Emerging Infectious Diseases in the Arctic

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Emerging Infections Outline

- The emergence of emerging infectious diseases
- Factors leading to emergence
- Examples from the Arctic

“Predicting is difficult, especially if it’s about the future.”

Neils Bohr

CDC

- **“The time has come to close the book on infectious diseases. We have basically wiped out infection in the United States.”**

  – **William Stewart, US Surgeon General, 1967**

Emerging Infectious Diseases, Defined

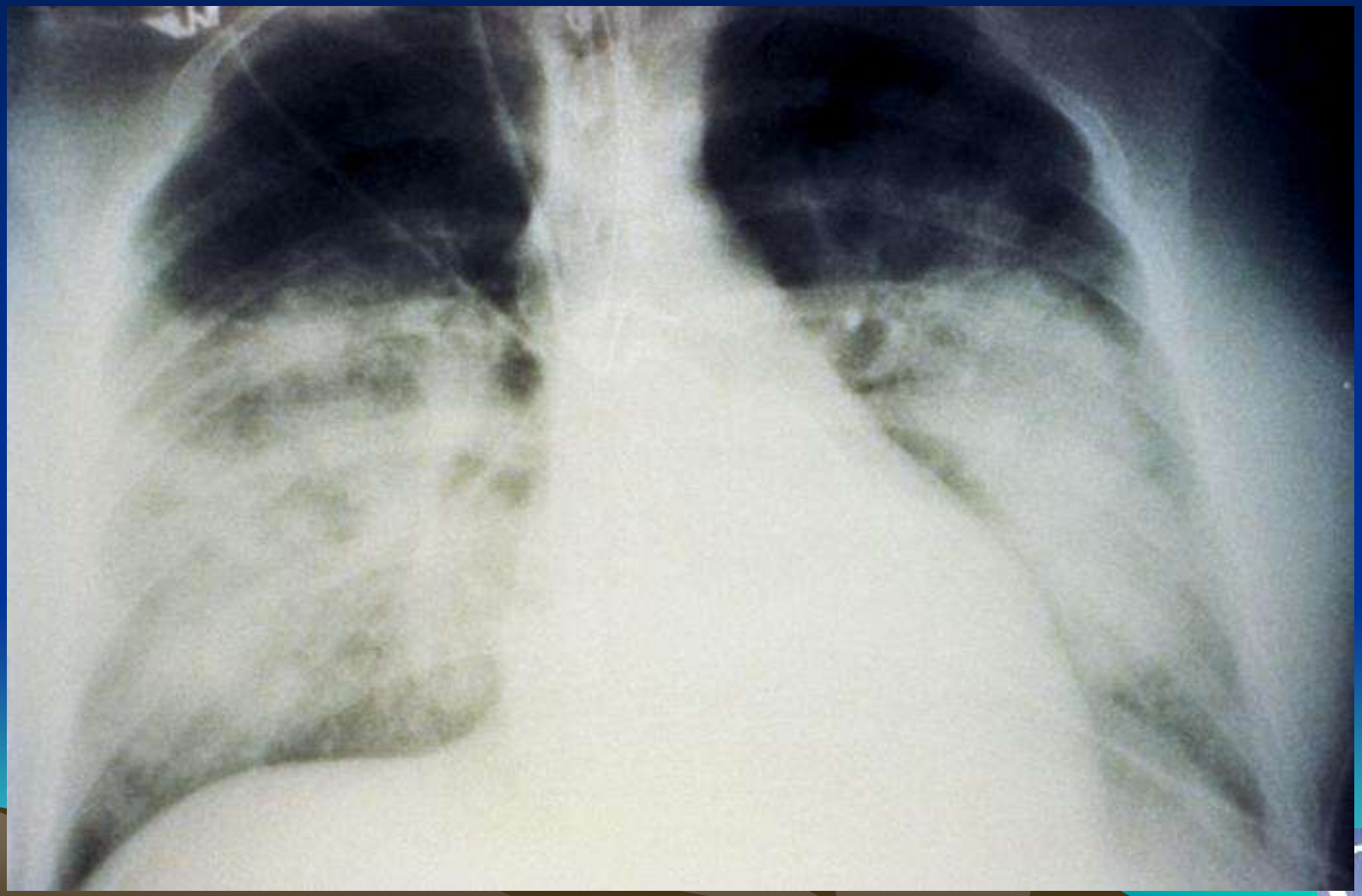
- "An emerging disease is one that has appeared in a population for the first time, or that may have existed previously but is rapidly increasing in incidence or geographic range. "
  - W.H.O.

- "An emerging infectious disease is an infectious disease whose incidence has increased in the past 20 years and could increase in the near future. "
  - Dr. Wick E. Pedia

Arctic Investigations Program
Priority Areas

- Surveillance
- Emerging Infectious Diseases
  - National Center for Emerging and Zoonotic Diseases
- Health Disparities
- Preparedness and Response
- Leadership in Circumpolar Health

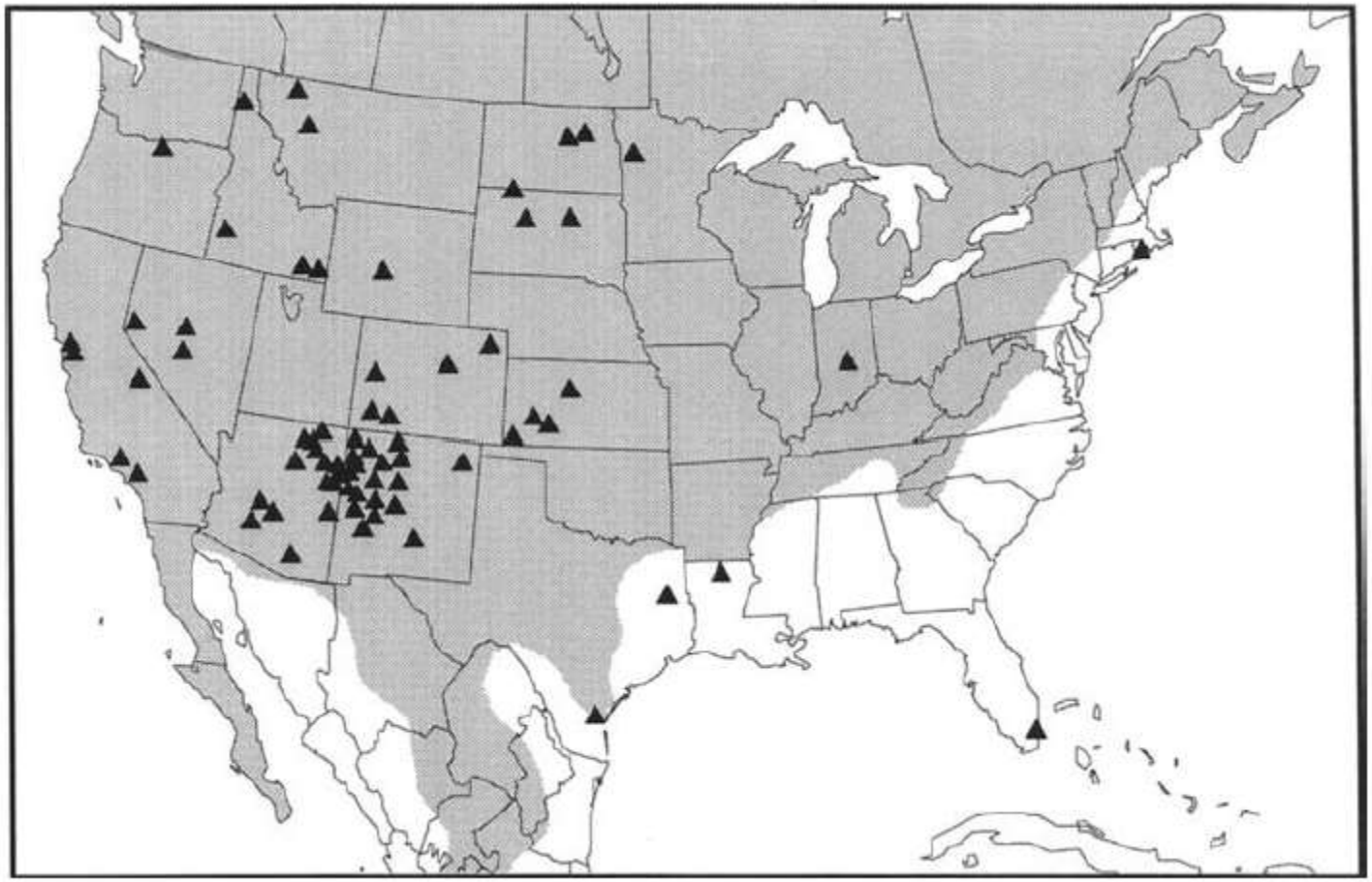
Crownpoint, N.M., 1993



Hantavirus, *Peromyscus maniculatus*

CDC

Hanta Virus Cases in US, 1993 – May 1994

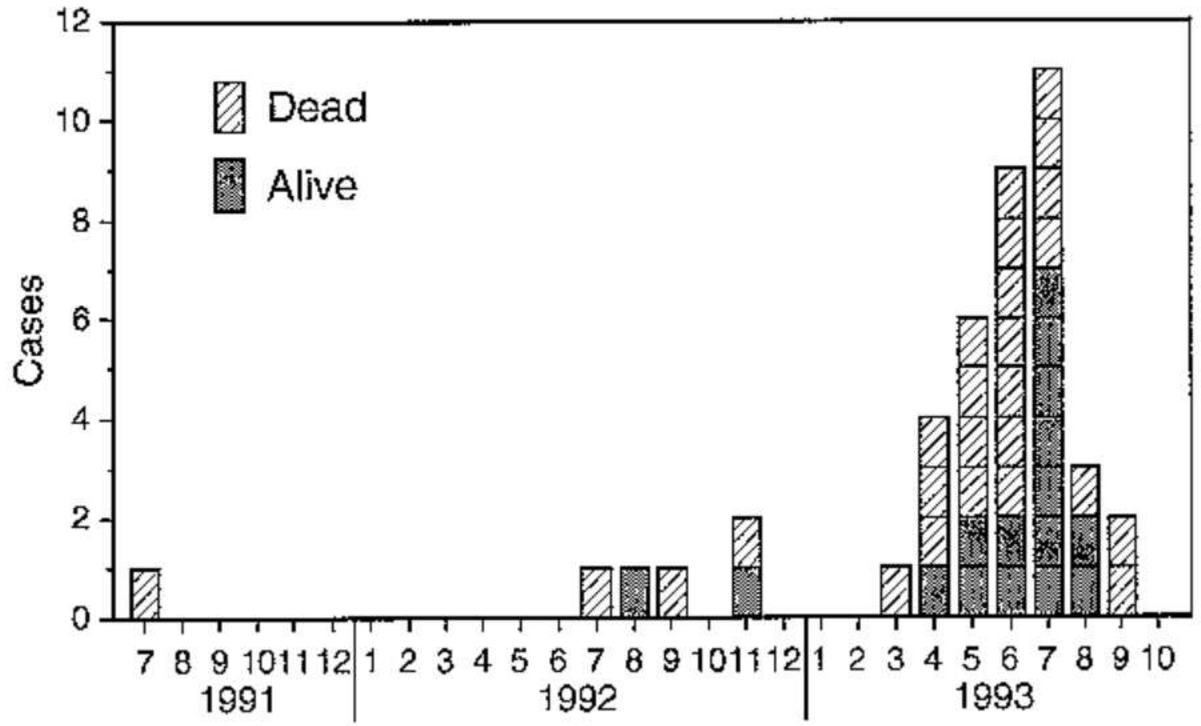


From Berkelman, JID 1994

CDC

Hantavirus Cases, by date, 1991 - 1993

FIGURE 2. Number of cases of hantavirus pulmonary syndrome, by month and year of onset — United States, July 7, 1991–October 21, 1993



CDC

Questions raised by Emerging Infections

- Clinical or public health significance?
  - How big is the outbreak?
  - What is the risk of death?

Questions raised by Emerging Infections

- Clinical or public health significance?
- What caused the outbreak?
  - New Hantavirus identified
    - "Sin Nombre Virus"

Questions raised by Emerging Infections

- Clinical or public health significance?
- Causative agent?
- How transmitted?
  - Animal to person
  - Person to person?
    - Not in U.S.
    - Andes Hantavirus, Argentina, 1996
      - Family and nosocomial spread

Questions raised by Emerging Infections

- Clinical or public health significance?
- Causative agent?
- How transmitted?
- **Clinical syndrome?**
  - **Case definition**
  - **No mild illness identified**

Questions raised by Emerging Infections

- Clinical or public health significance?
- Causative agent?
- How transmitted?
- Clinical syndrome?
- **Pathogenesis?**
  - **Lung microvascular and alveolar damage**
    - **respiratory distress, shock**

Questions raised by Emerging Infections

- Clinical or public health significance?
- Causative agent?
- How transmitted?
- Clinical syndrome?
- Pathogenesis?
- **How to diagnose?**
  - **Antibody assay, PCR, histochemical stain**
  - **No simple laboratory marker**

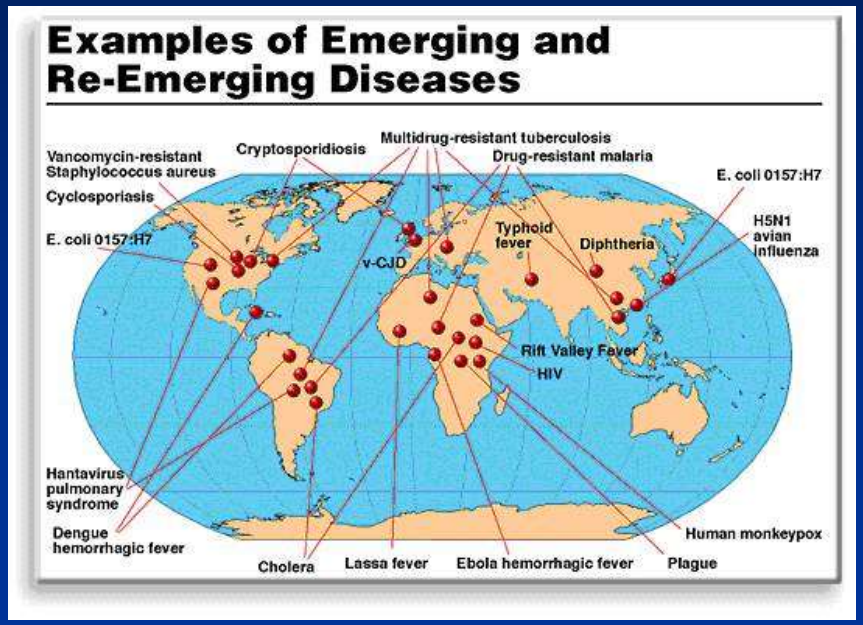
Questions raised by Emerging Infections

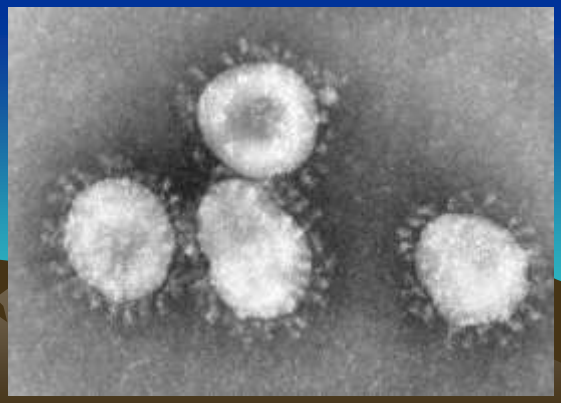
- Clinical or public health significance?
- Causative agent?
- How transmitted?
- Clinical syndrome?
- Pathogenesis?
- Diagnostics?
- **Therapy?**
  - **Supportive: fluid management, ventilation**
  - **Ribavirin trial**
    - **Inconclusive, stopped after 5 years**
    - **10 ribavirin, 13 placebo**

Questions raised by Emerging Infections

- Clinical or public health significance?
- Causative agent?
- How transmitted?
- Clinical syndrome?
- Pathogenesis?
- Diagnostics?
- Therapy?
- **Infection control and Prevention?**
  - **No infected health care workers (0 of 266)**
  - **Rodent control**

Examples of Emerging Infections





- Hantavirus
- West Nile Virus
- *E. coli* O157:H7
- H5N1 and H1N1 flu
- Dengue
- MERS
- Chikungunya virus
- “Bat-bugs”: Ebola, rabies, Marburg, SARS, Hendra, Nipah

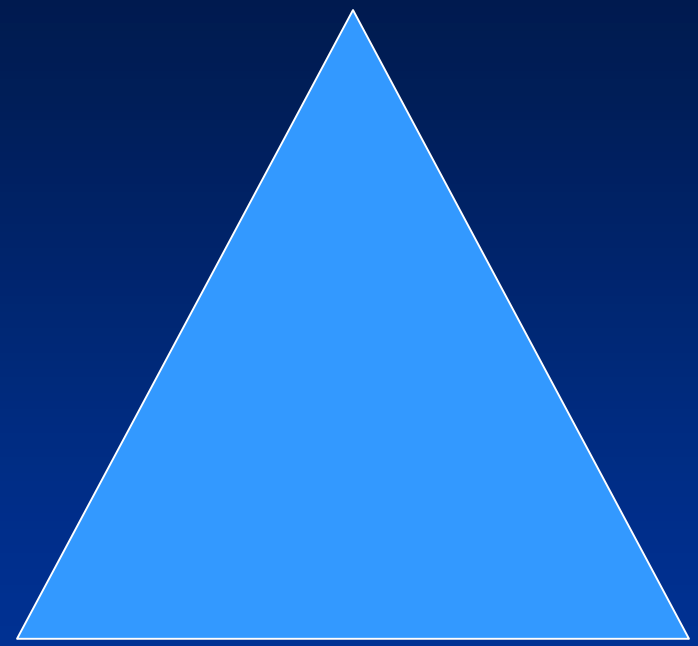
CDC

Factors in Disease Emergence

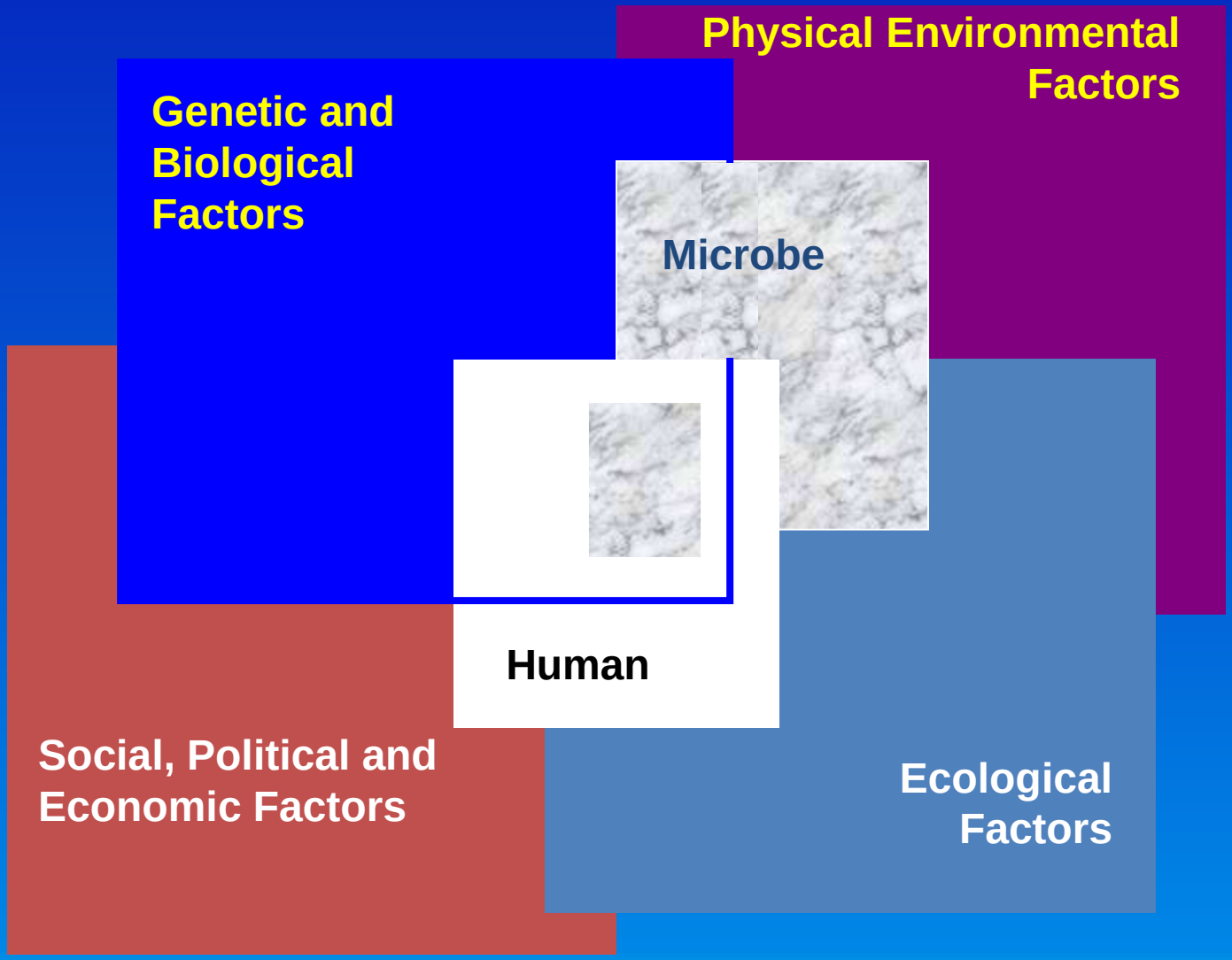
- Microbial adaptation and change
  - Genetic drift/shift, antibiotic selective pressure
- Host susceptibility to infection
  - Immunosuppression, transplant, nutrition deficit
- Changing ecosystems
  - Deforestation, economic development, climate and weather changes
- Technology and industry
  - Mass food production, global food supply, organ transplantation

Factors, II

- Human demographics and behavior
  - Population growth, sexual behavior, IV drug use
- International travel
  - Movement of goods and people
- Breakdown in public health
  - Premature program cuts, war and conflicts, inadequate sanitation, inadequate sterile environments


Person
Pathogen
Environment

Convergence Model



Convergence Model (Microbial Threats to Health – IOM/NAS, 2003)

Emerging Infections, A unified definition…

- Emerging
  - Increasing incidence
- Re-emerging
  - Was controlled, now increasing
- De-merging
  - Decreasing incidence
- Pre-merging
  - Incidence could increase

Emerging Infections in the Arctic:

Emerging

Vibrio parahaemolyticus Gastroenteritis among Cruise Ship Passengers, 2004

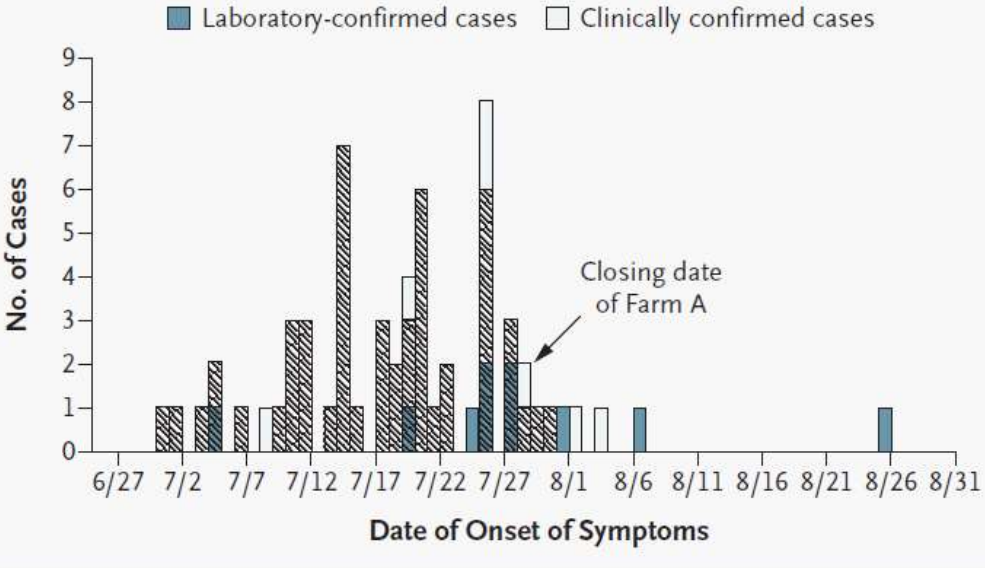


Figure 1. Cases of *Vibrio parahaemolyticus* Gastroenteritis in Alaska According to Date of Onset.

Of 62 cases of *V. parahaemolyticus* gastroenteritis, 10 cases were laboratory-confirmed and 52 met the clinical case definition. Hatch marks denote 51 patients who consumed oysters that were traced back to Farm A.

McLaughlin, et al., NEJM, 2005

Factor:
Increased ocean temperatures, Spread by animals or ship ballast water

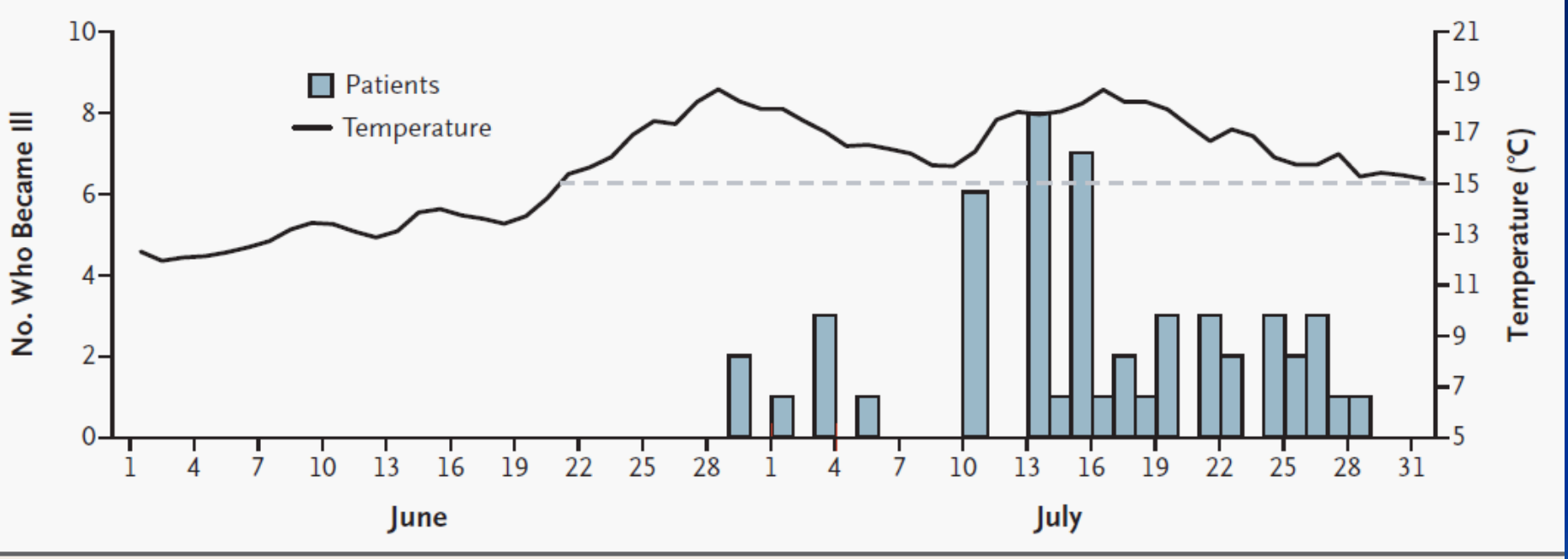
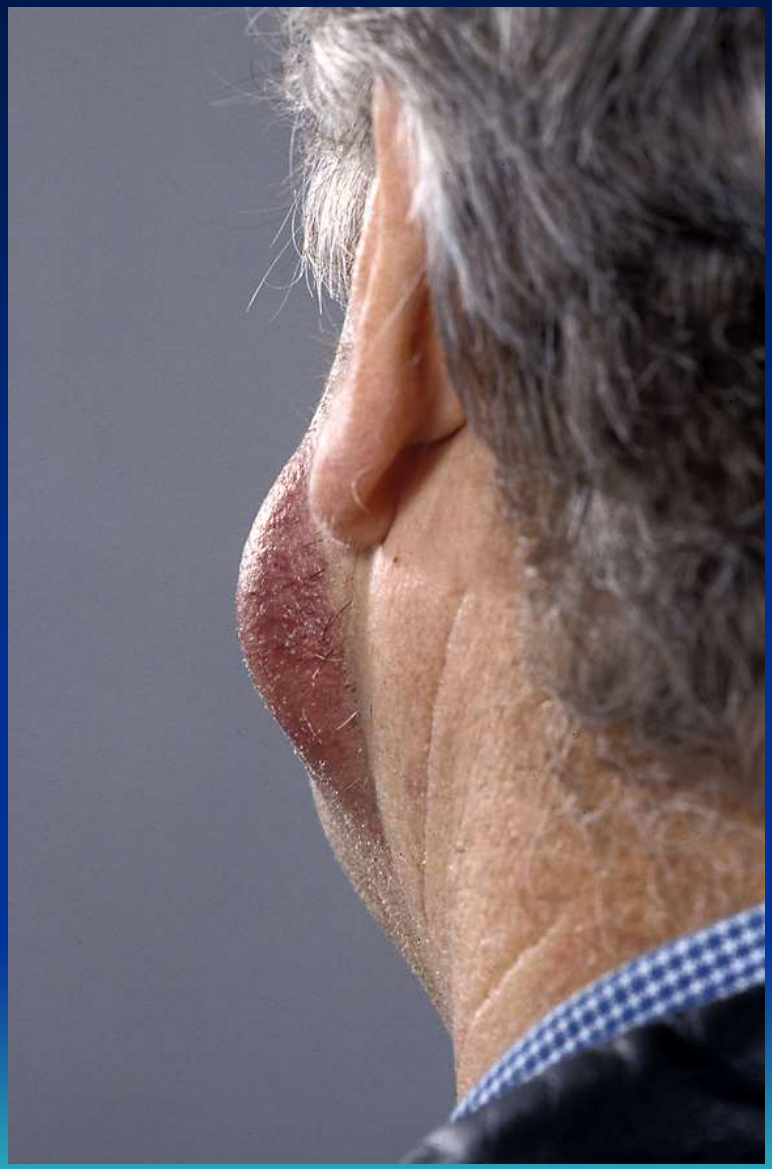


Figure 3. Number of Patients with *Vibrio parahaemolyticus* Infection Associated with Oysters from Farm A, According to the Harvest Date, and Mean Daily Water Temperatures at Farm A.

Tularemia
– rabbit fever

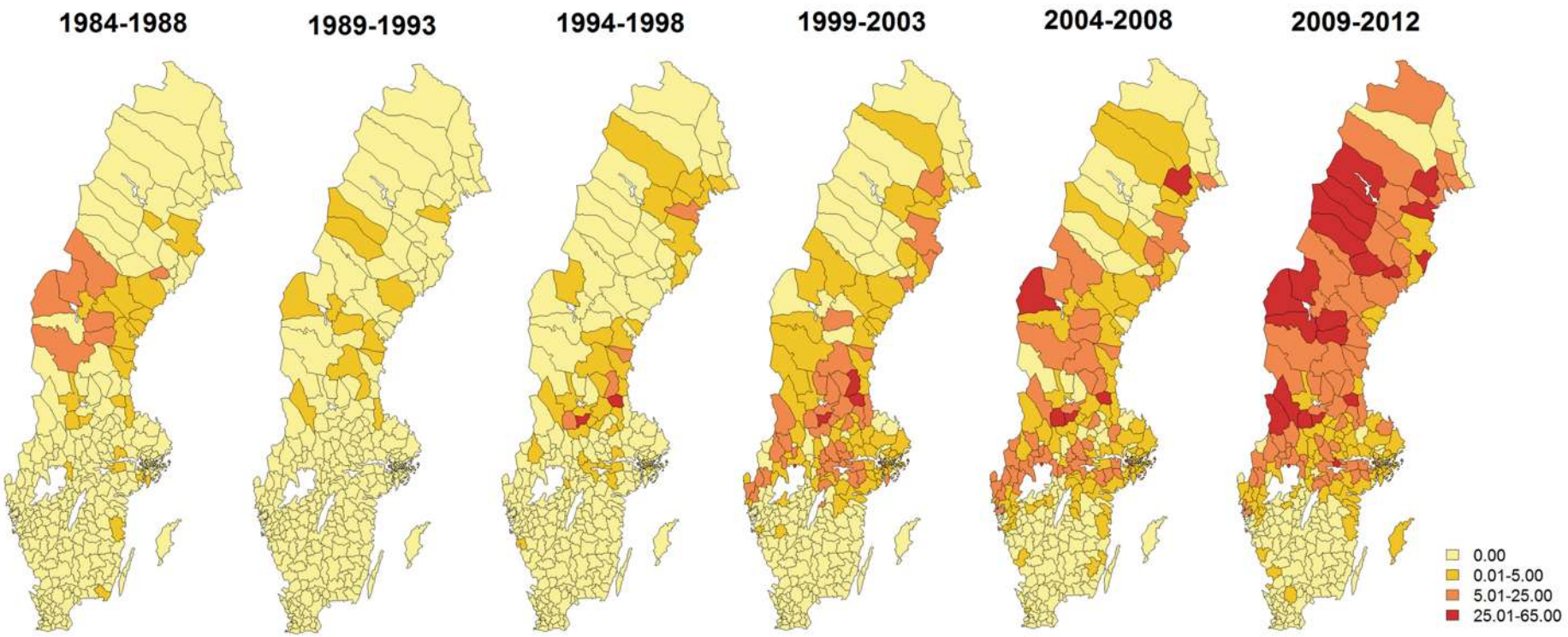
- Zoonotic
  - Rabbits
- Vectorborne
  - Mosquitos, ticks
- Ecological cycles poorly understood
- Rare disease,
- Highest incidence in Sweden, Finland, Turkey.



Courtesy of the patient and
Henrik Eliasson, MD Örebro. 2003

CDC

Incidence of tularemia in 189 municipalities per 5-year intervals, Sweden

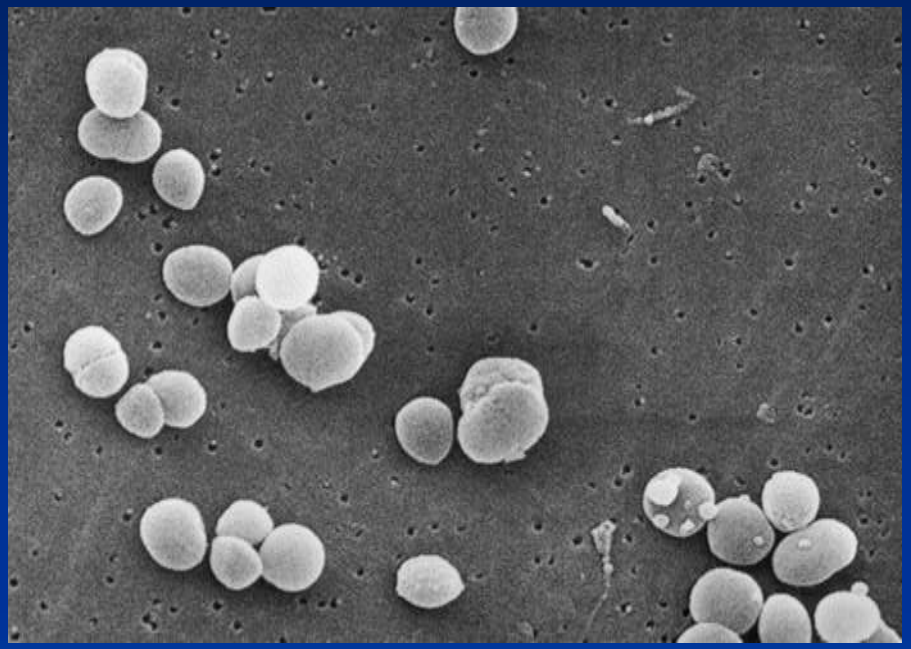


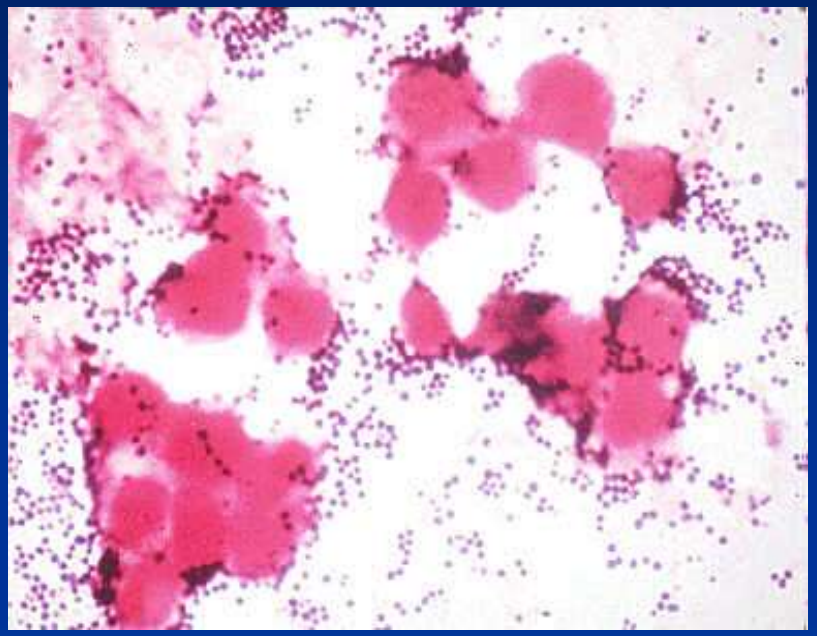
1. Desvars A, Furberg M, Hjertqvist M, Vidman L, Sjöstedt A, Rydén P, et al. Epidemiology and ecology of tularemia in Sweden, 1984–2012. Emerg Infect Dis [Internet]. 2015 Jan

Courtesy of Maria Furberg, Umea

CDC

Staphylococcus aureus





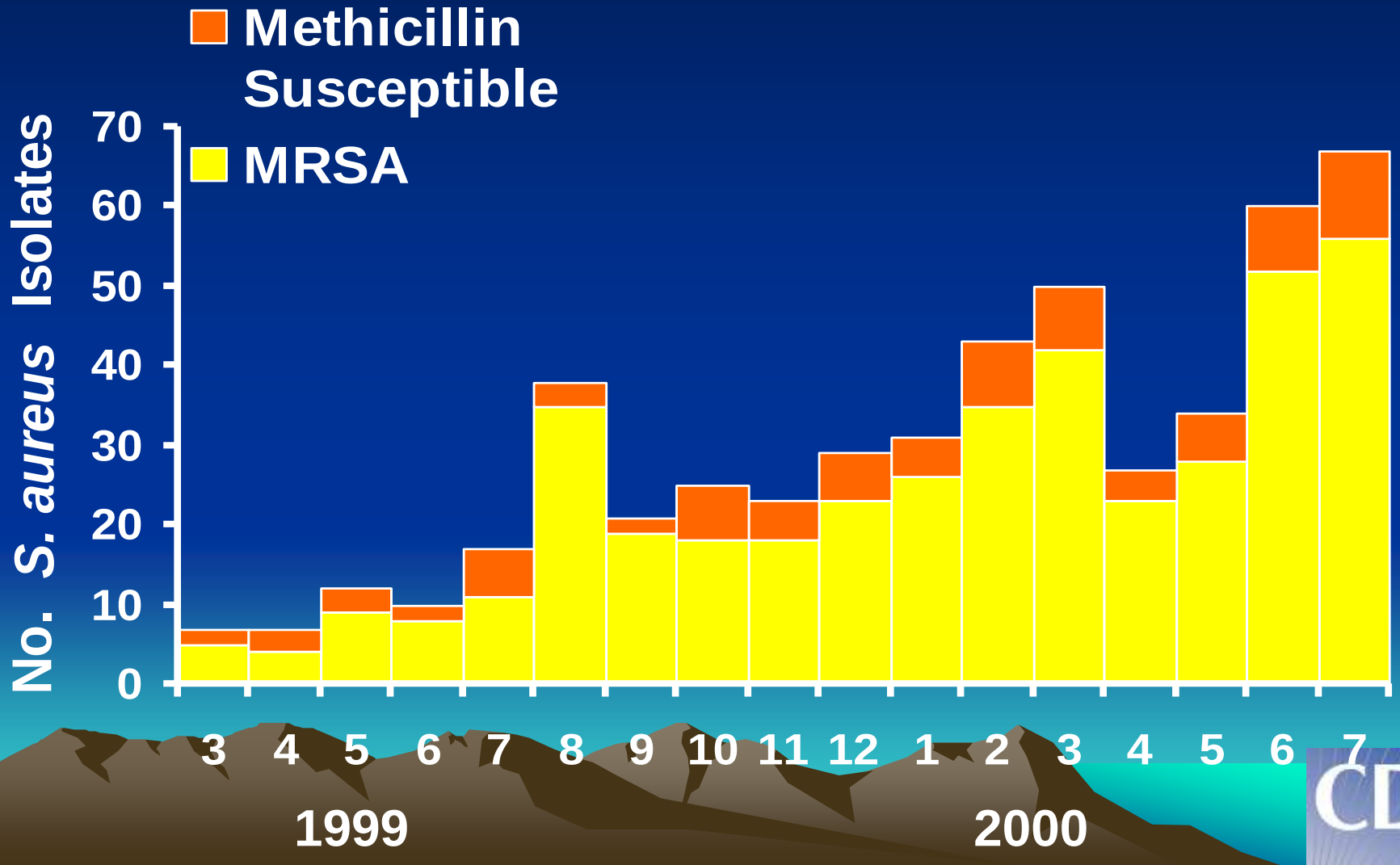
CDC

S. aureus Conditions

- Carrier state
- Direct infection
  - Skin
    - Boils (furuncles)
    - Cellulitis, impetigo
    - Wound infections
  - Deep infections
    - Post-trauma, surgery
    - Foreign material
    - Bursitis, arthritis, osteomyelitis
    - Pneumonia (post influenza)
    - Endocarditis
- Blood stream secondary to above
  - Metastatic infections
  - Vasculitis/coagulopathy
  - Sepsis and organ failure
- Toxin-mediated conditions
  - Scalded skin syndrome
  - Food poisoning
  - Toxic shock syndrome

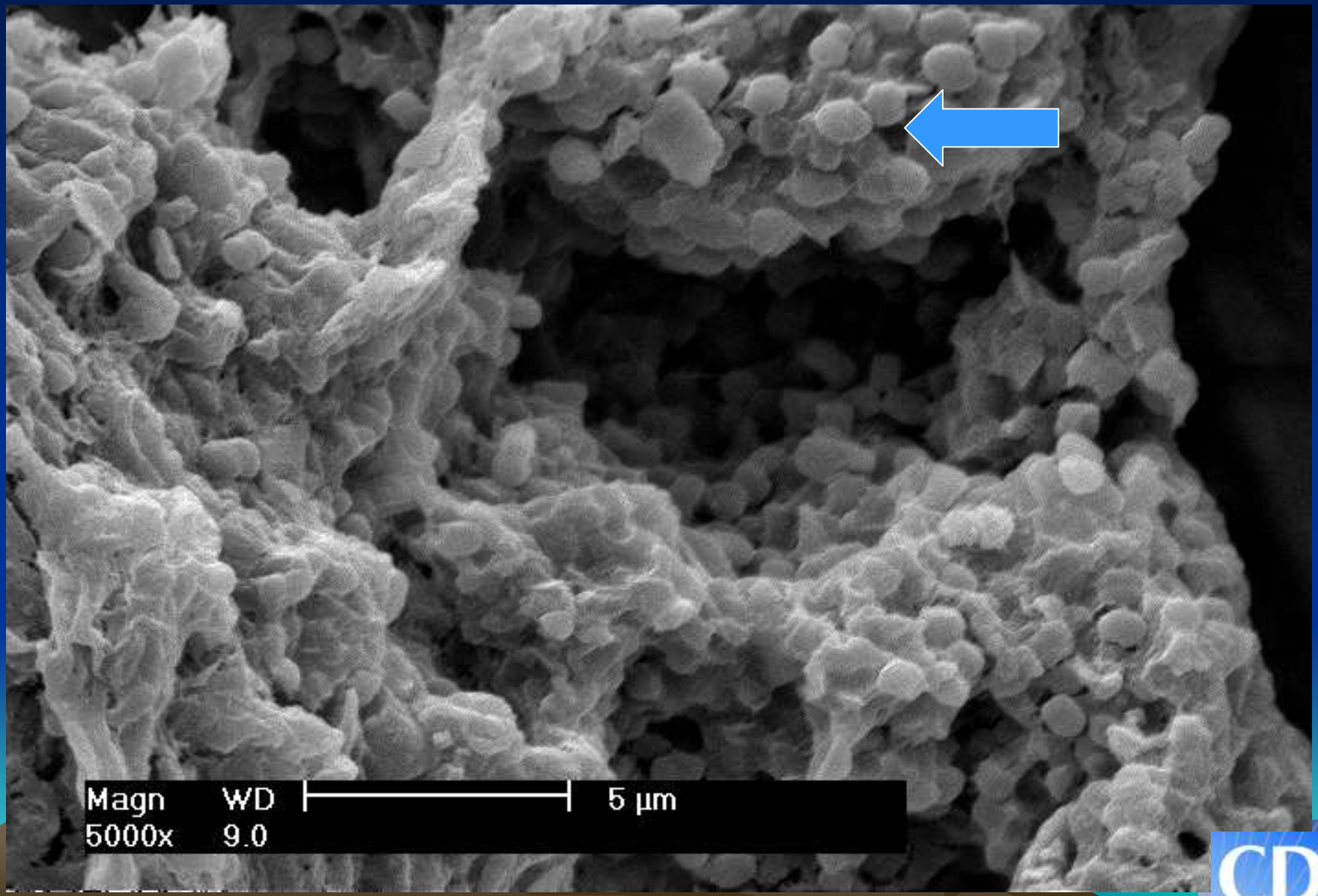
CDC

S. aureus Skin Infection Isolates, Southwest Alaska, 1999 - 2000



CDC

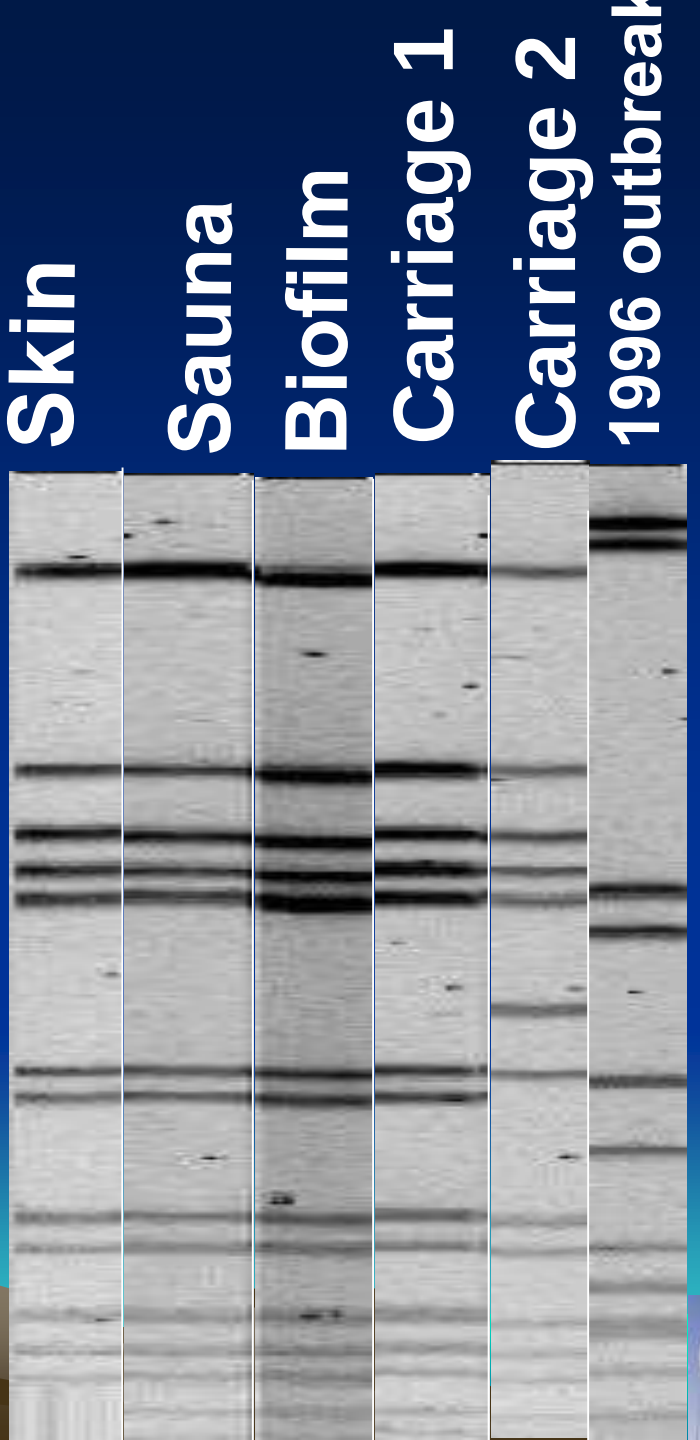
Biofilm from Sauna Wood Containing MRSA



CDC

MRSA PFGE Analysis

- 80 Total MRSA isolates
  - skin infection
  - sauna surface cultures
  - biofilm
  - nasal carriage
- 89% identical pattern
- 98% closely related



CDC

Risk Factors MRSA infection, Alaska

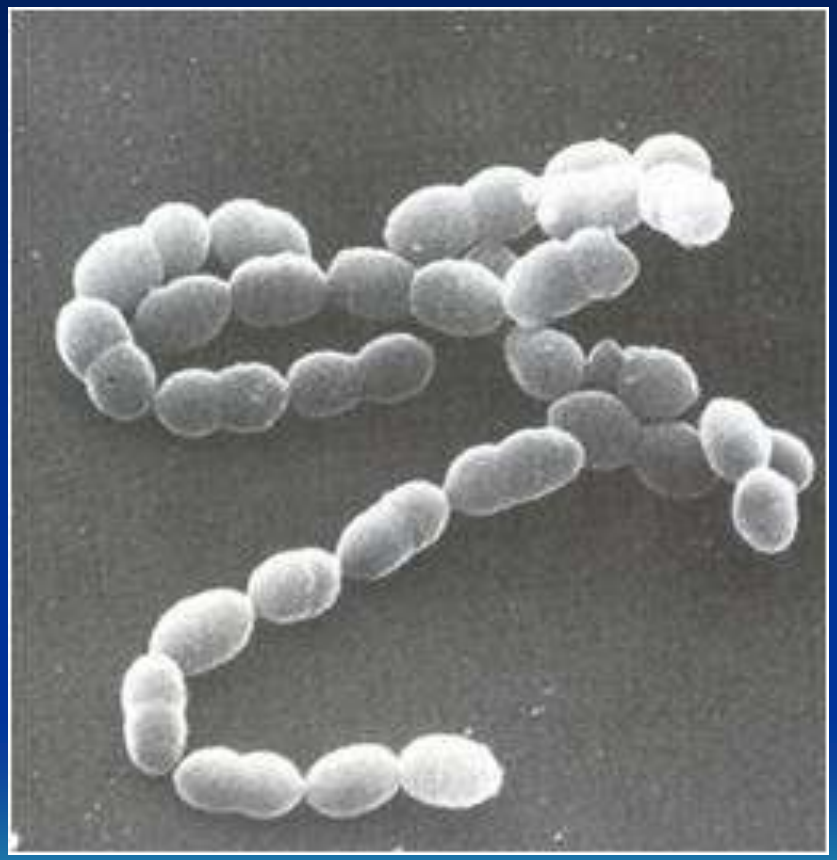
- Prior antibiotic use
  - Cephalosporin, select for MRSA
- Sauna use
  - More crowded sauna
  - MRSA-colonized sauna
- Household members with infection
- MRSA colonization

Baggett, ICHE, June 2003 and JID, April 2004

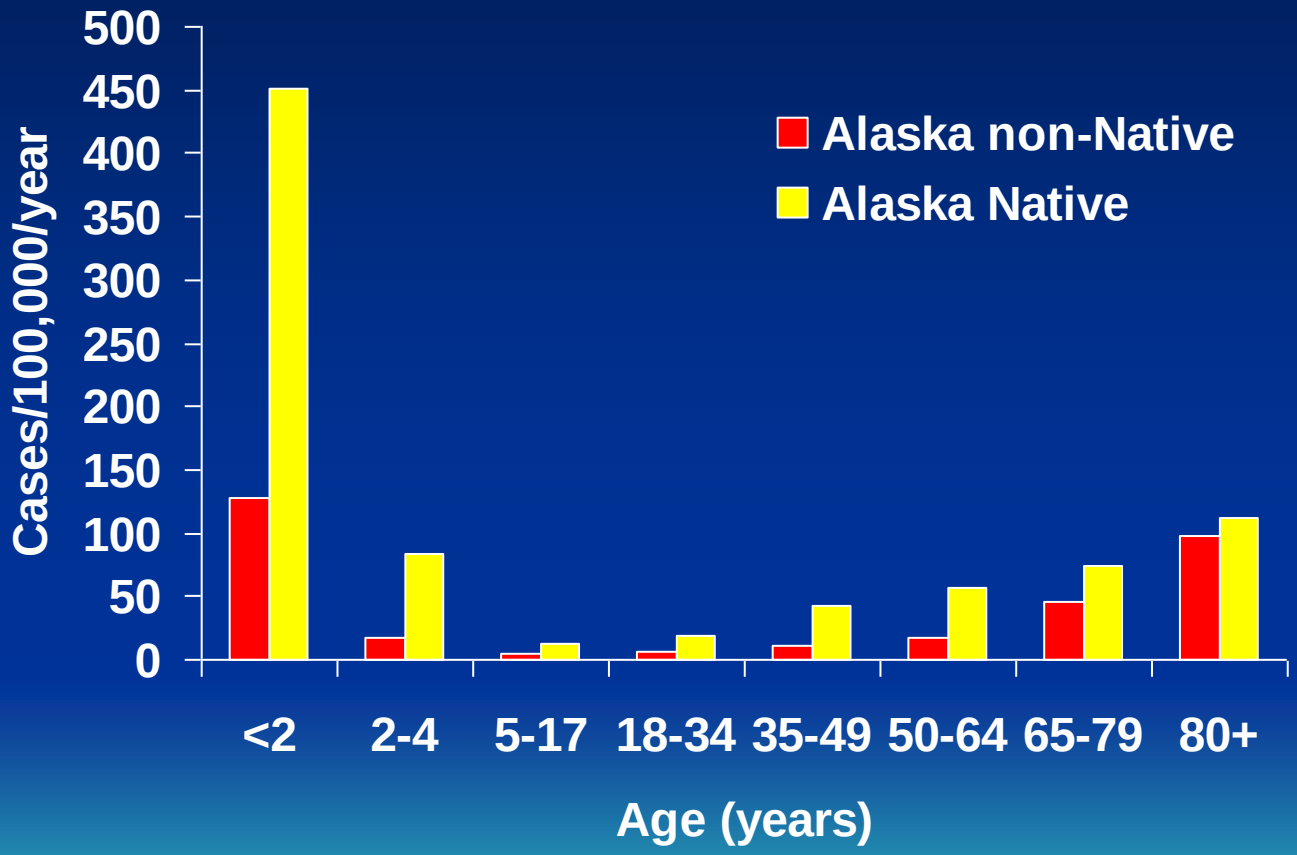
CDC

Streptococcus pneumoniae

- Human-only
- Nasopharyngeal colonization
- Invasive infection
- 2 vaccine types
  - Polysaccharide
  - Conjugate

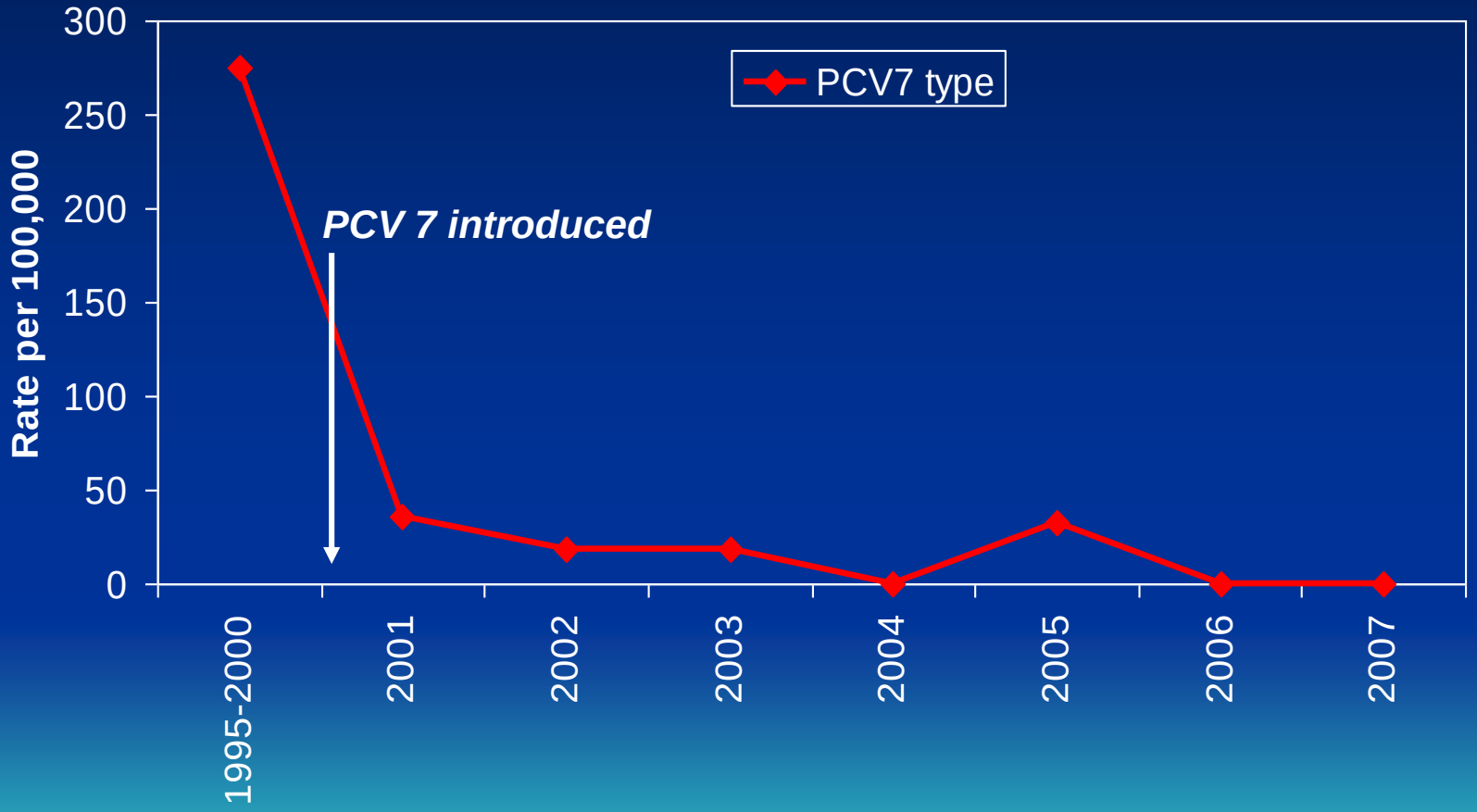


Invasive Pneumococcal Disease in Alaska, 1996-2000



CDC

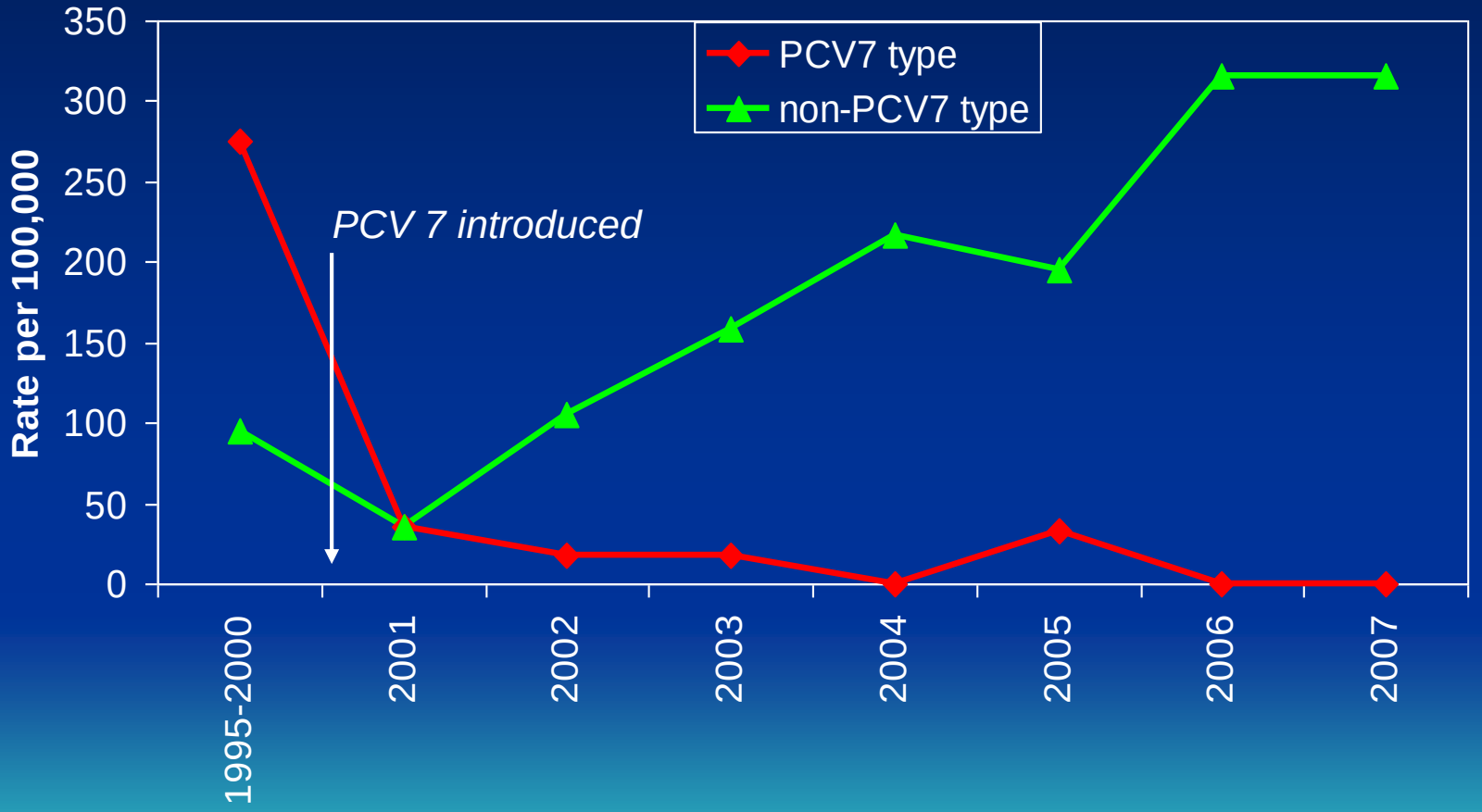
Vaccine-type Invasive Pneumococcal Disease Alaska Native Children < 2 years old



JAMA April 27, 2007

CDC

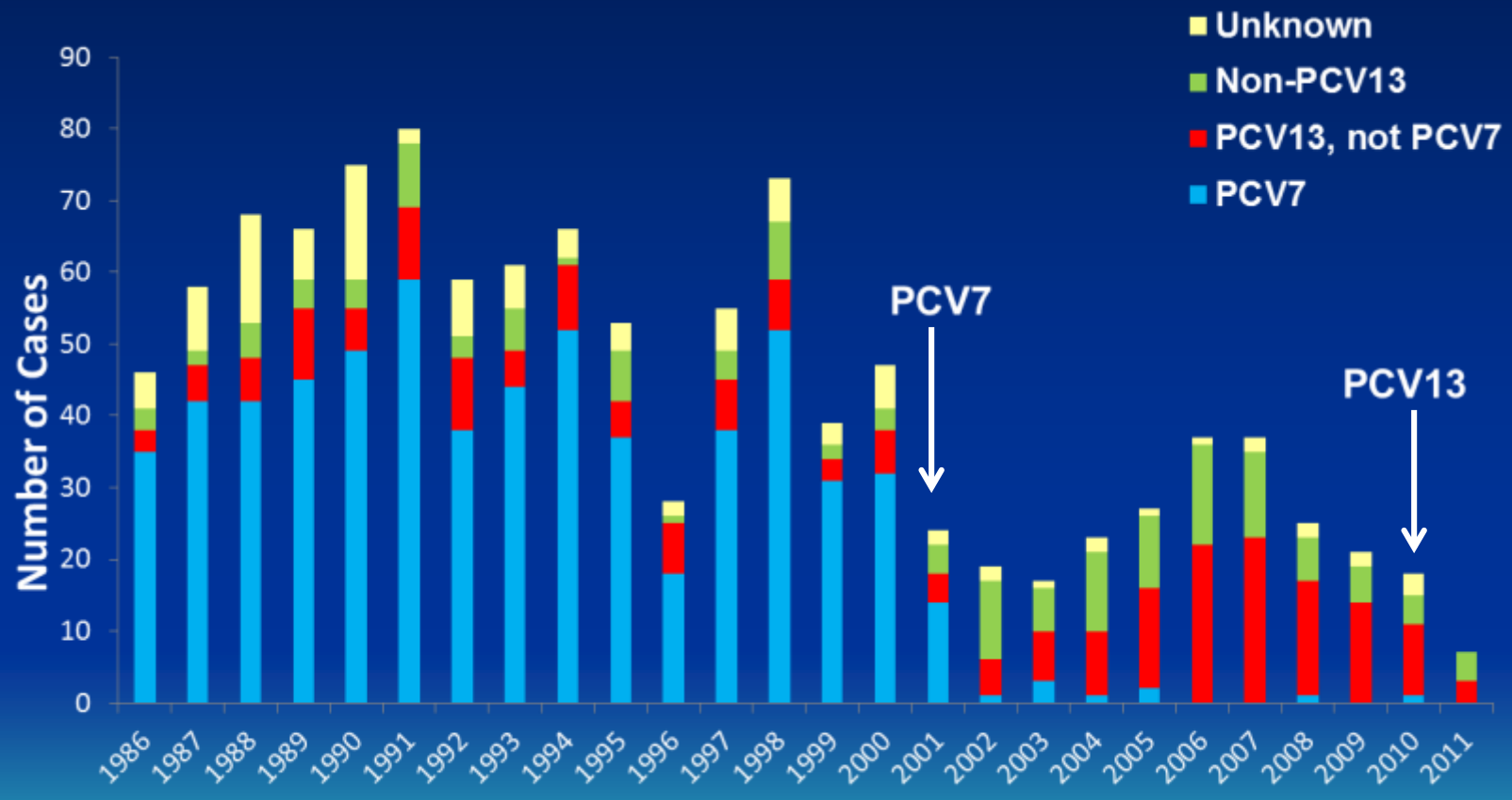
Invasive Pneumococcal Disease Rates
Alaska Native Children < 2 years old



JAMA April 27, 2007

CDC

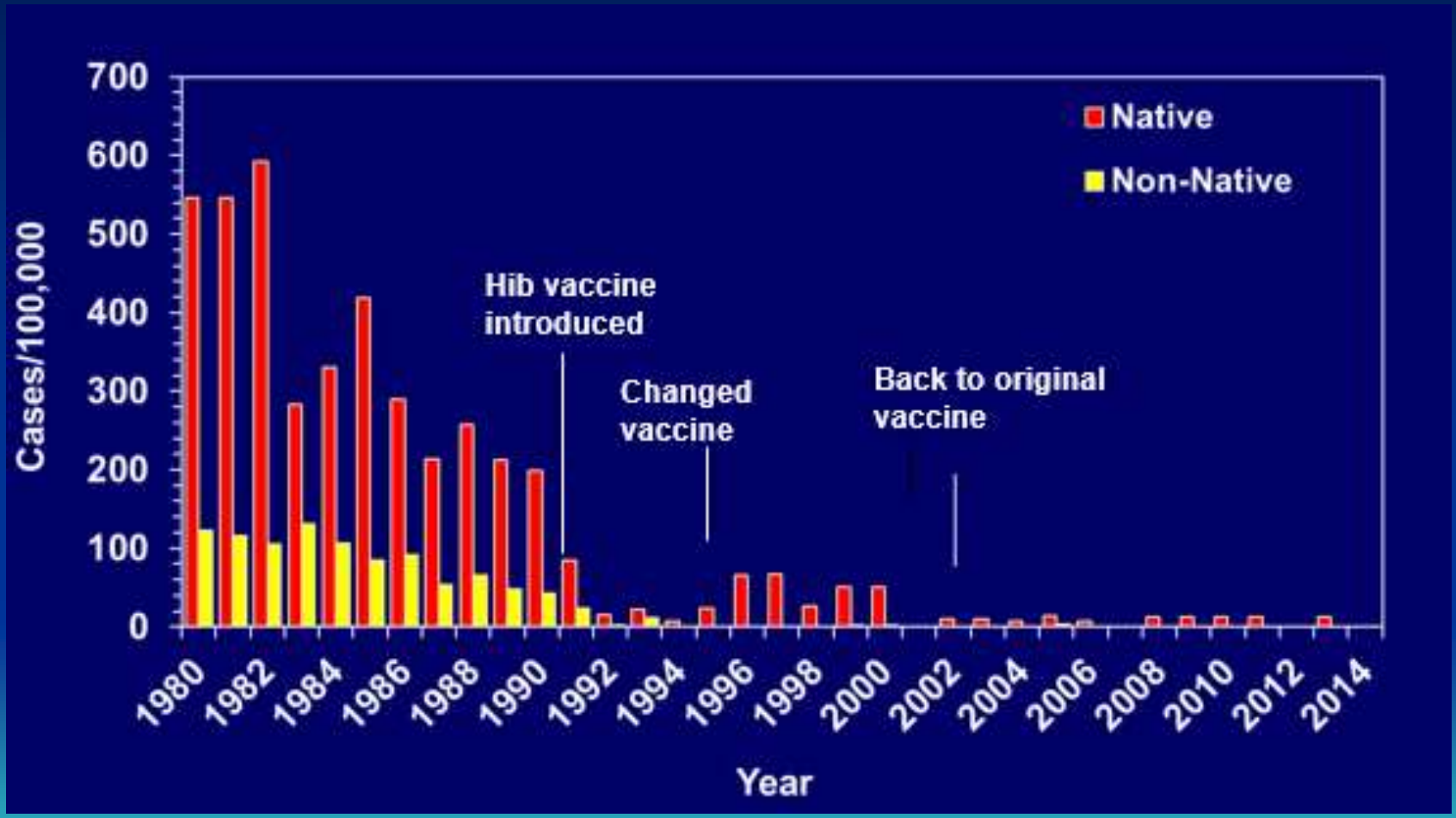
Invasive pneumococcal disease by vaccine Serotype in children < 5 Years, Alaska, 1986-2011



Emerging Infections in the Arctic:

Re-Emerging

Invasive Hib Disease, Children Aged <5 Years, Alaska, 1980 - 2014

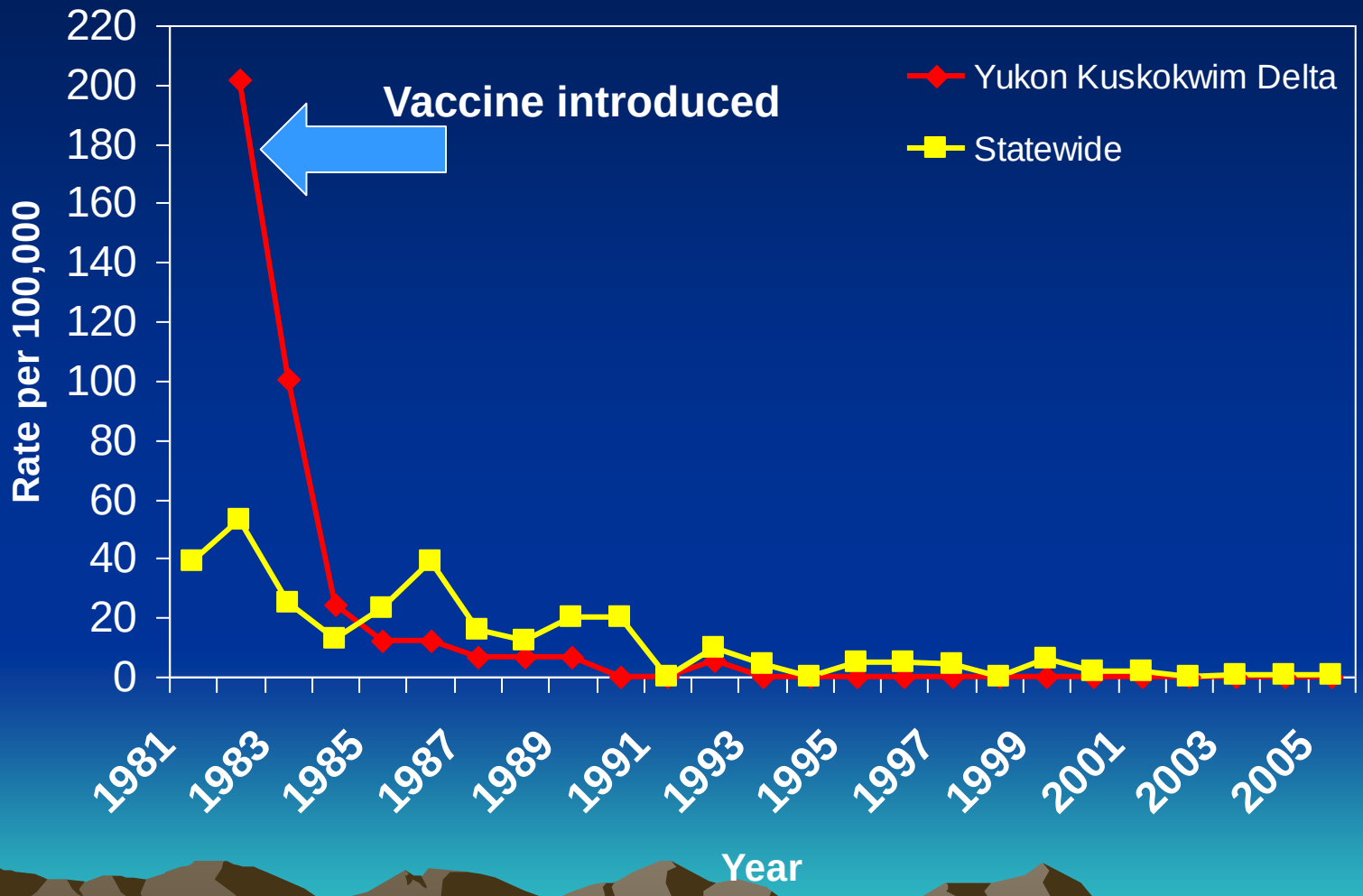


CDC

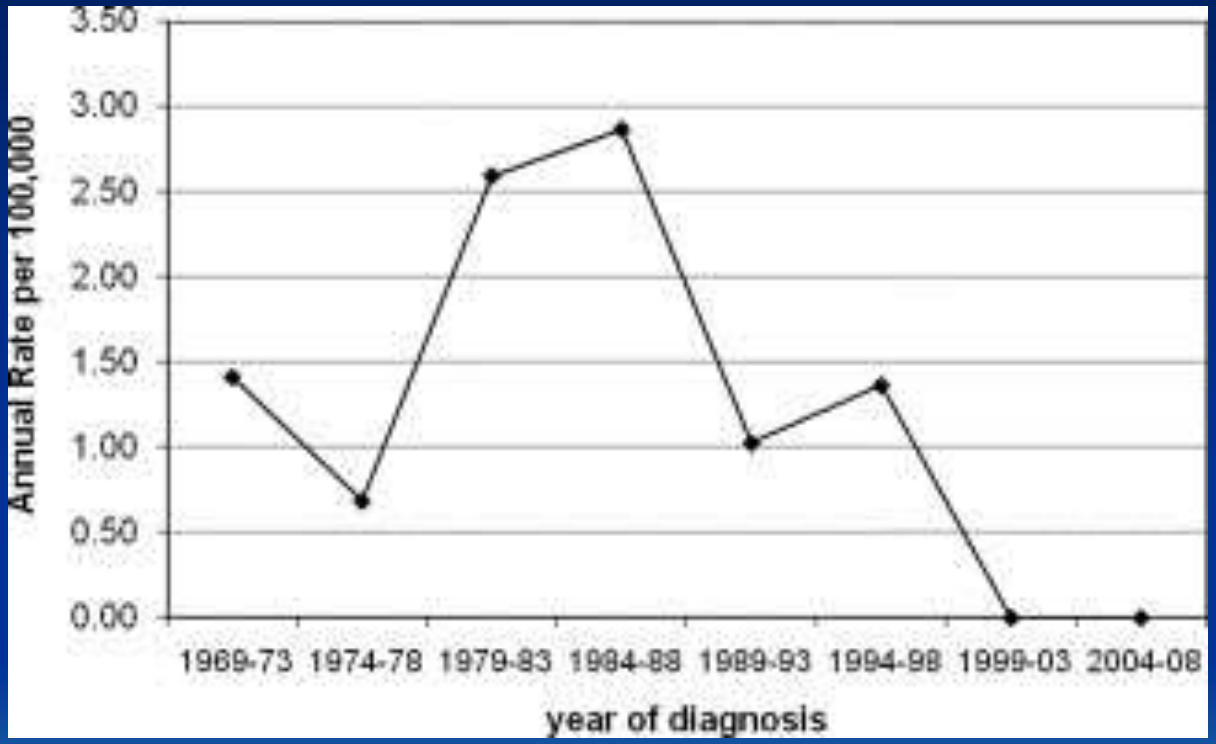
Emerging Infections in the Arctic:

De-Emerging

Hepatitis B in Alaska Native Persons, 1981- 2005



Hepatocellular Cancer in Alaska Native Children < 20 years old, 1969 - 2008



Emerging Infections in the Arctic:

Pre-merging

Challenges from Climate Change

Potentially Climate Sensitive Zoonoses

- Brucellosis: caribou
  - Increased stress from warming climate
- Toxoplasmosis: sea mammals?
  - Not just associated with cats, not reportable
- Trichinellosis: bear, seals, walrus
  - Arctic species resistant to freezing
- Giardiasis: beavers, day care
  - Northern migration of trees, beavers
  - Risk to drinking water

Other Potential Climate-related Diseases

- **Social Disruption**
  - Suicide, mental health concerns
  - Sexually transmitted diseases
- **Loss of traditional foods**
  - Diabetes, obesity, heart disease
- **Loss of water and sanitation systems**
  - Diarrhea, respiratory and skin infections

Conclusions

- Infectious diseases will continue to emerge, remerge, and demerge
- Major categories
  - Antimicrobial or vaccine pressure
  - Zoonoses
- Preparedness and response will continue to be a challenge