Zoonotic Infectious Diseases in Alaska

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Epidemiology Team Leader
Arctic Investigations Program, CDC
Anchorage, Alaska
Areas reporting confirmed occurrence of H5N1 avian influenza in poultry and wild birds since 2003
Characterizing wild bird contact and seropositivity to highly pathogenic avian influenza A (H5N1) virus in Alaskan residents

Carrie Reed, Dana Bruden, Kathy K. Byrd, Vic Veguilla, Michael Bruce, Debby Hurlbut, David Wang, Crystal Holiday, Kathy Hancock, Justin R. Ortiz, Joe Klejka, Jacqueline M. Katz, Timothy M. Uyeki

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Background Highly pathogenic avian influenza A (HPAI) H5N1 viruses have infected poultry and wild birds on three continents with more than 600 reported human cases (59% mortality) since 2003. Wild aquatic birds are the natural reservoir for avian influenza A viruses, and migratory birds have been documented with HPAI H5N1 virus infection. Since 2005, clade 2.2 HPAI H5N1 viruses have spread from Asia to many countries.

Objectives We conducted a cross-sectional seroepidemiological survey in Anchorage and western Alaska to identify possible behaviors associated with migratory bird exposure and measure seropositivity to HPAI H5N1.

Methods We enrolled rural subsistence bird hunters and their families, urban sport hunters, wildlife biologists, and a comparison group without bird contact. We interviewed participants regarding their exposures to wild birds and collected blood to perform serologic testing for antibodies against a clade 2.2 HPAI H5N1 virus strain.

**Results** Hunters and wildlife biologists reported exposures to wild migratory birds that may confer risk of infection with avian influenza A viruses, although none of the 916 participants had evidence of seropositivity to HPAI H5N1.

Conclusions We characterized wild bird contact among Alaskans and behaviors that may influence risk of infection with avian influenza A viruses. Such knowledge can inform surveillance and risk communication surrounding HPAI H5N1 and other influenza viruses in a population with exposure to wild birds at a crossroads of intercontinental migratory flyways.

Keywords Alaska, H5N1, influenza.

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Background

Zoonotic infections in Alaska: disease prevalence, potential impact of climate change and recommended actions for earlier disease detection, research, prevention and control

Karsten Hueffer¹, Alan J. Parkinson²*, Robert Gerlach³ and James Berner⁴

¹Department of Biology and Wildlife, Institute of Arctic Biology, University of Alaska Fairbanks, Fairbanks, AK, USA; ²Arctic Investigations Program, National Center for Emerging and Zoonotic Infectious Diseases, Centers for Disease Control and Prevention, Anchorage, AK, USA; ³Office of the State Veterinarian, Alaska Division of Environmental Health, Anchorage, AK, USA; ⁴Community Health Services, Alaska Native Tribal Health Consortium, Anchorage, AK, USA

Abstract
The zoonotic disease tularemia is endemic in large areas of the Northern Hemisphere, but research is lacking on patterns of spatial distribution and connections with ecologic factors. To describe the spatial epidemiology of and identify ecologic risk factors for tularemia incidence in Sweden, we analyzed surveillance data collected over 29 years (1984-2012). A total of 4,630 cases were notified, of which 3,524 met all study inclusion criteria. From the first to the second half of the study period, mean incidence increased 10-fold, from 6.26/100,000 persons during 1984-1998 to 2.47/100,000 persons during 1999-2012 (p<0.001). The incidence of tularemia was higher than expected in the boreal and alpine ecologic regions (p<0.001), and incidence was positively correlated with the presence of lakes and rivers (p<0.001). These results provide a comprehensive epidemiologic description of tularemia in Sweden and illustrate that incidence is higher in locations near lakes and rivers.
Serologic Investigation of Zoonotic Infections
Alaska

• Collaboration between
  – Arctic Investigations Program, CDC Alaska
  – Influenza Branch, CDC Atlanta
  – Alaska Native Tribal Health Consortium
  – Yukon Kuskokwim Health Corporation
Objectives

– Baseline assessment of seroprevalence of important zoonotic infections in four different Alaska populations
– Determine which infections warrant further investigation, surveillance or prevention and control activities
Serologic Investigation
Methods

• Study design
  – Cross-sectional seroprevalence study
• Blood draw
• Questionnaire for hunting and cleaning practices
• Study period
  – 1 year (2007-2008)
• Serologic testing for antibodies against:
  • Brucella, Echinococcus, Franciscella tularensis, Trichinella, Toxoplasma, Giardia, Cryptosporidia, Hepatitis E, Arbovirus panel, Coxiella burnetii, H5N1 & low path flu viruses
Zoonotic Serologic Investigation
Inclusion Criteria

- Alaska subsistence hunters* and family members aged ≥ 5 years
- Alaska sport hunters*
- Wildlife biologists/researchers**
- Anchorage and Bethel residents without wild bird exposure, aged ≥ 5 years

* who have hunted for at least 2 of the past 5 years
** who have had contact with wild birds for at least 1 Alaska field season in the past 5 years
Pilot Study to Establish Baseline Seroprevalence of Zoonotic Infections

• In the following populations:
  – 467 Alaska Native bird hunters & family members
    – 6 villages in western Alaska
  – 164 Alaskan Sport hunters
  – 205 Alaskans without wild bird exposure
  – 80 wildlife biologists/researchers
  916 total
Study Population

- Urban Sport Bird Hunters
- Rural Subsistence Bird Hunters and Families
- Controls
- Bird Researchers
Results

- Results Back for:
  - Brucella
  - Francisella tularensis
  - Trichinella
  - Echinococcus
  - Giardia intestinalis
  - Cryptosporidium
  - Coxiella burnetti
  - Arboviruses
    - Jamestown Canyon, Snowshoe hare
  - Hepatitis E
  - H5N1
  - Toxoplasma
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- Subsistence hunters and their families younger than the other 3 groups
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### Gender

- Subsistence hunters and their families younger than the other 3 groups
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- Subsistence hunters and their families younger than the other 3 groups
- Sport Hunters, Wildlife Researchers and Subsistence Hunters were mostly male
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- Subsistence hunters and their families younger than the other 3 groups
- Sport Hunters, Wildlife Researchers and Subsistence Hunters were mostly male
- Controls (No wild bird exposure) and Subsistence family members were mostly female
Demographics of Study Groups

<table>
<thead>
<tr>
<th>Demographic Factor</th>
<th>Level</th>
<th>No Wild Bird Exposure</th>
<th>Sport Hunter</th>
<th>Wildlife Researcher</th>
<th>Subsistence Hunter</th>
<th>Subsistence Family</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (original study)</td>
<td>17</td>
<td>204</td>
<td>164</td>
<td>82</td>
<td>237</td>
<td>229</td>
<td>916</td>
</tr>
<tr>
<td>n (zoonosis pathogen study)</td>
<td>196 (95%)</td>
<td>160 (98%)</td>
<td>77 (94%)</td>
<td>233 (98%)</td>
<td>221 (97%)</td>
<td>887 (97%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 15 Years</td>
<td>6% (n = 11)</td>
<td>3% (n = 5)</td>
<td>0% (n = 0)</td>
<td>16% (n = 38)</td>
<td>33% (n = 72)</td>
<td>14% (n=126)</td>
<td></td>
</tr>
<tr>
<td>15-24 Years</td>
<td>24% (n = 47)</td>
<td>9% (n = 15)</td>
<td>4% (n = 3)</td>
<td>37% (n = 87)</td>
<td>24% (n = 52)</td>
<td>23% (n=204)</td>
<td></td>
</tr>
<tr>
<td>25-34 Years</td>
<td>19% (n = 38)</td>
<td>11% (n = 17)</td>
<td>29% (n = 22)</td>
<td>16% (n = 37)</td>
<td>13% (n = 28)</td>
<td>16% (n=142)</td>
<td></td>
</tr>
<tr>
<td>35-49 Years</td>
<td>27% (n = 52)</td>
<td>36% (n = 58)</td>
<td>35% (n = 27)</td>
<td>21% (n = 49)</td>
<td>17% (n = 38)</td>
<td>25% (n=224)</td>
<td></td>
</tr>
<tr>
<td>≥50 Years</td>
<td>24% (n = 48)</td>
<td>41% (n = 65)</td>
<td>32% (n = 25)</td>
<td>9% (n = 22)</td>
<td>14% (n = 31)</td>
<td>22% (n=191)</td>
<td></td>
</tr>
</tbody>
</table>

| Gender            | % Female | 71% (n = 139) | 7% (n = 11) | 32% (n = 25) | 9% (n = 21) | 85% (n = 187) | 43% (n=383) |
| Residence         | % Rural  | 24% (n = 47)  | 4% (n = 7)  | 21% (n = 16) | 100% (n = 233) | 100% (n = 221) | 59% (n=524) |
| Ethnicity         | % Native Persons | 31% (n = 60) | 6% (n = 9)  | 0% (n = 0)   | 100% (n = 233) | 100% (n = 221) | 59% (n=523) |

- Subsistence hunters and their families younger than the other 3 groups
- Sport Hunters, Wildlife Researchers and Subsistence Hunters were mostly male
- Controls (No wild bird exposure) and Subsistence family members were mostly female
- All Subsistence hunters and their families lived rurally and were Alaska Native
Franciscella Tularensis, Influenza H5N1, and Brucella were not included in the Figure.

- No sera tested positive for F. Tularensis or H5N1, 1 positive for Brucella.
<table>
<thead>
<tr>
<th>Zoonosis</th>
<th>Seropositivity</th>
<th></th>
<th></th>
<th></th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Subsistence Hunter/Family Member</td>
<td>Sport Hunter</td>
<td>Researcher</td>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>Cryptosporidium</td>
<td>30%</td>
<td>27%</td>
<td>32%</td>
<td>27%</td>
<td>0.72</td>
</tr>
<tr>
<td><em>Giardia intestinalis</em></td>
<td>29%</td>
<td>12%</td>
<td>8%</td>
<td>5%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Arbovirus</td>
<td>24%</td>
<td>33%</td>
<td>52%</td>
<td>18%</td>
<td>0.0004</td>
</tr>
<tr>
<td>Coxiella Burnetii</td>
<td>11%</td>
<td>5%</td>
<td>1%</td>
<td>9%</td>
<td>0.05</td>
</tr>
<tr>
<td>Trichinella</td>
<td>3%</td>
<td>9%</td>
<td>1%</td>
<td>9%</td>
<td>0.0003</td>
</tr>
<tr>
<td>Echinococcus (granulosis)</td>
<td>2%</td>
<td>2%</td>
<td>4%</td>
<td>1%</td>
<td>0.60</td>
</tr>
<tr>
<td>Toxoplasma gondii</td>
<td>1%</td>
<td>5%</td>
<td>9%</td>
<td>3%</td>
<td>0.001</td>
</tr>
<tr>
<td>Hepatitis E (igG)</td>
<td>0%</td>
<td>7%</td>
<td>6%</td>
<td>4%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Flu H5N1</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Brucella</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>F. Tularensis</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

*Statistical significance across the different groups
## Seroprevalence by Organism, Alaska

<table>
<thead>
<tr>
<th>Zoonosis</th>
<th>Subsistence Hunter/Family Member</th>
<th>Sport Hunter</th>
<th>Researcher</th>
<th>Control</th>
<th>P value*</th>
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<td>33%</td>
<td>52%</td>
<td>18%</td>
<td>0.0004</td>
</tr>
<tr>
<td>Coxiella Burnetii</td>
<td>11%</td>
<td>5%</td>
<td>1%</td>
<td>9%</td>
<td>0.05</td>
</tr>
<tr>
<td>Trichinella</td>
<td>3%</td>
<td>9%</td>
<td>1%</td>
<td>9%</td>
<td>0.0003</td>
</tr>
<tr>
<td>Echinococcus (granulosis)</td>
<td>2%</td>
<td>2%</td>
<td>4%</td>
<td>1%</td>
<td>0.60</td>
</tr>
<tr>
<td>Toxoplasma gondii</td>
<td>1%</td>
<td>5%</td>
<td>9%</td>
<td>3%</td>
<td>0.001</td>
</tr>
<tr>
<td>Hepatitis E (igG)</td>
<td>0%</td>
<td>7%</td>
<td>6%</td>
<td>4%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Flu H5N1</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Brucella</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>F. Tularensis</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

*Statistical significance across the different groups
Seropositivity by Gender, Alaska

![Bar chart showing seropositivity for Cryptosporidium parvum and Giardia intestinalis by gender.](chart)

- Cryptosporidium parvum:
  - Male: 25%
  - Female: 35%

- Giardia intestinalis:
  - Male: 20%
  - Female: 15%

* P < .05

* Male is represented by blue bars, and Female is represented by red bars.
Gender Associations by Study Group, Alaska

**Cryptosporidium parvum**

<table>
<thead>
<tr>
<th>Group</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsistence hunter</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Subsistence family member</td>
<td>35</td>
<td>30</td>
</tr>
<tr>
<td>Wildlife researcher</td>
<td>32</td>
<td>28</td>
</tr>
<tr>
<td>Sport hunter</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>No wild bird exposure</td>
<td>25</td>
<td>20</td>
</tr>
</tbody>
</table>

**Giardia intestinalis**

<table>
<thead>
<tr>
<th>Group</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsistence hunter</td>
<td>32</td>
<td>28</td>
</tr>
<tr>
<td>Subsistence family member</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>Wildlife researcher</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Sport hunter</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>No wild bird exposure</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>
Gender Associations by Study Group, Alaska

**Cryptosporidium parvum**

- Subsistence hunter: Male > Female
- Subsistence family member: Male > Female
- Wildlife researcher: Male < Female
- Sport hunter: Male > Female
- No wild bird exposure: Male > Female

**Giardia intestinalis**

- Subsistence hunter: Male > Female
- Subsistence family member: Male > Female
- Wildlife researcher: Male > Female
- Sport hunter: Male > Female
- No wild bird exposure: Male > Female
Significant Differences in Seropositivity by Age-Class, Alaska

* P < .05
Differences in Seopositivity by Age Class and Group Alaska

- Cryptosporidium parvum
- Echinococcus spp.
- Coxiella burnetii
- California serogroup bunyavirus

Bar charts showing the percentage of persons seropositive for each organism across different age groups and exposure levels.
Seropositivity by Water Source
All Groups
Alaska

* P < .0001
Seropositivity by Water Source Subsistence Hunters and Family Alaska

% Antibody

Giardia intestinalis

Running Water

No Running Water

* P = .02
Conclusion I

- Exposures to a variety of zoonotic infections occurs in multiple different Alaska populations
Conclusion I

• Exposures to a variety of zoonotic infections occurs in multiple different Alaska populations
  – 1/3 exposed to Cryptosporidium parvum
  – 1/4 exposed to Arboviruses (JC or SSH)
  – 1/5 exposed to Giardia intestinalis
  – 1/10 exposed to Coxiella burnetii
Conclusion I

• Exposures to a variety of zoonotic infections occurs in multiple different Alaska populations
  – 1/3 exposed to Cryptosporidium parvum
  – 1/4 exposed to Arboviruses (JC or SSH)
  – 1/5 exposed to Giardia intestinalis
  – 1/10 exposed to Coxiella burnetii

• Minimal exposure to: Trichinella, Toxoplasma, Hepatitis E virus, Echinococcus or Brucella

• No exposure to influenza H5N1 or Francisella Tularensis
Conclusions II

• When comparing across the 4 groups:
  – Subsistence hunters and their family members had significantly higher seropositivity to Giardia
  – Researchers had significantly higher seropositivity to Arboviruses (JC & SSH) and Toxoplasmosis
  – Sports Hunters and Controls had higher seropositivity to Trichinella
Conclusions III

• When comparing by gender:
  – Females had significantly higher seropositivity to *Cryptosporidium parvum*
  – Males had significantly higher seropositivity to *Giardia intestinalis*
Conclusions IV

• When comparing by age:
  – Older aged persons had significantly higher seropositivity to:
    • Cryptosporidium parvum
    • Arboviruses
    • Coxiella burnetii
    • Echinococcus
Conclusions V

• When comparing by piped vs unpiped water:
  – Persons without piped water had significantly higher seropositivity to:
    • Giardia
Conclusions VI

• This study can serve as a baseline prevalence of zoonotic infection exposure to which future studies can be compared
Thank You!
Acknowledgements

Karen Miernyk, CDC, Arctic Investigations Program CDC/AIP
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Justin Ortiz, CDC/ID
Helen Peters CDC/AIP
Carrie Reed, CDC/ID
Karen Rudolph, CDC/AIP
Timothy M. Uyeki, CDC/ID
Results

• Results Back for:
  – Brucella
  – Francisella tularensis
  – Trichinella
  – Echinococcus
  – Giardia intestinalis
  – Cryptosporidium
  – Coxiella burnetti
  – Arboviruses
    • Jamestown Canyon, Snowshoe hare
  – Hepatitis E
  – influenza
  – Toxoplasma

Infectious Diseases Reportable to the State shown in blue
Arbovirus
Methods

• Testing
  – Used a neutralization assay (IgG) to determine neutralizing antibodies to SSH and JC
    • If > 1:20 = positive
    • Some cases were exposed to both viruses
    • If pos for both, the virus (JC or SSH) that was 4 fold higher diff in concentration was the one
  – IgM ELISA
    • Indicates recent exposure
Arbo
Methods

• We chose to test a subset of the serum samples for Arbo
• Sampling based on geographic location to get broadest geographic coverage
• All 5 study groups represented
• Among 916 samples, 482 (53%) tested by neutralization assay (IgG)
• 302 tested by IgM
  – Was this subsample of 302 randomly selected?
Brucella Methods

• Testing
  – *Brucella* spp. (*B. abortus*, *B. melitensis*, *B. suis*, *B. ceti*, *B. pinnipediae*)

• IgG antibodies were detected with a microagglutination test using the *B. abortus* strain 1119-3 as antigen
  – This strain reacts with antibodies to naturally occurring strains of *B. abortus*, *B. melitensis*, *B. suis*, *B. ceti*, and *B. pinnipediae*

• A titer of $\geq 160$ was considered a positive result, 20-80 borderline, and $<20$ was considered a negative result
Cryptosporidium parvum
Methods

• Testing

• IgG antibodies were detected with a multiplex bead assay using Cp17 and Cp23 as antigen
  – This assay has a sensitivity of 91% and a specificity of 87%.

• Antibody response to ≥2 antigens was considered a positive result
**Echinococcus granulosis**

**Methods**

- Testing
- IgG antibodies were detected with Luminex bead technology using hydatid cyst fluid
- This test has a sensitivity of 81% and a specificity of 99%
Echinococcus multilocularis

Methods

• Testing

• IgG antibodies were detected using an enzyme-linked immunosorbent assay (ELISA) with Em18 antigen

• This test has a sensitivity of 86% and a specificity of 99%
Giardia intestinalis

Methods

• IgG antibodies were detected with a multiplex bead assay using VSP3 and VSP5 as antigen
• This assay has a sensitivity of 93%
• Antibody response to ≥2 antigens was considered a positive result
Toxoplasma gondii

Methods

• Testing

• The commercial IgG enzyme immunoassay Platelia Toxo-G (Bio-Rad, Hercules, CA) was used according to the manufacturer’s instructions

• A titer of >10 IU was considered a positive result
Coxiella burnetii
Methods

• Testing

• The commercial IgG ELISA (Virion Serion Wurtzburg, Germany) was used according to the manufacturer’s instructions with the exception that samples were diluted 1:100

• Positive and borderline samples were further analyzed for both Phase I and Phase II IgG by immunofluorescence assay (IFA)

• A Phase I and/or Phase II IFA titer ≥1:16 was considered a positive result
Francisella tularensis (F. tularensis tularensis, F. tularensis holarctica)

Methods

• Testing
• IgG antibodies were detected using a microagglutination test
Hepatitis E
Methods

• Testing
• IgG antibodies were detected using an ELISA