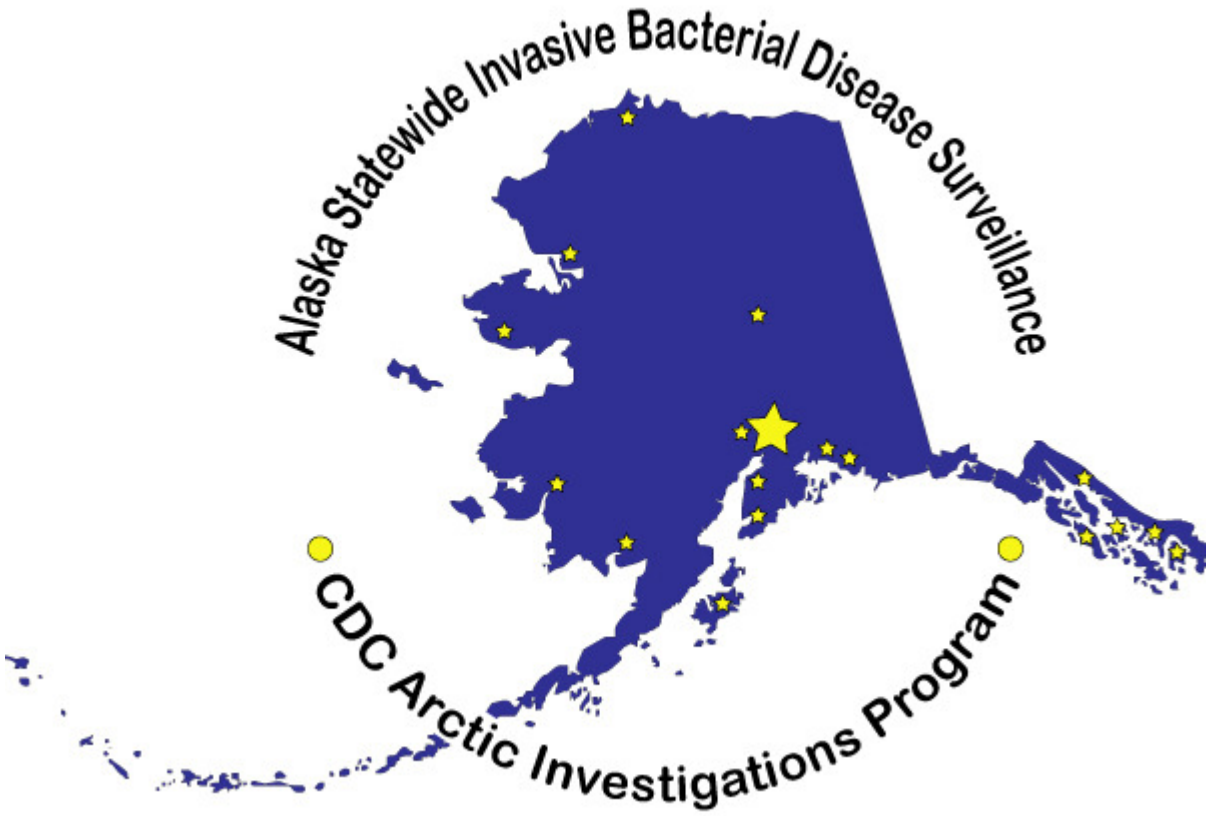

Surveillance of Invasive Bacterial Disease in Alaska, 2009

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Alaska Statewide Invasive Bacterial Disease

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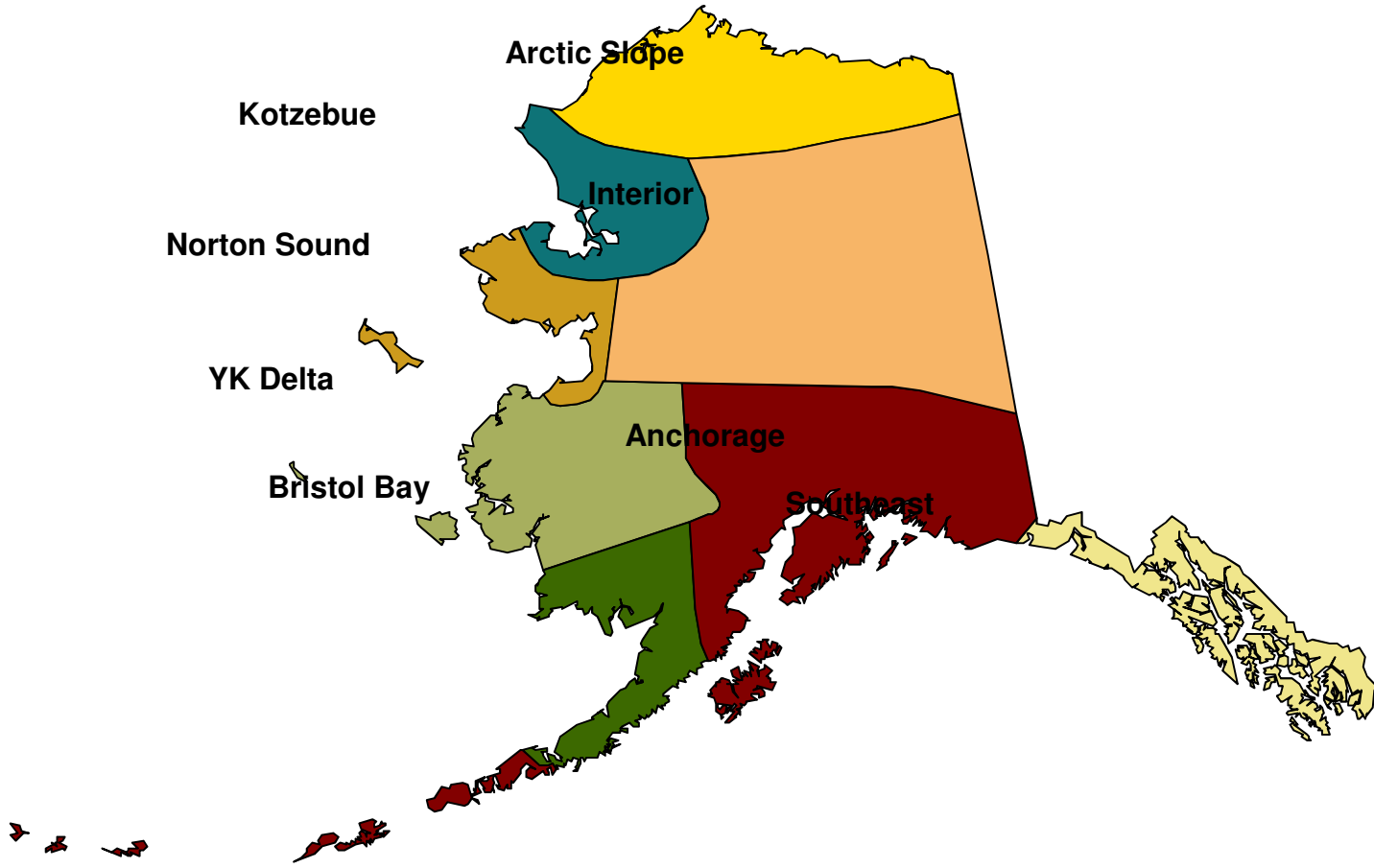
Summary

The Centers for Disease Control and Prevention's Arctic Investigations Program (AIP) in Anchorage, Alaska, maintains a statewide surveillance system for invasive diseases caused by *Streptococcus pneumoniae*, *Haemophilus influenzae, Neisseria meningitidis,* and groups A and B streptococci. Laboratories throughout the state are requested to send to AIP any isolates of these organisms recovered from a blood culture, CSF, or other normally sterile site in an Alaska resident. Isolate identification is confirmed and, when appropriate, serotyped and tested for antimicrobial susceptibility. The objectives of this system are to provide information on disease rates within the state, monitor the emergence of antimicrobial resistance, and to monitor the effectiveness of implemented vaccine programs, such as the 23-valent pneumococcal polysaccharide vaccine, the pneumococcal conjugate vaccine and *Haemophilus influenzae* type b vaccines.

Figure 1: Invasive Bacterial Disease Surveillance Regions – Alaska, 2009



In 2009, the total numbers of cases of invasive disease caused by these organisms reported to AIP were 148 *S. pneumoniae*, 21 *H. influenzae*, 5 *N. meningitidis*, 35 group A *Streptococci* (GAS) and 31 group B *Streptococci* (GBS). Alaska Native people had higher rates of disease than non-Native people for all

surveillance organisms. Rates of invasive pneumococcal disease were highest in Kotzebue. Rates for each organism by region are presented in the following table.

Table 1: Surveillance Organisms Reported by Region – Alaska, 2009

Region	*S. pneumoniae* n (rate*)	*H. influenzae* n (rate*)	*N. meningitidis* n (rate*)	GAS n (rate*)	GBS n (rate*)
Anchorage	98 (21.3)	9 (2)	3 (0.7)	17 (3.7)	21 (4.6)
Arctic Slope	1 (17.2)	0 (0)	0 (0)	0 (0)	0 (0)
Bristol Bay	1 (14.4)	0 (0)	0 (0)	0 (0)	0 (0)
Interior	30 (27.9)	2 (1.9)	0 (0)	9 (8.4)	4 (3.7)
Kotzebue	3 (37.2)	1 (12.4)	0 (0)	1 (12.4)	0 (0)
Norton Sound	0 (0)	0 (0)	0 (0)	0 (0)	2 (21.1)
Southeast	9 (13)	2 (2.9)	1 (1.4)	3 (4.3)	3 (4.3)
YK Delta	6 (24.1)	7 (28.1)	1 (4)	5 (20)	4 (1)
Total	148 (21.4)	21 (3)	5 (0.7)	35 (5.1)	31 (4.5)

*Cases per 100,000 population

Introduction

AIP conducts statewide surveillance of invasive *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Neisseria meningitidis*, and groups A and B *Streptococcus*. This program is part of a passive, laboratory-based surveillance system in which laboratories from all hospitals throughout the state are encouraged to participate. The population included in the AIP surveillance is the State of Alaska, which totaled 692,314 persons in 2009 [1]. Case detection occurs year-round as participating laboratories send isolates recovered from sterile sites to the AIP laboratory in Anchorage, accompanied by basic demographic and clinical information on the cases. Materials and forms for isolate shipment and data collection are provided to each laboratory by AIP. At year-end, AIP asks that each laboratory review their records and provide information on any cases that may have been overlooked. In 2009, 23 laboratories in Alaska participated in the invasive disease surveillance system, either by sending isolates to the AIP laboratory throughout the year, conducting year-end record reviews, or both. Beginning in January, 2007, invasive *S. pneumoniae*, GAS and GBS became reportable conditions to the State of Alaska Division of Public Health (DPH). Reports of cases of disease caused by these organisms, along with cases of invasive *H. influenzae* and *N. meningitidis* which were previously reportable, are shared between AIP and DPH.

AIP defines a case of invasive *S. pneumoniae, H. influenzae*, *N. meningitidis*, GAS or GBS as an isolate of the bacteria from a normally sterile site, including blood, cerebrospinal fluid, pleural fluid, peritoneal fluid or joint fluid that has been taken from a resident of Alaska. In addition, for GAS, isolates are requested from deep tissue infections such as might be collected from surgical debridement of cases of necrotizing fasciitis.

Invasive Pneumococcal Disease

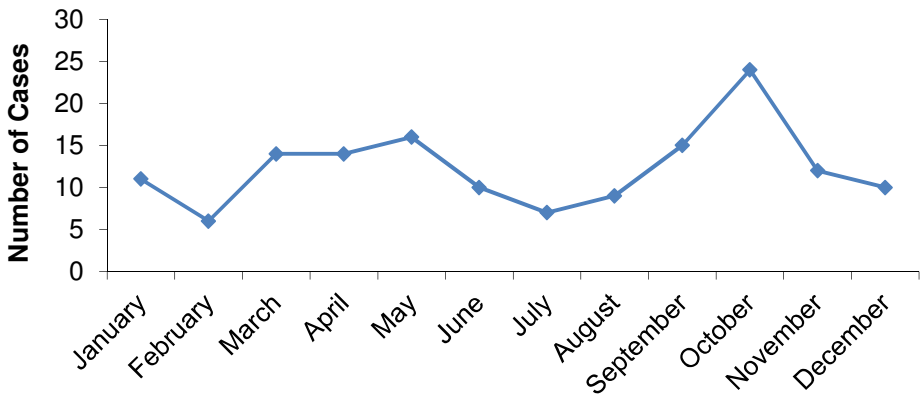
Overall Incidence

A total of 137 pneumococcal isolates were received at AIP in 2009. An additional 2 cases were detected through year-end follow up with participating laboratories and 9 cases through shared surveillance with the State DPH for a total of 148 cases of invasive pneumococcal disease. The overall rate for invasive pneumococcal disease in 2009 was 21.4 cases per 100,000 persons per year. Alaska rates for 2009 were higher than the Active Bacterial Core Surveillance (ABCs) 2009 national projected rate of 14.3/100,000 [2]. ABCs is a surveillance system operated in 10 states which covers a population of over 39 million persons.

Seasonality

Invasive *Streptococcus pneumoniae* cases were identified in each month of 2009. The largest number of cases was reported in October.

Figure 2: Invasive Pneumococcal Disease, by Month of Culture - Alaska, 2009



Race

In 2009, the state population was comprised of 20% Alaska Native people *(Alaska Natives 138,429, non-Natives 553,885)* [1]. Of all reported *S. pneumoniae* cases in 2009, 33% occurred among Alaska Native people for a total of 49 cases; the age-adjusted rate was 35.2/100,000 persons per year. Ninety-nine cases occurred among the non-Native population for an age-adjusted rate of 16.5/100,000 persons per year. The rate ratio of age-adjusted rates of *S. pneumoniae* disease for the Alaska Native population compared with the non-Native population in 2009 was 2.1.

Table 2: Invasive *Streptococcus pneumoniae* Cases by Race – Alaska, 2009

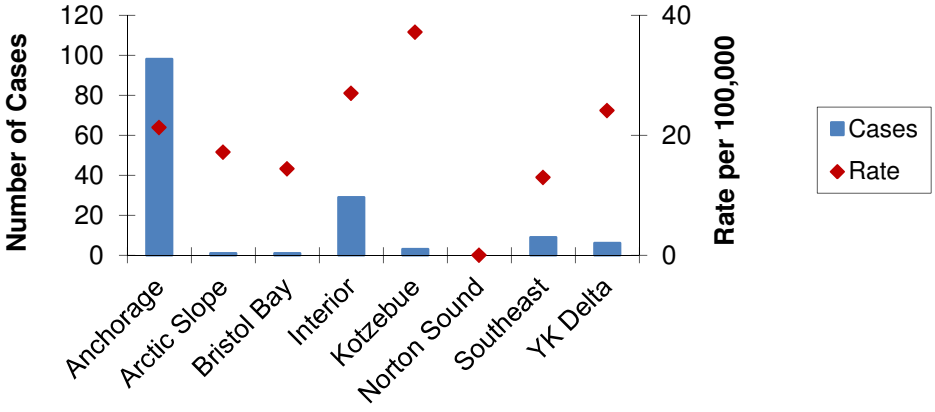
Race	Cases n (%)	Age Adjusted Rate*	% Male	Deaths n (%)
Alaska Native	49 (33)	35.2	47	5 (10.2)
Non-Native†	99 (67)	16.5	60	7 (7.2)‡
Total	148		56	12 (8.2)

*Cases per 100,000 per percent distribution of Alaska 2000 population
†Includes 4 cases for which race was unknown
‡Outcome unknown in 2 cases

Region

The highest percentage (56%) of invasive pneumococcal disease cases occurred in the Anchorage area in 2009. Rates of disease, however, were highest in Kotzebue (37.2/100,000 persons per year).

Figure 3: Invasive Pneumococcal Disease, Cases & Rates by Region - Alaska, 2009

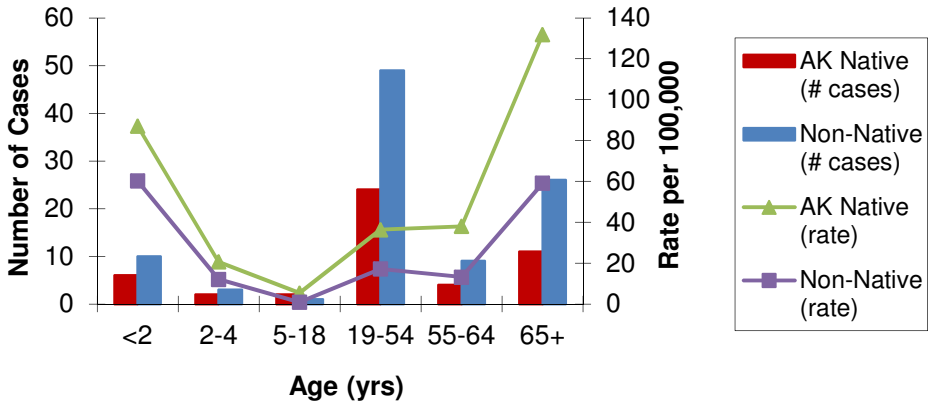


Age

Cases occurred in all age groups in 2009 ranging from 2 months to 97 years with a median age of 48 years. Overall, the highest rates of disease occurred in adults 65 years and older.

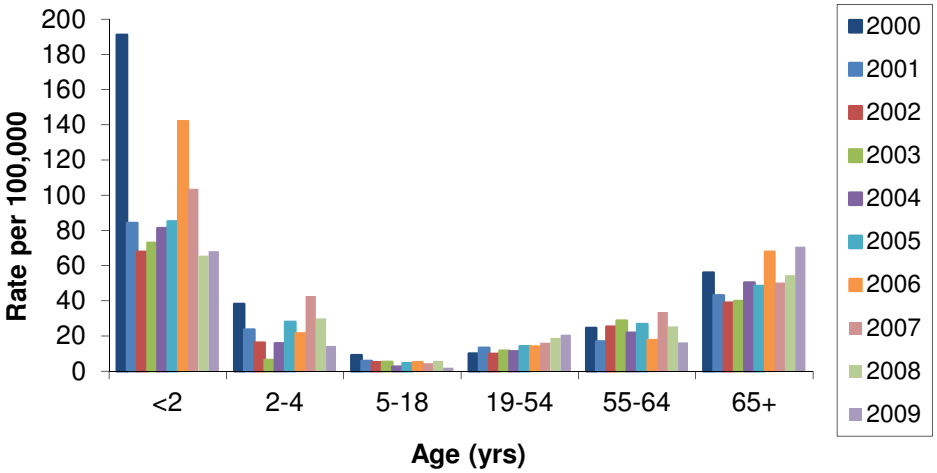
When stratified by age and race, the highest rates of disease in 2009 occurred in Alaska Native adults 65 years and older (131.9/100,000 persons per year).

Figure 4: Invasive Pneumococcal Disease, Cases & Rates by Age Group & Race - Alaska, 2009



Since the initiation of a pneumococcal conjugate vaccine program in 2001, overall rates of invasive disease have declined dramatically in children less than 2 years of age [3]. In 2000, overall yearly rates of pneumococcal disease in children less than 2 years were 191.2/100,000, dropping to a low of 67.9/100,000 in 2002 and then increasing to 142.2/100,000 in 2006. In 2008, the rate of invasive pneumococcal disease in children less than 2 years declined to 65.6/100,000 which is the lowest rate observed in this age group since vaccine introduction; in 2009, the rate increased slightly to 68.2/100,000.

Figure 5: Invasive Pneumococcal Disease by Age Group - Alaska, 2000-2009



Although pneumococcal disease rates dropped initially in AK Native and non-Native children less than 2 years of age after 2000, the rates of disease in AK Native children less than 2 years trended upward from a low of 93.6/100,000 in 2001 to 335.9/100,000 in 2006. This increase in rates was due primarily to disease caused by serotypes not contained in the pneumococcal conjugate vaccine [4,5]. In 2009, rates of disease in AK Native children less than 2 years declined to 87.1/100,000 which is the lowest rate since the introduction of the seven-valent pneumococcal vaccine. Rates of invasive disease in non-Native children less than 2 years declined during the same time period reaching 26.8/100,000 in 2005,

and following an increase to 64.4/100,000 in 2007, declined in 2008 to 6.2/100,000. In 2009, the rate of disease in non-Native children less than 2 years has increased again to 60.3/100,000.

Figure 6: Invasive Pneumococcal Disease in Alaska Natives, by Age Group - Alaska, 2000-2009

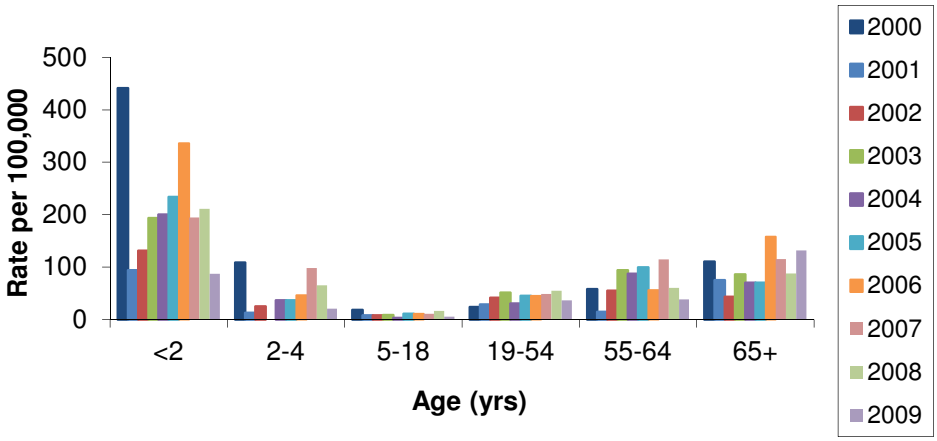
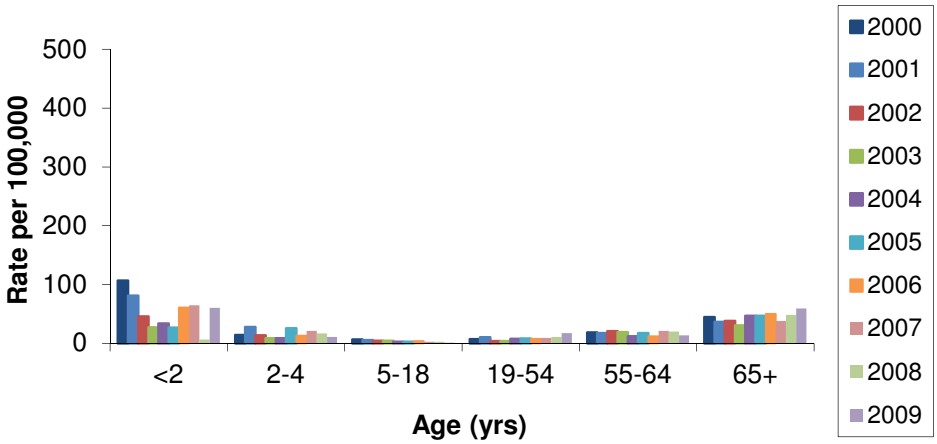


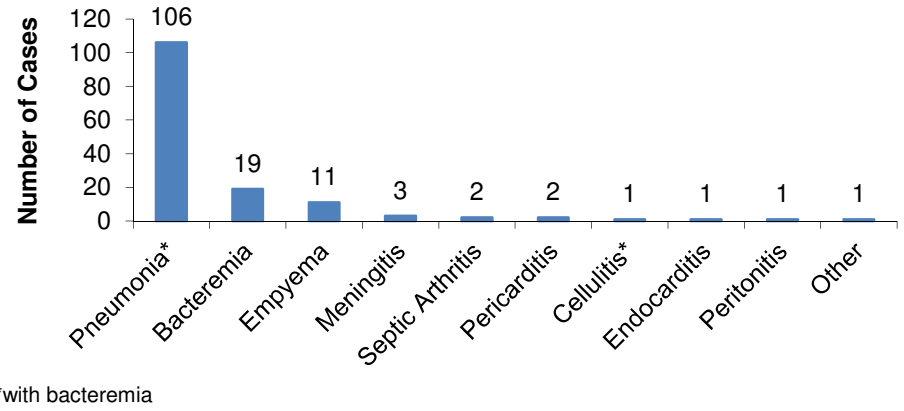
Figure 7: Invasive Pneumococcal Disease in Non-Natives, by Age Group - Alaska, 2000-2009



Clinical Presentation

The primary clinical presentation was determined by a review of the discharge diagnoses in each patient's individual medical record associated with the invasive bacterial illness. In cases with multiple discharge diagnoses, the most serious diagnosis related to the pneumococcal infection was recorded as the primary clinical presentation. Pneumonia with bacteremia was the most common primary clinical presentation in 2009 (72%) followed by bacteremia (13%). Eighteen cases had a secondary pneumococcal-related diagnosis in 2009 - 13 pneumonia, 2 cellulitis, 1 empyema, 1 osteomyelitis, and 1 unidentified other presentation.

Figure 8: Primary Clinical Presentations of Invasive Pneumococcal Disease - Alaska, 2009



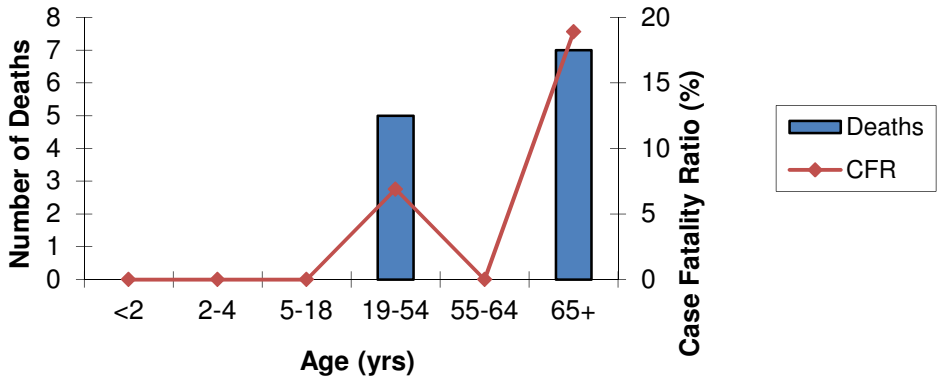
*with bacteremia

In 2009, blood was the most common source of a positive culture which was used to identify 137 (93%) of 147 cases. Pleural fluid was the positive site for 5 (3%) of cases; two cases were identified from cerebrospinal fluid, 1 case from joint fluid, 1 case from a pericardial aspirate and 1 case from an unidentified non-sterile site.

Mortality

In 2009, the overall case fatality ratio for *S. pneumoniae* in Alaska was 8.2% (12 deaths out of 146 cases for which outcomes were known). The case fatality ratio for AK Natives was higher than non-Natives; 10.2% (5 deaths) and 7.2% (7 deaths), respectively. The majority of deaths and the highest case fatality ratio occurred in the 65+ age category (7 deaths) 18.9%.

Figure 9: Invasive Pneumococcal Deaths & Case Fatality Ratios by Age Group - Alaska, 2009



Serotype

Serotyping of invasive pneumococcal isolates is performed at AIP using internationally standardized methods. Serotype identification is based on the organism's polysaccharide capsule which is a principal virulence factor for pneumococci. This information provides a way to categorize organisms and to determine if the infection was due to a type that could be prevented by use of one of the available pneumococcal vaccines. Serotyping was performed on all of the *S. pneumoniae* cases for which an isolate was available.

Table 3: Invasive Pneumococcal Serotype Distribution by Race and Age Group – Alaska, 2009

		Alaska Native				Non-Native				Unknown
Serotype	Total n (%)	<2	2-18	19-64	65+	<2	2-18	19-64	65+	All Ages
01	1 (<1)	-	-	-	-	1	-	-	-	-
03	12 (9)	-	-	3	1	-	-	6	2	-
04	1 (<1)	-	-	-	-	-	-	1	-	-
06A	1 (<1)	-	-	1	-	-	-	-	-	-
06C	5 (4)	-	-	-	2	-	-	1	2	-
07C	2 (1)	-	-	-	-	-	-	1	-	1
07F	39 (28)	2	2	3	2	2	2	20	5	1
08	4 (3)	-	-	2	-	-	-	2	-	-
09N	8 (6)	-	-	5	-	-	-	2	1	-
10A	1 (<1)	-	-	-	-	-	-	1	-	-
11A	2 (1)	-	-	1	-	-	-	-	-	1
12F	1 (<1)	-	-	1	-	-	-	-	-	-
14	1 (<1)	-	-	-	-	-	-	-	1	-
15A	5 (4)	1	-	1	-	-	-	3	-	-
15B	3 (2)	1	-	-	-	-	-	2	-	-
15C	1 (<1)	1	-	-	-	-	-	-	-	-
16F	5 (4)	-	-	2	-	-	-	2	1	-
17F	1 (<1)	-	-	1	-	-	-	-	-	-
19A	29 (21)	1	1	3	2	4	1	8	8	1
19F	1 (<1)	-	-	-	-	-	-	-	1	-
20	1 (<1)	-	-	1	-	-	-	-	-	-
22F	4 (3)	-	-	2	1	1	-	-	-	-
23A	2 (1)	-	-	1	1	-	-	-	-	-
23B	1 (<1)	-	-	-	-	-	-	1	-	-
28	1 (<1)	-	-	-	-	-	-	1	-	-
31	2 (1)	-	-	-	-	-	-	-	2	-
33F	3 (2)	-	-	-	-	1	-	2	-	-
Total	137	6	3	27	9	9	3	53	23	4

In 2009, the most common pneumococcal serotypes were 7F (39 isolates, 28%) and 19A (29 isolates, 21%). From 1986 through 2001, serotype 14 was the most common invasive pneumococcal serotype ranging from 7.4% to 23.5% of isolates. Following introduction in 2001 of the pneumococcal conjugate vaccine which includes serotype 14, the proportion of serotype 14 isolates dropped to 1.5% of serotyped isolates in 2006, did not cause any invasive pneumococcal disease in 2007 or 2008, and only one case in 2009. Disease caused by serotypes 7F and 19A, which are not included in the conjugate vaccine, has continually increased. Prior to 2005, yearly numbers of cases of serotype 7F disease and the proportion of total isolates ranged from 1 to 10 and 0.9% to 9.3%, respectively. Although the majority (62.5%) of serotype 7F disease occurred in AK Natives during 2005, the proportion of 7F disease occurring in non-Natives has gradually increased by 76% versus 24% in Alaska Natives in. The majority (74%) of serotype 7F cases and serotype 19A cases (55%) occurred in the Anchorage area in 2009.

Table 4: Invasive Pneumococcal Serotype Distribution by Region – Alaska, 2009

Serotype	Anchorage	Arctic Slope	Interior	Kotzebue	Southeast	YK Delta
01	1	-	-	-	-	-
03	8	-	3	-	1	-
04	1	-	-	-	-	-
06A	-	-	1	-	-	-
06C	5	-	-	-	-	-
07C	2	-	-	-	-	-
07F	28	-	8	2	-	1
08	2	-	2	-	-	-
09N	6	-	2	-	-	-
10A	1	-	-	-	-	-
11A	1	-	-	-	1	-
12F	-	-	-	-	-	1
14	1	-	-	-	-	-
15A	3	-	2	-	-	-
15B	2	-	-	1	-	-
15C	1	-	-	-	-	-
16F	4	-	-	-	-	1
17F	1	-	-	-	-	-
19A	16	-	7	-	3	3
19F	-	-	1	-	-	-
20	-	-	1	-	-	-
22F	2	1	-	-	1	-
23A	2	-	-	-	-	-
23B	1	-	-	-	-	-
28	1	-	-	-	-	-
31	1	-	-	-	-	-
33F	3	-	-	-	-	-
Total	94	1	27	3	6	6

Vaccine Serotypes

Two vaccine types were licensed for prevention of pneumococcal disease in 2009. In 2001, the pneumococcal conjugate vaccine (PCV7) was included in the Alaska childhood vaccination schedule. This vaccine provides protection against the 7 most common pneumococcal serotypes causing invasive disease among children (types 4, 6B, 9V, 14, 18C, 19F, 23F). The table below shows the proportion of invasive infections from 2009 that were due to serotypes found in the PCV7 vaccine. There were no cases of pneumococcal disease caused by serotypes contained in the PCV7 vaccine in children less than 5 years of age, the age group for which the vaccine is recommended.

Table 5: Proportion of Invasive Isolates Contained in the PCV7 Vaccine by Age Group and Race – Alaska, 2009

Age (yrs)	Alaska Native (%)	Non-Native (%)	Total (%)
<2	0 (0%) of 6	0 (0%) of 10	0 (0%) of 16
2-4	0 (0%) of 1	0 (0%) of 2	0 (0%) of 3
5+	0 (0%) of 38	3 (4%) of 76	3 (3%) of 114
Total	0 (0%) of 45	3 (3%) of 88	3 (2%) of 133

For the year covered by this report, the 23-valent polysaccharide vaccine (Ps23V) was recommended in Alaska for all persons 65 years and older, and for persons over age 2 who are at higher risk for pneumococcal disease [5]. In 2009, for persons 65 years and older, 24 (75%) of 32 cases serotyped were potentially vaccine preventable invasive pneumococcal illnesses.

Vaccine Failures

A PCV7 vaccine failure is defined as invasive pneumococcal disease caused by a serotype contained in the PCV7 vaccine in a child less than five years old who has had at least two doses of vaccine. There were no vaccine failures in 2009.

Potentially Preventable Deaths

In 2009, pneumococcal vaccine status was known for 90 (61%) of the 148 cases; 59 cases (40%) did receive a pneumococcal vaccine prior to illness and 31 cases (21%) had no record of a pneumococcal vaccine.

Table 6: Potentially Vaccine Preventable Invasive Pneumococcal Deaths – Alaska, 2009

Serotypes	< 2 years	2-4	5-18	19-54	55-64	65+	Total
PCV7	0	0	0	0	0	1 (14%)	1 (8%)
Ps23V	0	0	0	4 (80%)	0	2 (29%)	6 (50%)
Non-Vaccine	0	0	0	0	0	2 (29%)	2 (17%)
Unknown	0	0	0	1 (20%)	0	2 (29%)	3 (25%)
Total	0	0	0	5	0	7	12

Overall, 50% of all pneumococcal-related mortality in 2009 was potentially preventable with the use of the 23-valent polysaccharide vaccine in persons over 2 years old; 25% of deaths were due to disease caused by serotypes not contained in the 23-valent vaccine.

Six of the 12 deaths in 2009 from invasive *S. pneumoniae* occurred from serotypes contained within the Ps23V vaccine; 2 of the deaths were in individuals eligible for the vaccine. Of those two deaths, one occurred in a vaccinated individual; time since vaccination was 12 years.

Table 7: Invasive Pneumococcal Disease, Serotypes of Fatal Cases – Alaska, 2009

Serotype	Deaths n (%)	Serotype Frequency (n)
03*	1 (8%)	12
07F*	1 (3%)	38
09N*	1 (13%)	8
16F	1 (20%)	5
19A*	3 (10%)	29
19F†*	1 (100%)	1
23A	1 (50%)	2

†Serotypes contained in the 7-valent conjugate vaccine
*Serotypes contained in the 23-valent polysaccharide vaccine

Associated Medical Conditions

The presence of one or more associated medical conditions was reported in 85% of invasive pneumococcal cases in 2009. Cigarette smoking was the most prevalent risk factor observed in adults followed by chronic lung disease and alcohol abuse.

Table 8: Associated Medical Conditions Identified in Invasive Pneumococcal Cases – Alaska, 2009*

Medical Condition/Risk Factor	Adult Cases (≥ 18 years) n=123, Cases (%)
Cigarette smoking	53 (43)
Chronic lung disease	43 (35)
Alcohol abuse	25 (20)
Diabetes	21 (17)
Immunosuppressive treatment	12 (10)
Injection drug use	0 (0)
Asplenia	0 (0)

*More than one risk factor was identified in several cases

Antibiotic Resistance

Susceptibility testing was performed on all isolates received in 2009. Results of the testing are presented in the following table.

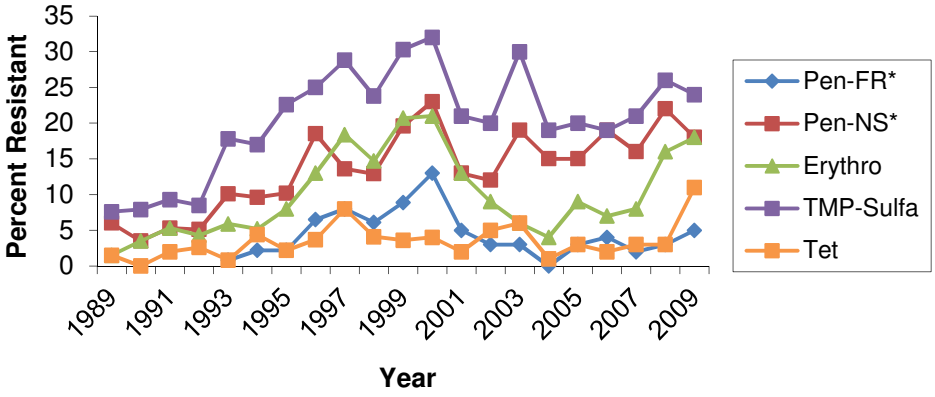
Table 9: Antibiotic Resistance in Invasive *Streptococcus pneumoniae* Isolates – Alaska, 2009

Antibiotic	Susceptible	Intermediate	Resistant	I + R	Total Tested
Penicillin	112 (82%)	18 (13%)	7 (5%)	25 (18%)	137
TMP-sulfa	104 (76%)	7 (5%)	26 (19%)	33 (24%)	137
Erythromycin	113 (82%)	0 (0%)	24 (18%)	24 (18%)	137
Ceftriaxone	129 (94%)	3 (2%)	5 (4%)	8 (6%)	137
Tetracycline	122 (90%)	1 (1%)	13 (10%)	14 (11%)	136
Chloramphenicol	136 (99%)	0 (0%)	1 (1%)	1 (1%)	137
Rifampin	137 (100%)	0 (0%)	0 (0%)	0 (0%)	137
Vancomycin	135 (99%)	0 (0%)	1 (1%)	1 (1%)	136
Levofloxacin	125 (91%)	0 (0%)	12 (9%)	12 (9%)	137
Clindamycin	136 (99%)	0 (0%)	1 (1%)	1 (1%)	137

Cut points from the Minimum Inhibitory Concentration (MIC) Interpretive Standards were used to determine if an isolate was 'susceptible', 'intermediate', or 'resistant' to the antibiotic being tested [6]. The MIC Interpretive Standards definitions of 'susceptible', 'intermediate', and 'resistant' can be found in the Appendix.

Serotypes found in the PCV7 vaccine are more likely to be non-susceptible to penicillin and erythromycin than non-vaccine serotypes. One potential benefit of the use of this vaccine was an anticipated decline in antibiotic resistance among circulating pneumococci. Following the initiation of the PCV7 vaccine in 2001, antibiotic resistance among invasive pneumococci dropped. During 2003, TMP-sulfa and penicillin resistance increased, however, both decreased in 2004 to levels of resistance seen in 2002 and have remained fairly stable. After steadily declining from 2000 to a low of 4% in 2004, erythromycin resistance has increased to 18% of tested isolates in 2009. Tetracycline resistance occurred in 11% of isolates in 2009; this is the highest level of resistance seen in pneumococcal isolates to date.

Figure 10: Trends in Antibiotic Resistance Among Invasive Pneumococcal Isolates - Alaska, 1989 - 2009



*Pen-FR = fully resistant, Pen-NS = non-susceptible

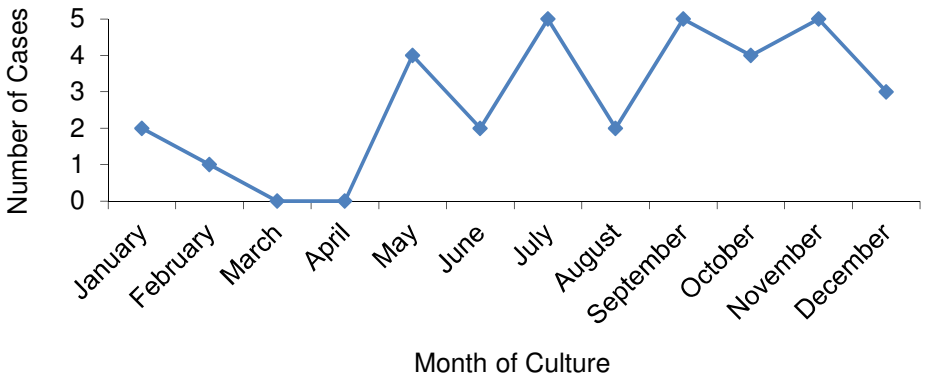
Invasive *Haemophilus influenzae*

Overall Incidence

In 2009, there were 21 cases of invasive *Haemophilus influenzae* in Alaska, for a statewide rate of 3/100,000 persons per year. This rate is higher than the national projected rate of 1.6/100,000 persons per year [8]. There was one death caused by *H. influenzae* in 2009 for a case fatality ratio of 5%.

Seasonality

Figure 11: *Haemophilus influenzae* Disease by Month of Culture - Alaska, 2009

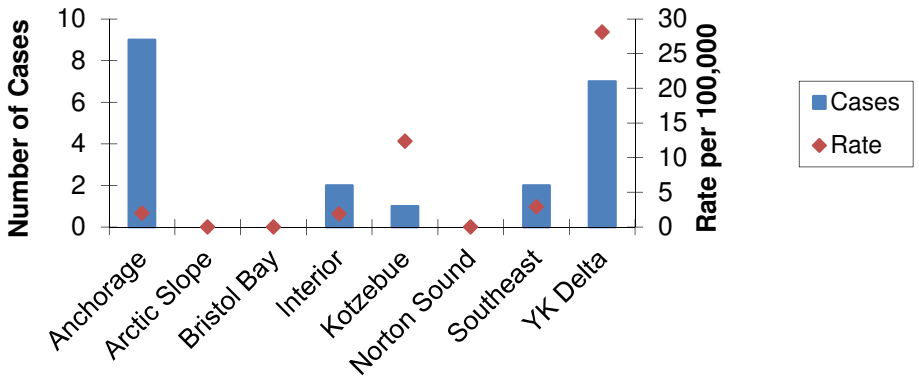


Cases of invasive *H. influenzae* occurred throughout 2009; however, due to the small number of cases, trends in seasonality cannot be determined.

Region

The highest rates of disease caused by invasive *H. influenzae* cases in 2009 were in YK Delta, 28.1/100,000 (7 cases), and Kotzebue, 12.4/100,000 (1 case). The largest number of cases occurred in the Anchorage area (9 cases), but the rate was much lower (2/100,000).

Figure 12: Invasive *Haemophilus influenzae*, Cases & Rates by Region - Alaska, 2009



Race

Table 10: Invasive *Haemophilus influenzae* Cases by Race – Alaska, 2009

Race	Cases n (%)	Age Adjusted Rate*	% Male	Deaths n (%)
Alaska Native	12 (57%)	7.3	50	1 (8%)
Non-Native	9 (43%)	1.6	22	0 (0%)
Total	21		38	1 (5%)

*Cases per 100,000 per percent distribution of Alaska 2000 population

In 2009, 57% of the cases occurred in Alaska Natives. Age-adjusted rates were calculated for Alaska Natives and non-Natives. The age-adjusted rate ratio of *H. influenzae* disease for the Alaska Native population compared with the non-Native population in 2009 was 4.6.

Age

H. influenzae cases ranged in age from newborn to 80 years of age in 2009 (median 48.8 years). Overall, the highest rates of disease occurred in children less than 2 years old and adults 65 and older.

Rates of disease in Alaska Native versus non-Native populations by age group were variable; overall numbers of cases and rates by race and age group are presented in Figure 14. The highest rates of disease occurred in Alaska Native children less than two years of age, 43.6/100,000 persons per year and Alaska Native adults 65 years and older, 36/100,000 persons per year.

Figure 13: Invasive *Haemophilus influenzae* by Age Group - Alaska, 2009

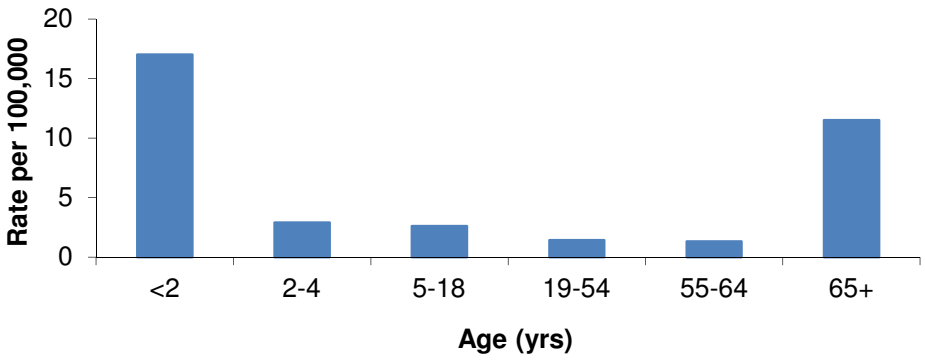
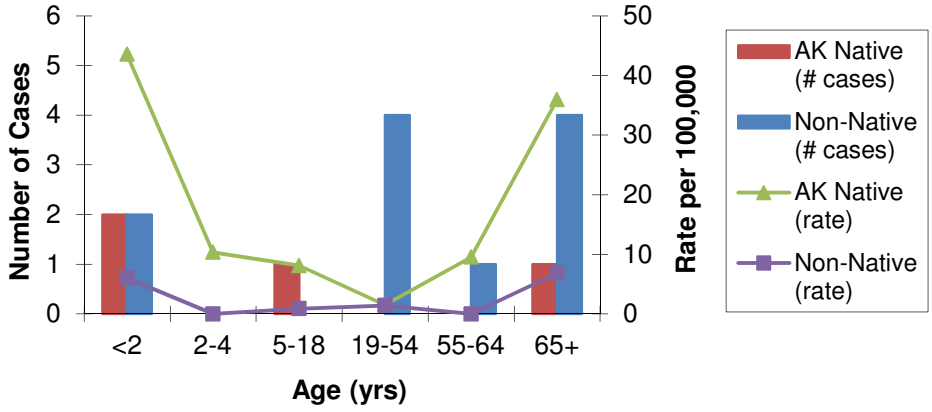


Figure 14: Invasive *Haemophilus influenzae*, Cases & Rates by Age Group & Race - Alaska, 2009



Clinical Presentation

The primary clinical presentation was determined by a review of the discharge diagnoses in each patient's individual medical record associated with the invasive bacterial illness. For cases with more than one diagnosis, the most serious *H. influenzae*-related diagnosis was recorded as the primary clinical presentation. In 2009, pneumonia with bacteremia was the most common presentation (48% of cases).

All *H. influenzae* isolates were from blood samples in 2009.

Table 11: Primary Clinical Presentation of Invasive *Haemophilus influenzae* - Alaska, 2009

Primary Presentation	n (%)
Pneumonia*	10 (48%)
Bacteremia	8 (38%)
Cellulitis	2 (9%)
Amnionitis	1 (5%)
Total	21

*with bacteremia

Serotypes

All isolates received at AIP are serotyped; 20 of the 21 cases in 2009 had isolates and were serotyped. The bacterial capsule is the basis for serotyping and is the primary virulence factor. Serotype b has been the most common serotype in the past, but its prevalence has decreased with use of the childhood Hib vaccine. Surveillance of serotypes is important for monitoring vaccine effectiveness and emergence of non-vaccine serotypes.

Table 12: Serotypes of Invasive *Haemophilus influenzae* Cases by Race – Alaska, 2009

		Alaska Native				Non-Native			
Serotype	Total n (%)	<2	2-18	19-64	65+	<2	2-18	19-64	65+
a	2	1	1	0	0	0	0	0	0
b	4	2	2	0	0	0	0	0	0
e	4	0	1	0	0	0	0	1	2
f	2	0	0	0	0	0	0	2	0
NT*	8	0	0	1	3	1	1	1	1
Total	20	3	4	1	3	1	1	4	3

*Non-typable

Hib

In recent years, the prevalence of *H. influenzae* type b has declined due to increased use of a childhood vaccine against this serotype. Four cases of Hib occurred in 2009, all in vaccinated children. Two cases occurred in children under the age of 2 years; one received the Pentacel vaccine and one the PedVaxHib vaccine. The other cases occurred in a seven and an eight year old and both had a history of an immunocompromised condition.

Antibiotic Resistance

Twenty *Haemophilus influenzae* isolates received at AIP were tested for susceptibility to chloramphenicol, ceftriaxone and TMP/sulfa. All 20 isolates were susceptible to chloramphenicol and ceftriaxone; seven isolates were fully resistant to TMP/sulfa, 6 had intermediate resistance and 7 were susceptible.

Table 13: Summary of Invasive *Haemophilus influenzae* Case Characteristics, Alaska, 2009

Sex	Age (Yrs)	Race	Residence	Site of Isolation	Clinical Presentation(s)	Serotype*	Associated Medical Conditions	Survived
F	Newborn	Non-Native	Anchorage	Blood	Bacteremia	NT	None	Yes
F	0.6	AK Native	Other	Blood	Bacteremia	b	None	Yes
M	1	AK Native	Other	Blood	Cellulitis	a	None	Yes
F	1.9	AK Native	Other	Blood	Pneumonia	b	None	Yes
M	2.8	AK Native	Other	Blood	Pneumonia	e	Chronic lung disease	Yes
M	7.9	AK Native	Other	Blood	Pneumonia	b	Immunosuppressive treatment	Yes
M	8.3	AK Native	Other	Blood	Bacteremia	a	None	Yes
F	8.4	AK Native	Other	Blood	Cellulitis	b	None	Yes
M	8.6	Non-Native	Anchorage	Blood	Cellulitis	NT	Diabetes	Yes
F	25	Non-Native	Anchorage	Blood	Amnionitis, septic abortion	NT	Smoking	Yes
M	48.8	AK Native	Other	Blood	Bacteremia	Unknown	Alcohol abuse	Yes
F	49.1	Non-Native	Anchorage	Blood	Pneumonia	e	Chronic lung disease	Yes
F	50.9	Non-Native	Anchorage	Blood	Pneumonia	f	Chronic lung disease	Yes
F	54.2	Non-Native	Anchorage	Blood	Bacteremia	f	Chronic lung disease	Unknown
F	55.5	AK Native	Other	Blood	Pneumonia	NT	Smoking, chronic lung disease	Yes
F	65.7	Non-Native	Anchorage	Blood	Pneumonia	e	Smoking, chronic lung disease	Yes
M	68.4	Non-Native	Other	Blood	Pneumonia	NT	Diabetes	Yes
F	68.5	AK Native	Other	Blood	Pneumonia	NT	Chronic lung disease	Yes
F	69.7	AK Native	Anchorage	Blood	Pneumonia	NT	Smoking, immunosuppressive treatment	Yes
M	74.8	AK Native	Other	Blood	Bacteremia	NT	Immunosuppressive treatment	No
F	80.4	Non-Native	Anchorage	Blood	Bacteremia	e	Immunosuppressive treatment	No

*NT = non-typeable

Invasive *Neisseria meningitidis*

Overall Incidence

A total of 5 cases of invasive *Neisseria meningitidis* were reported to AIP in 2009 for an overall rate of 0.7/100,000. The Alaska rates are slightly higher than the ABCs 2009 national projected rate of 0.3/100,000 [9]. There were no invasive *N. meningitidis*-related deaths in Alaska in 2009.

Seasonality

One *N. meningitidis* case occurred in each month of January, February, April, July and August; no clusters of related cases were reported.

Race

In 2009, 60% of the cases occurred in non-Natives. Age-adjusted rates were calculated for Alaska Natives and non-Natives. The age-adjusted rate ratio of *N. meningitidis* disease for the Alaska Native population compared with the non-Native population in 2009 was 3.3.

Table 14: Invasive *Neisseria meningitidis* Cases by Race – Alaska, 2009

Race	Cases n (%)	Age Adjusted Rate*	% Male	Deaths n (%)
Alaska Native	2 (40%)	1.3	0	0 (0%)
Non-Native†	3 (60%)	0.4	67	0 (0%
Total	5		40	0

*Cases per 100,000 per percent distribution of Alaska 2000 population
†Includes 1 case for which race was unknown

Region

Three cases of invasive *N. meningitidis* occurred in Anchorage and one case occurred in both the Southeast and the YK Delta.

Age

Invasive *N. meningitidis* cases reported in 2009 ranged in age from 0.3 to 77.1 years old; the median age was 47.9 years.

Clinical Presentation

The primary clinical presentation was determined by a review of the discharge diagnoses in each patient's individual medical record associated with the invasive bacterial illness. In cases with multiple discharge diagnoses, the most serious diagnosis related to the *N. meningitidis* infection was recorded as the primary clinical presentation. Two cases presented with meningitis, two with bacteremia and one with pneumonia; one case had a secondary clinical presentation of cellulitis.

N. meningitidis was isolated from blood in all five cases in 2009.

Mortality

There were no *N. meningitidis*-related deaths reported in Alaska in 2009.

Serogroup

Five invasive *N. meningitidis* cases in 2009 were serogrouped; four were serogroup B and one was serogroup Y.

Table 15: Summary of Invasive *Neisseria Meningitidis* Cases Characteristics, Alaska, 2009

Sex	Age (yrs)	Race	Residence	Site of Isolation	Clinical Presentation(s)	Serogroup	Associated Medical Conditions	Survived
F	0.3	AK Native	Other	Blood	Bacteremia	B	None	Yes
F	1.6	Non-Native	Anchorage	Blood	Meningitis	B	None	Yes
F	47.9	AK Native	Anchorage	Blood	Meningitis	B	Chronic lung disease, asplenia	Yes
M	58.5	Non-Native	Other	Blood	Pneumonia, cellulitis	B	None	Yes
M	77.1	Non-Native	Anchorage	Blood	Bacteremia	Y	None	Yes

Invasive group A *Streptococcus*

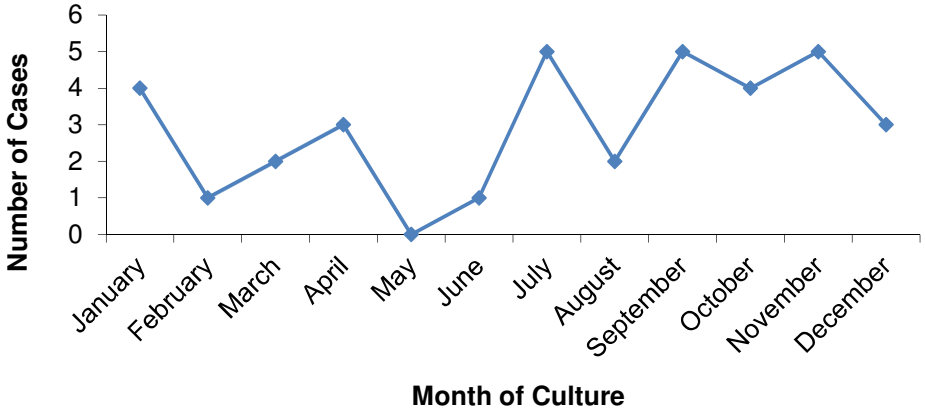
Overall Incidence

A total of 35 cases of invasive group A *Streptococcus* (GAS) were reported to AIP in 2009. The overall rate of invasive GAS disease in the state of Alaska was 5.1/100,000 persons per year. The Alaska rate is higher than the ABCs 2009 national projected rate of 3.6/100,000 [10]. In 2009, there were 3 GAS-related deaths (all cases *emm* type 82) for a case fatality ratio of 8.8%.

Seasonality

Cases of group A *Streptococcus* occurred throughout the year in 2009 with no apparent trends in seasonality.

Figure 15: Invasive group A *Streptococcus*, by Month of Culture - Alaska, 2009



Race

In 2009, 57% of invasive GAS cases in Alaska occurred in the Alaska Native population for an age-adjusted rate of 14.2/100,000 persons per year which was six times higher than the non-Native age-adjusted rate of 2.4/100,000 persons per year.

Table 16: Invasive group A *Streptococcus* Cases by Race – Alaska, 2009

Race	Cases n (%)	Age Adjusted Rate*	% Male	Deaths n (%)
Alaska Native	20 (57%)	14.2	50	2 (10.5%)†
Non-Native	15 (43%)	2.4	73	1 (7%)
Total	35		60	3 (8.6%)

*Cases per 100,000 per percent distribution of Alaska 2000 population
†Outcome unknown in one case

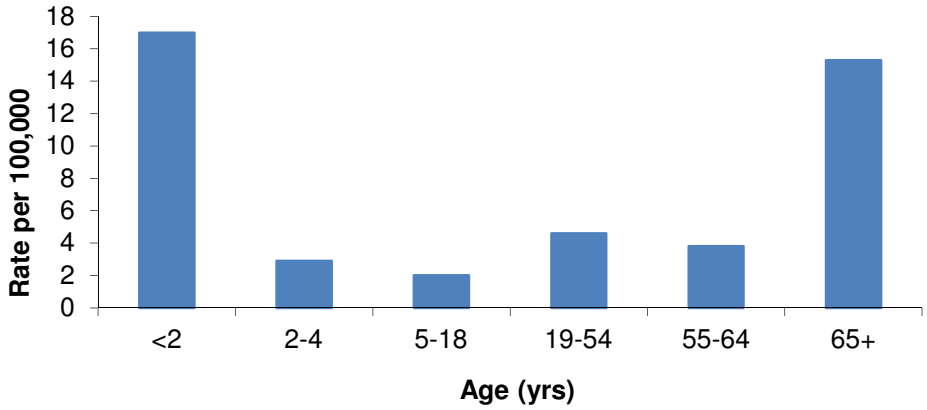
Region

Seventeen (48.5%) of the 35 invasive group A *Streptococcus* cases in 2009 were reported in the Anchorage area, 9 cases in the Interior, 5 cases in the YK Delta, 3 cases in Southeast, and one case in Kotzebue.

Age

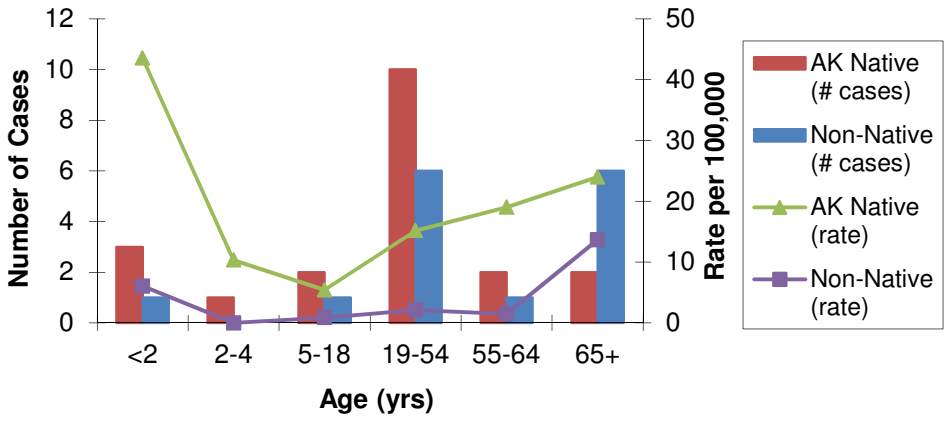
Invasive group A *Streptococcus* cases reported in 2009 ranged in age from 6 months to 90.5 years old; the median age was 48.3 years. Highest rates of disease occurred in children less than two years old (17/100,000).

Figure 16: Invasive group A *Streptococcus* by Age Group - Alaska, 2009



When stratified by race, the highest rates of invasive group A streptococcal disease occurred in Alaska Native children less than two years old (43.6/100,000 persons per year). The highest GAS disease rate in the non-Native population occurred in adults 65 and older (13.7/100,000 persons per year).

Figure 17: Invasive group A *Streptococcus*, Cases & Rates by Age Group & Race - Alaska, 2009



Clinical Presentation

The primary clinical presentation was determined by a review of the discharge diagnoses in each patient's individual medical record associated with the invasive bacterial illness. In cases with multiple discharge diagnoses, the most serious diagnosis related to the GAS infection was recorded as the primary clinical presentation. Table 17 shows the primary clinical presentations of invasive group A *Streptococcus* in Alaska for 2009. Nine cases also presented with secondary diagnoses including streptococcal toxic shock syndrome, cellulitis, necrotizing fasciitis, bursitis and pneumonia.

Group A *Streptococcus* was isolated from blood samples in 29 (83%) of 35 cases, four from joint fluid, and one each from bone and synovial fluid.

Table 17: Primary Clinical Presentations of Invasive group A *Streptococcus* – Alaska, 2009

Primary Presentation	n (%)
Cellulitis*	12 (34%)
Bacteremia	8 (23%)
Septic arthritis	5 (14%)
Pneumonia*	3 (9%)
Empyema	2 (6%)
Endometritis	2 (6%)
Osteomyelitis	2 (6%)
Endocarditis	1 (3%)
Total	35

*with bacteremia

Table 18: Summary of Invasive group A *Streptococcus* Case Characteristics, Alaska, 2009

Sex	Age (yrs)	Race	Residence	Site of Isolation	Clinical Presentation(s)	*emm* Type	Associated Medical Conditions	Survived
F	0.5	AK Native	Other	Blood	Bacteremia	108.10	None	Yes
M	0.5	AK Native	Other	Blood	Bacteremia	82.00	None	Yes
M	1.5	AK Native	Other	Blood	Bacteremia	82.00	None	Yes
M	1.5	Non-Native	Anchorage	Blood	Bacteremia	101.00	Unknown	Yes
F	3.5	AK Native	Other	Blood	Bacteremia		None	Yes
M	5.5	AK Native	Other	Blood	Pneumonia	1.00	None	Yes
M	11.2	AK Native	Other	Joint fluid	Septic arthritis, cellulitis	1.00	None	Unknown
M	15.8	Non-Native	Anchorage	Blood	Empyema, pneumonia	5.14	None	Yes
M	21.3	Non-Native	Other	Joint fluid	Cellulitis, bursitis	73.00	Smoking, diabetes	Yes
F	26	Non-Native	Other	Blood	Endometritis	73.00	None	Yes
M	30.3	AK Native	Other	Bone	Osteomyelitis		Smoking	Yes
F	32.1	AK Native	Other	Blood	Cellulitis	82.00	Alcohol abuse	Yes
F	33.1	AK Native	Other	Blood	Endometritis	82.00	Smoking, chronic lung disease	Yes
M	34.2	AK Native	Anchorage	Blood	Bacteremia	82.00	Alcohol abuse	Yes
M	36.4	Non-Native	Other	Blood	Pneumonia	1.00	Smoking	Yes
F	37.1	AK Native	Anchorage	Blood	Osteomyelitis	58.00	None	Yes
M	38.1	Non-Native	Other	Blood	Empyema, pneumonia	1.00	None	Yes
M	48.3	AK Native	Anchorage	Joint fluid	Septic arthritis, cellulitis	82.00	Smoking, alcohol abuse	Yes
M	49	AK Native	Other	Joint fluid	Septic arthritis, necrotizing fasciitis	82.00	None	Yes
F	51.9	AK Native	Anchorage	Synovial fluid	Septic arthritis	82.00	Smoking, alcohol abuse	Yes
M	52.2	Non-Native	Anchorage	Blood	Septic arthritis	108.10	None	Yes
M	52.7	Non-Native	Other	Blood	Cellulitis, strep toxic shock syndrome	82.00	Diabetes	Yes
M	53.7	AK Native	Other	Blood	Bacteremia	82.00	Chronic lung disease, alcohol abuse, diabetes	Yes
F	54	AK Native	Anchorage	Blood	Cellulitis	80.00	None	Yes
F	56.4	AK Native	Anchorage	Blood	Cellulitis	92.00	Chronic lung disease	Yes
F	59	AK Native	Anchorage	Blood	Pneumonia	82.00	None	No
F	62.8	Non-Native	Anchorage	Blood	Cellulitis	82.00	None	Yes
F	65.7	Non-Native	Other	Blood	Cellulitis, necrotizing fasciitis, strep toxic shock syndrome	108.10	Diabetes	Yes
M	67.8	Non-Native	Anchorage	Blood	Cellulitis	11.00	Diabetes	Yes
M	71	Non-Native	Other	Blood	Cellulitis		Alcohol abuse	Yes
F	78.1	Non-Native	Anchorage	Blood	Bacteremia	118.00	None	Yes
M	78.5	AK Native	Anchorage	Blood	Cellulitis	2.00	Smoking, chronic lung disease	Yes
F	80.3	AK Native	Anchorage	Blood	Endocarditis, pneumonia	82.00	None	No
M	81.3	Non-Native	Anchorage	Blood	Cellulitis	12.00	Immunosuppressive treatment	Yes
M	90.5	Non-Native	Anchorage	Blood	Cellulitis	82.00	None	No

Invasive group B *Streptococcus*

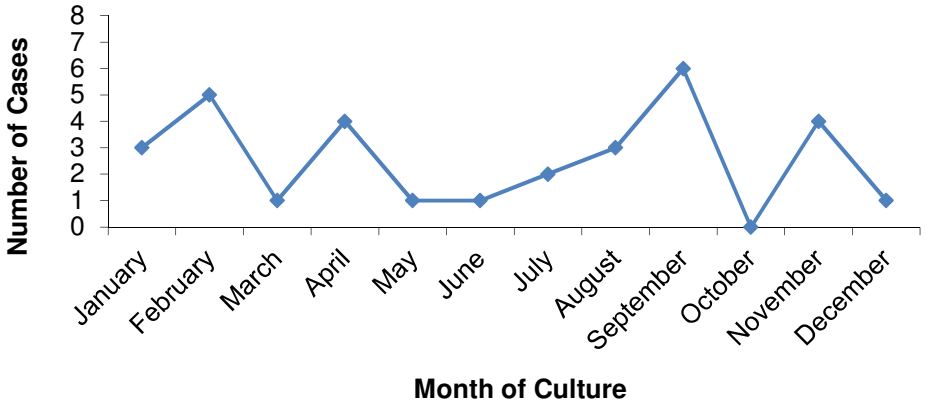
Overall Incidence

A total of 31 cases of invasive group B *Streptococcus* (GBS) were reported to AIP in 2009. The overall rate of invasive GBS disease in the state of Alaska was 4.5/100,000 persons per year. The Alaska rate is lower than the ABCs 2009 national projected rate of 6.9/100,000 [11]. In 2009, there were six GBS-related deaths for a case fatality ratio of 20% (outcome was unknown in 1 case).

Seasonality

Cases of group B *Streptococcus* occurred throughout the year with no apparent trends in seasonality.

Figure 18: Invasive group B *Streptococcus*, by Month of Culture - Alaska, 2009



Race

In 2009, 19% of invasive group B *Streptococcus* cases in Alaska occurred in the Alaska Native population; the age-adjusted rate was 4.2/100,000 persons per year which is slightly higher than the non-Native rate of 3.8/100,000 persons per year.

Table 19: Invasive group B *Streptococcus* Cases by Race – Alaska, 2009

Race	Cases n (%)	Age Adjusted Rate*	% Male	Deaths n (%)
Alaska Native	6 (19)	4.2	33	0 (0)
Non-Native	25 (81)‡	3.8	72	6 (24)†
Total	31		65	6 (19)†

*Cases per 100,000 per percent distribution of Alaska 2000 population
‡Includes one case for which race was unknown
†Outcome unknown in one case

Region

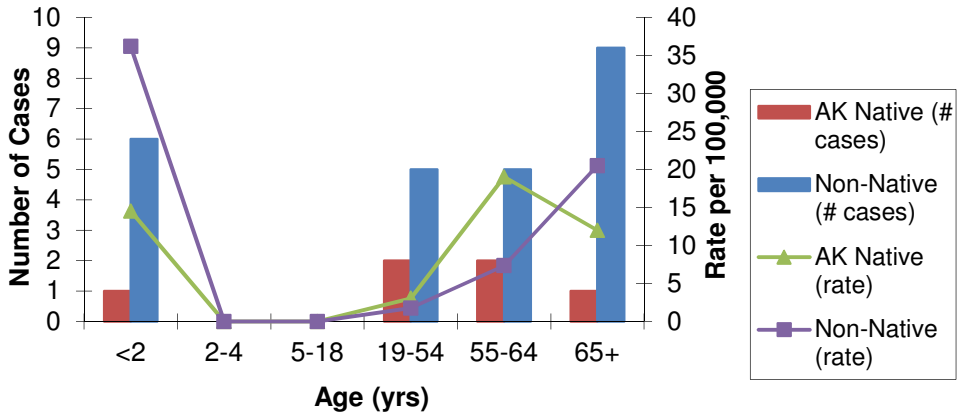
In 2009, 21 (68%) of the 31 reported GBS cases occurred in Anchorage; four cases were reported in the Interior, three cases in Southeast Alaska, two cases in Norton Sound and one in the YK Delta.

Age

Invasive group B *Streptococcus* cases reported in 2009 ranged in age from newborn to 88.1 years old; the median age was 55.7 years. Highest rates of disease occurred in children less than two years old (29.8/100,000 persons per year).

Figure 19: Invasive group B *Streptococcus* by Age Group - Alaska, 2009

Figure 20: Invasive group B S*treptococcus*, Cases & Rates by Age Group & Race - Alaska, 2009



When stratified by race, the highest rates of disease occurred in non-Native children less than 2 years of age (36.2/100,000 persons per year). There were three cases of early-onset disease (less than 7 days old) for a rate of 0.3/1,000 births.

Clinical Presentation

The primary clinical presentation was determined by a review of the discharge diagnoses in each patient's individual medical record associated with the invasive bacterial illness. In cases with multiple discharge diagnoses, the most serious diagnosis related to the GBS infection was recorded as the primary clinical presentation. In 2009, the most common clinical presentation was bacteremia which occurred in 11 cases (35%).

Group B *Streptococcus* was isolated from blood in 28 (90%) of 31 cases in 2009; two cases were isolated from cerebrospinal fluid and one case was isolated from an unspecified sterile site.

Table 20: Primary Clinical Presentations of Invasive group B *Streptococcus* – Alaska, 2009

Primary Presentation	n (%)
Bacteremia	11 (35)
Pneumonia*	6 (19)
Cellulitis*	5 (16)
Meningitis	2 (7)
Osteomyelitis	2 (7)
Endocarditis	2 (7)
Septic arthritis	1 (3)
Other	1 (3)
No information	1 (3)
Total	31

*with bacteremia

Antibiotic Resistance

Susceptibility testing was performed on 28 GBS isolates received in 2009; one additional isolate was tested for tetracycline resistance. Results of the testing are presented in the following table.

Table 21: Antibiotic Resistance in Invasive group B *Streptococcus* Isolates – Alaska, 2009

Antibiotic	Susceptible	Intermediate	Resistant	I + R	Total Tested
Penicillin	28 (100%)	0 (0%)	0 (0%)	0 (0%)	28
Ceftriaxone	28 (100%)	0 (0%)	0 (0%)	0 (0%)	28
Erythromycin	13 (46%)	0 (0%)	15 (54%)	15 (54%)	28
Tetracycline	5 (17%)	0 (0%)	24 (83%)	24 (83%)	29
Levofloxacin	27 (100%)	0 (0%)	0 (0%)	0 (0%)	27
Clindamycin	20 (71%)	0 (0%)	8 (29%)	8 (29%)	28
Vancomycin	28 (100%)	0 (0%)	0 (0%)	0 (0%)	28

All isolates tested were susceptible to penicillin, ceftriaxone, levofloxacin and vancomycin. Resistance to tetracycline, erythromycin and clindamycin was seen in 83%, 54% and 29%, respectively, of isolates tested. One isolates from one of the early onset cases was resistant to tetracycline and one was resistant to erythromycin; the isolate from the third case was susceptible to all antibiotics tested.

Table 21: Summary of Invasive group B *Streptococcus* Case Characteristics, Alaska, 2009

Sex	Age (yrs)	Race	Residence	Site of Isolation	Clinical Presentation(s)	Associated Medical Conditions	Survived
F	Newborn	Non-Native	Anchorage	Blood	Bacteremia	None	Yes
F	Newborn	AK Native	Other	Blood	Bacteremia	None	Yes
M	Newborn	Non-Native	Other	Blood	Pneumonia	None	Yes
M	11 days	Non-Native	Anchorage	CSF	Meningitis	None	Yes
M	0.1	Non-Native	Other	Blood	Cellulitis	None	Yes
M	0.2	Non-Native	Other	Blood	Pneumonia	Chronic lung disease	No
F	0.3	Non-Native	Anchorage	CSF	Meningitis	None	Yes
M	20.6	AK Native	Anchorage	Blood	Bacteremia	Smoking, alcohol abuse	Yes
F	37.1	AK Native	Anchorage	Blood	Osteomyelitis	None	Yes
M	39.2	Non-Native	Other	Blood	Cellulitis	Diabetes	Yes
M	42.9	Non-Native	Anchorage	Blood	Bacteremia	Smoking	Yes
M	43.3	Non-Native	Anchorage	Blood	Septic arthritis	Smoking, alcohol abuse	Yes
F	46.7	Non-Native	Anchorage	Blood	Endocarditis	Smoking	Yes
F	53.9	Non-Native	Anchorage	Blood	Cellulitis	Smoking	Yes
M	55.3	Non-Native	Anchorage	Blood	Pneumonia	Smoking, alcohol abuse	Yes
F	55.7	AK Native	Anchorage	Blood	Bacteremia	Smoking, chronic lung disease	Yes
M	57.6	Non-Native	Anchorage	Blood	Bacteremia	None	No
M	60.1	Non-Native	Anchorage	Blood	Endocarditis	None	No
M	61.8	AK Native	Anchorage	Blood	Bacteremia	Smoking, chronic lung disease, immunosuppressive treatement	Yes
M	62.3	Non-Native	Other	Blood	Bacteremia	None	Yes
M	62.8	Unknown	Other	Other	Unknown	Unknown	Unknown
M	65.2	Non-Native	Other	Blood	Bacteremia	Diabetes	Yes
M	65.3	Non-Native	Other	Blood	Bacteremia	Diabetes	No
F	66.4	Non-Native	Other	Blood	Osteomyelitis	Immunosuppressive treatment	No
F	66.5	AK Native	Anchorage	Blood	Bacteremia	None	Yes
M	68.3	Non-Native	Anchorage	Blood	Cellulitis, osteomyelitis	Diabetes	Yes
M	79.3	Non-Native	Anchorage	Blood	Pneumonia	None	No
F	81.7	Non-Native	Anchorage	Blood	Pneumonia	None	Yes
M	83	Non-Native	Anchorage	Blood	Pneumonia	None	Yes
F	85.1	Non-Native	Anchorage	Blood	Other	Diabetes	Yes
M	88.1	Non-Native	Anchorage	Blood	Cellulitis	Chronic lung disease, diabetes	Yes

References

[1] State of Alaska, Department of Labor & Workforce Development. Retrieved 4/9/2010 from http://almis.labor.state.ak.us

[2] Centers for Disease Control and Prevention. 2010. Active Bacterial Core Surveillance Report, Emerging Infections Program Network, *Streptococcus pneumoniae*, 2009.

[3] Hennessy TW, Singleton RJ, Bulkow LR, Bruden DL, Hurlburt DA, Parks, D, Moore M, Parkinson AJ, Schuchat A, Butler JC. Impact of heptavalent pneumococcal conjugate vaccine on invasive disease; antimicrobial resistance and colonization in Alaska Natives: progress towards elimination of a health disparity. *Vaccine* 2005;23:5464-73.

[4] Singleton RJ, Hennessy TW, Bulkow LR, Hammitt LL, Zulz T, Hurlburt DA, Butler JC, Rudolph K, Parkinson A. Invasive pneumococcal disease caused by nonvaccine serotypes among Alaska Native children with high levels of 7-valent pneumococcal conjugate vaccine coverage. JAMA 2007;297(16):1784-92.

[5] Wenger JD, Zulz T, Bruden D, Singleton R, Bruce MG, Bulkow L, Parks D, Rudolph K, Hurlburt D, Ritter T, Klejka J, Hennessy T. Invasive pneumococcal disease in Alaskan children: impact of the seven-valent pneumococcal conjugate vaccine and the role of water supply. *Pediatr Infect Dis J* 2010;29: 251-256.

[6] State of Alaska, Department of Health & Human Services. Retrieved 3/17/11 from http://www.epi.hss.state.ak.us/bulletins/docs/b2009_24.pdf

[7] Clinical and Laboratory Standards Institute (CLSI). *Performance Standards for Antimicrobial Susceptibility Testing; Nineteenth Informational Supplement.* 2009; 29(3): M100-S19. p.21.

[8] Centers for Disease Control and Prevention. 2010. Active Bacterial Core Surveillance Report, Emerging Infections Program Network, *Haemophilus influenzae*, 2009.

[9] Centers for Disease Control and Prevention. 2010. Active Bacterial Core Surveillance Report, Emerging Infections Program Network, *Neisseria meningitidis*, 2009.

[10]Centers for Disease Control and Prevention. 2010. Active Bacterial Core Surveillance Report, Emerging Infections Program Network, Group A *Streptococcus*, 2009.

[11] Centers for Disease Control and Prevention. 2010. Active Bacterial Core Surveillance Report, Emerging Infections Program Network, Group B *Streptococcus*, 2009.

Appendix

MIC Interpretive Standards Definitions:

CLSI [5] provides recommended interpretive categories for various Minimum Inhibitory Concentration values (cut points) for each organism/antibiotic combination which are defined as follows:

1. Susceptible (S):

The "susceptible" category implies that isolates are inhibited by the usually achievable concentrations of antimicrobial agent when the recommended dosage is used for the site of infection.

2. Intermediate (I):

The "intermediate" category includes isolates with antimicrobial agent MICs that approach usually attainable blood and tissue levels and for which response rates may be lower than for susceptible isolates. The "intermediate" category implies clinical efficacy applicability in body sites where the drugs are physiologically concentrated (e.g., quinolones and β-lactams in urine) or when a higher dosage of a drug can be used (e.g., β-lactams). The "intermediate" category also includes a buffer zone which should prevent small, uncontrolled technical factors from causing major discrepancies in interpretations, especially for drugs with narrow pharmacotoxicity margins.

3. Resistant (R):

Resistant strains are not inhibited by the usually achievable concentrations of the agent with normal dosage schedules, and/or that demonstrate MICs or zone diameters that fall in the range where specific microbial resistance mechanisms are likely (e.g., β-lactamases) are likely, and clinical efficacy of the agent against the isolate has not been reliably shown in treatment studies.