Environmental Health Investigations During Outbreaks

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8th Annual OutbreakNet Meeting
August 30, 2012
OUTLINE

1. Background

2. Systems Approach: Basis for Environmental Health Investigations

3. Environmental Assessments during Outbreak Investigations
   • 2006 Spinach – *E. coli* O157:H7 Outbreak
   • 2010 Lettuce – *E. coli* O145 Outbreak
   • 2011 *Campylobacter jejuni* – Guillain Barré Syndrome Outbreak

4. Remaining Challenges
BACKGROUND
BACKGROUND

Farm production  Processing  Store  Consumer
SYSTEMS APPROACH: BASIS FOR ENVIRONMENTAL HEALTH INVESTIGATIONS
SYSTEMS APPROACH: BASIS FOR ENVIRONMENTAL HEALTH INVESTIGATIONS

Watershed

Protective Systems: Irrigation water; drinking & wastewater; waste disposal; land use; policies & regulations; practices.

Technology & Processes

Equipment

Community

Policy & Regulations

Economics

Environmental Health

How? Why?

Epidemiology

Where? When?

Who?

Lab

Agent? Identification and/or confirmation

Environmental Assessment

Identify Contributing Factors & Environmental Antecedents Linked to Health Outcome

Adverse Health Outcomes

Increasing severity of illness

Outbreak

No illness

Successful Protective System

Unsuccessful Protective System

Exposure
ENVIRONMENTAL ASSESSMENTS DURING OUTBREAK INVESTIGATIONS
ENVIRONMENTAL ASSESSMENTS DURING OUTBREAK INVESTIGATIONS

Protective Systems:
Irrigation water; drinking & wastewater; waste disposal; land use; policies & regulations; practices

Successful Protective System
No illness

Unsuccessful Protective System

Exposure

Environmental Health
How? Why?

Watershed

Technology & Processes
Equipment
Economics
Community
Policy & Regulations

Identify Contributing Factors & Environmental Antecedents Linked to Health Outcome

Environmental Assessment
ENVIRONMENTAL ASSESSMENTS DURING OUTBREAK INVESTIGATIONS

Exposure Assessment: Case-control study design

Exposure?  Illness?  Investigators at beginning of investigation
ENVIRONMENTAL ASSESSMENTS DURING OUTBREAK INVESTIGATIONS

Identify Contributing Factors & Environmental Antecedents Linked to Health Outcome

Environment Assessment

Four dimensions:
- Area (bi-dimensional)
- Depth
- Time

Environmental Health
How? Why?

Exposure

Successful Protective System

Unsuccessful Protective System

No illness

Watershed

Protective Systems: Irrigation water; drinking & wastewater; waste disposal; land use; policies & regulations; practices

Technology & Processes

Equipment

Economics

Policy & Regulations

Community
ENVIRONMENTAL ASSESSMENTS DURING OUTBREAK INVESTIGATIONS

Identify Contributing Factors & Environmental Antecedents Linked to Health Outcome

Environmental Health
How? Why?

Four dimensions

Winter
Spring
Summer
Fall

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec
ENVIRONMENTAL ASSESSMENTS DURING OUTBREAK INVESTIGATIONS

- **2006 Spinach – *E. coli* Outbreak**
  - Multiple states reported *E. coli* O157:H7 infections to CDC
  - Epidemiologic investigation:
    - fresh spinach identified as vehicle of infection
    - Cases: >500 (200 hospitalizations/4 deaths in 26 states)
  - Bagged spinach traced-back to four farms in CA
  - Laboratory work: *E. coli* O157:H7 PFGE genetic matches from patients and spinach to environmental samples at a single farm
ENVIRONMENTAL ASSESSMENTS DURING OUTBREAK INVESTIGATIONS

- **2006 Spinach – *E. coli* Outbreak**
  - Environmental assessment:
    - Surface runoff from grazing areas
      - Irrigation wells
      - Cultivated fields
    - Use of surface water for irrigation
    - Well construction
    - Surface water-ground water interactions
      - Rate of pumping – intense pumping
      - Depth of GW table
      - GW recharge
ENVIRONMENTAL ASSESSMENTS DURING OUTBREAK INVESTIGATIONS

- 2006 Spinach – *E. coli* Outbreak

![Diagram showing Riverbed Elevation and percolation losses in San Benito River for August and September 2006.](image)
ENVIROMENTAL ASSESSMENTS DURING OUTBREAK INVESTIGATIONS

- **2010 Lettuce – *E. coli* Outbreak**

  - **Epidemiologic investigation:**
    - First STEC O145 associated-foodborne-outbreak reported in the US
    - 26 confirmed cases and 7 probable cases (MI, OH, NY, PA, TN)
    - 12 hospitalizations and 3 HUS
    - Vehicle: Epi-Aid issued outbreak associated with romaine lettuce

  - Lettuce traced-back to a farm in Yuma County, AZ

  - **Laboratory work:**
    - NY reported isolating *E. coli* O145 from lettuce
    - PulseNet confirmed lettuce isolate as PFGE match to outbreak strain
ENVIRONMENTAL ASSESSMENTS DURING OUTBREAK INVESTIGATIONS

2010 Lettuce – *E. coli* Outbreak

- Environmental assessment:
  - Hydrology
    - Sources of Irrigation Water
    - Precipitation Events
      - Gila River overflow; runoff to irrigation canals → pathways?
  - Non-point Sources for Microbial Pollution (pathogen loads)
    - Animal: cattle and dairy farms, and seasonal sheep grazing
    - Human: housing development and RV park with OWW systems
ENVIRONMENTAL ASSESSMENTS DURING OUTBREAK INVESTIGATIONS

- **2011 Campylobacter jejuni–Guillain-Barré Syndrome Outbreak**

  - Epidemiologic investigation: July 8–26
    - Water and food → potential human exposures to *C. jejuni*
    - As of July 21
      - 83% of GBS cases had antecedent diarrhea (*C. jejuni* infections)
      - GBS subtypes getting specified
    - As of August 26
      - 26 AFP patients had GBS (May 1-July 15 onset)
        - 18 in SLRC (2/3 in northern part of the city)
        - 8 Yuma County residents
2011 C. jejuni-GBS outbreak: potential pathways of contamination (lit rev)

Animals:
- Cattle, poultry, sheep, wild birds, pork

Fecal material

Water sources

Waste: Wastewater & solid waste

Food production & processing

Food processing and/or preparation

Human Population

Adequately treated drinking water

Inadequately treated drinking water

Untreated drinking water

Recreational water

Irrigation water

Inadequately treated drinking water

Adequately treated drinking water

X

X

ENVIRONMENTAL ASSESSMENTS DURING OUTBREAK INVESTIGATIONS
## ENVIRONMENTAL ASSESSMENTS DURING OUTBREAK INVESTIGATIONS

### C. jejuni-GBS Outbreak: Epidemiologic, Biologic, and Clinical Characteristics of C. jejuni

#### Epidemiologic

<table>
<thead>
<tr>
<th>Reservoir/Source</th>
<th>Cattle and other mammals, avian species / Feces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affected human hosts</td>
<td>Humans of all ages –often in clusters of cases</td>
</tr>
<tr>
<td>Links to Guillain-Barré Syndrome (GBS)</td>
<td>One person in 1,000 C. jejuni-infected people develops GBS</td>
</tr>
<tr>
<td></td>
<td>One person in 3 with GBS had antecedent C. jejuni-infection</td>
</tr>
</tbody>
</table>

#### Biologic/Laboratory

<table>
<thead>
<tr>
<th>Culture temperature</th>
<th>37°C and 42°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth and survivability</td>
<td>Gram-negative, micro-aerophilic bacteria; Survivability: 4 weeks in water and 5 weeks in urine at 4 °C, and 2 months in human bile at 37°C</td>
</tr>
</tbody>
</table>

#### Clinical

<table>
<thead>
<tr>
<th>Cause of diarrheal illness</th>
<th>Common</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical manifestations</td>
<td>Acute gastroenteritis and colitis</td>
</tr>
<tr>
<td>Outcome of infection</td>
<td>Usually self-limited</td>
</tr>
</tbody>
</table>
ENVIRONMENTAL ASSESSMENTS DURING OUTBREAK INVESTIGATIONS

EH investigations are not routine sanitary surveys or inspections.
ENVIRONMENTAL ASSESSMENTS DURING OUTBREAK INVESTIGATIONS

*C. jejuni*-GBS outbreak: potential pathways of contamination

- Cattle, wild birds, sheep
- Fecal material
- Humans

Water sources & sewer

- Drinking Water
- Rinsing produce

Surface water/Sewer leaks to groundwater?

Humans

Sewer system, SLRC

Colorado River

Borehole Well, SLRC
REMAINING CHALLENGES
REMAINING CHALLENGES

Earlier involvement of EH team during outbreak investigations

Exposure Minimization & Prevention

Epidemiology
- Where? When?
- Who?

Environmental Health
- How? Why?

Lab
- Agent?
- Identification, confirmation

Week: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 ...
REMAINING CHALLENGES

Shifting the paradigm about EH investigations; they:

- Are neither routine sanitary surveys nor sanitary inspections
- Require and foster stakeholders’ collaboration at local, State, and national levels
- Are holistic, four-dimensional approaches to identify sources and pathways of food & water contamination
- Are intended to help in minimizing exposures and formulating preventive measures
Thank you!

Questions?

For more information please contact Centers for Disease Control and Prevention

1600 Clifton Road NE, Atlanta, GA 30333
Telephone: 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348
E-mail: cdcinfo@cdc.gov Web: http://www.cdc.gov

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