



## **International Circumpolar Surveillance (ICS): Prevention and Control of Infectious Diseases**

Biannual Report - Arctic Council Ministerial Meeting,  
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Ongoing circumpolar surveillance of invasive infectious diseases caused by:

*Streptococcus pneumoniae*

*Haemophilus influenzae*

*Neisseria meningitidis*

Group A Streptococcus

Group B Streptococcus

Period of data collection 1999-2004

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## Abstract

**PROJECT: INTERNATIONAL CIRCUMPOLAR SURVEILLANCE: PREVENTION AND CONTROL OF INFECTIOUS DISEASES.** Region: Circumpolar Project. Period: 1999-2006. Lead Country/Permanent Participant: United States. Leader: Dr. Alan Parkinson, Arctic Investigations Program, National Center for Infectious Diseases Center for Disease Control & Prevention, 4055 Tudor Centre Drive, Anchorage, Alaska 99508 USA, +907-729-3407, fax +907-729-3429, email: [ajpl@cdc.gov](mailto:ajpl@cdc.gov). Arctic Council Participation: United States, Canada, Denmark/Greenland, Iceland, Norway, Sweden, Finland, Russian Federation. Implementing Agency: US Centers for Disease Control and Prevention, Atlanta, Georgia. The goal of this project is to establish an integrated International Circumpolar Surveillance (ICS) network linking hospitals and public health laboratories throughout the Arctic for the purpose of monitoring emerging and reemerging infectious disease problems within Arctic communities, and assist in the formulation of preventive strategies. The plan is to establish population based surveillance of diseases of most concern to residents of Arctic countries, to determine the rates of disease, populations at greatest risk, and the most effective preventive strategies. ICS was established for invasive pneumococcal disease in the U.S. Arctic (Alaska) and northern Canada (1999), Greenland, Iceland, Norway, and Finland (2000), and Sweden (2003). Surveillance for other invasive bacterial diseases (i.e., those caused by *Haemophilus influenzae*, *Neisseria meningitidis*, groups A & B streptococcus) was initiated for the North American Arctic in 2000 and will be implemented in other Arctic countries in subsequent years. The surveillance of other diseases such as tuberculosis, HIV/AIDS, and hepatitis as well as infectious diseases that may emerge as a consequence of climate change can be added to ICS as the need and support arise.

## Acknowledgements

ICS is a collaboration between the following organizations:

CDC's Arctic Investigations Program, Anchorage, Alaska  
Health Canada's Centre for Infectious Disease Control, Ottawa, Ontario  
Health Departments of the Yukon Territory, Northwest Territories, Nunavut, Nunavik, and Labrador  
National Centre for Streptococcus, Provincial Laboratory of Public Health, Edmonton Alberta  
Laboratoire de Sante Publique du Quebec, Montreal, Quebec  
National Centre for Meningococcus Provincial Laboratory of Public Health, Winnipeg, Manitoba  
Office of the Medical Officer of Health, Nuuk, Greenland  
Department of Microbiology, Landspítali University Hospital, Reykjavik, Iceland  
Norwegian Institute for Public Health, Oslo, Norway  
National Public Health Institute, Helsinki, Finland  
National Public Health Laboratory, Oulu, Finland  
Department of Microbacteriology, Sunderby Hospital, Lulea, Sweden  
Statens Serum Institute, Copenhagen, Denmark  
State Sanitary Epidemiology Surveillance Centre, Arkhangelsk, Russian Federation

(The individual laboratories that contribute data to the ICS network are listed in Appendix A).

## Summary

Human health is a critical component of any sustainable development program. Sustainable economic development is frequently accompanied by changes in a number of factors, which impact human health and promote the emergence of infectious disease problems. With increased air travel and international trade Arctic communities are no longer isolated from infectious disease threats. Circumpolar surveillance of infectious diseases may serve as an early warning system of emerging threats and provide increased capacity to monitor the effectiveness of public health control measures.

The purpose of this project is to establish an integrated International Circumpolar Surveillance (ICS) system for infectious diseases by creating a network of hospital and public health laboratories throughout the Arctic. The network would allow collection and sharing of uniform laboratory and epidemiologic data between Arctic countries that will describe the prevalence of infectious diseases of concern to Arctic residents and assist in the formulation of prevention and control strategies.

The ICS network was established in 1999, first linking clinical and public health laboratories in the U.S. Arctic (Alaska), and northern Canada for the surveillance of invasive diseases caused by *Streptococcus pneumoniae*. Greenland, joined the pneumococcal surveillance network in 2000, followed by Iceland, Norway and Finland in 2001, and the northern Swedish country of Norbotten in 2003. In 2000, expanded surveillance of other invasive bacterial diseases caused by *Haemophilus influenzae*,

*Neisseria meningitidis*, and groups A and B streptococcus was implemented in the U.S. Arctic and northern Canada; Greenland began expanded reporting in 2001 and N. Sweden in 2003. Surveillance of invasive disease caused by these bacteria was chosen because rates of these diseases are elevated in indigenous peoples of the north, strains of these bacteria may acquire antibiotic resistance, these bacteria are routinely cultured in the clinical laboratory, and diseases caused by clinically important serotypes of *Streptococcus pneumoniae*, *Haemophilus influenzae* and *Neisseria meningitidis* are vaccine preventable.

Rates of invasive pneumococcal disease, (commonly pneumonia and bacteremia), for the period 1999-2004 were higher in Alaska Native and northern Canadian Aboriginal populations than in non-Native and non-Aboriginal populations. The highest rates occur in Native and Aboriginal children under the age of two years. Analysis of pneumococcal serotypes causing disease in Arctic north American populations indicates that between 78-84% of invasive pneumococcal disease could potentially be prevented. In the U.S. Arctic (Alaska), statewide use of the infant 7-valent conjugate vaccine began in 2001. Immunization programs using both the 23-valent adult vaccine and the 7-valent conjugate vaccine were begun in two northern Canadian regions in 2002 and have since been initiated in all northern Canadian regions. Continued surveillance of invasive pneumococcal disease in these regions will monitor the impact and effectiveness of these vaccine programs.

Surveillance of invasive diseases caused by *Haemophilus influenzae*, *Neisseria meningitidis*, and groups A and B streptococcus were undertaken in the U.S. Arctic, northern Canada, Greenland and N. Sweden in 2000-2004.

Prior to 1991, rates of invasive *Haemophilus influenzae* type b disease in the U.S. Arctic were among the highest in the world, however since the introduction of conjugate vaccine programs in 1991, the rates of invasive *Haemophilus influenzae* type b disease have declined by 92%. Universal vaccine programs for invasive *Haemophilus influenzae* type b disease began in Canada in 1992 and there have been similar reductions in rates of invasive disease caused by *Haemophilus influenzae* type b. Surveillance in 2000-2004 show that overall rates of *Haemophilus influenzae* type b remain elevated in the U.S. Arctic when compared to the general U.S. population. The most common serotype in northern Canada was serotype a.

Continued surveillance for invasive diseases caused by all serotypes of *Haemophilus influenzae* in Arctic countries is important to be able to monitor the impact of conjugate vaccine programs and to monitor the potential emergence of other serotypes that may replace *Haemophilus influenzae* type b as a major cause of severe diseases in Arctic populations.

Similarly, surveillance of diseases caused by *Neisseria meningitidis* showed that in the U.S. Arctic, the highest rates of disease occurred in Alaska Native children less than two years old (16.7/100,000). Of 33 U.S. Arctic isolates serogrouped, 26 (79%) were serogroup B, and 21 of the 26 (81%) occurred in persons between 2-64 years of age. As in the case of *Streptococcus pneumoniae* and *Haemophilus influenzae*, continued surveillance of invasive diseases caused by *Neisseria meningitidis* allows for the

monitoring of disease trends in populations, the detection of clusters of disease, and provides serogroup information critical for vaccine recommendations.

As the Arctic Council chair, the Russian Federation hosted Arctic Council meetings during 2005-2006. This presented opportunities to explore the possibility of expanded ICS activities to include to northern regions of the Russian Federation. In addition, the International Union for Circumpolar Health held the 13<sup>th</sup> International Congress on Circumpolar Health in Novosibirsk from June 12-16, 2006, allowing further discussion and planning on the International Polar Year and Arctic Human Health Initiative, and the hosting of an ICS working group meeting. Other plans for ICS include the addition of northern Sweden in 2004 as part of the surveillance system for invasive pneumococcal disease, the continued surveillance of invasive diseases caused by *Streptococcus pneumoniae*, *Haemophilus influenza*, *Neisseria meningitidis*, and groups A and B streptococcus in the U.S. Arctic, northern Canada, and Greenland, and expansion in 2005 of the surveillance of diseases caused by *Haemophilus influenza*, *Neisseria meningitidis*, and groups A and B streptococcus to include Iceland, Norway, Finland and northern Sweden. The surveillance of other diseases such as tuberculosis, HIV/AIDS, and hepatitis, as well as those infectious diseases that may emerge as a consequence of climate change can be added to ICS as the need and support arise.

### **ICS Management Team**

The CDC's Arctic Investigations Program coordinates the project. Team members include:

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The ICS web site is located at <http://www.cdc.gov/ncidod/aip/research/ics.html>

### **ICS Steering Committee**

A steering committee has been formed that consists of public health experts with interests in health problems in Arctic populations. Members are drawn from each participating country and from interested permanent participant indigenous people's organizations. The purpose of the steering committee is to guide and review ICS activities, approve reports and publications, and recommend new surveillance activities. Current members are listed in Appendix B.

### **Data Management**

In the U.S. Arctic and northern Canada, laboratory, demographic and clinical data are collected prospectively, while in Greenland, Iceland, Norway, Finland, and northern Sweden summary data are collected in aggregate at the end of the year. All data are

entered into a database maintained at AIP where the data are analyzed and a yearly summary report is produced.

## **Introduction**

Arctic populations have long endured the debilitating effects of both endemic and epidemic infectious diseases, the effects of which have impacted both social and economic development in circumpolar regions of the globe. Because infectious diseases are a global threat, their prevention and control requires a global response. Global surveillance is a critical component of prevention and control of infectious diseases. The International Circumpolar Surveillance (ICS) project was established in 1998 and aims to create an infectious disease surveillance network of hospital and public health laboratories and authorities throughout the Arctic States: the U.S. Arctic (Alaska), northern Canada, Greenland, Iceland, Norway, Finland, Sweden and the northern regions and Oblasts of the Russian Federation. ICS allows for the collection, comparison and sharing of uniform laboratory and epidemiological data on infectious diseases of concern, and assists in the formulation of prevention and control strategies.

Early goals for ICS were to identify collaborators with expertise in infectious disease prevention and control and public health in Arctic regions and to develop political support for the establishment of an international network. These goals were achieved through the engagement of the International Union for Circumpolar Health and the Arctic Council.

The International Union for Circumpolar Health (IUCH) is a union of five circumpolar health organizations. These include: the American Society for Circumpolar Health, the Canadian Society for Circumpolar Health, the Nordic Council for Arctic Medical Research, the Siberian Branch of the Russian Academy of Sciences, Medical Section, and the Danish Greenlandic Society of Circumpolar Health. The objective of the IUCH is to promote international cooperation in circumpolar health. The IUCH sponsors the International Congress on Circumpolar Health, a meeting held every three years. The last meeting was held in Novosibirsk, Russian Federation, June 12-16, 2006. There are currently eight active working groups affiliated with the IUCH. These are: Birth defects, Cancer, Health Surveys, Indigenous Peoples, Injury Prevention, Occupational Safety & Health and Infectious Diseases. ICS is actively engaged in the IUCH Infectious Disease Working group.

The Arctic Council was established in 1996 as a ministerial level forum to provide a means of promoting cooperation and coordination among the Arctic Nations (United States, Canada, Greenland [Denmark], Norway, Sweden, Finland, and Russia) on common Arctic concerns, in particular those of sustainable development and environmental protection. Consultation and participation with indigenous peoples in the Arctic Council is achieved through representation from the Inuit Circumpolar Conference, the Saami Council, the Russian Association of Indigenous Peoples of the North, Aleut International Associations, and the Indigenous Peoples Secretariat as permanent participants of the Arctic Council. The Arctic Council oversees and coordinates programs formally established in 1989 under the Arctic Environmental Strategy which include: Arctic Monitoring and Assessment Program (AMAP), Protection

of Arctic Marine Environment, Conservation of Arctic Flora and Fauna, Emergency, Prevention, and Preparedness and Response, and Sustainable Development and Utilization (SDU).

Human health activities currently reside in the AMAP and the SDU working groups. The International Circumpolar Surveillance Prevention and Control of Emerging Infectious Diseases program was endorsed as a project within the Sustainable Development and Utilization working group in 2000.

The Arctic Council provides access to governmental, non-governmental and indigenous peoples organizations important for improving human health in Arctic regions, as well as to other multi-national economic cooperatives with interests in multinational infectious disease prevention and control (i.e., International Union for Circumpolar Health, Council of Nordic Ministers, European Union's Northern Dimension, Council of Baltic State Ministers).

The increasing role of the Arctic Council in addressing public health issues provides a unique opportunity to partner with Arctic nation ministries of health, non-governmental organizations and indigenous peoples organizations to address health concerns of circumpolar communities.

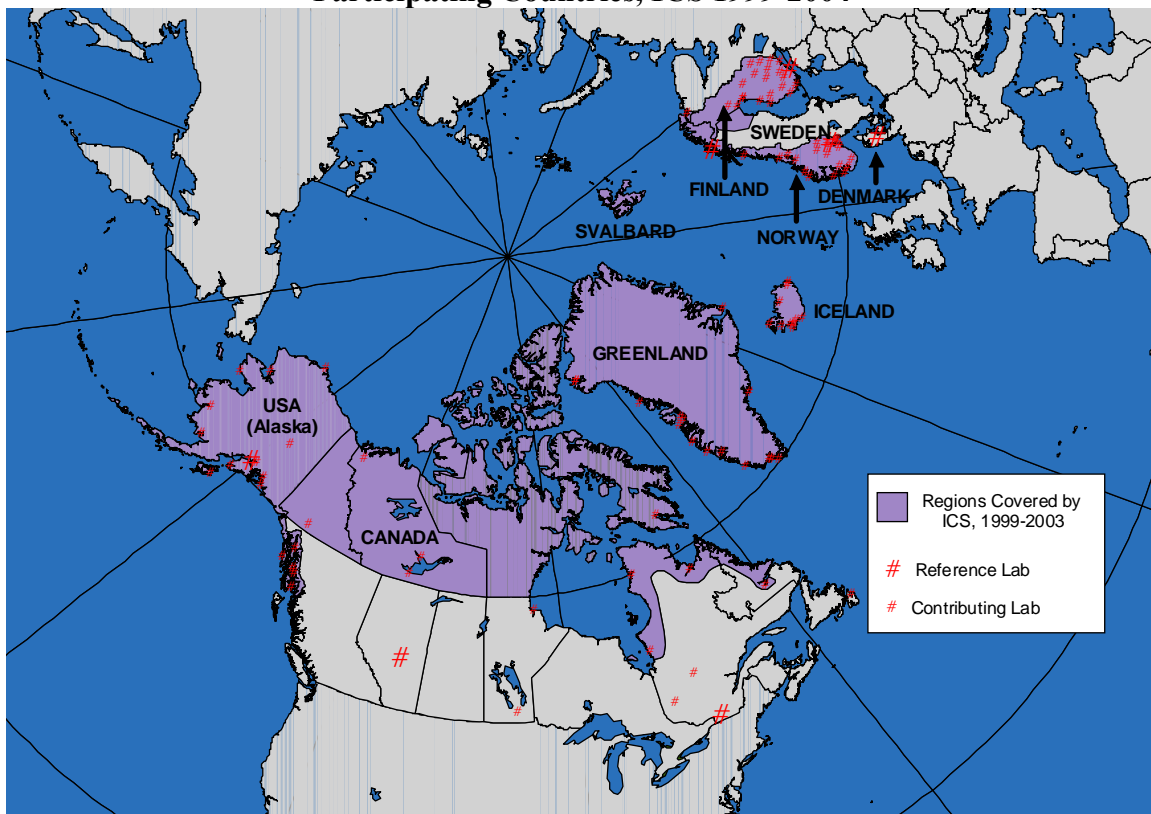
ICS is currently coordinated by the CDC's Arctic Investigations Program (AIP) based in Anchorage, Alaska. The goal of the project is to establish an integrated network of hospital and public health facilities throughout the Arctic countries to monitor infectious diseases of concern. The priorities and overall direction of ICS are currently governed by an international Steering Committee consisting of two representatives from each participating country and representation from interested indigenous peoples' organizations. Individual projects are managed by working groups that focus on a specific disease or group of diseases or condition(s) under surveillance. The invasive bacterial disease working group manages the surveillance of invasive bacterial diseases caused by *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Neisseria meningitidis*, and groups A and B streptococcus. These pathogens were selected for ICS because rates of these diseases are elevated in indigenous peoples of the north, strains of these pathogens are rapidly acquiring resistance to commonly used antibiotics, these pathogens are routinely cultured in the clinical laboratory, and clinically important serotypes of *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Neisseria meningitidis* are vaccine preventable in infants and adults. While no vaccines are currently available for diseases caused by groups A and B streptococcus, detection is important for possible outbreaks and to assess the effectiveness of control measures.

### **The Network**

Beginning in 1999, isolates of *Streptococcus pneumoniae* recovered from patients with invasive disease were collected from 23 clinical laboratories in Alaska and 14 clinical laboratories in northern Canada. The isolates were forwarded to reference laboratories in the U.S. Arctic and Alberta or Quebec, respectively. The reference laboratories performed serotyping and antimicrobial susceptibility testing and established a quality control program for *Streptococcus pneumoniae*. Identified cases were also reported to

local public health personnel who reviewed and provided clinical, demographic, and immunization history. Case and culture information was forwarded to the ICS coordinator at Arctic Investigations Program for analysis, report generation and dissemination. In 2000, Greenland joined ICS. Pneumococcal isolates from patients with invasive disease were forwarded from 15 district hospitals to reference laboratories in Nuuk, Greenland, and Copenhagen, Denmark, for serotyping and susceptibility testing. Iceland, Norway and Finland joined ICS in 2001. In Iceland, 10 district hospitals participated and forwarded isolates to a reference laboratory in Reykjavik. Case reports are forwarded to AIP annually. Pneumococcal isolates from 33 district hospitals in Norway are sent to reference laboratories in Oslo or Tromso for serotyping and susceptibility testing, and, in Finland, pneumococcal isolates from patients with invasive disease are forwarded to reference laboratories in Oulu. In Norbotten, Sweden, data is collected at the Department of Microbacteriology, Sunderby Hospital, Lulea; serotyping is performed at the Swedish Institute for Infectious Disease Control in Stockholm. Surveillance of other invasive bacterial diseases (*Haemophilus influenzae*, *Neisseria meningitidis*, groups A & B streptococcus) in the U.S. Arctic, northern Canada and Greenland was added to ICS in 2000; Sweden has also provided data on these organisms since 2003.

**Participating Countries, ICS 1999-2004**





# ***Streptococcus pneumoniae***

## **Introduction**

*Streptococcus pneumoniae* is a leading cause of disease and death worldwide. In the U.S., it is the most common cause of meningitis, community acquired pneumonia, acute otitis media and sinusitis. The emergence and spread of drug-resistant strains of pneumococcus have complicated treatment of these common infections. Higher levels of resistance to penicillin ( $MIC \geq 4$  ug/ml) may increase the risk of death among persons with bacteremic pneumonia. Among the indigenous peoples of the U.S. Arctic, the rate of invasive pneumococcal disease is among the highest in the world and the age-adjusted rate is 2.5 times that for non-indigenous people. The prevalence of drug-resistant pneumococcal isolates recovered from persons with invasive disease has steadily increased and now more than 10% of isolates have reduced susceptibility to commonly used antibiotics. While there are more than 90 different serotypes of *Streptococcus pneumoniae*, most pneumococcal disease is potentially preventable through the use of the 23-valent pneumococcal polysaccharide vaccine in adults and the 7-valent conjugate vaccine for use in children less than two years of age.

## **Methods**

Isolates of invasive *Streptococcus pneumoniae* are sent to reference laboratories for confirmation, serotyping and antimicrobial susceptibility testing. Clinical and demographic data are collected on a standardized form. In the U.S. Arctic and northern Canada, reports are sent to the ICS coordinator at AIP. In Greenland, Iceland, Norway, Finland, and N. Sweden, aggregated data is sent to AIP once a year.

In the U.S. Arctic and northern Canada, susceptibility testing is conducted by micro broth dilution method according to NCCLS recommendations. In Finland and Greenland, testing is conducted by agar dilution and, in Iceland, Norway, and N. Sweden, disc diffusion methods are used. In the U.S. Arctic, northern Canada, Greenland, Norway, and N. Sweden, serotyping was performed by the Quellung method using antisera from Statens Serum Institute in Copenhagen, Denmark. Laboratories in Iceland performed serotyping using co-agglutination with Statens Serum Institute antisera. In Finland, serotyping was performed using counterimmunoelectrophoresis.

## **Results and Discussion**

A total of 9,254 *Streptococcus pneumoniae* cases were reported to ICS during the period 1999-2004. Cases were reported beginning in 1999 in the U.S. Arctic and northern Canada; Finland, Greenland, Iceland, and Norway began reporting in 2000; N. Sweden began reporting in 2003. A summary of the case demographics are presented in the following table.

***Streptococcus pneumoniae* Case Demographics, ICS 1999-2004\* Data**

Country	# Cases (rate†)	Sex M (%)	Age Range (Median)	< 2 yrs n (rate†)	2-64 yrs n (rate†)	65+ yrs n (rate†)	# Deaths (CFR‡)
Finland	3,314 (13)	1,870 (56)	0-100 (54)	294 (50)	1,971 (9)	1,049 (26)	<sup>a</sup>
Greenland	52 (18)	29 (56)	0-64 (44)	8 (88)	44 (17)	0 (0)	9 (17)
Iceland	236 (16)	121 (51)	0-98 (53)	37 (88)	107 (9)	92 (55)	30 (13)
N. Canada	228 (29)	134 (59)	0-83 (30)	44 (148)	161 (23)	23 (73)	10 (4)
N. Sweden	65 (13)	31 (48)	0.8-99 (70)	2 (21)	27 (7)	36 (38)	<sup>a</sup>
Norway	4,712 (21)	2,349 (50)	0-99 (63)	268 (43)	2,194 (12)	2,250 (66)	348 (7)
U.S. Arctic	647 (17)	354 (55)	0-100 (42)	133 (109)	403 (12)	111 (48)	84 (13)

\*N. Canada and U.S. Arctic began data collection in 1999, the remaining countries in 2000 (excepting Sweden which began in 2003)

†Cases per 100,000 population per year

‡Case fatality ratio

<sup>a</sup>Finland and N. Sweden did not report outcome data

Two countries, northern Canada and the U.S. Arctic, reported racial data. Rates of invasive pneumococcal disease for the period 1999-2004 were higher in Alaska Native (42/100,000) and northern Canadian Aboriginal (39/100,000) populations than in non-Native (11/100,000) and non-Aboriginal (10/100,000) populations. Alaska Natives and northern Canadian Aboriginals have consistently higher rates of disease in all age categories than non-Natives and non-Aboriginals. The highest rates occur in Native and Aboriginal children under the age of two years, 231/100,000 and 183/100,000 respectively, compared with non-Native and non-Aboriginal rates of 56/100,000 and 43/100,000, respectively.

The most prevalent pneumococcal serotypes reported by ICS countries during the period 1999-2004 were 1 (6%), 2 (8%) and 3 (12%). All three serotypes are included in the 23-valent pneumococcal polysaccharide vaccine. Serotypes were not reported by Norway.

Pneumococcal susceptibility to penicillin was reported from the U.S. Arctic and northern Canada for 1999-2004, from Greenland, Iceland and Finland for 2001-2004, and from N. Sweden for 2003-2004. The U.S. Arctic reported that 6% of pneumococcal isolates were fully resistant to penicillin, compared with 3% from northern Canada, and < 1% of isolates from Greenland, Iceland, Finland, and N. Sweden were fully resistant to penicillin.

**Proportion of Vaccine Preventable Cases from Invasive Pneumococcal Disease, ICS 1999-2004 Data**

	Finland n/Denom* (%)	Greenland n/Denom* (%)	Iceland n/Denom* (%)	N. Canada n/Denom* (%)	U.S. Arctic n/Denom* (%)
Cases ≥ 2 years old with serotype in the 23-valent pneumococcal polysaccharide vaccine	2,026/2,319 (87)	35/39 (90)	84/95 (88)	165/178 (93)	384/442 (87)
Cases < 2 years old with serotype in the 7-valent pneumococcal conjugate vaccine	116/182 (64)	3/6 (50)	16/19 (84)	25/40 (63)	66/122 (54)

\*Number of isolates serotyped by country by age group

For the countries reporting serotype data, 87-93% of pneumococcal cases in persons ≥ 2 years of age were preventable with use of the 23-valent polysaccharide vaccine. Use of

the 7-valent conjugate vaccine would have potentially prevented 50-84% of pneumococcal cases in children < 2 years of age during the period 1999-2004.

Analysis of pneumococcal serotypes causing disease in North American arctic populations indicates that more than 61% of invasive pneumococcal disease in children less than 2 years old could potentially be prevented. In Alaska, statewide use of the infant 7-valent conjugate vaccine began in 2001. Immunization programs using the 7-valent conjugate vaccine were initiated in all northern Canadian regions by 2006. Prior to the initiation of 7-valent conjugate vaccine programs in the U.S. Arctic and northern Canada, the proportion of preventable pneumococcal disease in children less than 2 years old in each region was 84% and 78%, respectively. Continued surveillance of invasive pneumococcal disease in these regions will monitor the impact and effectiveness of these vaccine programs for both preventing invasive pneumococcal disease and reducing the proportion of isolates from patients that are resistant to antibiotics.

## ***Haemophilus influenzae***

### **Introduction**

*Haemophilus influenzae* causes a wide variety of diseases ranging from upper respiratory tract illness such as conjunctivitis, otitis media, and sinusitis, to lower respiratory tract diseases (epiglottitis, pneumonia and empyema), to invasive disease outside the respiratory tract (meningitis, pneumonia, septic arthritis). There are 6 different serotypes (a-f) of *Haemophilus influenzae*. *Haemophilus influenzae* type b was the most common cause of childhood meningitis in the United States prior to the introduction of childhood conjugate vaccines in 1991. The incidence of invasive *Haemophilus influenzae* type b disease has declined by over 90% in countries where the vaccine is widely used.

### **Methods**

Data for cases of invasive *Haemophilus influenzae* (all serotypes) are collected in N. Sweden (since 2003), Greenland (since 2001), northern Canada and the U.S. Arctic (both since 2000). Isolates of invasive *Haemophilus influenzae* are sent to reference laboratories for confirmation and serotyping. Clinical and demographic data are collected on a standardized form. In the U.S. Arctic and northern Canada, reports are sent to the ICS coordinator at AIP. In Greenland and N. Sweden, aggregated data is sent to AIP once a year. In the U.S. Arctic, northern Canada, and Greenland, serotyping was performed by the latex agglutination method using commercial antisera. N. Sweden did not provide serotype data.

### **Results and Discussion**

A total of 136 invasive *Haemophilus influenzae* cases were reported to ICS during the years 2000-2004. Greenland did not report any occurrences of invasive *Haemophilus influenzae* disease during this period. Demographics of the cases reported by northern Canada, N. Sweden, and the U.S. Arctic are presented in the following table.

### ***Haemophilus influenzae* Case Demographics, ICS 2000-2004 Data**

<b>Country</b>	<b># Cases (rate*)</b>	<b>Sex M (%)</b>	<b>Age Range (Median)</b>	<b>&lt; 2 yrs n (rate*)</b>	<b>2-64 yrs n (rate*)</b>	<b>65+ yrs n (rate*)</b>	<b># Deaths (CFR†)</b>
N. Canada	51 (8)	28 (55)	0.1-93 (1)	32 (129)	15 (3)	4 (15)	2 (4)
N. Sweden	3 (1)	3 (100)	24-87 (37)	0 (0)	2 (0.5)	1 (1)	‡
U.S. Arctic	82 (3)	39 (48)	0-91 (34)	28 (28)	33 (1)	21 (11)	14 (17)

\*Cases per 100,000 population per year

†Case fatality ratio

‡Outcomes not reported by N. Sweden

The highest rates of invasive *Haemophilus influenzae* disease occurred in Alaska Native and northern Canadian aboriginal children less than two years old, 77 cases per 100,000 and 154 cases per 100,000 respectively. The most common clinical presentations were pneumonia in the U.S. Arctic (44%) and meningitis in northern Canada (33%).

The most common serotype in northern Canada was serotype a, which comprised 54% of isolates serotyped. In the U.S. Arctic, serotype b remains the most common serotype and accounted for 30% of serotyped isolates.

Prior to 1991, rates of invasive *Haemophilus influenzae* type b disease in the U.S. Arctic were among the highest in the world, however, since the introduction of conjugate vaccine programs in 1991, the rates of invasive *Haemophilus influenzae* type b disease have declined by 92%. Universal vaccine programs for invasive *Haemophilus influenzae* type b disease began in Canada in 1992 and they have experienced a similar decline in rates of invasive disease caused by *Haemophilus influenzae* type b.

Continued surveillance for invasive diseases caused by all serotypes of *Haemophilus influenzae* in Arctic countries is important to be able to monitor the impact of conjugate vaccine programs and to monitor the potential emergence of other serotypes that may replace *Haemophilus influenzae* type b as a cause of severe diseases in these populations.

## ***Neisseria meningitidis***

### **Introduction**

*Neisseria meningitidis* is a leading cause of bacterial meningitis in many parts of the world. The greatest incidence occurs in winter and spring; epidemics occur irregularly. Meningococcal disease is primarily a disease of young children, but epidemics can occur in newly aggregated young adults, such as new military recruits and collage students. There are 7 serogroups (A,B,C,Y,W-135). Groups B and C are responsible for most cases in the U.S. Group A is common in Africa, Nepal, and India, whereas group B is common in South America. Group C has been responsible for community outbreaks in both the U.S. and Canada. Vaccines containing Groups A, C, Y and W-135 meningococcal polysaccharides are available and a new Group B conjugate vaccine is now being used.

## Methods

Data for cases of invasive *Neisseria meningitidis* are collected in N. Sweden (since 2003), Greenland (since 2001), northern Canada and the U.S. Arctic (both since 2000). Isolates of invasive *Neisseria meningitidis* are sent to reference laboratories for confirmation and serogrouping. Clinical and demographic data are collected on a standardized form. In the U.S. Arctic and northern Canada, reports are sent to the ICS coordinator at AIP. In Greenland and N. Sweden, aggregated data is sent to AIP once a year.

Serogroup testing of *Neisseria meningitidis* isolates from Alaska is performed at the Canadian National Centre for Meningococcal Disease in the CNS Infections Laboratory in Winnipeg.

## Results and Discussion

A total of 53 invasive *Neisseria meningitidis* cases were reported to ICS from the U.S. Arctic, northern Canada, northern Sweden, and Greenland for the period 2000-2004. Case demographics are presented in the following table.

### *Neisseria meningitidis* Case Demographics, ICS 2000-2004 Data

Country	# Cases (rate*)	Sex M (%)	Age Range (Median)	< 2 yrs n (rate*)	2-64 yrs n (rate*)	65+ yrs n (rate*)	# Deaths (CFR†)
Greenland	8	5 (63)	1-41 (9)	3	4	1	0
N. Canada	4	1 (25)	0.3-16 (1)	3	1	0	1
N. Sweden	1	1 (100)	1 case (0.3)	1	0	0	‡
U.S. Arctic	40	24 (60)	0.2-90 (14)	6	32	2	5

\*Cases per 100,000 population per year

†Case fatality ratio

‡Outcomes not reported by N. Sweden

In N. Canada, the rate of disease was higher in non-Aboriginal children (17.2/100,000) than Aboriginal children (11/100,000). In the U.S. Arctic, the highest rates of disease occurred in Alaska Native children less than two years old (16.7/100,000). Of 33 U.S. Arctic isolates serogrouped, 26 (79%) were serogroup B, and 21 of the 26 (81%) occurred in persons between 2-64 years of age.

The most common clinical presentation of *Neisseria meningitidis* cases in all countries was meningitis, reported for all cases in N. Canada and N. Sweden, 88% of cases in Greenland, and 55% of cases in the U.S. Arctic.

Surveillance of invasive diseases caused by *Neisseria meningitidis* not only allows for the detection of clusters of disease but also provides serogroup information critical for vaccine recommendations.

# Group A Streptococcus

## Introduction

Illnesses caused by group A streptococcus (*Streptococcus pyogenes*) ranges from mild strep throat and skin infections such as impetigo, to more severe and sometimes life threatening diseases such as necrotizing fasciitis (“flesh eating disease”) and streptococcal toxic shock syndrome. About 20% of patients with necrotizing fasciitis and more than 50% with streptococcal toxic shock syndrome die. About 10-15% of patients with other forms of invasive streptococcal diseases die. About 9,000 cases of invasive Group A streptococcal disease occur annually in the U.S. Of these, about 300 were streptococcal toxic shock syndrome and 600 were necrotizing fasciitis. In contrast, several million cases of strep throat and impetigo occur each year. Although healthy people can get invasive Group A streptococcal disease, people with chronic illnesses like cancer, diabetes, and dialysis and those who use immunosuppressive medications such as steroids are at higher risk. Outbreaks occur in which one form of clinical presentation predominates. Group A streptococcal infections are treated with antibiotics. Early treatment may reduce the risk of death. For those with severe illness, supportive care in intensive care unit may be needed. For those with necrotizing fasciitis, surgery often is needed. There is no vaccine for group A streptococcal infections. There are more than 80 serotypes of group A streptococcus. The distribution of serotypes varies greatly temporally, geographically, and by disease presentation.

## Methods

Data for cases of invasive group A streptococcus are collected in N. Sweden (since 2003), Greenland (since 2001), northern Canada and the U.S. Arctic (both since 2000). Isolates of invasive group A streptococcus are sent to reference laboratories for confirmation. Clinical and demographic data are collected on a standardized form. In the U.S. Arctic and northern Canada, reports are sent to the ICS coordinator at AIP. In Greenland and N. Sweden, aggregated data is sent to AIP once a year.

## Results and Discussion

A total of 186 invasive group A streptococcus cases were reported to ICS during the period 2000-2004. Case demographics are presented in the following table.

**Group A Streptococcus Case Demographics, ICS 2000-2004 Data**

Country	# Cases (rate*)	Sex M (%)	Age Range (Median)	< 2 yrs n (rate*)	2-64 yrs n (rate*)	65+ yrs n (rate*)	# Deaths (CFR†)
Greenland	1 (0.4)	1 (100)	1 case – 64	0 (0)	1 (0.5)	0 (0)	1 (100)
N. Canada	31 (5)	20 (65)	0.1-76 (33)	9 (36)	17 (3)	5 (19)	7 (23)
N. Sweden	6 (1)	2 (33)	63-91 (67)	0 (0)	1 (0.2)	5 (5)	‡
U.S. Arctic	148 (5)	80 (54)	0.1-93 (43)	11 (11)	111 (4)	26 (14)	17 (11)

\*Cases per 100,000 population per year

†Case fatality ratio

‡Outcomes not reported by N. Sweden

Eighty-four percent of all reported GAS cases in northern Canada occurred in Aborigines; the highest rates of disease were in children less than two years old (49.4/100,000). In the U.S. Arctic, the highest rates of disease also occurred in Alaska Native children less than two years old (33.4/100,000).

The most common group A streptococcus clinical presentation in northern Canada and the U.S. Arctic was cellulitis, occurring in 32% and 36% of cases respectively. In N. Sweden, the most common clinical presentation was bacteremia (83% of cases). The one case reported in Greenland presented with meningitis.

## Group B Streptococcus

### Introduction

Group B streptococcus (*Streptococcus agalactiae*) causes sepsis, pneumonia and meningitis. In adults, group B streptococcus causes sepsis and soft tissue infections and pregnancy-related infections such as sepsis, amnionitis, urinary tract infections and stillbirth. This pathogen emerged in the 1970s as the most common cause of sepsis in newborns. Prevention includes universal screening of all pregnant women at 35-37 weeks gestation for carriage of group B streptococcus and treatment using antibiotics. Early onset disease has declined by 70% in the U.S. since the early 1990's when screening programs were first introduced.

### Methods

Data for cases of invasive group B streptococcus are collected in N. Sweden (since 2003), Greenland (since 2001), N. Canada and the U.S. Arctic (both since 2000). Isolates of invasive group B streptococcus are sent to reference laboratories for confirmation. Clinical and demographic data are collected on a standardized form. In the U.S. Arctic and northern Canada, reports are sent to the ICS coordinator at AIP. In Greenland and N. Sweden, aggregated data is sent to AIP once a year.

### Results and Discussion

A total of 157 invasive group B streptococcus cases were reported to ICS during the period 2000-2004. Case demographics are presented in the following table.

**Group B Streptococcus Case Demographics, ICS 2000-2004 Data**

Country	# Cases (rate*)	Sex M (%)	Age Range (Median)	< 2 yrs n (rate*)	2-64 yrs n (rate*)	65+ yrs n (rate*)	# Deaths (CFR†)
Greenland	3 (1)	2 (67)	61-84 (67)	0 (0)	1 (0.5)	2 (17)	2 (67)
N. Canada	16 (2)	4 (25)	0-67 (33)	4 (16)	11 (2)	1 (4)	1 (6)
N. Sweden	17 (3)	6 (35)	0-84 (62)	5 (53)	4 (1)	8 (8)	‡
U.S. Arctic	121 (4)	66 (55)	0-90 (48)	34 (34)	61 (2)	26 (14)	12 (10)

\*Cases per 100,000 population per year

†Case fatality ratio

‡Outcomes not reported by N. Sweden

The highest rates of invasive group B streptococcal disease occurred in children less than two years old in northern Sweden (53/100,000) and the U.S. Arctic non-Native population (36.2/100,000).

The most commonly reported clinical presentations for group B streptococcal cases was septicemia in 38% of cases in northern Canada, 67% of cases in Greenland and 36% of cases in the U.S. Arctic and bacteremia in 100% of cases in N. Sweden.

Continued surveillance is important to be able to monitor disease rates and impact of intervention programs as well as potential adverse consequences (such as the emergence of antibiotic resistance) of using antibiotics as a prevention strategy.

### **Future plans, 2007-2008**

ICS plans to continue surveillance of invasive bacterial diseases in the US Arctic, northern Canada, Greenland, Iceland, Norway, Finland and Sweden, and in 2007-2008.

The International Polar Year will create opportunities to expand ICS activities under the Arctic Human Health Initiative. Specific goals include:

The establishment of circumpolar surveillance systems for tuberculosis.

The Russian Chairmanship of the Arctic Council through 2006, and the triennial meeting of the International Union for Circumpolar Health to be held in Novosibirsk in June of 2006 both presented the opportunity to further expand ICS activities to include northern regions of the Russian Federation. In 2007 activities will include the planning and chairing an Infectious Disease Working Group meeting with Russian infectious disease experts from northern and far eastern regions of the Russian Federation. This meeting will be conducted in collaboration with the Northern Forum, the WHO, the International Union for Circumpolar Health and the Norwegian Institute for Public Health. The objective of this meeting is to establish partnerships within the Sanitary Surveillance and Epidemiology Centers in the Barents Sea and Far East regions of the Russian Federation and to begin sharing surveillance information on diseases of concern such as tuberculosis, and Hepatitis b.

ICS will explore options for establishing an ICS International Fellowship program at the CDC's Arctic Investigations Program for 2007-2008. The International Fellow would receive training in infectious disease surveillance, epidemiology and laboratory methods, and assist in the expansion of the ICS network.

It is also likely that climate change will have an impact on the prevalence of climate sensitive infectious diseases in Arctic regions. Ambient temperature increases in Arctic regions may result in the northerly expansion of mosquito borne diseases such as those caused by West Nile or other arboviruses. It is possible that as the ambient temperature increases, we may see the prevalence of such diseases as botulism, hepatitis, paralytic shellfish poisoning, tularemia, brucellosis, echinococcus, and trichinosis increase. Establishing circumpolar surveillance systems within ICS for the early detection of



climate sensitive infectious diseases will allow timely implementation of prevention and control measures.

## Appendix A – ICS Participating Laboratories

### FINLAND

<b>Reference Laboratory</b>	National Public Health Institute (KTL) Laboratory, Oulu
<b>Laboratories</b>	Et.-Pohjanmaan sh-piiri, Seinäjoen sairaalan mikrobiol. lab. Etelä-Karjalan keskussairaalan kl.mikrobiologian laboratorio HY – Serobakteriologian laitos Jorvin sairaala, kliinisen mikrobiologian laboratorio KYS – Mikrobiologian laboratorio Kainuun keskussairaalan mikrobiologian laboratorio Kanta-Hämeen keskussairaalan mikrobiologian laboratorio Keski-Pohjanmaan keskussairaalan mikrobiologian laboratorio Keski-Suomen keskussairaalan mikrobiologian laboratorio Kymenlaakson keskussairaalan mikrobiologian laboratorio Lapin keskussairaalan mikrobiologian laboratorio Länsi-Pohjan keskussairaalan laboratorio Mikkelin keskussairaalan mikrobiologian laboratorio OYKS – Mikrobiologian laboratorio Oulun kiakonissalairoksen laboratorio Pohjois-Karjalan keskussairaalan mikrobiologian laboratorio Päijät-Hämeen keskussairaalan mikrobiologian laboratorio Rauman aluesairaalan laboratorio Satakunnan keskussairaalan mikrobiologian laboratorio Savonlinnan keskussairaalan laboratorio TAYS – Mikrobiologian laboratorio TYKS – Mikrobiologian laboratorio Vaasan keskussairaalan mikrobiologian laboratorio

### GREENLAND

<b>Reference Laboratories</b>	Statens Serum Institute, Copenhagen, Denmark Central lab at Queen Ingrid's Hospital, Nuuk, Greenland
<b>Laboratories</b>	Nanortalik Hospital Qaqortoq Hospital Narsaq Hospital Paamiut Hospital Maniitsoq Hospital Sisimut Hospital Asiaat Hospital Qasigiannugit Hospital Ilulissat Hospital Qeqertarsuaq Hospital Uummannaq Hospital Upernavik Hospital Qaanaaq Hospital Ammassalik Hospital Ittoqqortoormiit Hospital

### ICELAND

<b>Reference Laboratory</b>	Department of Microbiology, Landspítali University Hospital, Reykjavik
<b>Laboratories</b>	Akranes Hospital Isafjordur District Hospital Stykkisholmur Local Health Center St. Joseph's Hospital Hafnarfjorour Municipal Hospital of Vestmannaeyjar Akureyri Egilstadir Health Center Selfoss Health Center Sudurnes Health Center (Keflavik) Regional Hospital Neskaupstadur

### NORTHERN CANADA

<b>Laboratory Centre for Disease Control</b>	Respiratory Division, Bureau of Infectious Diseases, Laboratory Centre for Disease Control, Ottawa
<b>Reference Laboratories</b>	National Centre for Streptococcus, Provincial Laboratory of Public Health, Edmonton, AB Laboratoire de Santé Publique du Québec, Montréal, QC National Centre for Meningococcus, Provincial Laboratory of Public Health, Winnipeg, MB
<b>Laboratories</b>	Whitehorse General Hospital, Whitehorse, YK Stanton Regional Health Board, Yellowknife, NT H.H. Williams Memorial Hospital, Hay River, NT Inuvik Regional Hospital, Inuvik, NT Baffin Regional Hospital, Iqaluit, NU Churchill Regional Health Authority, Churchill, MB Cadam Provincial Laboratory, Winnipeg, MB Ungava Tulattavik Health Centre, Kuujjuaq, QC Inulitsavik Hospital, Puvirnituq, QC Cree Health Board, Chisasibi, QC CSSSR, Chibougamou, QC Val d'Or Hospital, Val d'Or, QC Melville Hospital, Goose Bay, NL Newfoundland Public Health Laboratory, St. John's, NL
<b>Public Health</b>	Yukon Communicable Disease Control, Whitehorse, YK Health Protection Unit, Government of NWT, Yellowknife, NT JA Hildes Northern Medical Unit, Winnipeg, MB Régie Régionale de la Santé et des Services Sociaux, Kuujjuaq, QC Région Cri de la Baie James, Module de Santé Publique, Montreal, QC Communicable Disease Control, Health Laborador Corporation, Goose Bay, NL IMPAct Coordinator, Vaccine Evaluation Centre, Vancouver, BC

### NORTHERN SWEDEN

<b>Reference Laboratory</b>	Swedish Institute for Infectious Disease Control, Stockholm
<b>Laboratories</b>	Department of Microbacteriology, Sunderby Hospital, Lulea Department of Microbiology, University Hospital, Umea

### NORWAY

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**U.S. ARCTIC**

<b>Reference Laboratory</b>	Arctic Investigations Program, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Anchorage, AK
<b>Laboratories</b>	<p>Alaska Native Medical Center, Anchorage, AK          Alaska Regional Hospital, Anchorage, AK          Bartlett Regional Hospital, Juneau, AK          Bassett Army Hospital, Fort Wainwright, AK          Central Peninsula General Hospital, Soldotna, AK          Cordova Community Medical Center, Cordova, AK          Elmendorf Air Force Base Hospital, Anchorage, AK          Fairbanks Memorial Hospital, Fairbanks, AK          Kakanak Hospital, Dillingham, AK          Ketchikan Regional Hospital, Ketchikan, AK          Manilaq Medical Center, Kotzebue, AK          Norton Sound Regional Hospital, Nome, AK          Petersburg Medical Center, Petersburg, AK          Providence Alaska Medical Center, Anchorage, AK          Providence Island Medical Center, Kodiak, AK          Samuel Simmonds Memorial Hospital, Barrow, AK          Sitka Community Hospital, Sitka, AK          South Peninsula Hospital, Homer, AK          Southeast Area Regional Health Corporation, Sitka, AK          State Public Health Laboratory, Division of Public Health, Department of Health and Social Services, Anchorage, AK          Valdez Community Hospital, Valdez, AK          Valley Hospital, Palmer, AK          Wrangell General Hospital, Wrangell, AK          Yukon-Kuskokwim Delta Regional Hospital, Bethel, AK</p>

## **Appendix B – Steering Committee Members**

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## Appendix C – ICS Activities

### 1998

ICS Working Group established consisting of public health representatives from the US Centers for Disease Control & Prevention, the Alaska Native Health Tribal Consortium, the State of Alaska Division of Public Health, Health Canada, Ministry of Health North West Territories, National Center for Streptococcus Edmonton Alberta Canada. This meeting established a list of diseases and conditions of concern to peoples living in Arctic regions. These included: invasive bacterial diseases, tuberculosis, respiratory syncytial virus infections, hepatitis, sexually transmitted diseases, and cancer. A pilot ICS project was established in 1999 to conduct laboratory-based population-based surveillance for invasive pneumococcal disease in the US and northern Canada.

### 2000

#### **Invasive Bacterial Disease Working Group, Toronto, Ontario, Canada, March 9.**

Reviewed invasive pneumococcal disease data collected from the US arctic and northern Canada during the pilot study year (1999), and focused on problems encountered in regard to specimen handling, shipping data collection and analysis. It was decided to expand the pathogens under surveillance to include *Haemophilus influenzae*, *Neisseria meningitidis*, groups A and B streptococcus. Greenland, Iceland, Norway and Finland joined ICS to submit data annually on invasive pneumococcal disease. Establishment of an ICS steering committee was proposed. Members would be public health representatives from each participating country and representative indigenous peoples' organizations with interests in Arctic human health.

#### **International Congress on Circumpolar Health, Harstad, Norway, June 4-11 2000.**

Working group meeting "International Circumpolar Surveillance of infectious diseases".

**Arctic Council Ministerial Meeting, Barrow, Alaska, October 10-13.** ICS was accepted as an Arctic Council Sustainable Development Working Group project.

### 2001

**Steering Committee Meeting, Copenhagen, Denmark, May 3-4.** The steering committee was established to guide and review ICS activities, as well as to identify, prioritize and initiate the development of new surveillance activities. While the current activities included infectious diseases of community concern, it was recognized that the model could also be used to monitor other human health priorities. Members included representatives from the US, Canada, Greenland, Norway, Finland, and the Indigenous Peoples Secretariat.

**Arctic Council Sustainable Development Working Group, Rovaniemi, Finland, April 4.** ICS update presented.

### 2002

**Steering Committee Meeting, Atlanta, GA, March 25.** Meeting was held in conjunction with the International Conference on Emerging Infectious Diseases. ICS progress and plans were reviewed. Additional steering committee members included representatives from Iceland and the Russian Federation.

**Invasive Bacterial Disease Working Group, Anchorage, Alaska, May 9.** Meeting was held in conjunction with the 3<sup>rd</sup> International Symposium on Pneumococci and Pneumococcal Diseases. Surveillance activities within each participating country were reviewed. The international quality control program for *Streptococcus pneumoniae* was reviewed and plans to expand this program to include reference laboratories in northern Europe were discussed.

**Arctic Council Sustainable Development Working Group, Oulu, Finland, May 14.** ICS update presented.

**Arctic Council Sustainable Development Working Group Inari Finland October 9.** ICS update presented. A written report on ICS progress and plans for 2003-2004 were provided to the Ministerial Meeting October 10.

Presentations on ICS were made to public health officials from the State Sanitary Epidemiology and Surveillance Centres in Naryan Mar and Murmansk in November, 2002. This visit was arranged as part of the Norwegian Institute of Public Health's Nordic Council of Ministers funded Infectious Diseases Control Program in the Barents Sea regions of the Russian Federation.

In November 2002 the Arctic Investigations Program hosted a delegation of Hospital Physicians and public health officials from Chukotka and presented an overview of infectious disease prevention and control activities in the US Arctic and the ICS program.

## **2003**

**Arctic Council Sustainable Development Working Group Reykjavik, Iceland April.** ICS update presented.

**12<sup>th</sup> International Congress on Circumpolar Health, Nuuk, Greenland, September 10-13.** Working group meeting "Strategies for increasing cooperation for the prevention and control of infectious diseases in circumpolar areas". ICS expansion to include Tb, HIV/AIDS, Hepatitis b explored.

ICS was a topic presented at the 4<sup>th</sup> Conference on Combating Infectious Diseases in the Barents Region of the Russian Federation held in Petrozavodsk, Karelia, September 18-19, 2003. This meeting presented opportunities to meet with and discuss ICS with epidemiologists from the State Sanitary Epidemiology Centres from Murmansk, Karelia, Arkhangelsk, and St. Petersburg. This meeting was co-sponsored by the Norwegian Institute of Public Health as part of a Nordic Council of Ministers funded Infectious Diseases Control Program in the Barents Sea regions of the Russian Federation.

## **2004**

**Steering Committee Meeting Atlanta GA February 29.** Meeting was held in conjunction with the International Conference on Emerging Infectious Diseases.

**Invasive Bacterial Diseases Working Group Meeting, Montreal, Quebec, December 9.** Meeting was held in conjunction with the Canadian National Immunization Conference.

**2005**

**Steering Committee Meeting Copenhagen, Denmark, April 6.** Meeting was held in conjunction with the European Congress of Clinical Microbiology and Infectious Diseases.

**International Polar Year Arctic Human Health Initiative Advisory Committee Meeting, April 7-8.**

**Invasive Bacterial Diseases Working Group Meeting, Toronto, Ontario, November 29.**

**2006**

**Tuberculosis Working Group Meeting, Yellowknife, Northwest Territories, February 2.** Organizational meeting to discuss the establishment of an ICS tuberculosis working group.

**Steering Committee Meeting, Atlanta, GA, March 19.** Held in conjunction with the International Conference on Emerging Infectious Diseases.

**13<sup>th</sup> International Congress on Circumpolar Health, Novosibirsk, Russian Federation, June 12-16.** A meeting of the International Union for Circumpolar Health Infectious Disease Working Group was held at this meeting.

**Sustainable Development of Arctic Cities – Third World Forum Networking Event, Vancouver, BC, July 19-20.** Information on ICS presented.

## Appendix D – Publications, Presentations, Reports, Abstracts

### 2006

- Bruce MG, Deeks S, et al. Epidemiology of *Haemophilus influenzae* serotype a, an Emerging Pathogen in Northern Canada and Alaska? International Conference on Emerging Infectious Diseases, Atlanta, GA, March 19-22.
- Cottle T, Bruce M, et al. International Circumpolar Surveillance of Invasive Bacterial Diseases, 2000-2005. International Conference on Emerging Infectious Diseases, Atlanta, GA, March 19-22.
- Bruce MG, Cottle T, et al. The International Circumpolar Surveillance System for Population Based Surveillance of Invasive Pneumococcal Disease 1999-2004. 16<sup>th</sup> European Congress on Clinical Microbiology and Infectious Diseases, Nice, France, March 31-April 6.
- Bruce MG, Cottle T, et al. The International Circumpolar Surveillance System for Population Based Surveillance of Invasive Pneumococcal Disease 1999-2004. 13<sup>th</sup> International Congress on Circumpolar Health, Novosibirsk, Russian Federation, June 12-16.
- Cottle T, Bruce M, et al. International Surveillance of Invasive Bacterial Diseases, 2000 – 2005. 13<sup>th</sup> International Congress on Circumpolar Health, Novosibirsk, Russian Federation, June 12-16.

### 2005

- Bruce MG, Cottle T, et al. The International Circumpolar Surveillance System for Population Based Surveillance of Invasive Pneumococcal Disease 1999-2003. 15<sup>th</sup> European Congress on Clinical Microbiology and Infectious Diseases, Copenhagen, Denmark.
- Cottle T, Bruce M, Parks D, Deeks SL, Tam T, Jensen K, Brinklov, Nystedt A, Parkinson AJ. International Circumpolar Surveillance of Invasive Bacterial Diseases: 2000-2004. 15<sup>th</sup> European Congress on Clinical Microbiology and Infectious Diseases, Copenhagen, Denmark.

### 2004

- Bruce MG, Cottle T, Butler JC, Parks D, Tam T, Deeks S, Lovgren M, Jette L, Kristinsson K, Sigmundstottir G, Brinklov Jensen K, Lovoll O, Nuorti P, Herva E, Hennessy T, Parkinson AJ. The International Circumpolar Surveillance System for Population Based Surveillance of Invasive Pneumococcal Disease 1999-2002. International Conference on Emerging Infectious Diseases, Atlanta GA, February 29-March 3, 2004
- Cottle T, Bruce M, Butler J, Parks D, Tam T, Deeks S, Parkinson AJ. Surveillance of Invasive Bacterial Diseases in Northern Canada and the US Arctic 2000-2003. International Conference on Emerging Infectious Diseases, Atlanta GA, February 29-March 3, 2004
- Bruce MG, Cottle T, Butler JC, Parks D, Tam T, Deeks S, Lovgren M, Jette L, Kristinsson K, Sigmundstottir G, Brinklov Jensen K, Lovoll O, Nuorti P, Herva E, Hennessy T, Parkinson AJ. The International Circumpolar Surveillance System for Invasive Pneumococcal Disease 1999-2002. 14<sup>th</sup> European Congress on Clinical Microbiology and Infectious Diseases, Prague, Czech Republic, May 1-4, 2004

- Cottle T, Bruce M, Butler J, Parks D, Tam T, Deeks S, Parkinson AJ. Surveillance of Invasive Bacterial Diseases in Greenland, Northern Canada and the US Arctic. 14<sup>th</sup> European Congress on Clinical Microbiology and Infectious Diseases, Prague, Czech Republic, May 1-4, 2004

### 2003

- Bruce MG, Cottle T, Butler JC, Parks D, Tam T, Deeks S, Lovgren M, Jette L, Kristinsson K, Sigmundsdottir G, Brinklov Jensen K, Lovoll O, Nuorti P, Herva E, Hennessy T, Parkinson AJ. Use of the International Circumpolar Surveillance System for Population Based Surveillance of Invasive Pneumococcal Disease 1999-2001. 13<sup>th</sup> European Congress on Clinical Microbiology and Infectious Diseases, Glasgow, Scotland, May 10-13, 2003
- Parkinson AJ, Reasonover A, Lovgren M, Jette L. International Inter-Laboratory Quality Control program for Circumpolar Surveillance of *Streptococcus pneumoniae*. 13<sup>th</sup> European Congress on Clinical Microbiology and Infectious Diseases, Glasgow, Scotland, May 10-13, 2003
- Bruce M, Cottle T, Butler J, Parks D, Tam T, Lovgren M, Jette L, Kristinsson K, Sigmundsdottir G, Stenz F, Lovoll O, Nuorti P, Herva E, Parkinson A. The International Circumpolar Surveillance System for Population-based Surveillance of Invasive Pneumococcal Disease 1999-2001. 12<sup>th</sup> International Congress on Circumpolar Health, Nuuk, Greenland, September 8-10, 2003
- Cottle T, Bruce M, Butler J, Parks D, Tam T, Parkinson AJ. Surveillance of Invasive Diseases Caused by *Haemophilus influenzae*, *Neisseria meningitidis*, and Groups A & B Streptococci in Northern Canada and the US Arctic: 2000-2002. 12<sup>th</sup> International Congress on Circumpolar Health, Nuuk, Greenland, September 8-10, 2003
- Parkinson AJ, Butler J, Bruce M, Cottle T. Creating an International System for Invasive Bacterial Diseases: Public Health Partnerships and Politics. 12<sup>th</sup> International Congress on Circumpolar Health, Nuuk, Greenland, September 8-10, 2003

### 2002

- Parkinson AJ, Butler JC. 2002. Prevention and control of infectious diseases in the Arctic. Arctic Research of the United States. 15:27-31.
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