Invasive Bacterial Diseases in the Arctic

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Outline

- Introduction to Alaska
- International Circumpolar Surveillance
  - Invasive bacterial disease
- Examples
  - Group A *Streptococcus*
  - *Haemophilus influenzae* type A

Alaska

- Population: 700,000
  - Anchorage 280,000
  - 50 million salmon
  - 50,000 bears
- Became a State in 1959
  - Infrastructure and services not well developed
- “The Last Frontier”
  - “Boom and bust” economy
    - Fishing, logging, mining
    - Oil and Gas

Alaska Natives

- The indigenous people of Alaska
  - Eskimos: Inuit, Yupik, Siberian Yupik
  - Aleuts
  - Athabaskan
  - Coastal Tribes: Haida, Tlingit, Tsimshian
- 20 Languages
- 2010 Census: 130,000 persons
  - ~20% of State population

Alaska Native Demographics

- 60% live in rural areas
- 45% under age 19
  - vs. 30% of US overall population
- Income ½ that of non-Natives
  - Unemployment high
  - Housing older, more crowded
  - 20% without running water, flush toilets
  - Subsistence lifestyle

CDC's Arctic Investigations Program

- Mission: To prevent infectious disease morbidity and mortality in people of the Arctic and Subarctic
- Special emphasis on diseases of high incidence and concern among indigenous people

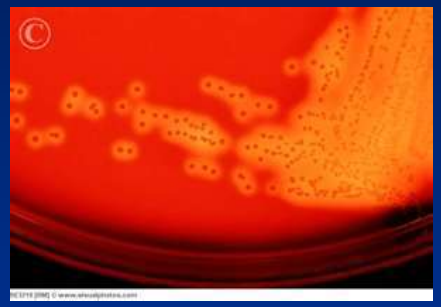
Priority Areas

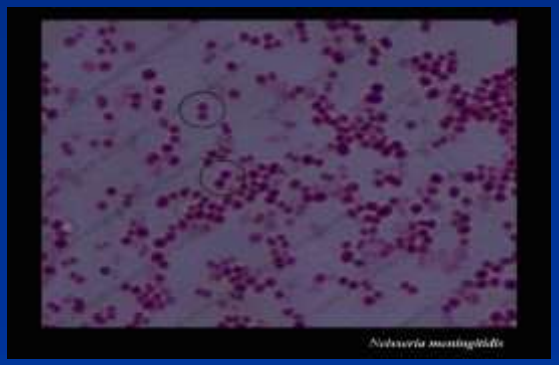
- Surveillance
- Emerging Infectious Diseases
- Health Disparities
- Preparedness and Response
- Leadership in Circumpolar Health

Priority Infections

- Vaccine preventable infections
  - *Streptococcus pneumoniae*
  - *Haemophilus influenzae*
  - *Neisseria meningitidis*
  - *Human papilloma virus*
- Infections that lead to chronic diseases
  - *Helicobacter pylori* — stomach ulcers, stomach cancer
  - *Hepatitis B, C* — cirrhosis, liver cancer
  - Human papilloma virus — cervical cancer, genital warts
  - Respiratory syncytial virus — chronic lung disease
- Emerging infections
  - Avian and pandemic influenza
  - Antibiotic-resistant infections
    - Methicillin-resistant *Staphylococcus aureus*
  - Climate-sensitive infections

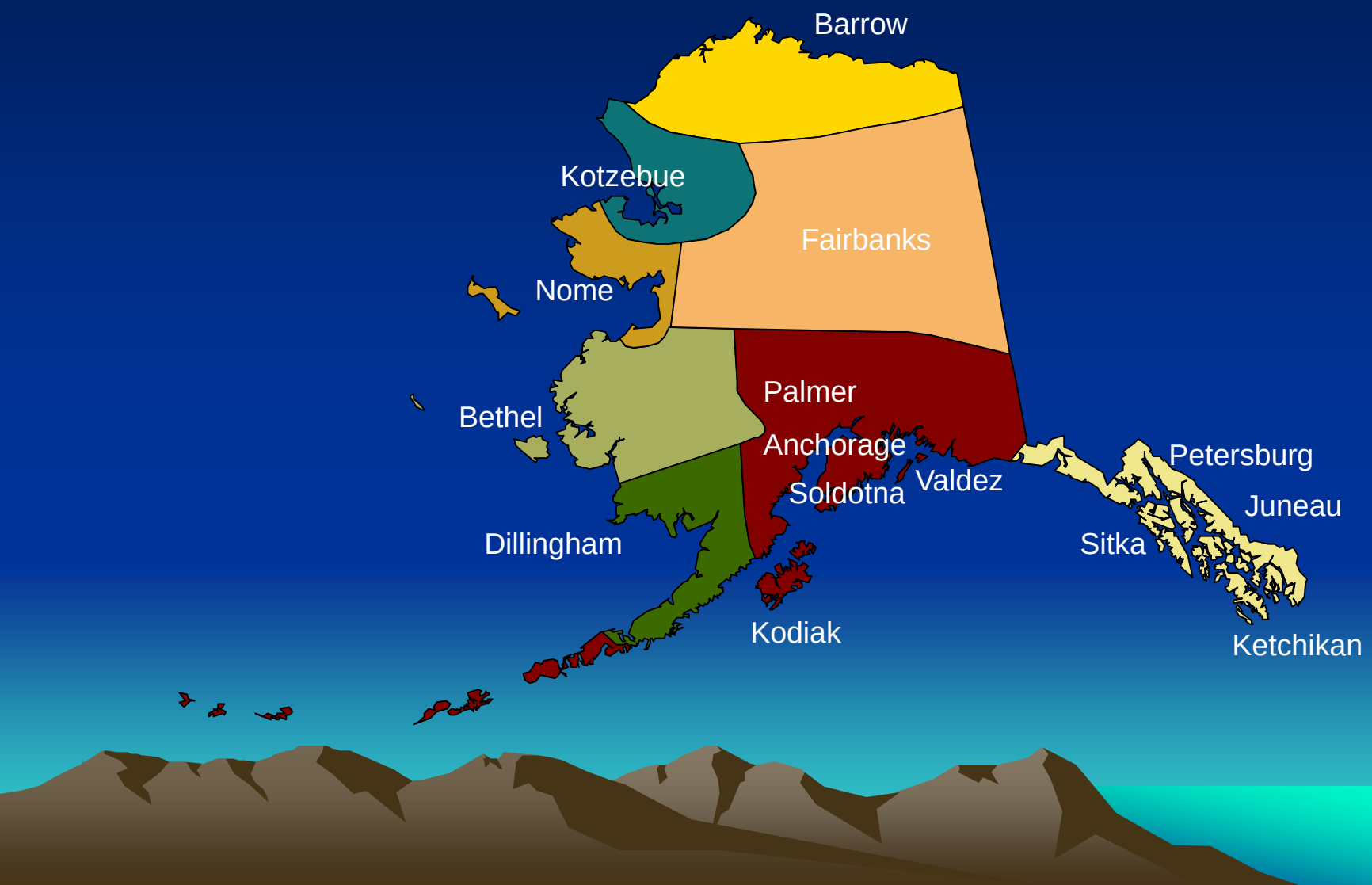
Surveillance Organisms





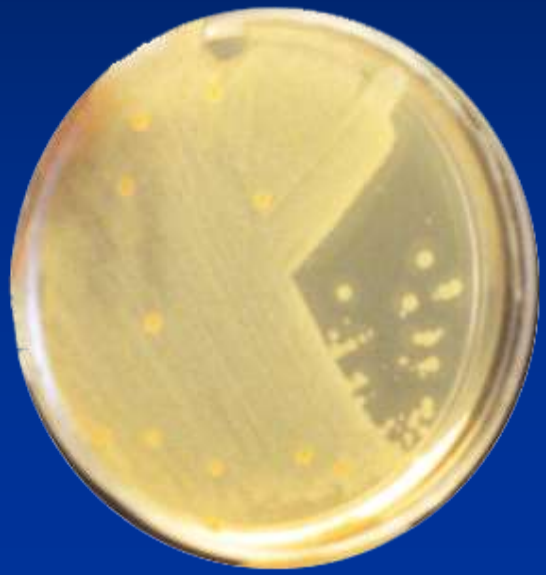
- *Haemophilus influenzae*, 1980
- *Streptococcus pneumoniae*, 1986
- *Neisseria meningitidis*, 2000
- Groups A & B *Streptococcus*, 2000

Statewide Invasive Bacterial Disease Surveillance



Methods

- Labs submit sterile site isolates
  - Blood, spinal, joint, pleural fluid
- Confirmation and serotyping
- Antimicrobial susceptibility
- Clinical and demographic information
- Annual audits for missing cases
- Yearly reports generated



International Circumpolar Surveillance

- Started in 1999
- Network of hospital, public health, and reference laboratories throughout the Arctic
- Standardize laboratory and data collection
  - Laboratory quality control program
- Monitor disease rates & trends

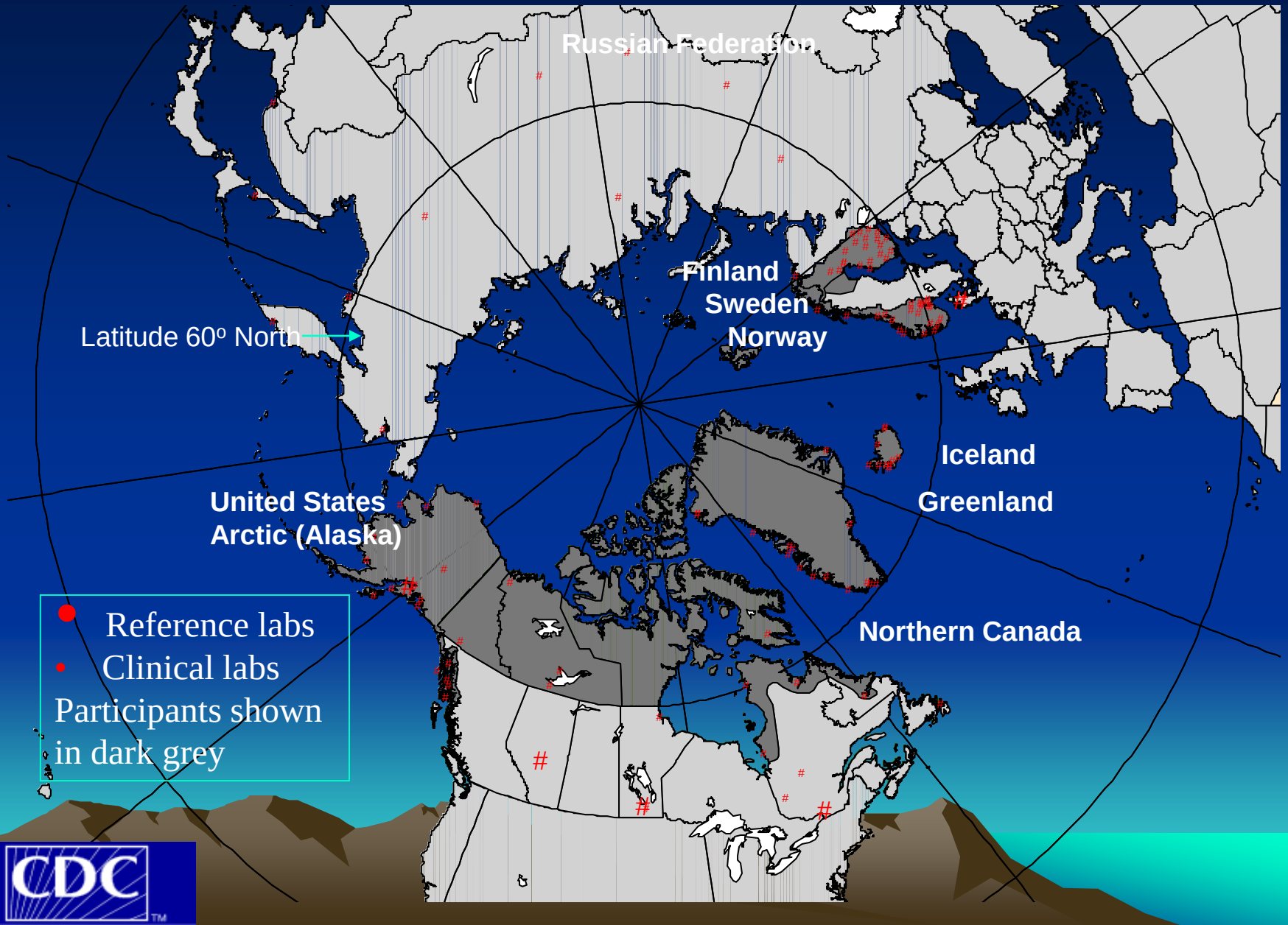
Why Circumpolar Surveillance?

- Similar geography, climate, populations
  - Can compare epidemiology
  - Rare diseases in small populations
- Existing public health surveillance data
- Arctic Cooperation
  - Arctic Council
  - Other multinational cooperatives
    - International Union for Circumpolar Health

International Circumpolar Surveillance (ICS) Diseases

- Invasive bacterial diseases
  - *Streptococcus pneumoniae*
  - *Haemophilus influenzae*
  - *Neisseria meningitidis*
  - Groups A & B *Streptococcus*
- Tuberculosis

ICS Invasive Bacterial Diseases Network



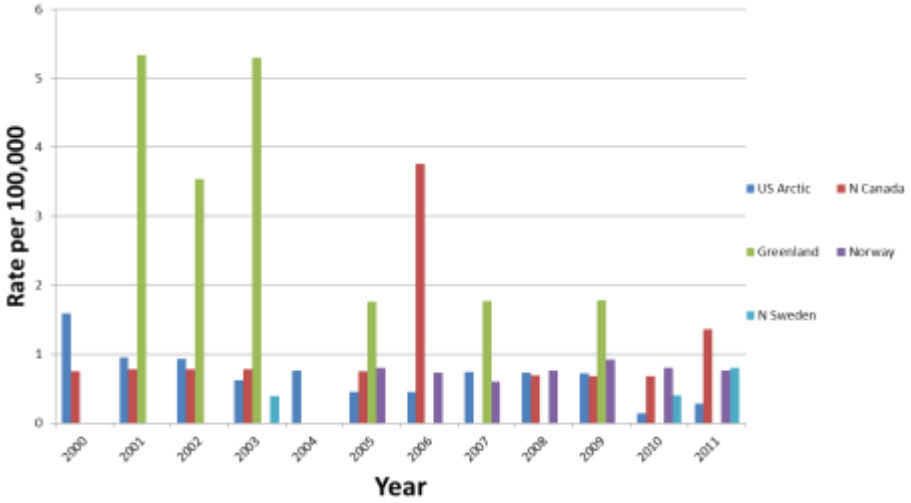
ICS Accomplishments

- Outbreak of *Streptococcus pneumoniae,* serotype 1
  - 2 regions of northern Canada, 2002
  - Vaccines used to control outbreak
- Detected emergence of *Haemophilus influenzae* type a among children in northern Canada and Alaska
  - New vaccine under development and testing
- Collaborations led to other Circumpolar infectious disease working groups
  - Viral hepatitis
  - *Helicobacter pylori*
  - Climate change and infectious diseases

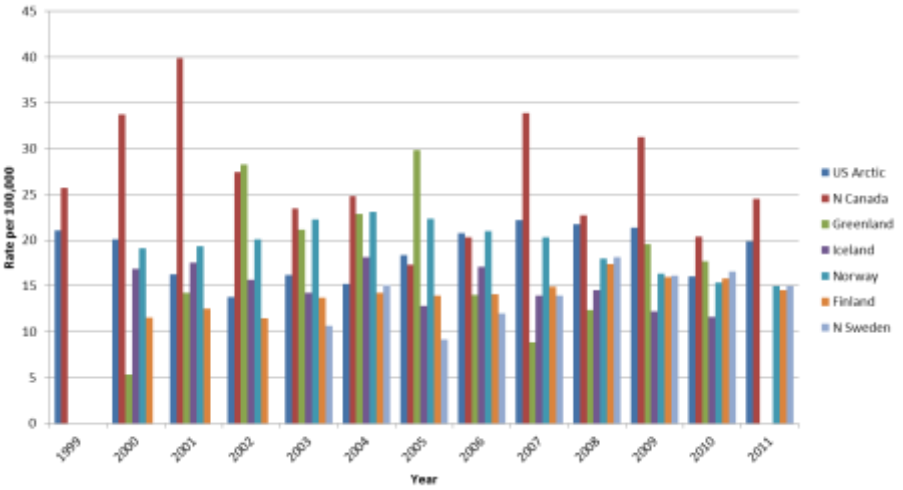
ICS Demographics

Country	Population	% Indigenous
Alaska	700,000	20
N Canada	135,000	60
Finland	5,300,000	< 1
Greenland	56,000	unknown
Norway	4,600,000	unknown
N Sweden	500,000	<5

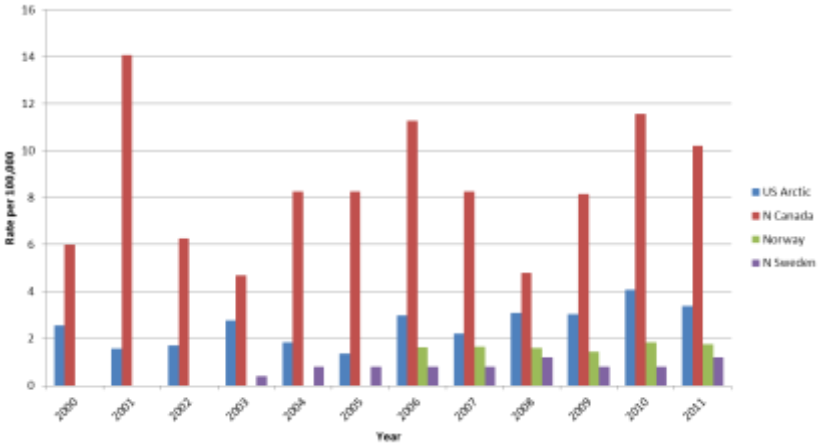
Neisseria meningitidis



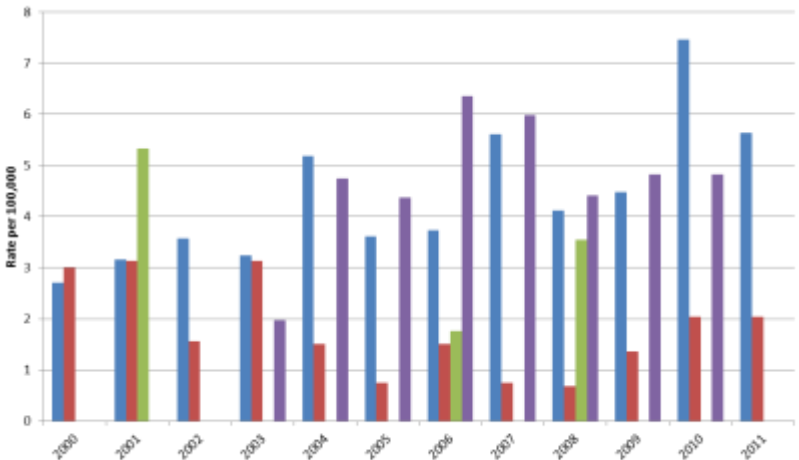
Streptococcus pneumoniae



Haemophilus influenzae



Group B *Streptococcus*



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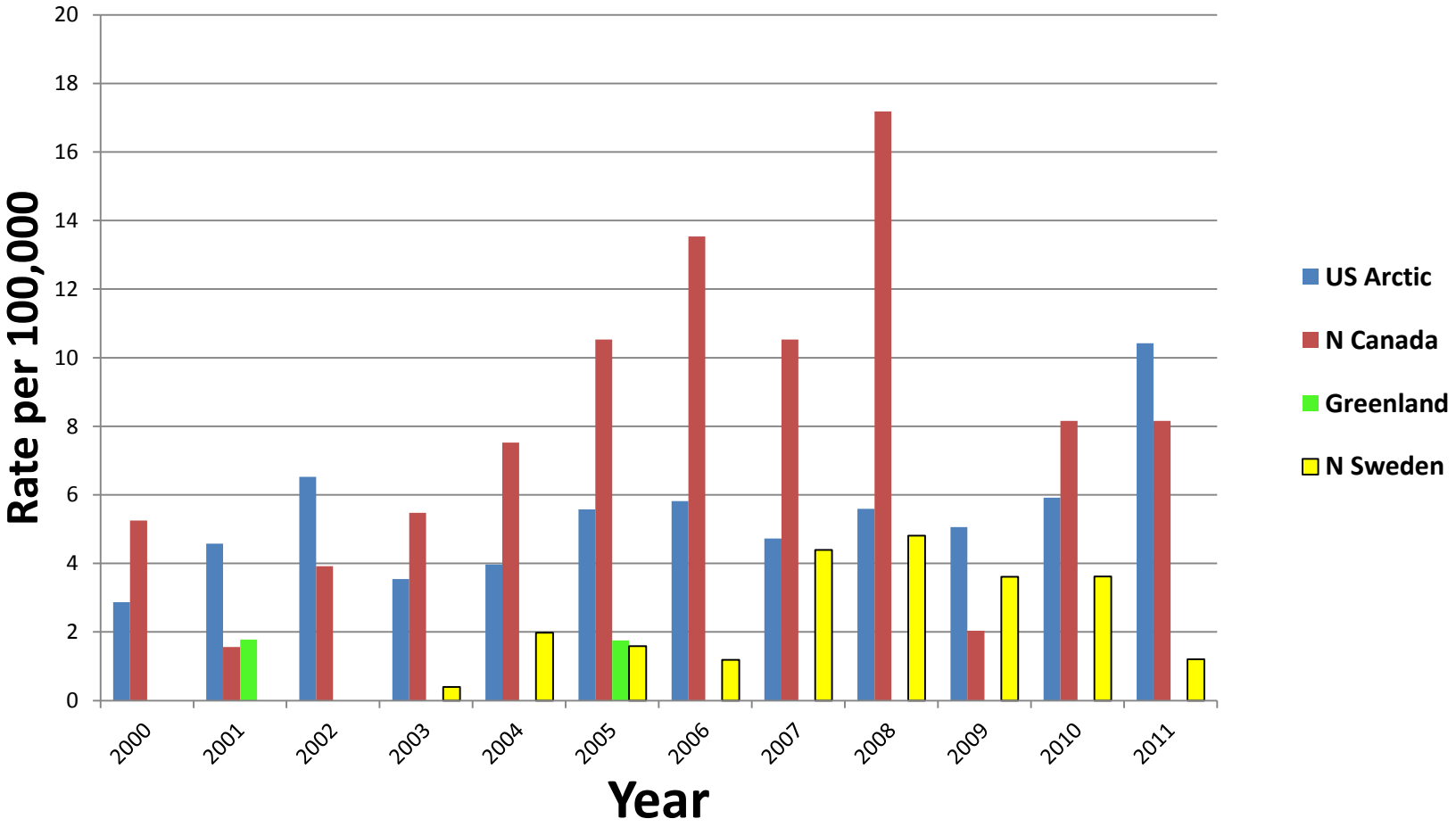
Group A streptococcus (GAS)
Streptococcus pyogenes

- Human pathogen
- Nasopharyngeal reservoir
- Most common: pharyngitis and skin infections
- Serious invasive infections
    - Necrotizing fasciitis, sepsis, meningitis, streptococcal toxic shock
- Incidence rates across Arctic are variable

Invasive Group A *Streptococcus* Disease Rates, ICS 2000-2011



GAS Incidence

- Incidence and severity of GAS infections has increased worldwide

- USA, annual
  - 10,000–15,000 invasive cases
  - 1,100–1,800 deaths

M Typing
emm Typing

M Typing

Bacterial surface protein

Allows serotyping of infecting strains

Emm Typing

- Sequencing of the 5’ region of the *emm* gene
  - encodes the M protein
  - >160 different *emm* genotypes
  - Majority of GAS outbreaks worldwide caused by *emm* types 1, 3, 12, and 28

Prevention of Invasive GAS

- For cases:

  Timely, accurate diagnosis and antibiotics

- For contacts:

  Targeted chemoprophylaxis to

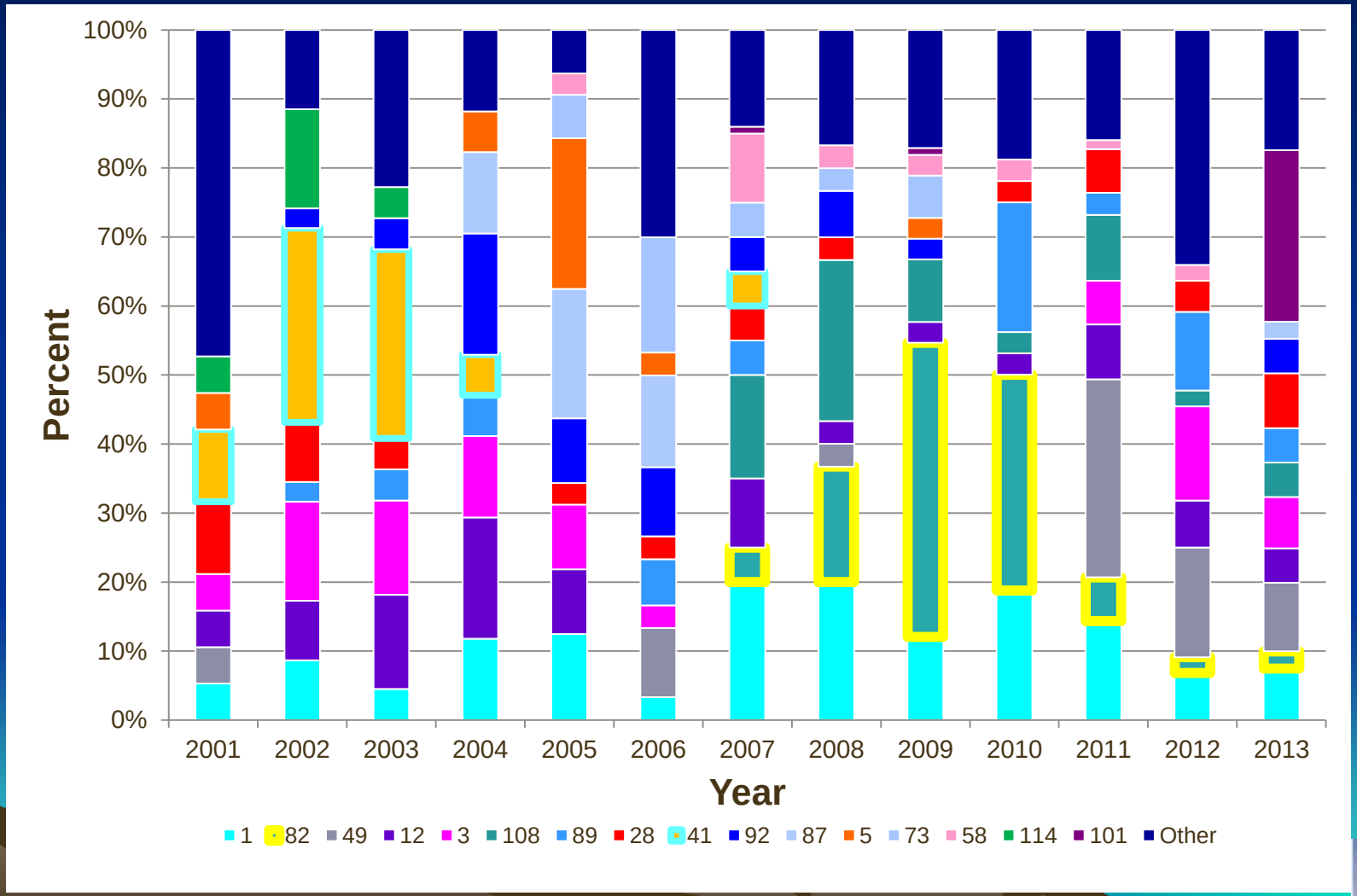
  - Household contacts ≥ 65 years of age
  - High risk groups (HIV-infected, diabetes, varicella)

- Vaccine
  - 26-valent, M protein-based
  - Phase II trials in 2005

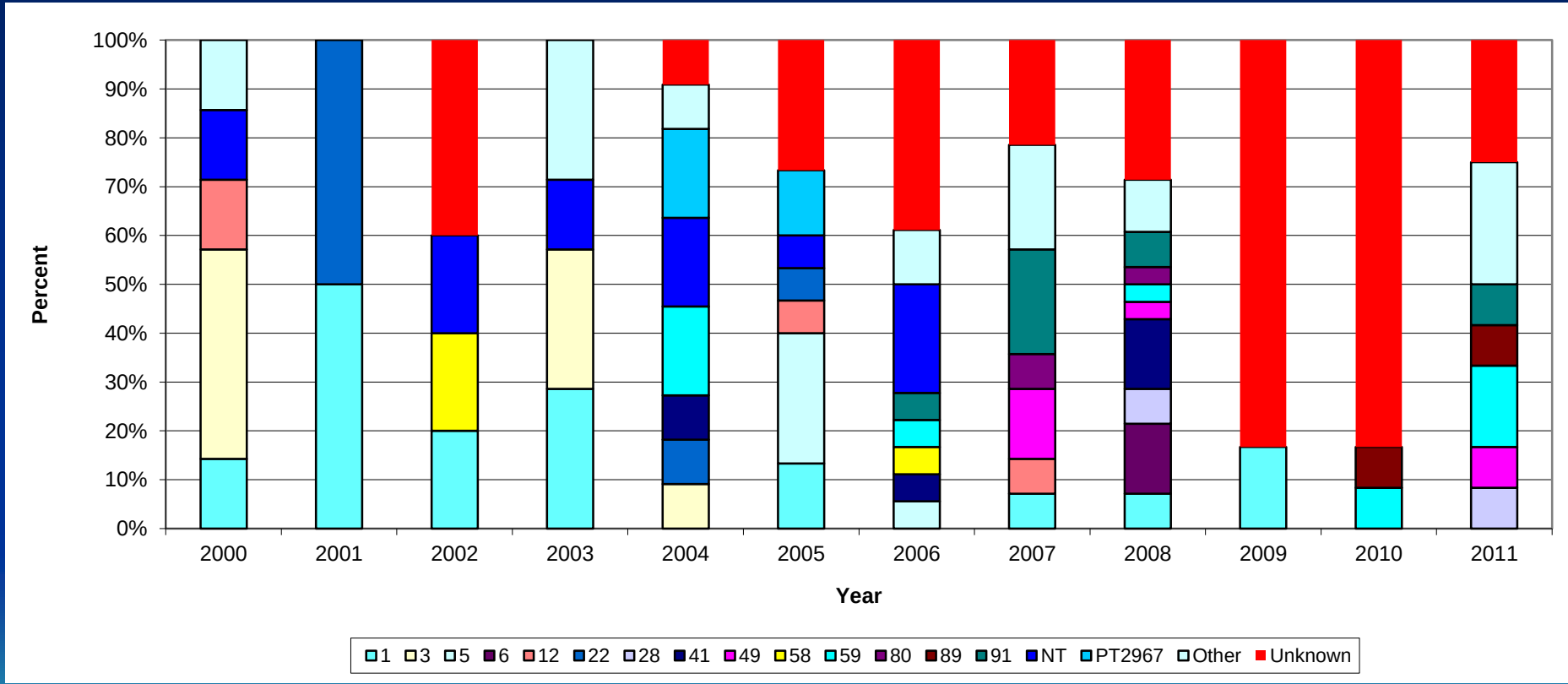
GAS Case-patient Age, Sex and Deaths

	Alaska 2000-2012 n=483	Northern Canada 2000-2011 n=129
Median Age (yrs)	48.5	39.4
Male %	54.2%	56.6%
Deaths	50 (10.4%)	12 (9.9%)

% of Isolates by *emm* type 2001-2013, Alaska

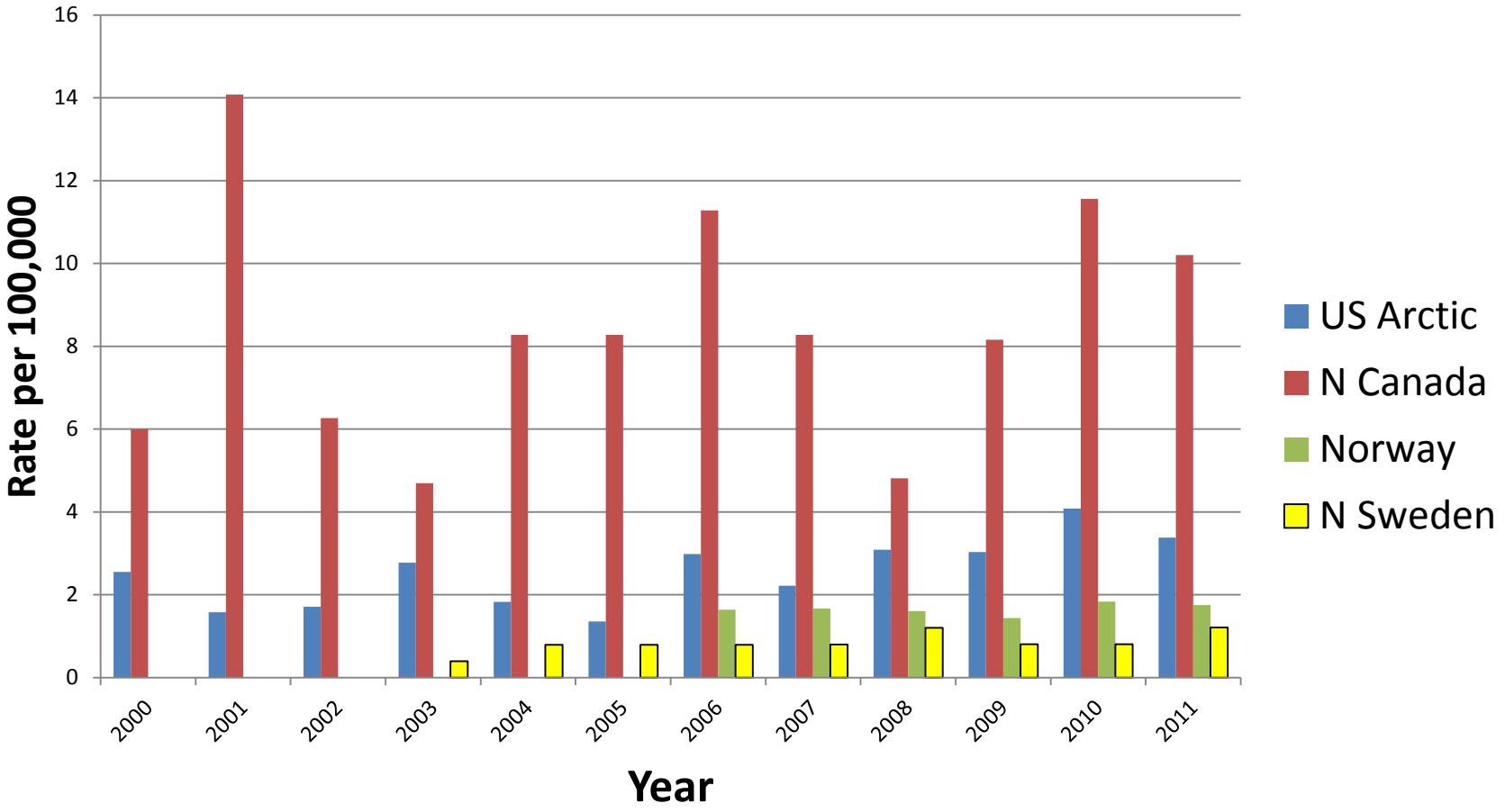


Percent of northern Canada isolates by M/emm* type, 2000 to 2011

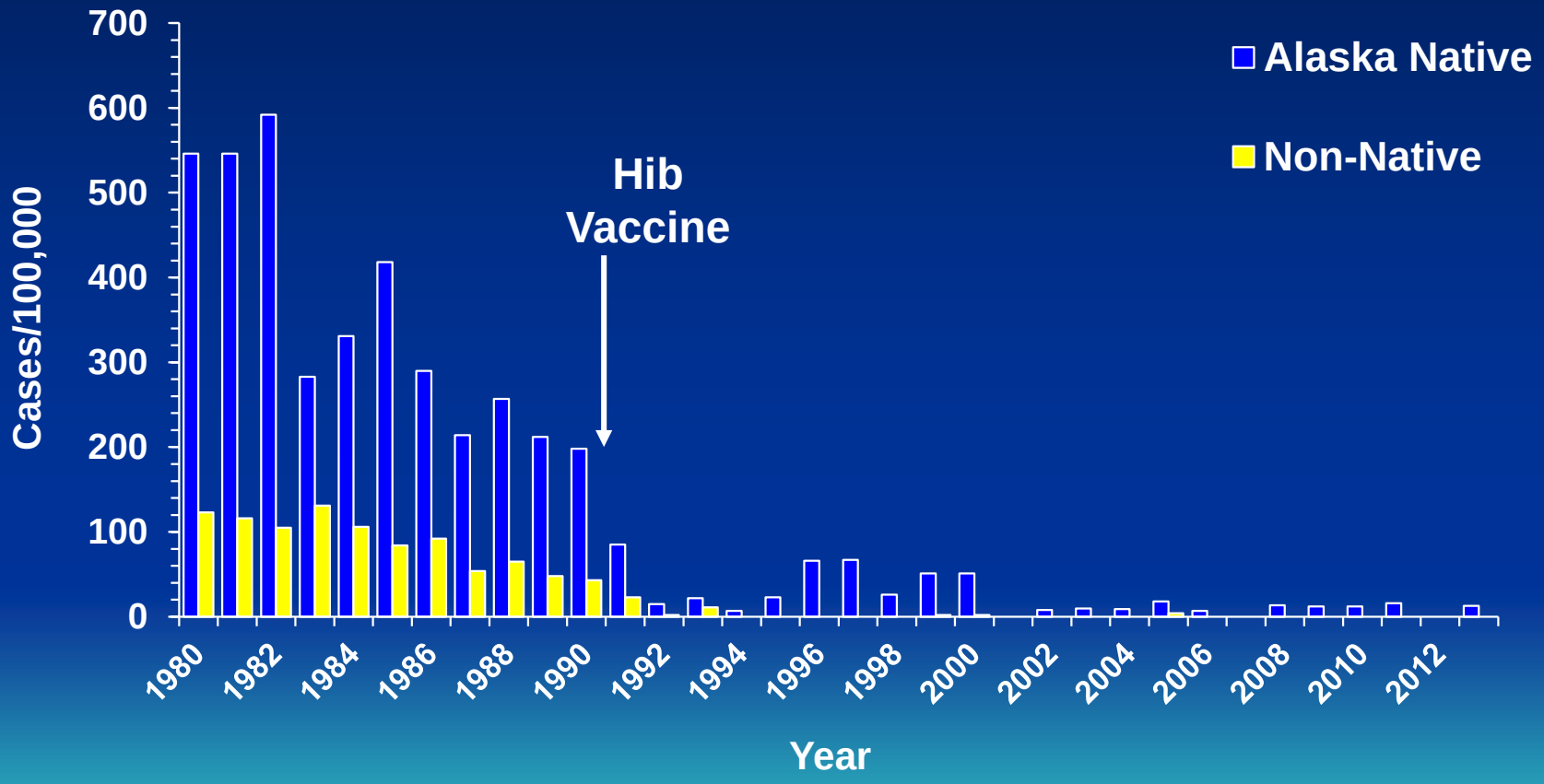


*2000 – 2005: M and *emm* types; 2006 – 2011: *emm* types.

Invasive *Haemophilus influenzae* Disease Rates, ICS 2000-2011



Invasive Hib Disease, Children Aged <5 Years, Alaska, 1980-November, 2013



R Singleton, et al. Pediatrics 2006 and CDC, unpublished data

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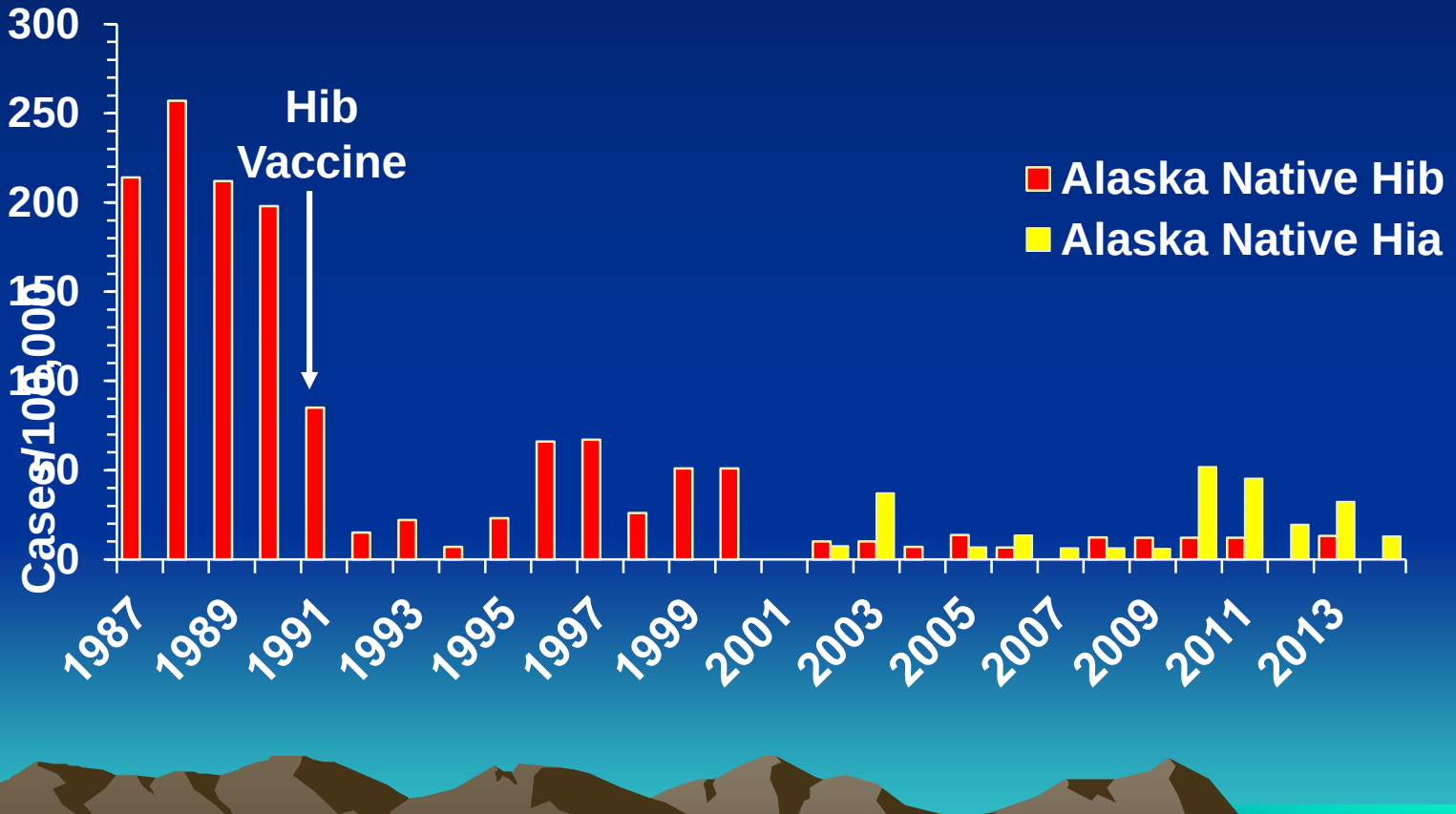
Invasive Hib Disease, Children Aged <5 Years, Alaska, 1980-November, 2013



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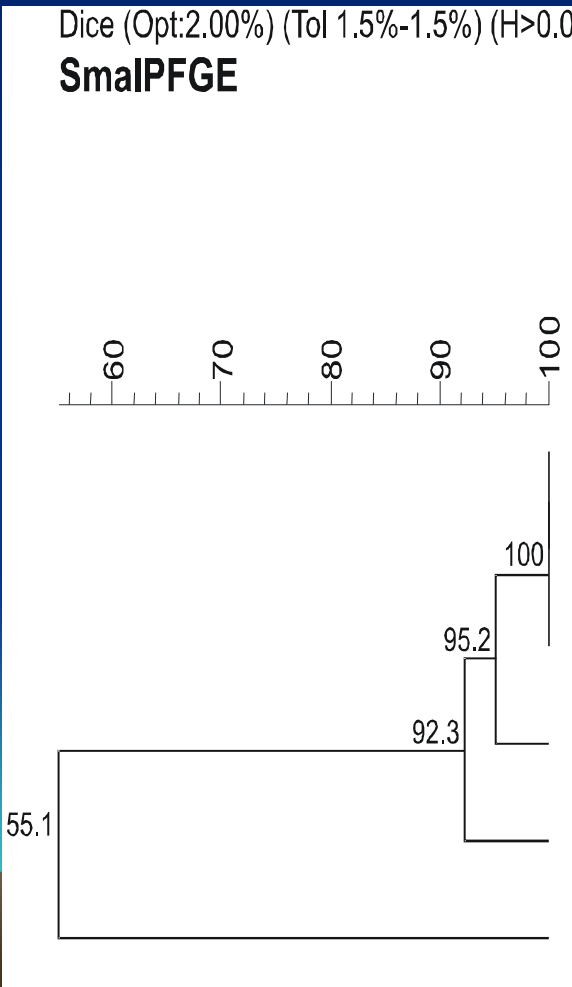
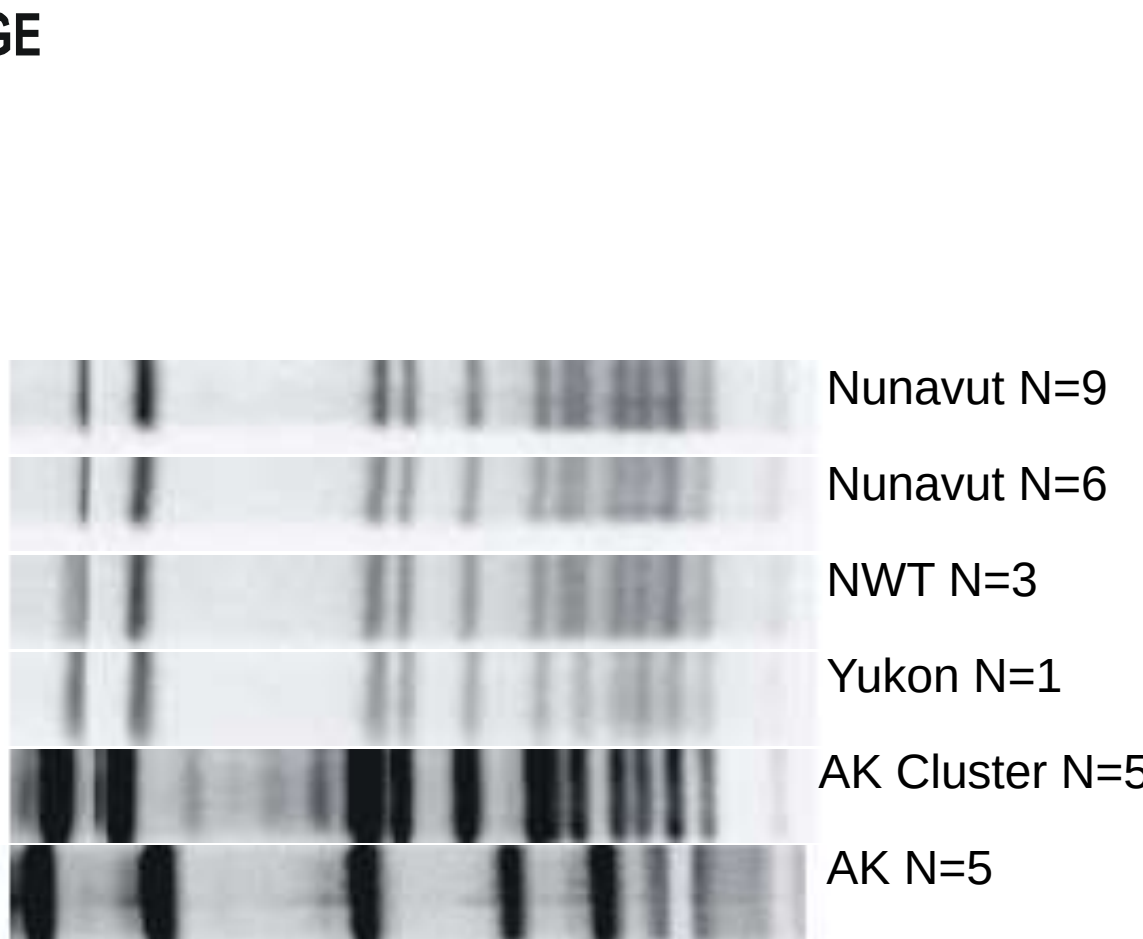
Hia Strain Typing, Alaska and Canada





Characteristics of Persons with Invasive Hia Alaska, 2002-2013

	N=40
Median Age (range)	0.7 year (4 months-48.3 years)
Sex (male%)	26 (65%)
Alaska Native	36 (90%)
Age appropriately vaccinated for Hib	35 (97%)*

* Of those children < 10 years old with known vaccine status (n=36)

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Hia Clinical Illness and Outcome in Children < 5, Alaska, 2002-2013

	N=37
Meningitis	15 (41%)
Pneumonia with bacteremia	9 (24%)
Septic Arthritis	6 (22%)
Bacteremia	1 (4%)
Cellulitis	3 (8%)
Hospitalization	31 (84%)
Death	3 (8%)

Hia Disease Summary

- Invasive *Hia* infection affects young Alaskan children
  - 94% American Indian/ Alaska Native
  - 70% without known underlying illness
- Invasive *Hia* infection frequently leads to death or disability
  - 25% died or had sequelae 1 year after illness
  - 11% Case fatality
- An effective vaccine would prevent death and illness in affected populations

Invasive Bacterial Diseases in Arctic

Summary

- Disease rates vary across populations
- International Circumpolar Surveillance
  - A successful model for
    - Data sharing
    - Comparing methods for prevention and treatment
    - Outbreak detection
    - Vaccine development
    - Research networks