INVASIVE GROUP A STREPTOCOCCAL INFECTION IN NEW ZEALAND, 2016

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DISCLAIMER

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ABBREVIATIONS

Abbreviation	Description
CANVAS	Coalition to Advance New Vaccines Against Group A *Streptococcus*
DHB	District health board
DNA	Deoxyribonucleic acid
emm	M protein gene
ESR	Institute of Environmental Science & Research Ltd.
GAS	Group A *Streptococcus*
ICD-10-AM	International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification
MELAA	Middle Eastern, Latin American or African ethnic group
NHI	National Health Index
NMDS	National minimum data set (hospital discharges)
NZDep2013	New Zealand index of deprivation 2013
PCR	Polymerase chain reaction

SUMMARY

Invasive group A streptococcal (GAS) infections are uncommon but serious, with a high mortality rate. Globally, and in New Zealand, invasive GAS infections have been noted to be increasing over the last decade or more [1]. In New Zealand, an increase in the incidence of invasive GAS infections was reported between 2002 and 2012 (from 3.9 to 7.9 per 100,000 population) [2]. Between 2011 and 2015 there was an overall decrease in incidence, however this increased again to 9.0 per 100,000 in 2016. Rates in New Zealand remain about twice those reported in other high-income countries (2–4 per 100,000 population) [2].

Invasive GAS infection is not a notifiable condition in New Zealand. Consequently, surveillance of invasive GAS infection is predominantly passive and laboratory based, and depends on individual laboratories sending clinically relevant GAS isolates to the Institute of Environmental Science and Research (ESR) for further typing.

This report is based on laboratory data and presents summary information on invasive GAS isolates referred to ESR in 2016.

The invasive GAS infection rate in New Zealand was 9.0 per 100,000 population in 2016—an increase from the rate of 7.5 per 100,000 in 2015 and similar to the peak of 9.3 cases per 100,000 in 2011 [2]. Patterns of invasive GAS infection in 2016 are consistent with other reports, including high rates in the very young and the very old, higher rates among those more socioeconomically deprived, and ethnic differences [1] with higher rates among Pacific peoples and Māori compared to European or Other ethnicities [2].

In 2016, the highest number of invasive GAS infections occurred in autumn, which is in contrast to 2014 and 2015 when infections were most common in summer. This autumn peak is also in contrast to other high-income countries in the northern hemisphere that report winter/spring peaks [3, 4].

Molecular *emm* typing for isolates in 2016 revealed that *emm* type 89, 26 and 101 were the most common. In New Zealand, *emm*26 had not been seen prior to 2015 when the first invasive GAS infection caused by *emm*26 was reported. There is diversity in the circulating *emm* types each year. The leading candidate GAS 30-valent vaccine, which has completed phase I trials, could have provided protection for up to 48% of invasive GAS cases in 2016—depending on vaccine efficacy and coverage. Theoretical protection from the vaccine could potentially increase to about 66% of cases being prevented if cross-opsonisation (cross-protection) is taken into account. The proposed 30-valent vaccine would have protected against three of the five most common *emm* types circulating in 2016 [5, 6].

Continued surveillance of invasive GAS infection and laboratory molecular typing of isolates will be important to continue to monitor trends in New Zealand.

INTRODUCTION

Group A *Streptococcus* (GAS) can cause invasive disease (necrotising fasciitis, cellulitis, bacteraemia, pneumonia, puerperal sepsis), non-invasive disease (pharyngitis, impetigo, superficial skin infections) and toxin-mediated disease (streptococcal toxic shock syndrome, scarlet fever). In addition, there are non-suppurative immunologic sequelae of GAS infections including acute rheumatic fever that may lead to rheumatic heart disease and post streptococcal glomerulonephritis. Rheumatic heart disease is a leading cause of acquired heart disease in young people worldwide. Together, invasive and non-invasive GAS diseases account for considerable mortality and morbidity in New Zealand [2, 7].

People with an increased risk for invasive GAS disease include those with chronic conditions such as cancer, diabetes, obesity, and chronic heart or lung disease, and those with compromised immune systems [7, 8]. People with skin lesions, the elderly, and adults with a history of alcohol abuse or injecting drug use also have increased risk of invasive GAS disease [9].

Invasive GAS infection is not a notifiable condition in New Zealand. Consequently, surveillance of invasive GAS infection is laboratory based, and depends on individual laboratories sending clinically relevant GAS isolates to the Institute of Environmental Science and Research (ESR) for further typing. M protein gene (*emm*) typing conducted at ESR is important for identifying outbreaks of invasive GAS infection and to assess the potential impact of a vaccine on disease incidence in New Zealand.

This is the second annual report on invasive GAS infections in New Zealand and presents summary information on invasive GAS isolates received by ESR in 2016.

METHODS

SURVEILLANCE METHODS

Surveillance of invasive GAS infection is laboratory based, and relies on individual laboratories sending clinically relevant GAS isolates for further typing. These isolates are sent to the Invasive Pathogens Laboratory at ESR for *emm* typing. The numbers presented in this report are therefore likely to undercount the true burden of disease in New Zealand.

The following data is collected about each patient who has an isolate sent for typing: National Health Index (NHI) number, age, sex, specimen type (blood, wound, tissue etc.), symptoms and date specimen collected. Symptoms were not well described. Ethnicity data was not consistently provided for cases where an isolate was received. Additional data (date of birth, date of death, sex, ethnicity, and domicile code) was obtained from NHI records held by the Ministry of Health and was matched with the laboratory data. Domicile codes were mapped to district health board (DHB) and the New Zealand Index of Deprivation 2013 (NZDep2013) [10].

In addition, hospital discharge data was obtained from the Ministry of Health from the National Minimum Dataset (NMDS). Information from laboratory isolates was matched with hospital discharges by the NHI where the specimen collection date was between the admission and discharge date. New Zealand hospitals use the ICD-10-AM clinical coding classification, developed by the World Health Organization and modified by the National Centre for Classification in Health, Australia.

LABORATORY METHODS

Identification of GAS isolates was carried out at individual laboratories prior to specimens being sent to ESR. At ESR molecular typing was performed by polymerase chain reaction (PCR) and deoxyribonucleic acid (DNA) sequencing of the *emm* gene. These methods are described in full by Beall *et al.* [11].

ANALYTICAL METHODS

Case definition

An invasive GAS infection was defined as one in which GAS was isolated from a normally sterile body site (eg, blood, cerebrospinal fluid, pleural fluid, synovial fluid) or where necrotising fasciitis was recorded in the symptoms field. This definition is consistent with the Centers for Disease Control and Prevention definition for surveillance of GAS [12]. Where the sample site was unknown, the infection was classified as invasive if one or more of the following ICD-10-AM codes was specified in the hospital discharge diagnoses: A40.0, sepsis due to *Streptococcus*, group A; A48.3, toxic shock syndrome; M72.6, necrotising fasciitis; or O85 puerperal sepsis.

30-day mortality

30-day mortality was defined as a date of death within 30 days of the laboratory sample being collected or, if a sample date was not provided, within 30 days of receipt of the sample at ESR.

Dates

Data in this report is based on isolates received by ESR in 2016. Data was extracted from the laboratory information system on 9 February 2017. Laboratory information was matched with NHI data and with NMDS data that was extracted on 19 April 2017.

Population rate calculations

The denominator data used to determine disease rates, except the rates for ethnic groups and deprivation, was from the 2016 mid-year population estimates published by Statistics New Zealand. All rates are presented as the number of cases per 100,000 population. Rates have not been reported where there were fewer than five cases in any category. Calculating population rates from fewer than five cases produces unstable rates.

Ethnicity

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). For more detail on classification refer to the Ministry of Health's ethnicity data protocols [13]. The denominator data used to determine disease rates for ethnic groups was based on the proportion of people in each ethnic group from the usually resident 2013 census population applied to the 2016 mid-year population estimates. Rates for each ethnic group were age-standardised to the New Zealand Census 2013 population.

This report presents the number of cases and population rates for different ethnic groups. However, caution should be exercised in the interpretation of these numbers, as ethnicity information is not always provided, different ethnic groups have different patterns of health care access, and the numbers may not accurately reflect the true burden of disease in the population.

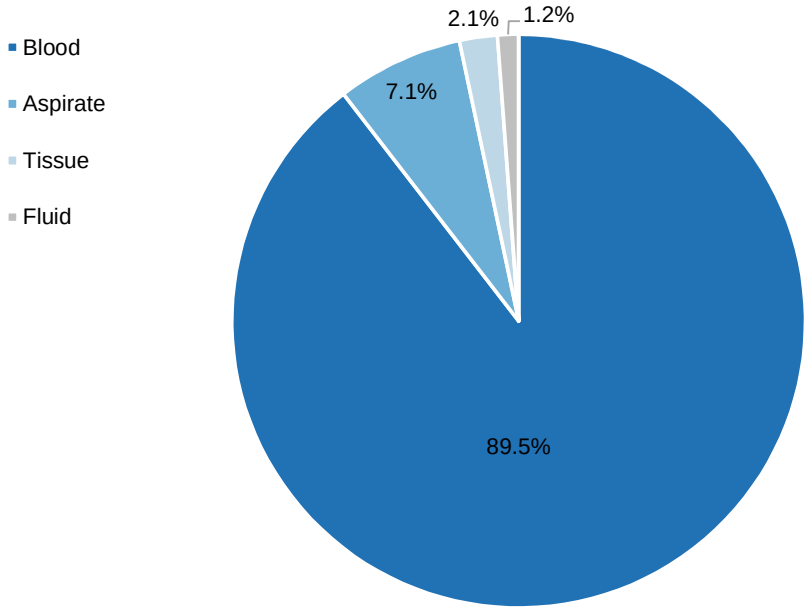
Deprivation index

Socio-economic deprivation is based on the New Zealand index of deprivation 2013 (NZDep2013). 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 [10]. The deprivation score is calculated for each geographical mesh block in New Zealand. Deprivation scores are grouped into deciles 1 to 10, where 1 represents the least deprived areas and 10 the most deprived areas. The denominator data used to determine disease rates for NZDep2013 categories is based on the proportion of people in each NZDep2013 category from the usually resident 2013 census population applied to the 2016 mid-year population estimates.

RESULTS

Applying our case definition, a total of 421 invasive GAS infections were identified in 2016. Of the 421 invasive GAS infections, 89.5% (377 isolates) were based on isolation from blood, 7.1% (30 isolates) from an aspirate (from bone or joint), 2.1% (nine isolates) from tissue (including six with necrotising fasciitis in the symptoms field), and 1.2% (five isolates) from fluid (including cerebrospinal, pleural and peritoneal) (Figure 1).

Figure 1. Proportion of invasive GAS isolates by sample type, 2016

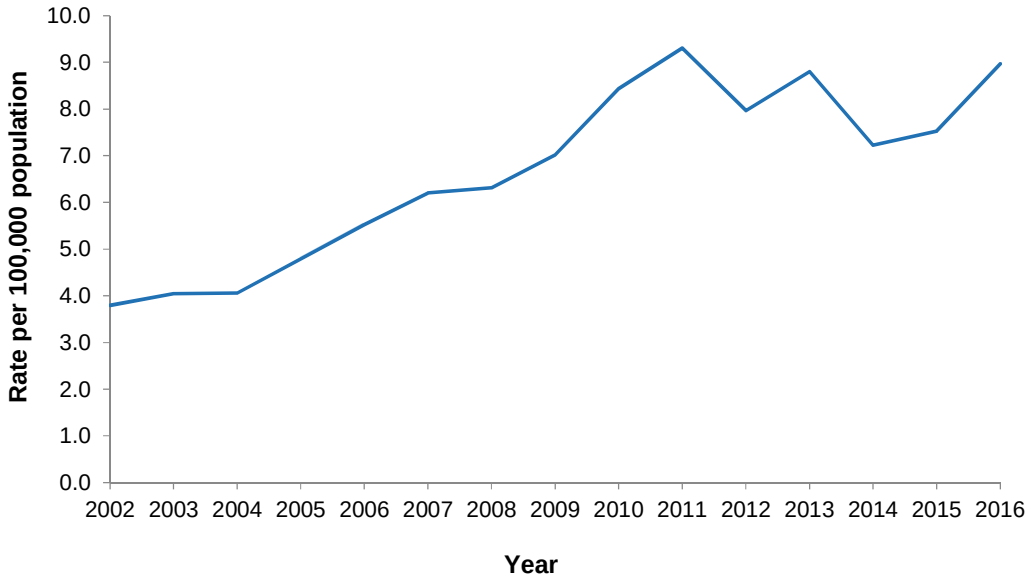


TREND IN DISEASE INCIDENCE BY YEAR

There were 421 invasive GAS isolates referred to ESR in 2016, giving a rate of 9.0 per 100,000 population, compared with 346 isolates (7.5 per 100,000 population) in 2015.

Between 2002 and 2011 there was an increasing trend in the rate of invasive GAS infections, from 3.8 per 100,000 population to 9.3 per 100,000. There was an overall decrease between 2011 and 2015, however, the rate increased again to 9.0 per 100,000 in 2016 (Figure 2, Table 2).

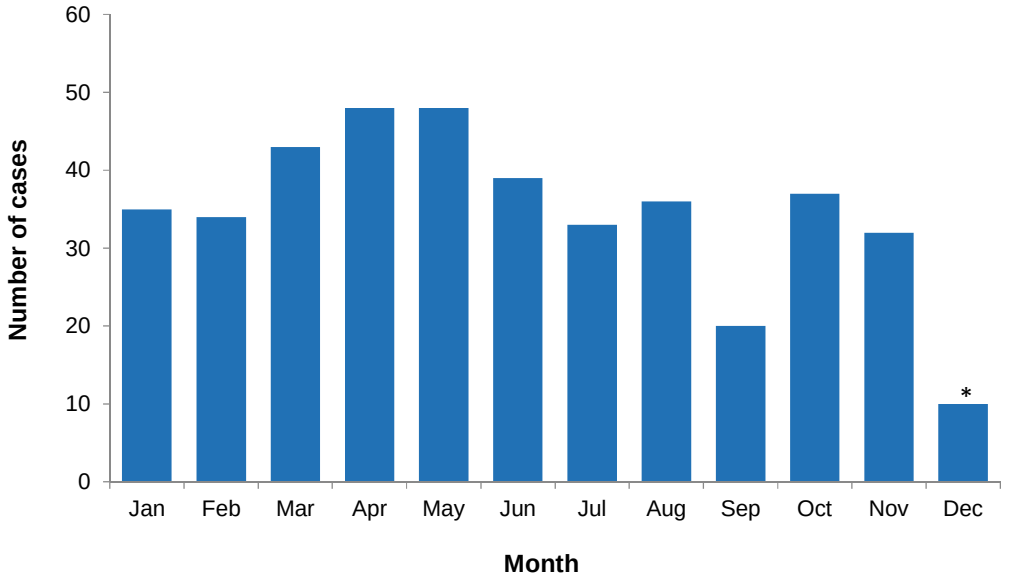
Figure 2. Invasive GAS infection rates by year, 2002–2016



DISEASE INCIDENCE BY MONTH

Figure 3 shows the monthly distribution of invasive GAS cases based on the date the specimen was collected. In 2016, the highest numbers of invasive GAS cases occurred in autumn (April and May, 48 cases each). This is in contrast to 2014 and 2015, where infections were most common in summer [14].

Figure 3. Number of cases of invasive GAS infection by month specimen collected, 2016



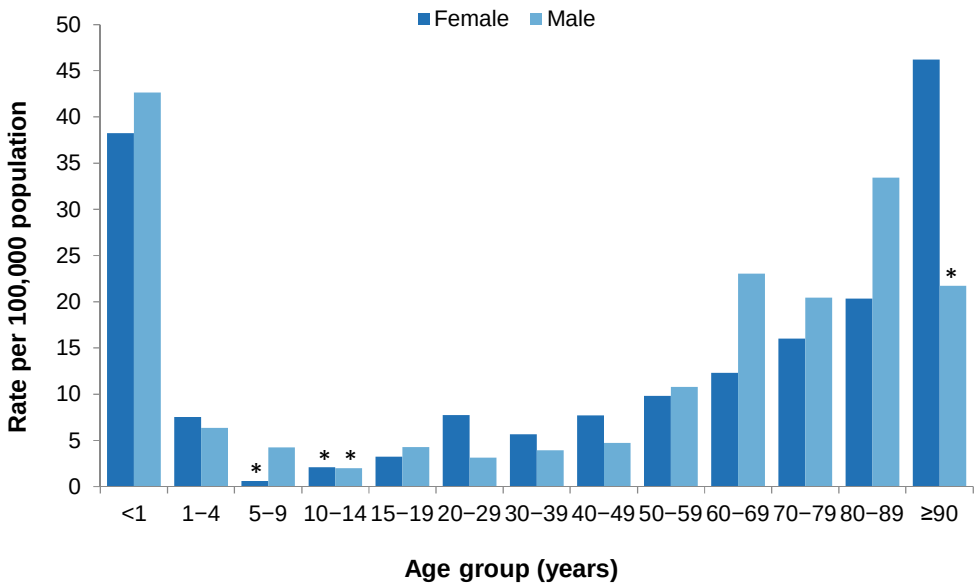
* Data incomplete as specimens collected in December 2016 and received at ESR in January 2017 are not included.

DISEASE INCIDENCE BY AGE AND SEX

The distribution of cases of invasive GAS infection by age group and sex is presented in Figure 4 and Table 3. Age and sex were available for all cases.

As in previous years, the age distribution followed a U-shaped curve with highest rates in the youngest and oldest age groups (Figure 4). The highest rate was for infants aged <1 year (40.5 per 100,000, 24 cases) followed by adults aged ≥90 years (38.4 per 100,000, 11 cases) (Table 3). The rates for all other age groups ranged from 2.0 to 26.0 per 100,000.

Figure 4. Invasive GAS infection rates by age group and sex, 2016



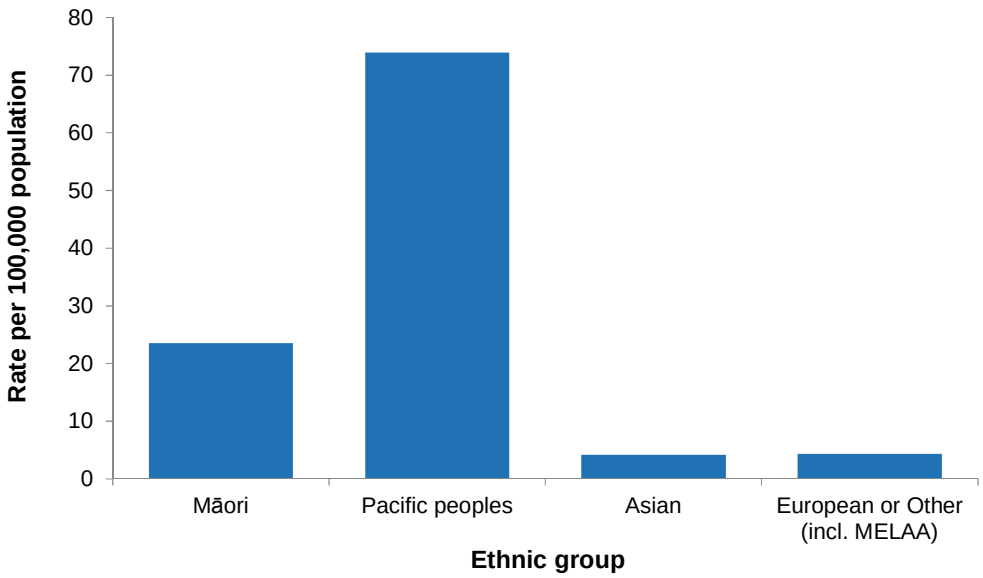
* Rate based on fewer than five cases.

DISEASE INCIDENCE BY ETHNICITY

Ethnicity was known for 99.3% (418/421) of cases of invasive GAS infection in 2016. The age-standardised rates by ethnic group are shown in Figure 5 and Table 4.

Pacific peoples had the highest age-standardised rate (73.9 per 100,000) of invasive GAS infection, which was over 17-times the European or Other rate (4.3 per 100,000). Māori had the second highest rate (23.5 per 100,000) which was over five-times the European or Other rate.

Figure 5. Age-standardised rates of invasive GAS infection by ethnicity, 2016

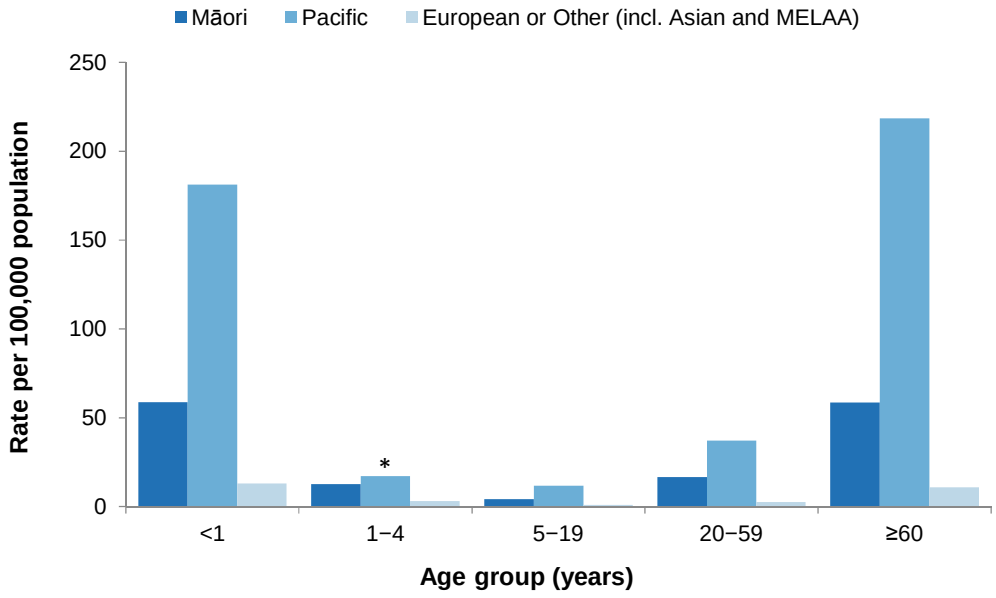


Age-standardised to the New Zealand Census 2013 population.
MELAA: Middle Eastern/Latin American/African.

DISEASE INCIDENCE BY AGE AND ETHNICITY

Pacific peoples aged ≥60 years and <1 year had the highest rates of invasive GAS infection in 2016 (218.5 and 181.3 per 100,000, respectively). Māori aged ≥60 years and <1 year also had high rates (58.7 and 58.8 per 100,000, respectively). All other age groups had ethnic-specific rates below 38.0 per 100,000 (Figure 6).

Figure 6. Invasive GAS infection rates by age group and ethnicity, 2016



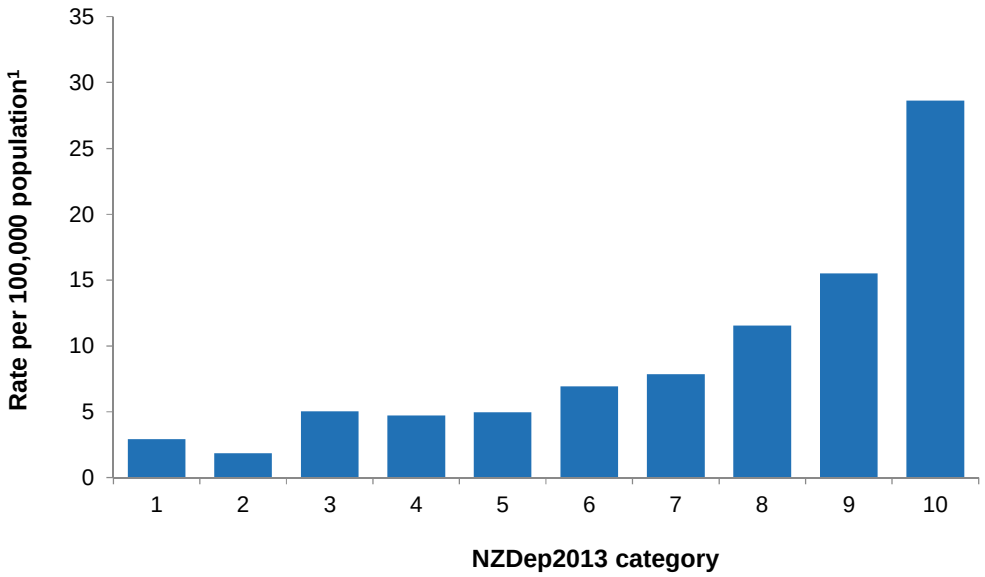
* Rate based on fewer than five cases.
MELAA: Middle Eastern/Latin American/African.

DISEASE INCIDENCE BY DEPRIVATION

The NZDep2013 decile could be assigned for 98.8% (416/421) of cases of invasive GAS infection in 2016. The distribution by NZDep2013 is shown in Figure 7 and Table 5.

There was a trend of an increasing rate of invasive GAS infections with increasing deprivation. Nearly half (48.8%) of the invasive GAS infection cases were from the most deprived areas (NZDep2013 deciles 9 and 10). The highest rates of invasive GAS were in decile 10 (28.6 per 100,000) and decile 9 (15.5 per 100,000). The rate in decile 10 was 10-times the rate in decile 1 and 16-times the rate in decile 2.

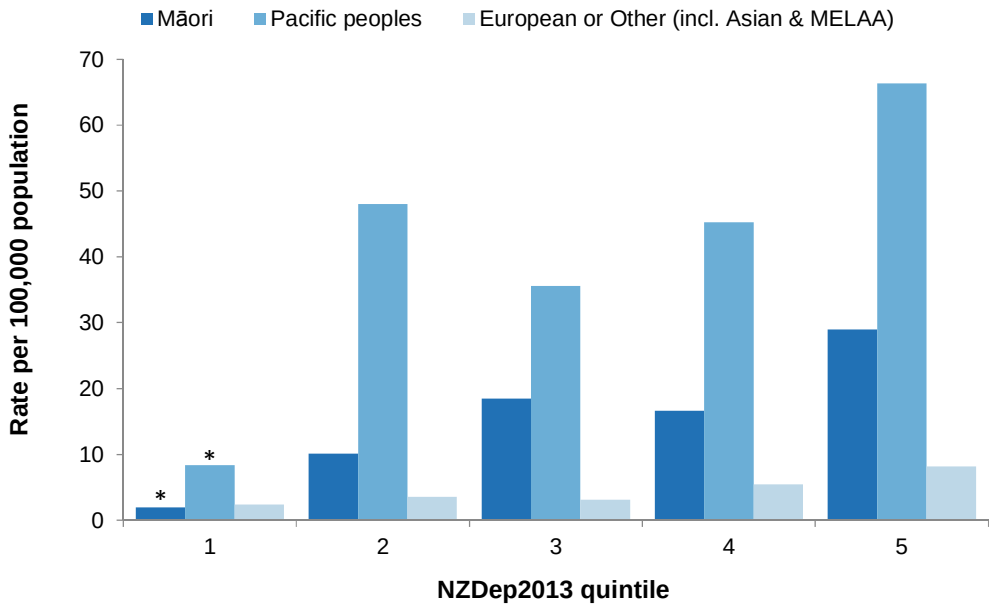
Figure 7. Invasive GAS infection rates by deprivation, 2016



DISEASE INCIDENCE BY ETHNICITY AND DEPRIVATION

Rates of invasive GAS infection increased with increasing deprivation for Māori and European or Other ethnic groups, while for Pacific peoples there was a higher rate in quintile 2 than in quintiles 3 and 4 (Figure 8).

Figure 8. Invasive GAS infection rates by ethnicity and deprivation, 2016



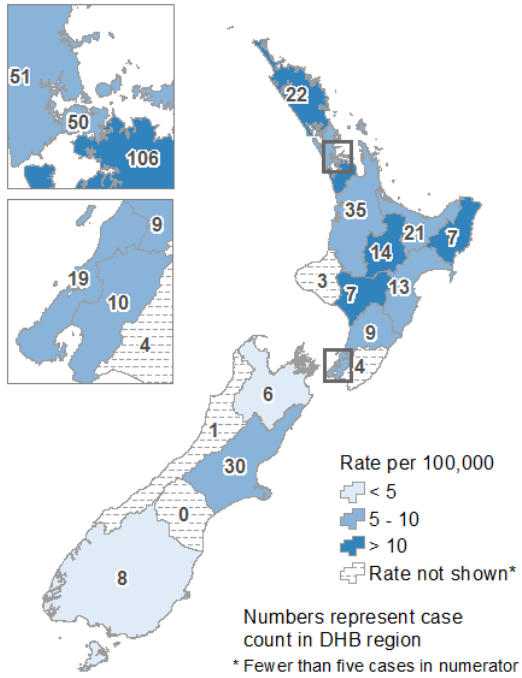
* Rate based on fewer than five cases.
MELAA: Middle Eastern/Latin American/African.

DISEASE INCIDENCE BY DISTRICT HEALTH BOARD

DHB was known for 98.8% (416/421) of cases of invasive GAS infection in 2016. The distribution of cases by DHB is presented in Figure 9 and Table 6.

The highest rate was for Counties Manukau (19.8 per 100,000) followed by Tairāwhiti (14.6 per 100,000) and Lakes (13.1 per 100,000) DHBs.

Figure 9. Number of cases and rate per 100,000 population of invasive GAS infection by DHB, 2016

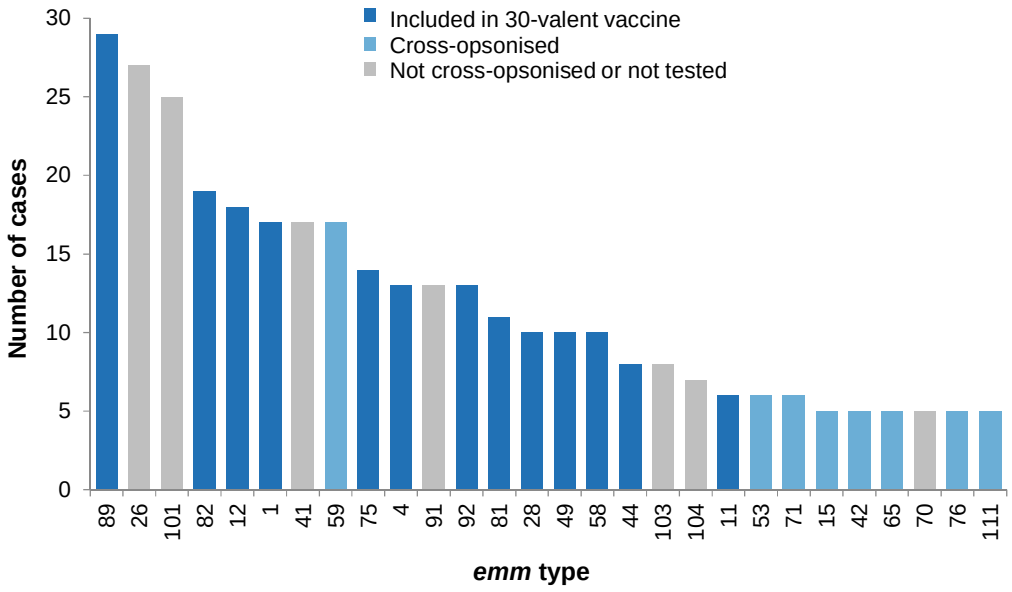


Does not include five cases where the DHB was unknown.

EMM TYPE DISTRIBUTION

The five most common *emm* types for invasive GAS infections in 2016 were *emm*89, 26, 101, 82 and 12, together accounting for 28.0% (118/421) of all isolates (Figure 10, Table 7). Three of the top five *emm* types are in the proposed 30-valent GAS vaccine, which has completed phase I trials. In 2016, 48.2% (203/421) of cases had *emm* types that are in the proposed vaccine (Figure 10) with the theoretical protection potentially rising to 66.3% (279/421) with cross-opsonisation (cross-protection) [5, 6].

Figure 10. Number of cases of invasive GAS infection by *emm* type, 2016

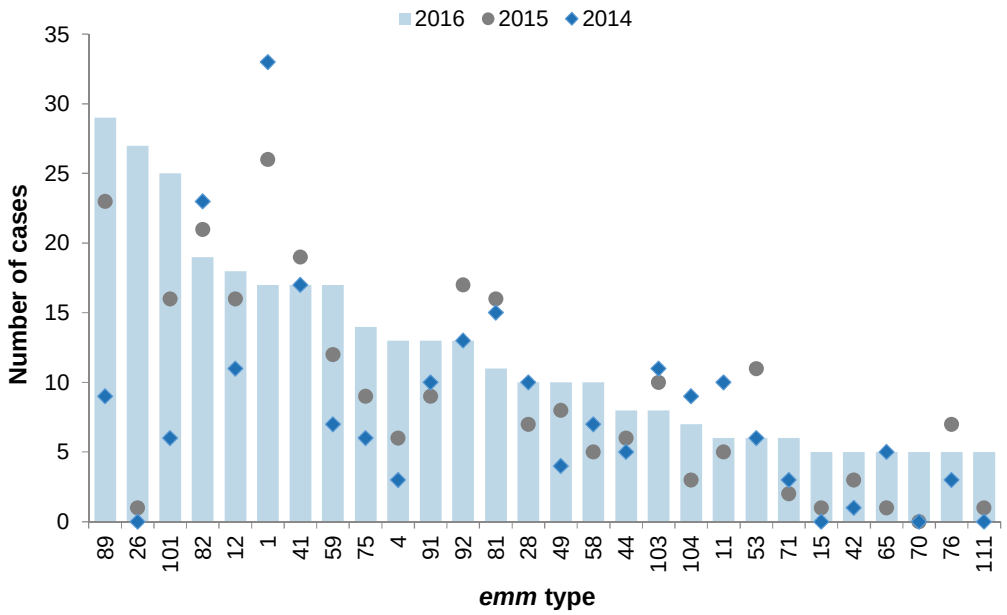


Note: *emm* types with fewer than five cases were not included.

Figure 11 shows the most common *emm* types associated with invasive GAS infections identified in 2016 and compares with the number of cases for 2014 and 2015. Between 2014 and 2016, *emm* types 26, 89 and 101 had the largest increases in cases: *emm*26 increasing from 0 to 27 cases (1 in 2015); *emm*89 from 9 to 29 cases (23 in 2015); and *emm*101 from 6 to 25 cases (16 in 2015) (Figure 11, Table 9).

In contrast, *emm*1 had the largest decrease in cases (33 in 2014 to 17 in 2016), although *emm*1 still remained the sixth most commonly identified *emm* type in 2016.

Figure 11. Number of cases of invasive GAS infection by *emm* type and year, 2014–2016



Note: *emm* types with fewer than five cases in 2016 were not included.

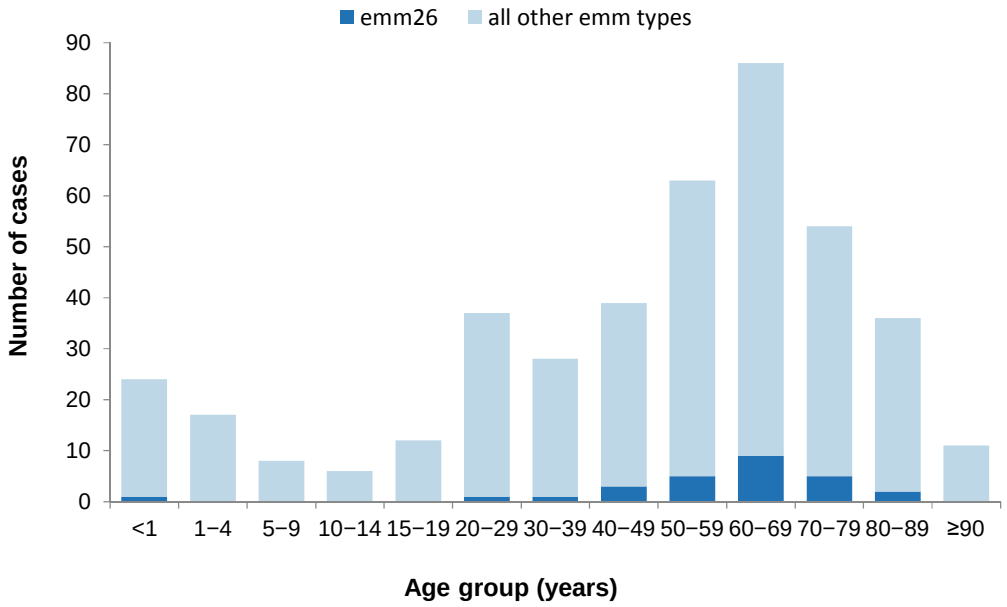
EMM TYPE 26

There were 27 cases of invasive GAS infection due to e*mm*26 in 2016. Prior to 2016, there had only been one case identified, which occurred in January 2015. The majority (85.2%) of e*mm*26 cases in 2016 occurred between March and July, with the last case in November. The monthly distribution of invasive GAS infections caused by *emm*26 and other *emm* types is presented in Table 10 in the appendix.

The majority (74.1%) of invasive GAS infections caused by *emm*26 were from the Auckland region: Counties Manukau (14 cases), Waitemata (4 cases) and Auckland (2 cases) DHBs (Table 11).

Infections caused by e*mm*26 followed a similar age distribution to all other *emm* types, with the highest number of cases occurring in the 60–69 years age group (Figure 12). Most cases (88.9%) were Pacific peoples, with twice as many cases in females (18 cases) than males (9 cases) (Table 12). Over half (15/27, 55.6%) of *emm*26 cases were from the most deprived areas (deciles 9 and 10).

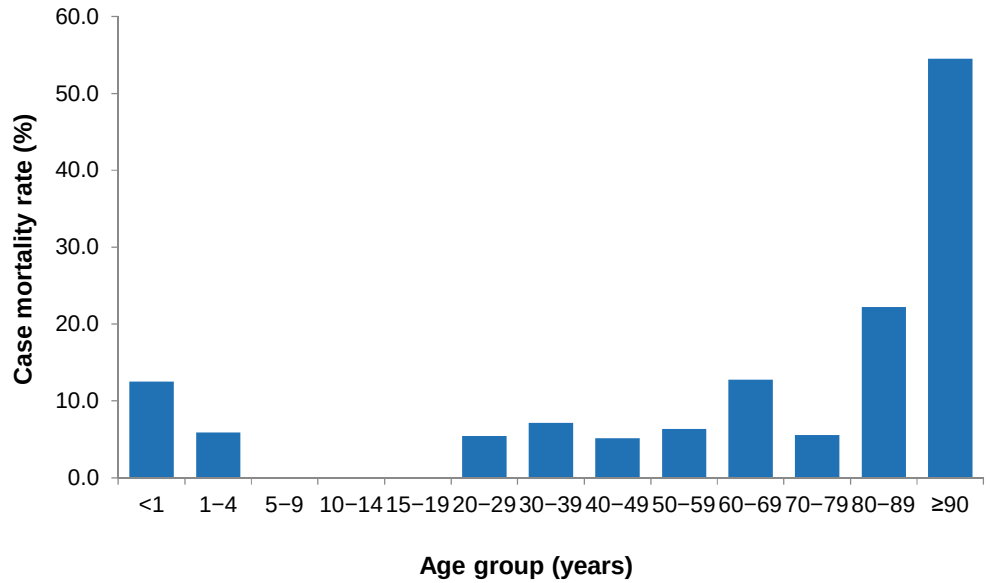
Figure 12. Number cases of invasive GAS infection caused by *emm*26 compared to all other *emm* types by age group, 2016



30-DAY MORTALITY

There were 42 deaths within 30 days among cases of invasive GAS infection in 2016, giving a 30-day case mortality rate of 10.0% (42/421). The median age of cases at death was 64 years. The 30-day mortality rate was highest in those aged ≥90 years (54.5%), followed by 80–89 years (22.2%) (Figure 13, Table 8).

Figure 13. 30-day case mortality rate for invasive GAS infection by age group, 2016



30-DAY MORTALITY BY *EMM* TYPE

Table 1 shows the *emm* types associated with 30-day mortality among cases of invasive GAS infection for 2014–2016. The *emm* types associated with the highest numbers of deaths for the three years combined were *emm*1 and *emm*92 (seven deaths each), with a 30-day case mortality rate of 9.2% and 16.3%, respectively.

In 2016, the *emm* type associated with the highest number of deaths was *emm*89 (four deaths), which was also the most common *emm* type identified. Of the 42 deaths in 2016, over half (52.4%, 22 deaths) were caused by *emm* types covered by the proposed 30-valent vaccine. *Emm*26, which accounted for the second highest number of invasive GAS cases, had no associated 30-day mortality.

Table 1. Number of deaths for invasive GAS infection by *emm* type, 2014–2016

emm type	Number of deaths[1]				Total cases 2014–2016	30-day case mortality
	2014	2015	2016	Total		
1	5	2	0	7	76	9.2
92	3	2	2	7	43	16.3
89	1	1	4	6	61	9.8
82	1	1	3	5	63	7.9
101	2	1	2	5	47	10.6
12	1	2	2	5	45	11.1
81	4	0	0	4	42	9.5
59	0	2	2	4	36	11.1
91	2	0	2	4	32	12.5
58	2	0	2	4	22	18.2
41	0	2	1	3	53	5.7
76	0	2	1	3	15	20.0
42	1	1	1	3	9	33.3
114	2	0	1	3	9	33.3
4	1	0	1	2	22	9.1
11	0	0	2	2	21	9.5
44	1	0	1	2	19	10.5
104	1	0	1	2	19	10.5
118	2	0	0	2	19	10.5
22	0	0	2	2	8	25.0
233	0	1	1	2	8	25.0
70	0	0	2	2	5	40.0
28	0	1	0	1	27	3.7
53	0	0	1	1	23	4.3
49	0	1	0	1	22	4.5
108	0	1	0	1	12	8.3
65	1	0	0	1	11	9.1
63	1	0	0	1	10	10.0
54	0	0	1	1	7	14.3
113	1	0	0	1	7	14.3
15	0	0	1	1	6	16.7
19	0	0	1	1	6	16.7
111	0	0	1	1	6	16.7
230	1	0	0	1	6	16.7
2	0	1	0	1	5	20.0
106	0	0	1	1	5	20.0
39	0	0	1	1	3	33.3
78	0	0	1	1	1	100.0
112	1	0	0	1	1	100.0
222	1	0	0	1	1	100.0
250	0	0	1	1	1	100.0
Other[2]	0	0	0	0	259	0.0
Total	**35**	**21**	**42**	**98**	**1093**	**9.0**

[1] Deaths within 30 days of laboratory sample collection or date received at ESR if unknown.

[2] Remaining *emm* types with no deaths.

DISCUSSION

This report describes the epidemiology of invasive GAS disease in New Zealand and the distribution of invasive GAS isolates genotyped at ESR in 2016. The incidence rate for invasive GAS infections was 9.0 per 100,000 population in 2016. An increase in the incidence of invasive GAS infections in New Zealand was reported from 3.9 per 100,000 population in 2002 to 9.3 in 2011 [2]. Between 2011 and 2015 there was an overall decreasing trend with rates decreasing form 9.3 to 7.2 per 100,000, however this increased in 2016. The 2016 rate is more than double the rates reported in other high-income countries of 2–4 per 100,000 population [3, 15, 16].

Similar to other high-income countries, the highest rates were seen at the extremes of age in the very young (<1 year) and in older people (≥80 years) [9]. In 2016, there were large differences in age-standardised rates of invasive GAS rates between ethnic groups. The ethnic disparities also appear to be widening with the rate for Pacific peoples compared to the European or Other ethnic group increasing from eight-times higher in 2014 to 17-times higher in 2016 [14]. This was also an increase from the seven-times higher rate for Pacific peoples compared to European reported for the period 2002–2012 [2]. One study from the United States reported that invasive GAS was 1.6-times more likely to occur among black persons than among those of other races [4]. Other reports have noted ethnic differences in invasive GAS disease, with people of African American, Hispanic, and Native American descent likely to have higher rates than White Americans [17].

High rates were also associated with high socioeconomic deprivation in New Zealand, with almost half (48.8%) of the cases from the most deprived areas (NZDep2013 deciles 9 and 10) in 2016, consistent with previous years. Williamson *et al*. noted the socioeconomic disparity and commented that although reasons for the disparity were unknown, lower socioeconomic status is linked to a higher prevalence of other known risk factors for invasive GAS disease such as obesity, diabetes mellitus and cardiovascular disease [2].

Interestingly, invasive GAS infections did not follow the more typical winter/spring seasonal pattern in 2016, with more cases occurring in autumn (April and May). This was in contrast to 2014 and 2015 data where the highest number of cases occurred in summer (January). The 2016 seasonal pattern is also in contrast to 2002–2012 where there was a slight peak in January [D Williamson, personal communication]. Other high-income countries in the northern hemisphere show an increase in cases during winter and spring months [3, 18, 19].

We report a 30-day mortality rate of 10.0% for 2016, which is the same as that reported by Williamson *et al*. for invasive GAS infections in New Zealand from 2002 to 2012 [2] and falls within the case mortality rate range reported from other high income countries of 8–16% [1, 4, 17]. The 30-day mortality in 2016 followed a similar pattern to other reports of increasing mortality with increasing age [2, 14]. Almost one in four cases with invasive GAS infection died within 30 days in the ≥80 years age group. This increased to one in two cases in the ≥90 years age groups.

Molecular *emm* typing is important to understand the epidemiology of invasive and non-invasive GAS infections and to assess the potential benefit of a vaccine in relation to disease incidence in New Zealand. International data on *emm* typing has informed the development of GAS vaccines. The leading candidate GAS vaccine is a 30-valent vaccine consisting of the following *emm* types: 1, 2, 3, 4, 5, 6, 11, 12, 14, 18, 19, 22, 24, 28, 29, 44, 49, 58, 73, 75, 77, 78, 81, 82, 83, 87, 89, 92, 114 and 118 (StreptAnova™) [6]. This vaccine has completed a phase I trial and results are pending. However, it is important to note that this experimental GAS vaccine is largely based on data from the United States and may not address the specific *emm* types circulating in New Zealand or neighbouring Pacific countries. The New Zealand Australian Coalition to Advance New Vaccines Against Group A *Streptococcus* (CANVAS) is actively working towards progressing a GAS vaccine [20].

Three of the top five *emm* types circulating in New Zealand in 2016 would be covered by the leading candidate 30-valent GAS vaccine. Up to 48.2% of cases in 2016 may have been prevented by the proposed 30-valent vaccine, depending on vaccine efficacy. Theoretical protection from the vaccine could potentially increase to about 66% of cases prevented if cross-opsonisation (cross protection of non-vaccine *emm* types in laboratory assays) is taken into account [5, 6]. This is similar to that reported by Williamson *et al.* for invasive GAS cases from 2002–2012 where 59% of cases would have been covered by the proposed 30-valent vaccine and theoretically up to 67% with cross opsonisation [2]. However, it is important to note that further studies are needed to characterise the potential effect of *in vitro* cross-opsonisation on vaccine efficacy in a clinical setting. As noted, there is diversity in circulating *emm* types by year which makes surveillance, and decisions about which *emm* types to include in a potential vaccine, a challenge [2].

In 2016, 27 invasive GAS infections caused by *emm*26 were reported, up from one in 2015 and not detected in New Zealand prior to 2015. Globally, *emm*26 was first documented in Kenya in 2000 [21] and has rarely been reported outside of Africa or the Middle East [22-24]. However, in 2016–2017, Alaska reported an outbreak of 54 cases of *emm*26 [25]. Some specific risk factors identified were being homeless (85%), recent misuse of alcohol (70%), and being male (69%). Most cases (72%) presented with cellulitis or a skin abscess and mortality was 9%. Alaska has a relatively high incidence of invasive GAS reported as 11.4 per 100,000 for 2011–2016. In contrast, the New Zealand *emm*26 cases were predominantly female (67%), over half (56%) were from the most deprived areas (NZDep2013 deciles 9 and 10), and the majority (93%) were Pacific peoples. There were no deaths associated with emm26. Possible links between *emm*26 invasive GAS infections seen in New Zealand, the Alaskan outbreak, and other reported cases in the United States are being investigated. Further monitoring of *emm*26 and associated risk factors will continue.

The highest number of cases and highest risk of mortality was among older people (≥80 years). This will need to be taken into consideration along with other risk factors such as diabetes and obesity should a GAS vaccine become available, to ensure the right age groups are targeted for vaccination [7].

Our analysis has several limitations, in particular it uses laboratory data from passive surveillance so is likely to underestimate the true incidence of invasive GAS infection in New Zealand. In addition, a limited amount of information is available from laboratory records and we have no information on clinical symptoms, risk factors or comorbidities to inform our analyses. Continued surveillance of invasive GAS infection and laboratory molecular typing of isolates will be important to monitor trends in New Zealand.

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APPENDIX

Table 2. Number of cases and rate per 100,000 population of invasive GAS infection by year, 2002–2016

Year	Cases	Rate[1]
2002	150	3.8
2003	163	4.0
2004	166	4.1
2005	198	4.8
2006	231	5.5
2007	262	6.2
2008	269	6.3
2009	302	7.0
2010	367	8.4
2011	408	9.3
2012	351	8.0
2013	391	8.8
2014	326	7.2
2015	346	7.5
2016	421	9.0

[1] Rate per 100,000 population.

Table 3. Number of cases and rate per 100,000 population of invasive GAS infection by sex and age group, 2016

Age group (years)	Female		Male		Total	
	Cases	Rate[1]	Cases	Rate[1]	Cases	Rate[1]
<1	11	38.3	13	42.6	24	40.5
1–4	9	7.5	8	6.4	17	6.9
5–9	1	-	7	4.2	8	2.5
10–14	3	-	3	-	6	2.0
15–19	5	3.2	7	4.3	12	3.8
20–29	26	7.8	11	3.1	37	5.4
30–39	17	5.7	11	3.9	28	4.8
40–49	25	7.7	14	4.7	39	6.3
50–59	31	9.8	32	10.8	63	10.3
60–69	31	12.3	55	23.0	86	17.5
70–79	25	16.0	29	20.5	54	18.1
80–89	16	20.3	20	33.4	36	26.0
≥90	9	46.2	2	-	11	38.4
Total	**209**	**8.8**	**212**	**9.2**	**421**	**9.0**

[1] Rate per 100,000 population. Where there were fewer than five cases in any category, a rate has not been calculated.

Table 4. Number of cases of invasive GAS infection by ethnicity and age group, 2016

Age group (years)	Ethnic group						
	Māori	Pacific peoples	Asian	MELAA[1]	European or other	Unknown	Total
<1	9	10	3	0	2	0	24
1–4	8	4	2	0	3	0	17
5–9	3	1	1	0	3	0	8
10–14	3	3	0	0	0	0	6
15–19	3	6	1	0	2	0	12
20–29	10	12	2	0	13	0	37
30–39	13	5	2	0	7	1	28
40–49	13	15	2	0	8	1	39
50–59	21	23	3	0	16	0	63
60–69	26	30	4	0	25	1	86
70–79	7	21	0	0	26	0	54
80–89	3	5	0	1	27	0	36
≥90	0	0	0	0	11	0	11
Total	**119**	**135**	**20**	**1**	**143**	**3**	**421**
Crude rate[2]	17.1	46.8	3.7	-	4.6	-	9.0
Age-standardised rate[3]	23.5	73.9	4.1	-	4.3	-	9.4

[1] Middle Eastern/Latin American/African.

[2] Rate per 100,000 population for all ages. Where there were fewer than five cases in any category, a rate has not been calculated. The 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 2016 mid-year population estimates.

[3] Age-standardised rate per 100,000 population, standardised to the New Zealand census 2013 population.

Table 5. Number of cases and rate per 100,000 population of invasive GAS infection by deprivation, 2016

NZDep2013 category[1]	Cases	Rate[2]
1	14	2.9
2	9	1.8
3	24	5.0
4	22	4.7
5	23	4.9
6	32	6.9
7	36	7.8
8	53	11.6
9	72	15.5
10	131	28.6
Unknown	5	-
Total	**421**	**9.0**

[1] New Zealand index of deprivation (1 = least deprived and 10 = most deprived).

[2] Rate per 100,000 population. Denominator data is based on the proportion of people in each NZDep2013 category from the usually resident 2013 census population data applied to the 2016 mid-year population estimates.

Table 6. Number of cases and rate per 100,000 population of invasive GAS infection by DHB, 2016

District Health Board	Cases	Rate[2]
Northland	22	12.8
Waitemata	51	8.6
Auckland	50	9.9
Counties Manukau	106	19.8
Waikato	35	8.8
Lakes	14	13.1
Bay of Plenty	21	9.3
Tairawhiti	7	14.6
Taranaki	3	-
Hawke's Bay	13	8.1
Whanganui	7	11.1
Mid Central	9	5.2
Wairarapa	4	-
Hutt Valley	10	6.9
Capital & Coast	19	6.2
Nelson Marlborough	6	4.1
West Coast	1	-
Canterbury	30	5.6
South Canterbury	0	-
Southern	8	2.5
Unknown	5	-
Total	**421**	**9.0**

[1] Rate per 100,000 population. Where there were fewer than five cases in any category, a rate has not been calculated.

Table 7. Number of cases of invasive GAS infection by *emm* type, 2016

emm type	30-valent theoretical coverage	*emm* cluster	Number of cases	Percentage (%)[1]
89	vaccine antigen	E4	29	6.9
26	not determined	M26	27	6.4
101	not determined	D4	25	5.9
82	vaccine antigen	E3	19	4.5
12	vaccine antigen	A-C4	18	4.3
1	vaccine antigen	A-C3	17	4.0
41	not determined	D4	17	4.0
59	cross-opsonised	E6	17	4.0
75	vaccine antigen	E6	14	3.3
4	vaccine antigen	E1	13	3.1
91	not determined	D4	13	3.1
92	vaccine antigen	E2	13	3.1
81	vaccine antigen	E6	11	2.6
28	vaccine antigen	E4	10	2.4
49	vaccine antigen	E3	10	2.4
58	vaccine antigen	E3	10	2.4
44	vaccine antigen	E3	8	1.9
103	not determined	E3	8	1.9
104	not determined	E2	7	1.7
11	vaccine antigen	E6	6	1.4
53	cross-opsonised	D4	6	1.4
71	cross-opsonised	D2	6	1.4
15	cross-opsonised	E3	5	1.2
42	cross-opsonised	E6	5	1.2
65	cross-opsonised	E6	5	1.2
70	not opsonised	D4	5	1.2
76	cross-opsonised	E2	5	1.2
111	cross-opsonised	M111	5	1.2
Other[2]			87	20.7
Total			**421**	**100.0**

[1] Percentage of total cases.

[2] Includes the remaining *emm* types with fewer than five cases in 2016.

Source: [5, 6]

Table 8. Number of deaths and 30-day case mortality rate for invasive GAS infection by age group, 2016

Age group (years)	Number of deaths[1]	Total cases	30-day case mortality rate (%)
<1	3	24	12.5
1–4	1	17	5.9
5–9	0	8	0.0
10–14	0	6	0.0
15–19	0	12	0.0
20–29	2	37	5.4
30–39	2	28	7.1
40–49	2	39	5.1
50–59	4	63	6.3
60–69	11	86	12.8
70–79	3	54	5.6
80–89	8	36	22.2
≥90	6	11	54.5
Total	**42**	**421**	**10.0**

[1] Deaths within 30 days of laboratory sample collection or date received at ESR if unknown.

Table 9. Number of cases of invasive GAS infection by *emm* type and year, 2014–2016

emm type	Number of cases		
	2014	2015	2016
89	9	23	29
26	0	1	27
101	6	16	25
82	23	21	19
12	11	16	18
1	33	26	17
41	17	19	17
59	7	12	17
75	6	9	14
4	3	6	13
91	10	9	13
92	13	17	13
81	15	16	11
28	10	7	10
49	4	8	10
58	7	5	10
44	5	6	8
103	11	10	8
104	9	3	7
11	10	5	6
53	6	11	6
71	3	2	6
15	0	1	5
42	1	3	5
65	5	1	5
70	0	0	5
76	3	7	5
111	0	1	5
Other[1]	99	85	87
Total	**326**	**346**	**421**

[1] Includes the remaining *emm* types with fewer than five cases in 2016

Table 10. Number of cases of invasive GAS infection caused by *emm*26 and other *emm* types by month, 2016

Month specimen collected	Number of cases		
	*emm*26	Other *emm* types	Total
January	0	35	35
February	1	33	34
March	6	37	43
April	4	44	48
May	4	44	48
June	3	36	39
July	6	27	33
August	0	36	36
September	1	19	20
October	1	36	37
November	1	31	32
December*	0	10	10

* Data incomplete as specimens collected in December 2016 and received at ESR in January 2017 are not included

Table 11. Number of cases of invasive GAS infection caused by *emm*26 and other *emm* types by DHB, 2016

District health board	Number of cases		
	*emm*26	Other *emm* types	Total
Northland	0	22	22
Waitemata	4	47	51
Auckland	2	48	50
Counties Manukau	14	92	106
Waikato	2	33	35
Lakes	0	14	14
Bay of Plenty	0	21	21
Tairawhiti	1	6	7
Taranaki	0	3	3
Hawke's Bay	0	13	13
Whanganui	0	7	7
Mid Central	0	9	9
Wairarapa	1	3	4
Hutt Valley	2	8	10
Capital & Coast	0	19	19
Nelson Marlborough	0	6	6
West Coast	0	1	1
Canterbury	1	29	30
South Canterbury	0	0	0
Southern	0	8	8
Unknown	0	5	5

Table 12. Number of cases of invasive GAS infection caused by *emm*26 and other *emm* types by demographic category, 2016

Demographic category	Number of cases		
	*emm*26	Other *emm* types	Total
Sex			
Male	9	203	212
Female	18	191	209
Age group (years)			
<1	1	23	24
1–4	0	17	17
5–9	0	8	8
10–14	0	6	6
15–19	0	12	12
20–29	1	36	37
30–39	1	27	28
40–49	3	36	39
50–59	5	58	63
60–69	9	77	86
70−79	5	49	54
80−89	2	34	36
≥90	0	11	11
Ethnic group			
Māori	0	119	119
Pacific peoples	24	111	135
Asian	1	19	20
MELAA[1]	0	1	1
European or Other	1	142	143
Unknown	1	2	3
NZDep2013 decile			
1	0	14	14
2	0	9	9
3	3	21	24
4	1	21	22
5	1	22	23
6	1	31	32
7	4	32	36
8	2	51	53
9	5	67	72
10	10	121	131
Unknown	0	5	5

[1] Middle Eastern/Latin American/African.

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