An outbreak of *Salmonella* Javiana associated with amphibian contact—Mississippi, 2001

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Salmonellosis

- 1.4 million illnesses annually in US
- Gastrointestinal illness
- Results from ingestion of foods of animal origins
- Fresh produce, water, reptiles also implicated
- 2500 *Salmonella* serotypes
Salmonella Javiana, an emerging pathogen, 1990-2000
Salmonella Javiana

- 40% infections occur in children aged < 5 years
- Occurs almost exclusively in late summer
- Highest incidence in Southeastern United States
Incidence of *S. Javiana* by county, 2001

= Counties with incidence of > 1.4/100,000 population
Outbreak in Mississippi, September 2001

- 66% of cases in Jackson metropolitan area
- Incidence in Jackson area = 13/10^5 population
S. Javiana infections by week, Mississippi, 2001

- **0-4 years**
- **≥ 5 years**

Number Ill

Month:
- January
- March
- May
- July
- September

CDC
Case-control study definitions

- Case: culture-confirmed S. Javiana infection between August and September 2001 in a MS resident
- Control:
  - <5 years old
    birth registry
    matched to month, year, county
  - >5 years old
    sequential digit dialing
    matched by age, county
- 2 controls per case
Case-control study methods

- Written questionnaire
  - Food, water, environmental exposures
  - Patients: 7 days before illness
  - Controls: 7 days before interview

- 55/57 eligible patients matched to 104 controls
Characteristics of patients (n=55)

- 31 (56%) female
- Median age 24 months (range 3 months-70 years)
- Median duration of illness: 7 days
- Symptoms:
  - Fever (86%)
  - Abdominal pain (83%)
  - Bloody diarrhea (44%)
- 40 (73%) received antibiotics
- 9 (16%) hospitalized
- No deaths
# Univariate analysis

<table>
<thead>
<tr>
<th>Potential Risk Factor</th>
<th>Patients (N=55)</th>
<th>Controls (N=104)</th>
<th>mOR</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private Insurance</td>
<td>76.4%</td>
<td>57.7%</td>
<td>2.5</td>
<td>0.025</td>
</tr>
<tr>
<td>Watermelon</td>
<td>11.8%</td>
<td>1.0%</td>
<td>9.1</td>
<td>0.045</td>
</tr>
<tr>
<td>Orange Juice</td>
<td>49.1%</td>
<td>31.4%</td>
<td>2.9</td>
<td>0.016</td>
</tr>
<tr>
<td>Lake/Pond</td>
<td>40.0%</td>
<td>18.3%</td>
<td>2.8</td>
<td>0.006</td>
</tr>
<tr>
<td>Snakes</td>
<td>14.6%</td>
<td>2.9%</td>
<td>7.3</td>
<td>0.013</td>
</tr>
<tr>
<td>Turtles</td>
<td>18.2%</td>
<td>3.8%</td>
<td>6.2</td>
<td>0.006</td>
</tr>
<tr>
<td>Frogs/Toads</td>
<td>54.6%</td>
<td>28.8%</td>
<td>2.6</td>
<td>0.004</td>
</tr>
</tbody>
</table>
## Multivariate analysis

<table>
<thead>
<tr>
<th>Potential Risk Factor</th>
<th>Patients Exposed N (%)</th>
<th>Odds Ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private Insurance</td>
<td>42/55 (76.4%)</td>
<td>2.5</td>
<td>0.019</td>
</tr>
<tr>
<td>Watermelon</td>
<td>6/51 (11.8%)</td>
<td>10.4</td>
<td>0.057</td>
</tr>
<tr>
<td>Turtle exposure*</td>
<td>10/55 (18.2%)</td>
<td>5.1</td>
<td>0.023</td>
</tr>
<tr>
<td>Frog/Toad exposure</td>
<td>30/55 (54.6%)</td>
<td>2.3</td>
<td>0.021</td>
</tr>
</tbody>
</table>

* 8/10 also had exposure to frogs/toads
### Age subgroup analysis

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Frog/Toad Exposure N (%)</th>
<th>Matched Odds Ratio</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;6 months</td>
<td>1/4 (25)</td>
<td>1.0</td>
<td>0.09-11.0</td>
</tr>
<tr>
<td>6 months-3 years</td>
<td>17/26 (65)</td>
<td>3.7</td>
<td>1.4-9.8</td>
</tr>
<tr>
<td>4 years-15 years</td>
<td>10/18 (56)</td>
<td>2.9</td>
<td>0.84-9.6</td>
</tr>
<tr>
<td>&gt;15 years</td>
<td>2/7 (29)</td>
<td>1.0</td>
<td>0.16-6.4</td>
</tr>
</tbody>
</table>
Laboratory investigation

- All isolates pan-susceptible
- Molecular subtyping (PFGE) at LA State Public Health Laboratory and CDC
- 51 isolates
  - 18 distinct patterns
  - Not a point-source outbreak
  - Most common pattern found in 20/51 (39%)
    - no common epidemiologic link
Animal testing

- 23 frogs and toads collected from patients’ yards
- S. Javiana not isolated
- S. Newport isolated from toad
Limitations

• Exposure to frogs and toads includes indirect contact- may be surrogate for another exposure
• Limited number of frog and toad samples collected
• Limited number of frog and toad species collected may not include species that may be reservoirs for S. Javiana
Conclusions

• Contact with amphibians and their environment may be risk factors for infection
• Indirect exposure to frogs/toads may explain increased incidence of S. Javiana among toddlers and young children
• Amphibian reservoir may explain seasonality and geographic distribution of S. Javiana
Geographic distribution of S. Javiana and green treefrog
Recommendations

- Consider amphibians along with reptiles as potential sources of salmonellosis
- Promote handwashing after contact with amphibians
- Further studies to better determine distribution of *Salmonella* serotypes in amphibian reservoirs
Acknowledgements

- **MS State Department of Health**
  - M. Currier
  - S. Hand
  - J. Campbell

- **MS Museum of Natural Science**
  - K. Dierolf

- **CDC**
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  - J. Crump
  - V. Janakiraman
  - H. Flettemier
  - S. van Duyne
  - R. Middendorf
  - P. Mead
  - K. Mølbak
# Exposure to Frogs/Toads by Month

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Patients with Exposure to Frogs/Toads N (%)</th>
<th>Controls with Exposure to Frogs/Toads N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August and September 2001</td>
<td>30/55 (54.6%)</td>
<td>30/104 (28.8%)</td>
</tr>
<tr>
<td>August 2001</td>
<td>15/26 (57.7%)</td>
<td>12/48 (25.0%)</td>
</tr>
<tr>
<td>September 2001</td>
<td>15/29 (51.7%)</td>
<td>18/56 (32.1%)</td>
</tr>
<tr>
<td>Late September 2001</td>
<td>7/13 (53.9%)</td>
<td>8/24 (33.3%)</td>
</tr>
</tbody>
</table>
# Age of residence among patients, N=55

<table>
<thead>
<tr>
<th>Patient group</th>
<th>Median age of home</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure to frogs/toads</td>
<td>15 years</td>
<td>0.0264</td>
</tr>
<tr>
<td>No exposure to frogs/toads</td>
<td>22 years</td>
<td></td>
</tr>
</tbody>
</table>