

Figure 9. Rate per 100,000 population of invasive pneumococcal disease due to serotype 3 by age group and year, 2007–2019



Note: Data presented from 2009 onwards is based on IPD notifications and data prior to 2009 is from ESR's national laboratory-based surveillance of IPD. Rates for the <2 and 2–4 years are based on less than five cases and are considered unstable.

The number of serotype 6A cases from 2017–2019 was very low. There were two cases in 2017 (both in ≥65 years age group), three cases in 2018 (one in 5–64 year old group and two in the ≥65 years age group), and one case in 2019 (5–64 year old group).

ANTIMICROBIAL SUSCEPTIBILITY

Table 27 shows the antimicrobial susceptibility of the 489 isolates from culture-positive IPD cases referred to ESR in 2017. 21.9% of isolates were resistant to penicillin (meningitis breakpoints) and 0.4% were cefotaxime resistant. The proportion of isolates that were resistant to penicillin increased to 24.5% and 27.5% in 2018 and 2019, respectively. Among the penicillin-resistant isolates (meningitis breakpoints), 20.6 % (22/107) were multiresistant to at least three additional antibiotics, most commonly co-trimoxazole, erythromycin and tetracycline.

Due to the change to EUCAST susceptibility testing methods in 2016, the rates of penicillin resistance, cefotaxime resistance and multidrug resistance for 2016 to 2019 are not all directly comparable with those for earlier years. However, the rates of penicillin resistance (based on the CLSI and EUCAST meningitis resistance breakpoint of MIC ≥0.12 mg/L) and the rates of cefotaxime resistance (based on the CLSI non-meningitis resistance breakpoint and the EUCAST resistance breakpoint of MIC ≥4 mg/L) are comparable and therefore trends in these rates of resistance for the 2010–2019 period were compared. Penicillin resistance has significantly increased from a low of 14.1% in 2011 to 27.5% in 2019 (p value < 0.01). In contrast, there has been a significant decrease in rates of cefotaxime resistance (p value < 0.01).

All isolates remain susceptible to vancomycin and moxifloxacin. Rifampicin susceptibility has been tested since 2010, with no resistance identified.

Table 27. Antimicrobial susceptibility among isolates from invasive pneumococcal disease cases, 2017

Antibiotic	EUCAST clinical breakpoints[a]			Susceptibility (%)		
	S[b]	I[b]	R[b]	S[b]	I[b]	R[b]
	Minimum inhibitory concentration (MIC, mg/L)					
Penicillin						
meningitis	≤0.06	-	≥0.12	78.1	-	21.9
non-meningitis[c]	≤0.06	0.12–2	≥4	78.1	21.5	0.4
Cefotaxime	≤0.5	1–2	≥4	96.7	2.9	0.4
	Zone diameter (mm)					
Chloramphenicol	≥21	-	≤20	99.6	-	0.4
Clindamycin[d]	≥19	-	≤18	91.0	-	9.0
Co-trimoxazole	≥18	15–17	≤14	78.1	2.7	19.2
Erythromycin	≥22	19–21	≤18	88.1	0.0	11.9
Moxifloxacin	≥22	-	≤21	100	-	0.0
Rifampicin	≥22	17–21	≤16	100	0.0	0.0
Tetracycline	≥25	22–24	≤21	89.6	0.0	10.4
Vancomycin	≥16	-	≤15	100	-	0.0

[a] European Committee on Antimicrobial Susceptibility Testing [18].
[b] S: susceptible, I: intermediate, and R: resistant.
[c] EUCAST also provide several additional dose-specific penicillin breakpoints for pneumonia. Based on the susceptible breakpoint (MIC ≤0.5) for a dose of 1.2 g 6 hourly, 95.1% of isolates would be categorised as susceptible.
[d] The percentage resistant given is for constitutive clindamycin resistance. No isolates had inducible clindamycin resistance.

Table 28. Antimicrobial susceptibility among isolates from invasive pneumococcal disease cases, 2018

Antibiotic	EUCAST clinical breakpoints[a]			Susceptibility (%)		
	S[b]	I[b]	R[b]	S[b]	I[b]	R[b]
	Minimum inhibitory concentration (MIC, mg/L)					
Penicillin						
meningitis	≤0.06	-	≥0.12	75.5	-	24.5
non-meningitis[c]	≤0.06	0.12–2	≥4	75.5	23.7	0.8
Cefotaxime	≤0.5	1–2	≥4	98.3	1.7	0.0
	Zone diameter (mm)					
Chloramphenicol	≥21	-	≤20	99.3	-	0.8
Clindamycin[d]	≥19	-	≤18	93.8	-	6.2
Co-trimoxazole	≥18	15–17	≤14	75.5	4.5	20.0
Erythromycin	≥22	19–21	≤18	91.0	0.2	8.9
Moxifloxacin	≥22	-	≤21	99.6	-	0.4
Rifampicin	≥22	17–21	≤16	100	0.0	0.0
Tetracycline	≥25	22–24	≤21	92.8	0.2	7.0
Vancomycin	≥16	-	≤15	99.8	-	0.2

[a] European Committee on Antimicrobial Susceptibility Testing [19].
[b] S: susceptible, I: intermediate, and R: resistant.
[c] EUCAST also provide several additional dose-specific penicillin breakpoints for pneumonia. Based on the susceptible breakpoint (MIC ≤0.5) for a dose of 1.2 g 6 hourly, 96.6% of isolates would be categorised as susceptible.
[d] The percentage resistant given is for constitutive clindamycin resistance. No isolates had inducible clindamycin resistance.

Table 29. Antimicrobial susceptibility among isolates from invasive pneumococcal disease cases, 2019

Antibiotic	EUCAST clinical breakpoints[a]			Susceptibility (%)		
	S[b]	I[b]	R[b]	S[b]	I[b]	R[b]
	Minimum inhibitory concentration (MIC, mg/L)					
Penicillin						
meningitis	≤0.06	-	≥0.12	72.5	-	27.5
non-meningitis[c]	≤0.06	0.12–2	≥4	72.5	26.2	1.3
Cefotaxime	≤0.5	1–2	≥4	97.4	2.6	0.0
	Zone diameter (mm)					
Chloramphenicol	≥21	-	≤20	98.3	-	1.7
Clindamycin[d]	≥19	-	≤18	94.9	-	5.2
Co-trimoxazole	≥13	10–12	≤9	84.1	1.3	14.6
Erythromycin	≥22	19–21	≤18	91.9	0.4	7.7
Moxifloxacin	≥22	-	≤21	100	-	0.0
Rifampicin	≥22	17–21	≤16	100	0.0	0.0
Tetracycline	≥25	22–24	≤21	93.1	0.4	6.4
Vancomycin	≥16	-	≤15	100	-	0.0

[a] European Committee on Antimicrobial Susceptibility Testing [20]
[b] S: susceptible, I: intermediate, and R: resistant.
[c] EUCAST also provide several additional dose-specific penicillin breakpoints for pneumonia. Based on the susceptible breakpoint (MIC ≤0.5) for a dose of 1.2 g 6 hourly, 94.9% of isolates would be categorised as susceptible.
[d] The percentage resistant given is for constitutive clindamycin resistance. No isolates had inducible clindamycin resistance.

Penicillin and cefotaxime resistance among isolates from cases in the different age groups is shown in Table 30–Table 31. Penicillin resistance was higher among isolates from cases <5 years old across all 3 years when compared to 5–64 year-olds (27.8% vs 21.0% in 2017; 26.8% vs 25.5% in 2018; and 31.8% vs 22.4% in 2019).

Table 30. Penicillin and cefotaxime resistance among isolates from invasive pneumococcal disease cases, 2017

Age group (years)	Penicillin		Cefotaxime			
	Resistant[a] MIC ≥0.12 mg/L		Intermediate MIC 1–2 mg/L		Resistant MIC ≥4 mg/L	
	Number	%[b]	Number	%[b]	Number	%[b]
<2 (n=20)	2	10.0	0	-	0	-
2–4 (n=16)	8	50.0	0	-	0	-
5–64 (n=238)	50	21.0	6	2.5	0	-
≥65 (n=215)	47	21.9	8	3.7	2	0.9
All ages (n=489)	**107**	**21.9**	**14**	**2.9**	**2**	**0.4**

[a] EUCAST meningitis breakpoints; no intermediate category [18].
[b] Percentage of the isolates from the cases within the age group.

Table 31. Penicillin and cefotaxime resistance among isolates from invasive pneumococcal disease cases, 2018

Age group (years)	Penicillin		Cefotaxime			
	Resistant[a] MIC ≥0.12 mg/L		Intermediate MIC 1–2 mg/L		Resistant MIC ≥4 mg/L	
	Number	%[b]	Number	%[b]	Number	%[b]
<2 (n=25)	6	24.0	0	-	0	-
2–4 (n=16)	5	31.3	0	-	0	-
5–64 (n=267)	68	25.5	7	2.6	0	-
≥65 (n=223)	51	22.9	2	0.9	0	-
All ages (n=531)	**130**	**24.5**	**9**	**1.7**	**2**	**0.0**

[a] EUCAST meningitis breakpoints; no intermediate category [19].
[b] Percentage of the isolates from the cases within the age group.

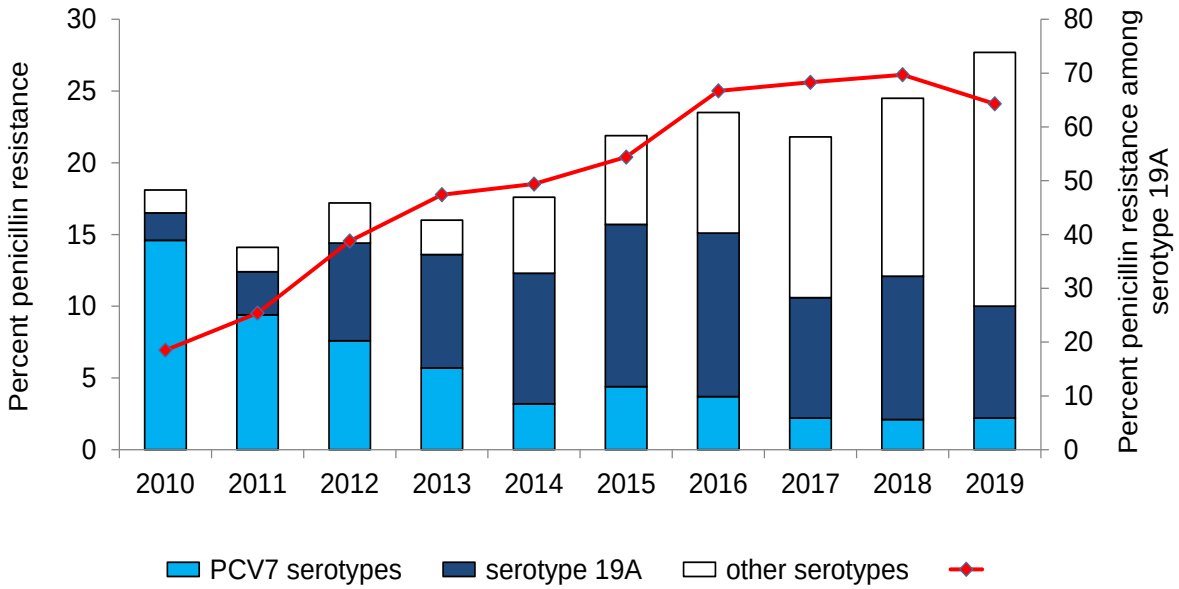
Table 32. Penicillin and cefotaxime resistance among isolates from invasive pneumococcal disease cases, 2019

Age group (years)	Penicillin		Cefotaxime			
	Resistant[a] MIC ≥0.12 mg/L		Intermediate MIC 1–2 mg/L		Resistant MIC ≥4 mg/L	
	Number	%[b]	Number	%[b]	Number	%[b]
<2 (n=15)	2	13.3	0	-	0	-
2–4 (n=7)	5	71.4	0	-	0	-
5–64 (n=116)	26	22.4	0	-	0	-
≥65 (n=95)	31	32.6	6	6.3	0	-
All ages (n=233)	**64**	**27.5**	**6**	**2.6**	**0**	**0.0**

[a] EUCAST meningitis breakpoints; no intermediate category [20].
[b] Percentage of the isolates from the cases within the age group.

Since the introduction of PCV into the childhood immunisation schedule, the serotype distribution among penicillin-resistant invasive pneumococci has changed markedly, with a steady decline in the proportion of penicillin resistance due to PCV7 types (Figure 10). In 2006–2007, PCV7 types accounted for 92.8% of the penicillin resistance compared with just 7.7% in 2019. Conversely, other serotypes now account for the majority of penicillin-resistant invasive pneumococci. The relative contribution of serotype 19A to penicillin-resistant invasive pneumococci has decreased in recent years. In 2017, serotype 19A accounted for 38.3% of the penicillin-resistant isolates, but only 28.1% in 2019 (Figure 10). However, in recent years serotype 19A isolates were more likely to be penicillin resistant, from an average of 15.8% in 2006–2007 to 68.3% in 2017, dropping to 62.1% in 2019 (Figure 8). The relative contribution of PCV serotypes among penicillin resistant isolates is decreasing as more non-vaccine serotypes become more common from 2017 to 2019. In 2017 the next most prevalent serotype among the penicillin-resistant isolates was type 15A that accounted for 16.8% of isolates respectively. In 2018 the next most prevalent serotype among the penicillin-resistant isolates was type 12F that accounted for 13.1% of isolates. In 2019 the next most prevalent serotype among the penicillin-resistant isolates was also type 12F that accounted for 23.3% of isolates.

Figure 10. Penicillin-resistance among pneumococci from invasive disease cases, 2007–2019



Note: The bar chart and scale on the left-hand vertical axis show the percentage of pneumococcal isolates from invasive disease that were penicillin resistant (meningitis breakpoints). Each bar is split to indicate the proportion of the penicillin-resistant isolates that were PCV7 serotypes, the proportion that were serotype 19A and the proportion that were other serotypes. The line graph and scale on the right-hand vertical axis show the percentage of serotype 19A isolates that were penicillin resistant.

DISCUSSION

In June 2008 the first IPD vaccine (PCV7) was introduced into the New Zealand childhood immunisation programme. The overall notification rate for IPD decreased by 40% from 2009 to 2015 across all age groups (16.2 per 100,000 in 2009; 9.7 per 100,000 in 2015), and has remained between 10.1 and 11.4 cases per 100,000 from 2016 to 2019.

A number of important changes to the vaccine schedule have been implemented since 2008. In 2011, PCV10 was introduced, PCV10 was replaced by PCV13 in 2014, and PCV10 was re-introduced to the childhood immunisation schedule in mid-2017. PCV13 is still available and funded for people who are determined to be at high-risk for IPD, including high-risk children and adults 65 and over[1]. Adults who are 65 and over are also recommended to receive 23PPV, but vaccinations are not funded for this group.

The direct impact of the introduction of PCV into the immunisation schedule is apparent when examining the rates of IPD for children <5 years of age. The rates for all IPD among children <5 years of age declined by 76% from 2009 to 2015 (32.6 per 100,000 in 2009, 7.8 per 100,000 in 2015). However, since 2016, the rates have increased and have now stabilised at approximately 15 cases per 100,000 (14.7–15.0 per 100,000 from 2016 to 2019).

Similarly, over the same time period, the rate of IPD notification among children < 2 years of age had also decreased by 74% from 46.0 per 100,000 in 2009 to 11.8 in 2015. However, from 2016 to 2019 the rate of IPD has increased again, reaching a high of 23.9 per 100,000 in 2018 (more than two times higher than the rate seen in 2015 and the highest rate in children <2 years of age since 2014). Even with the increase since 2015, overall, between 2009–2019, there has been an approximate 50% decrease in the annual incidence rate of IPD in the <2 years age group.

The indirect impact of the childhood immunisation programme due to reduced carriage and transmission of *S. pneumoniae* can be seen in the notification rates in older age groups. This is supported by the 40% decrease in overall IPD rates since 2009. Importantly, changes in the paediatric immunisation schedule are expected to have delayed indirect effects on older age groups. For example, while PCV10 was re-introduced in 2017, the IPD rates and serotype distribution among older age groups from 2017–2019 may still reflect the impact of PCV13 in the childhood immunisation programme between 2014 and 2017. From 2009 to 2019, the rates of IPD among those aged 65 and over has decreased 43% from 44.0 per 100,000 to 25.0 per 100,000. Importantly, 65–75% of cases among those who are 65 and over from 2017 to 2019 were due to PPV23 serotypes.

Pacific peoples and Māori continue to be disproportionately affected by IPD across all age groups. However, the gap between Pacific peoples and European or Other ethnic groups may be narrowing slightly. Specifically, in 2016 the age-standardised rate of IPD among Pacific peoples was 5.7 times higher than the rate in European or Other ethnic groups, but this gap has narrowed annually from 2017 to 2019 (4.6 times higher). For Māori, the gap remained largely unchanged since 2016 (3.8 times higher in 2016 and 3.7 times higher in 2019). The age-standardised rate for Māori has not changed much since 2010, fluctuating between 23 and 28 cases per 100,000 (25.3 per 100,000 in 2010, 24.7 per 100,000 in 2019). The age-standardised rates for Pacific peoples have decreased from 48.6 cases per 100,000 in 2010 to 39.1 cases per 100,000 in 2018, before reaching a low of 30.9

cases per 100,000 in 2019. Importantly, Maori and Pacific peoples are over-represented in the IPD cases in children <2 years of age, and the proportion of these cases in these ethnicities is increasing. In 2017, 52% of cases <2 years of age were either Māori or Pacific peoples. This proportion increased in 2018 to 55%, and in 2019 to 69% of all IPD cases in children <2 years of age being of Māori or Pacific peoples ethnicities.

From 2017 to 2019, the Southern Region consistently had the lowest annual incidence rate each year, while Midland Region consistently had the highest annual incidence rate each year. The annual incidence rate in Whanganui DHB was consistently one of the three highest each year from 2017 to 2019, driven almost entirely by adult IPD cases (only one child under 5 was reported 2017–2019 in this DHB). In contrast, the annual incidence rate in Canterbury DHB was consistently one of the three lowest each year from 2017 to 2019.

The three most common serotypes from 2017 to 2019 were 19A (PCV13/PCV10), 8 (non-PCV), and 22F (non-PCV). These collectively accounted for increasing proportions from 27.6%, 30.9%, to 36.8%, respectively from 2017 to 2019. The proportion of isolates that are vaccine preventable (PCV13 serotypes) in 2017 was 32.4% and this proportion decreased to 26.7% in 2019. Importantly, this decrease may be due to both the direct impact of PCV10 in children and a delayed indirect impact among older adults resulting from PCV13 administration to children prior to 2017. Among the additional 2 serotypes only contained in PCV13 (in addition to 19A), 6A is uncommon in New Zealand (accounting for 1–3 cases annually from 2017–19) and serotype 3 was reported among 6–7% of cases annually 2017–19.

Following the introduction of PCV in New Zealand in 2008, serotype 19A became the predominant serotype in 2011, a trend also seen in other countries [24]. From 2014 to 2017, the PCV13 era, the proportion of all isolates that were 19A significantly decreased. However, the proportion of all isolates that are 19A has started to again increase. This serotype is important because it has a greater potential to cause IPD compared with other serotypes [24]. The continued prominence of 19A as the most common serotype could pose a problem in the future, particularly as the proportion of 19A isolates that were penicillin-resistant in 2019 was approximately 65%, an increase from under 20% in 2011.

Close monitoring of 19A in the community is imperative as international evidence is building against the effectiveness of PCV10 on indirect or direct protection against 19A. Globally, among the few regions that have switched from PCV13 to PCV10, Belgium observed a 10-fold increase in 19A cases among 0–2 year-olds after switching from PCV13 to PCV10 [25]. Additionally, researchers in Belgium were concerned because 19A was the 3rd most common serotype reported there (8.3% of isolates), and one of the most antibiotic resistant serotypes [25]. In light of these findings, in 2019 Belgium switched from PCV10 back to PCV13 [26]. Similarly, individual counties in Sweden chose to switch from PCV7 to either PCV10 or PCV13 in 2009. By 2016, 19A had significantly increased in older age groups in counties that made the switch to PCV10 (but not in counties with PCV13) and cross-protection from 19F was not observed in PCV10 counties. There were 0 cases of 19A among <5 in counties with PCV13 from 2013–2016. The age-adjusted rate ratio for 19A was significantly higher when comparing PCV10 and PCV13 counties [27].

From 2017 to 2019, the number of children <5 years of age who were diagnosed with serotype 19A increased in New Zealand. In 2017, there were four children, two of whom were 2–4 years old and both fully vaccinated with either PCV10 or PCV13, and two unvaccinated children. In 2018, there were again 4 children <5 years of age, all of whom

had received at least one PCV dose before 19A disease onset. Two of the children were either fully vaccinated (PCV13) or on schedule (PCV10) for their age, and two of the children were under vaccinated (PCV10 and PCV13) for their age at the time of diagnosis. And in 2019, the number of children <5 years of age who were diagnosed with serotype 19A increased to 10, nine of whom had received at least one dose of PCV before disease onset (see Table 17). Four of these children were either on schedule for their age or fully vaccinated at the time of their diagnosis. Five children were under vaccinated for their age at the time of their diagnosis, and one child was unvaccinated.

Though overall incidence of IPD has decreased since the introduction of PCV in New Zealand, from 2017 to 2019 the majority of cases in adults over 65 are vaccine preventable and there are early indications of a continued resurgence of 19A in the community. There should be a concerted effort to ensure high vaccine uptake particularly among Māori and Pacific peoples over 55 years of age, older populations over 65 years of age, and ongoing surveillance to ensure adequate serotype coverage by the current PCV schedule.

REFERENCES

1. Ministry of Health. *Immunisation Handbook 2017*. 2nd ed. Ministry of Health; 2018.

2. Heffernan H, Martin D. *Invasive Pneumococcal Disease in New Zealand, 2008*. Institute of Environmental Science and Research Ltd (ESR); 2009.

3. Heffernan H, Morgan J, Woodhouse R, et al. *Invasive Pneumococcal Disease in New Zealand, 2009*. Institute of Environmental Science and Research Ltd (ESR); 2010.

4. Heffernan H, Morgan J, Woodhouse R. *Invasive Pneumococcal Disease in New Zealand, 2010*. Institute of Environmental Science and Research Ltd (ESR); 2011.

5. Lim E, Heffernan H. *Invasive Pneumococcal Disease in New Zealand, 2011*. Institute of Environmental Science and Research Ltd (ESR); 2012.

6. Lim E, Heffernan H. *Invasive Pneumococcal Disease in New Zealand, 2012*. Institute of Environmental Science and Research Ltd (ESR); 2013.

7. Institute of Environmental Science and Research (ESR). *Invasive Pneumococcal Disease in New Zealand, 2013*. Institute of Environmental Science and Research Ltd (ESR); 2014.

8. Institute of Environmental Science and Research (ESR). *Invasive Pneumococcal Disease in New Zealand, 2014*. Institute of Environmental Science and Research Ltd (ESR); 2015.

9. Institute of Environmental Science and Research (ESR). *Invasive Pneumococcal Disease in New Zealand, 2015*. Institute of Environmental Science and Research Ltd (ESR); 2016.

10. Green M, Cawley P. In vitro antimicrobial susceptibility of Streptococcus pneumoniae in New Zealand. *NZ Med J*. 1979;90(640):53-55.

11. Heffernan H. Antimicrobial susceptibility of clinically significant Streptococcus pneumoniae isolates. *NZ Med J*. 1987;100(824):327.

12. Martin D, Brett M. Pneumococci causing invasive disease in New Zealand, 1987-94: serogroup and serotype coverage and antibiotic resistances. *NZ Med J*. 1996;109(1027):288-290.

13. Brett M, Martin D. A significant increase in antimicrobial resistance among pneumococci causing invasive disease in New Zealand. *NZ Med J*. 1999;112(1085):113-115.

14. Heffernan H, Martin D, Woodhouse R, et al. Invasive pneumococcal disease in New Zealand 1998-2005: capsular serotypes and antimicrobial resistance. *Epidemiol Infect*. 2008;136(3):352-359.

15. Ministry of Health. *Communicable Disease Control Manual 2012*. Ministry of Health; 2012.

16. Lund E, Henrichsen J. Laboratory diagnosis, serology and epidemiology of Streptococcus pneumoniae. In: *Methods in Microbiology*. 12th ed. Academic Press; 1978.

17. European Committee on Antimicrobial Susceptibility Testing. *Antimicrobial Susceptibility Testing. EUCAST Disk Diffusion Method. Version 7.0*.; 2019. www.eucast.org

18. European Committee on Antimicrobial Susceptibility Testing. *Breakpoint Tables for the Interpretation of MICS and Zone Diameters. Version 7.0.*; 2017. www.eucast.org

19. European Committee on Antimicrobial Susceptibility Testing. *Breakpoint Tables for the Interpretation of MICS and Zone Diameters. Version 8.1.*; 2018. www.eucast.org

20. European Committee on Antimicrobial Susceptibility Testing. *Breakpoint Tables for the Interpretation of MICS and Zone Diameters. Version 9.0.*; 2019.

21. PTAC Immunisation Subcommittee. *Immunisation Subcommittee of PTAC Minutes of Meeting Held 23 May 2016.*; 2017. https://www.pharmac.govt.nz/assets/ptac-immunisation-subcommittee-minutes-2016-05.pdf.

22. Clinical and Laboratory Standards Institute. *Performance Standards for Antimicrobial Disk Susceptibility Tests; Approved Standard.* 12th ed. CLSI; 2015.

23. Institute of Environmental Science and Research (ESR). *Invasive Pneumococcal Disease in New Zealand, 2016*. Institute of Environmental Science and Research Ltd (ESR); 2018.

24. Isturiz R, Sings HL, Hilton B, Arguedas A, Reinert R-R, Jodar L. Streptococcus pneumoniae serotype 19A: worldwide epidemiology. *Expert Rev Vaccines*. 2017;16(10):1007-1027. doi:10.1080/14760584.2017.1362339

25. Desmet S, Verhaegen J, Van Ranst M, Peetermans W, Lagrou K. Switch in a childhood pneumococcal vaccination programme from PCV13 to PCV10: a defendable approach? *Lancet Infect Dis*. 2018;18(8):830-831. doi:10.1016/S1473-3099(18)30346-3

26. Agence Fédérale des Médicaments et des Produits de Santé. *Recent Information July 2019: Atorvastatin + Perindopril, Dextrometorphan Sachets 20mg / 10ml, Darvadstrocel, Phenelzine, Spironolactone + Altizide, Rabies Vaccine, Pneumococcal Vaccine in Infants*. CBiP; 2019. https://www.cbip.be/fr/gows/query?number=900#pne

27. Naucler P, Galanis I, Morfeldt E, Darenberg J, Örtqvist Å, Henriques-Normark B. Comparison of the Impact of Pneumococcal Conjugate Vaccine 10 or Pneumococcal Conjugate Vaccine 13 on Invasive Pneumococcal Disease in Equivalent Populations. *Clin Infect Dis*. 2017;65(11):1780-1790.e1. doi:10.1093/cid/cix685

APPENDIX

CASE REPORT FORM — Invasive Pneumococcal Disease

Invasive pneumococcal disease EpiSurv No. _____

Reporting Authority

Name of Public Health Officer responsible for case

Notifier Identification

Reporting source* ○ General Practitioner ○ Hospital-based Practitioner ○ Laboratory ○ Self-notification ○ Outbreak Investigation ○ Other

Name of reporting source **Organisation**

Date reported* **Contact phone**

Usual GP **Practice** **GP phone**

GP/Practice address Number Street Suburb

Town/City Post Code ☐ GeoCode

Case Identification

Name of case* Surname Given Name(s)

NHI number* **Email**

Current address* Number Street Suburb

Town/City Post Code ☐ GeoCode

Phone (home) **Phone (work)** **Phone (other)**

Case Demography

Location **TA*** **DHB***

Date of birth* **OR** **Age** ○ Days ○ Months ○ Years

Sex* ○ Male ○ Female ○ Indeterminate ○ Unknown

Occupation*

Occupation location ○ Place of Work ○ School ○ Pre-school

Name

Address Number Street Suburb

Town/City Post Code ☐ GeoCode

Alternative location ○ Place of Work ○ School ○ Pre-school

Name

Address Number Street Suburb

Town/City Post Code ☐ GeoCode

Ethnic group case belongs to* (tick all that apply)

☐ NZ European ☐ Maori ☐ Samoan ☐ Cook Island Maori

☐ Niuean ☐ Chinese ☐ Indian ☐ Tongan

☐ Other (such as Dutch, Japanese, Tokelauan) *(specify)

Invasive pneumococcal disease EpiSurv No.

Basis of Diagnosis

CLINICAL PRESENTATION*

Pneumonia	○ Yes	○ No	○ Unknown
Bacteraemia without focus	○ Yes	○ No	○ Unknown
Meningitis	○ Yes	○ No	○ Unknown
Empyema	○ Yes	○ No	○ Unknown
Septic arthritis	○ Yes	○ No	○ Unknown
Other	○ Yes	○ No	○ Unknown

If other, specify _____

LABORATORY CRITERIA

Specimen* (tick all with positive results)

Blood	☐ culture		☐ NAAT[2]	[1] refer to the case report form instructions
CSF	☐ culture	☐ antigen detection[1]	☐ NAAT	[2] nucleic acid amplification test
Pleural fluid	☐ culture	☐ antigen detection[1]	☐ NAAT	
Joint fluid	☐ culture		☐ NAAT	
Other sterile site specimen (specify)	☐ culture		☐ NAAT	

STATUS* ○ Under investigation ○ Confirmed ○ Not a case

ADDITIONAL LABORATORY DETAILS

Capsular type* _____

ESR Updated ☐ Laboratory

Date result updated _____ Sample Number _____

Clinical Course and Outcome

Date of onset*		☐ Approximate	☐ Unknown
Hospitalised*	○ Yes	○ No	○ Unknown
Date hospitalised*		☐ Unknown	
Hospital*			
Died*	○ Yes	○ No	○ Unknown
Date died*		☐ Unknown	

Was this disease the primary cause of death?* ○ Yes ○ No ○ Unknown

If no, specify the primary cause of death*

Outbreak Details

Is this case part of an outbreak (i.e. known to be linked to one or more other cases of the same disease)?*

☐ Yes **If yes, specify Outbreak No.***

Invasive pneumococcal disease EpiSurv No.

Risk Factors

Premature <37 weeks gestation (if case is <1 year of age)* ○ Yes ○ No ○ Unknown

Congenital or chromosomal abnormality (*includes Down's syndrome*)* ○ Yes ○ No ○ Unknown

Chronic lung disease or Cystic Fibrosis* ○ Yes ○ No ○ Unknown

Anatomical or functional asplenia* ○ Yes ○ No ○ Unknown

Immunocompromised* ○ Yes ○ No ○ Unknown

Includes HIV/AIDS, lymphoma, organ transplant, multiple myeloma, nephrotic syndrome, chronic drug therapy (e.g. chemotherapy or >20 mg/d prednisolone in last year), dysgammaglobulinaemia and sickle cell anaemia.

Chronic illness* ○ Yes ○ No ○ Unknown

Includes CSF leak, intracranial shunts, diabetes, cardiac disease (angina, MI, heart failure, coronary bypass), pulmonary disease (asthma, bronchitis, emphysema), chronic liver disease, renal impairment and alcohol related.

Cochlear implants* ○ Yes ○ No ○ Unknown

Current smoker* ○ Yes ○ No ○ Unknown

Smoking in the household (if case is <5 years of age)* ○ Yes ○ No ○ Unknown

Attends childcare (if case is <5 years of age)* ○ Yes ○ No ○ Unknown

Attends childcare (regular attendance >4 hours per week) in a grouped childcare setting outside the home.

Resident in long term or other chronic care facility* ○ Yes ○ No ○ Unknown

Other risk factors including illness that requires regular medical review (specify)*

Protective Factors

At any time prior to onset, had the case been immunised with the pneumococcal polysaccharide or pneumococcal conjugate vaccine?* ○ Yes ○ No ○ Unknown

If yes, specify vaccination details*

Source of information* ○ Patient/caregiver recall ○ Documented

Dose 1:* ○ Polysaccharide ○ Conjugate ○ Unknown

Date given* _____ Or age when first dose was given _____ ○ Weeks ○ Months ○ Years

Dose 2:* ○ Polysaccharide ○ Conjugate ○ Not given ○ Unknown

Date given* _____ Or age when second dose was given _____ ○ Weeks ○ Months ○ Years

Dose 3:* ○ Polysaccharide ○ Conjugate ○ Not given ○ Unknown

Date given* Or age when third dose was given ○ Weeks ○ Months ○ Years

Dose 4:* ○ Polysaccharide ○ Conjugate ○ Not given ○ Unknown

Date given* _____ Or age when fourth dose was given _____ ○ Weeks ○ Months ○ Years

Dose 5:* ○ Polysaccharide ○ Conjugate ○ Not given ○ Unknown

Date given* _____ Or age when fifth dose was given _____ ○ Weeks ○ Months ○ Years

Dose 6:* ○ Polysaccharide ○ Conjugate ○ Not given ○ Unknown

Date given* Or age when sixth dose was given ○ Weeks ○ Months ○ Years

NIR Vaccination Status (to be completed by ESR)

○ Fully vaccinated for age ○ Partially vaccinated for age ○ Not vaccinated ○ Not applicable

Date status updated NIR Reference

INSTITUTE OF ENVIRONMENTAL SCIENCE AND RESEARCH LIMITED

Kenepuru Science Centre
34 Kenepuru Drive, Kenepuru, Porirua 5022
PO Box 50348, Porirua 5240
New Zealand
T: +64 4 914 0700 **F:** +64 4 914 0770

Mt Albert Science Centre
120 Mt Albert Road, Sandringham, Auckland 1025
Private Bag 92021, Auckland 1142
New Zealand
T: +64 9 815 3670 **F:** +64 9 849 6046

NCBID – Wallaceville
66 Ward Street, Wallaceville, Upper Hutt 5018
PO Box 40158, Upper Hutt 5140
New Zealand
T: +64 4 529 0600 **F:** +64 4 529 0601

Christchurch Science Centre
27 Creyke Road, Ilam, Christchurch 8041
PO Box 29181, Christchurch 8540
New Zealand
T: +64 3 351 6019 **F:** +64 3 351 0010

www.esr.cri.nz