Waterborne Disease Outbreaks: Lesson Learned

Charlotte Smith
University of California, Berkeley
TCRDS Federal Advisory Committee
October 17, 2007

This Meeting's Presentations

Objectives

Waterborne Disease Outbreaks: Lessons Learned

Provisions

System compliance

Improvement

Research

FAC Questions

- How do states conduct surveillance?
  - Provide case studies that show differences and how this impacts outbreak characterization and reporting.
- What can we learn from outbreak case studies?
  - What was the cause?
  - What was the regulatory framework at the time?
  - Could have a revised TCR framework have prevented it, and if so, how?

FAC Questions (continued)

- How can we increase the number of outbreaks reported by small systems?
- What is the status of the checklist for State epidemiologists investigating outbreaks that was discussed in Nashville (See Appendix)
- What are the differences between reportable organisms in the US and other countries and what does that mean to TC/EC (see handout)

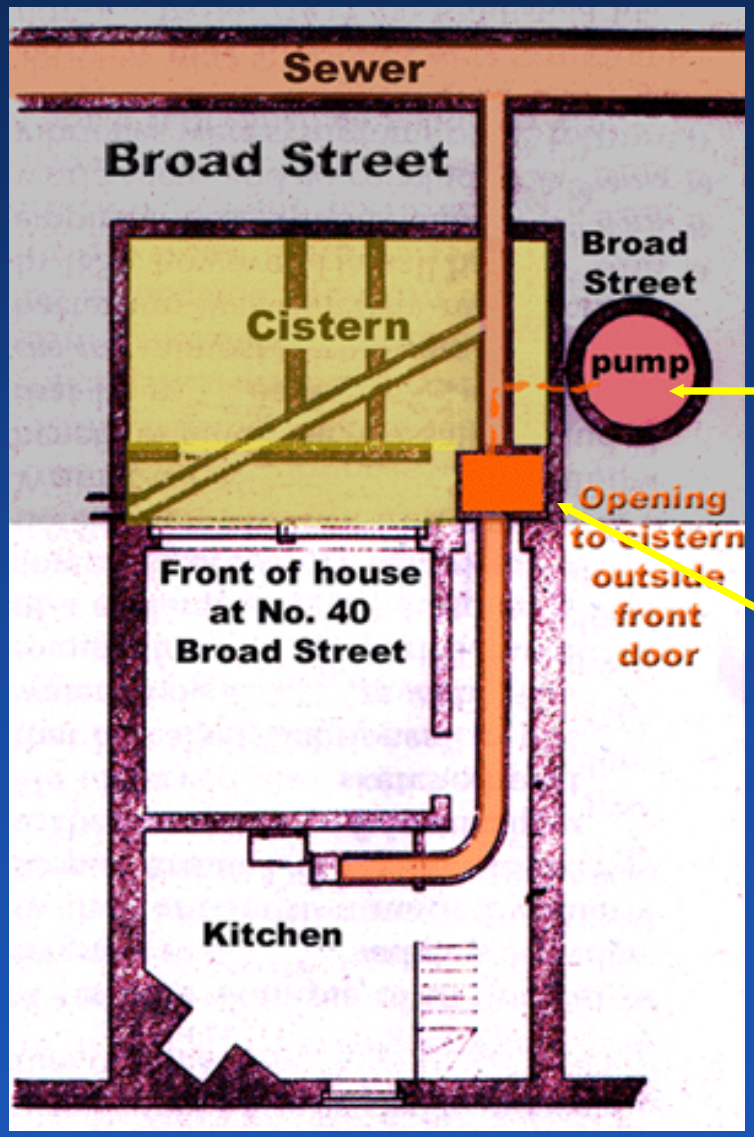
Lessons Learned From 3 Historic Distribution System Outbreaks

- Case Study 1: 40 Broad Street, London
  - Contamination/Cross-connection
- Case Study 2: South Bass Island, OH
  - Contamination/Cross-connection
- Case Study 3: Gideon, MO
  - Inspection / Maintenance

Case Study 1:

Contamination / Cross Connection

Cross-Connection at 40 Broad Street



Broken brickwork on pump

Broken brickwork on cesspool

“Do not use” order issued Sept 8, 1854

"I had an interview with the Board of Guardians of St. James's parish, on the evening of Thursday 7th September, and represented the above circumstances to them. In consequence of what I said, the handle of the pump was removed on the following day."

Too late to prevent contamination from baby Lewis (index case, died Sept 2nd), but <u>prevented additional cases</u> from contamination from Mr. Lewis who died Sept 8th from cholera.

Case Study 1: Lessons Learned

- Adequate distance between sewer lines and water lines should be maintained
- Intervention can prevent additional cases
- Communication between water purveyors and health professionals is imperative during an outbreak.
- More than one outbreak can occur at a time

Case Study 2:

Contamination / Cross Connection

South Bass Island, OH

- A community water system serves the downtown Village of Put-in-Bay
  - Lake Erie is the water source
- As many as 17 transient non-community water systems existed on the island
- Wells serve hundreds of small businesses and residences

Source: Michael G. Baker
Ohio EPA,
CSTE-2007, Nashville, TN

Case Study 2: Outbreak Characterization

- Duration: July 23 to September 12, 2004
- 1,450 cases of gastrointestinal illness in residents and visitors to South Bass Island were identified
- Included 29 clinically confirmed cases:
  - 16 cases due to *Campylobacter spp.,*
  - 9 cases due to *norovirus,*
  - *3 cases due to Giardia spp. and*
  - 1 case due to *Salmonella typhimurium.*

Source: Michael G. Baker Ohio EPA, CSTE-2007, Nashville, TN

Case Study 2: Epidemic Curve

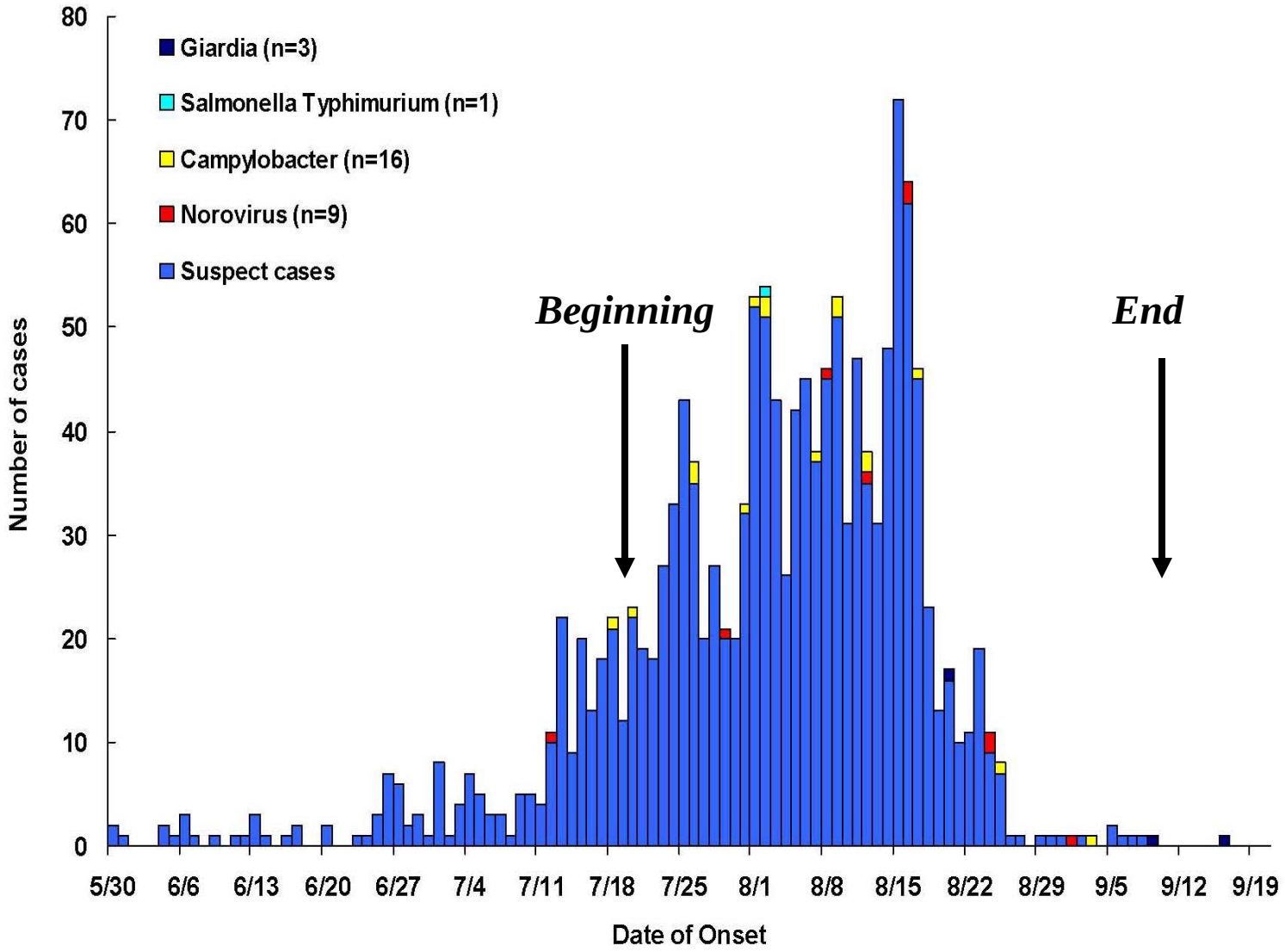


Figure 1. Cases of gastroenteritis by date of onset and etiology, South Bass Island, Ohio, May 30 – September 12, 2004 (N=1,450)

Case Study 2: Wastewater Treatment

- Permitted discharges to Lake Erie
  - Village of Put-in-Bay operates a Publicly Owned Treatment Works for municipality
  - Small package wastewater treatment works serve some businesses
- On-site systems in the township
  - Septic tank and leach field
  - Mound, subsurface sand filters and holding tanks

Source: Michael G. Baker Ohio EPA, CSTE-2007, Nashville, TN

Case Study 2: Auxiliary Wells

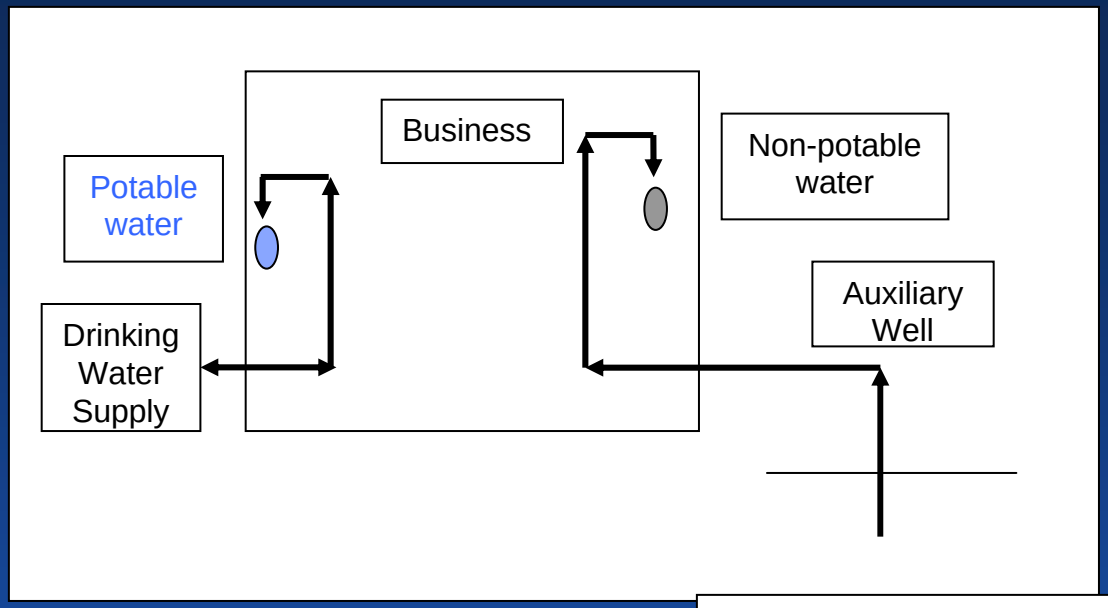
- Used by many businesses
- Connected to village systems for:
  - Geothermal cooling
  - Toilet flushing

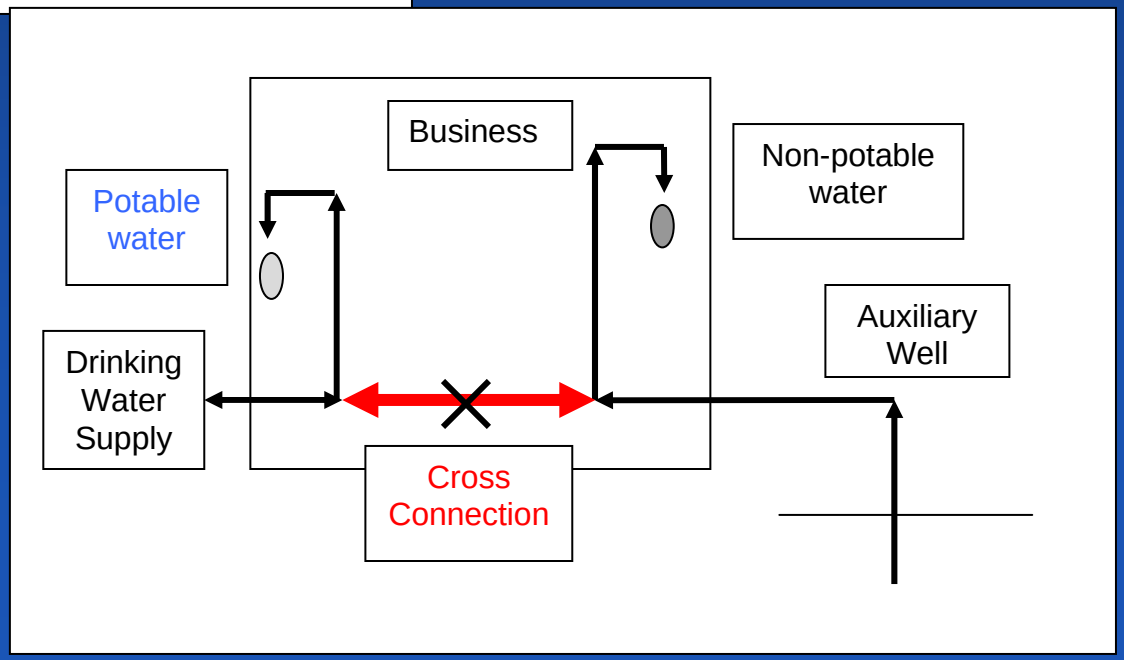
Source: Michael G. Baker Ohio EPA, CSTE-2007, Nashville, TN

Case Study 2: An Auxiliary Well

Source: Michael G. Baker Ohio EPA, CSTE-2007, Nashville, TN

Case Study 2: State Reported Illegal Cross-Connections





Case Study 2: Non-community sample results

- 112 samples were collected
- Of the 17 water systems sampled ALL had at least one Total Coliform positive detection
- 16 had positive detections for organisms other than T.C.

Source: Michael G. Baker Ohio EPA, CSTE-2007, Nashville, TN

Case Study 2: Non-Community Sample Results

E. Coli	12
Campylobacter DNA	12
Campylobacter Culture	2
Enterococci	7
Coliphages	8
Salmonella DNA/ *Crypto* DNA	4
Adenovirus/Enterovirus DNA	1
Giardia Cyst	1

Source: Michael G. Baker Ohio EPA, CSTE-2007, Nashville, TN

Case Study 2: Corrective Actions

- ODH issued advisory to residents and visitors to consider bottled water for drinking on August 26, 2004
- EPA began issuing Final Findings and Orders on August 26, 2004 to all PWS's
  - "No use" Orders were sent to any PWS with a TC+, EC+ or any other organism
  - Village of Put-in-Bay issued orders addressing Cross-connection - Backflow Prevention Program

Source: Michael G. Baker Ohio EPA, CSTE-2007, Nashville, TN

Case Study 2: Investigation Conclusions

- Likely cause of gastrointestinal outbreak:
  - Consumption of contaminated ground water from public and private water supplies on the island
  - Possible periodic contamination of the village water supply through cross connections to auxiliary wells

- The best permanent solution to protect public health is island-wide public water and sewer systems.

Source: Michael G. Baker Ohio EPA, CSTE-2007, Nashville, TN

Case Study 2: Contributing Factors

- Karst geology
- Increased precipitation before outbreak
- Increased volume to sewage treatment facilities
- Cross-connections to potable supply
- Inadequate inspection and maintenance of wells

Case Study 2: Lessons Learned (From perspective of Primacy Agency)

- When to look at water
- Credible threat
- Coordinating with multiple agencies
  - Incident command training
  - Communication process/tools
- Be prepared for media
  - Message mapping
- Not everyone will cooperate
- Need resources (people, laboratory)
  - Quick water quality analyses

Source: Michael G. Baker Ohio EPA, CSTE-2007, Nashville, TN

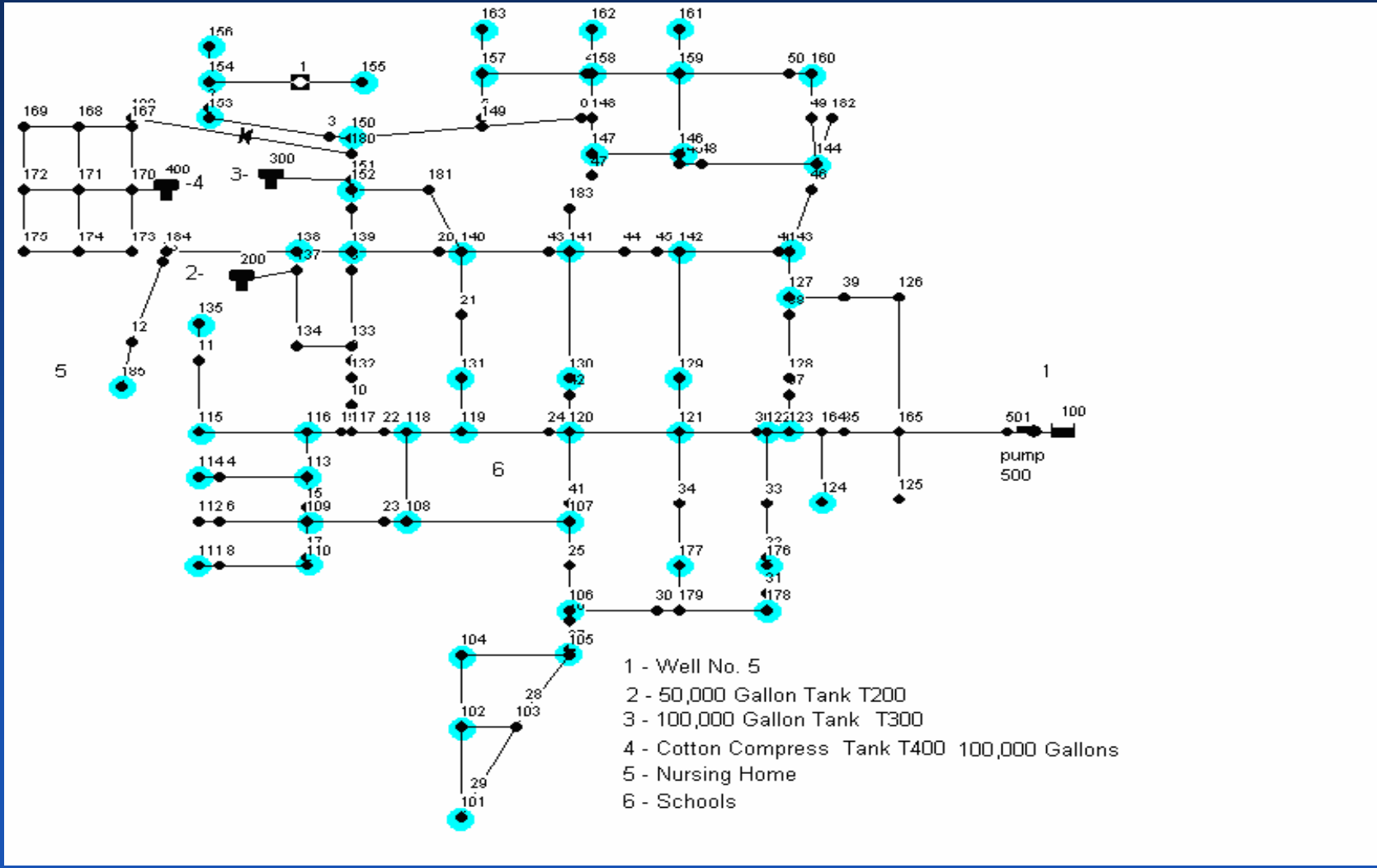
Case Study 3:

Integrity of Distribution System - Storage Facility

Case Study 3: Gideon, MO

- Undisinfected ground water source
- History of TCR violations
- Salmonella had contaminated the largest distribution system tank
  - Flushing moved pathogens through the distribution system
- 650 of the 1104 residents became ill and seven people died

Case Study 3: Flushing Moved Pathogens Through the Distribution System



Case Study 3: Insufficient Inspection

Photo: Robert M. Clark,

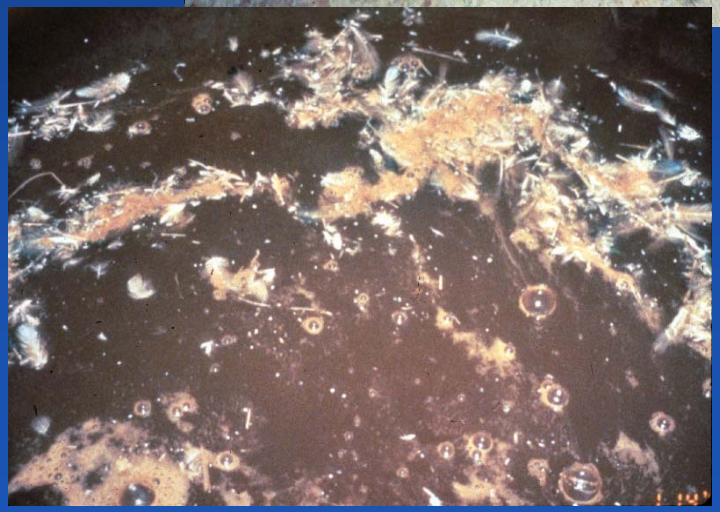
"City officials were not aware of any previous inspections"

Source: Angulo F.J, American Journal of Public Health, 1997.

Case Study 3: Bird Guano Contained Microbial Contaminants

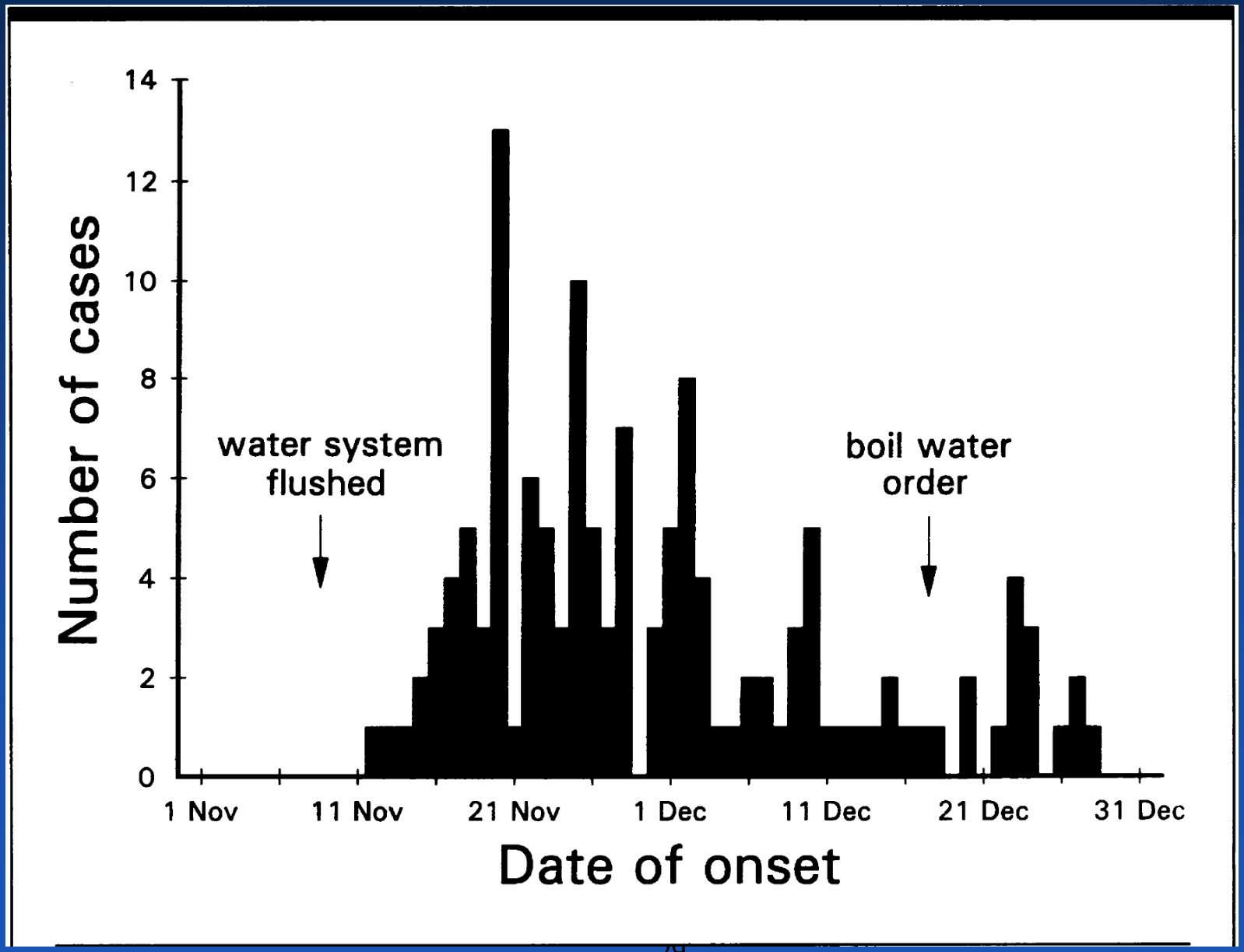
Fact: Bird guano may contain *Salmonella, Campylobacter, E. Coli and other organisms*

Question: Is *E. coli* too specific to indicate potential exposure to organisms in bird guano?



Photos: Robert M. Clark

Case Study 3: Epidemic Curve



Case Study 3: Lessons Learned

- Proper maintenance of storage facilities is critical.
- Water sanitation training for water system operators must be adequate.
- Groundwater disinfection would be helpful.

Source: Angulo F.J, et al.,
American Journal of Public Health, 1997.

- Attack rate and duration when linked to operations can help identify the source

Case Study 3: Boil Water Orders

- 86 % of people who developed diarrhea after boil water order was issued cited the following reason:
  - 44% forgot to boil water
  - 25 % didn’t believe it
  - 17 % didn’t boil water for ice
- Initial order did not give reason or link to associated illness

Source: Angulo F.J, et al., *American Journal of Public Health*, 1997.

What Can We Learn from These Outbreaks?

- There are two distinct but overlapping sets of procedures for:
  - Outbreak Prevention
  - Outbreak Investigation

Prevention Elements:

- Inspection/Maintenance
- Analytical Monitoring
- Boil Water Orders

Prevention: Inspection / Maintenance

Potential portal for contamination

Prevention: Analytical Monitoring

1. If a contaminant (human feces, animal feces, bird guano) is present what will be the TCR indicator (TC, FC, EC) result?

2. Can a specific organisms (*cholera*, *Salmonella, E. coli* 0157:H7, *Cryptosporidium*) occur in a much higher concentration than non-pathogenic E. coli, such that the organism is present but the *E. coli* result (e.g. Colilert test) will be negative?

Prevention: Analytical Monitoring

For the 3 outbreaks discussed:

- A positive *E. coli* test would have indicated the presence of fecal contamination and could have changed the epidemic curve/course of the outbreak
- Additional tests would have to be performed to identify the exact etiologic agents.

Boil Water Order: Greenville, Michigan

Birds blamed for Greenville *E. coli*

Updated: Sep 5, 2007 04:08 PM

GREENVILLE -- City officials in Greenville are now convinced bird droppings caused *E. coli* contamination in the city's water.

A Boil Water Advisory was issued August 22-26 after water samples taken in the Hillcrest Street area tested positive for the bacteria.

Apparently birds were nesting atop a water tank in Veterans Memorial Park that had 10 open bolt holes in it, and rainwater splashed their waste into the tank.

The city has now welded the holes shut and removed the birds to prevent future contamination.

Boil Water Order: Greenville, PA

Search Subjects

PENNSYLVANIA Department of Environmental Protection

Send This Article to a Friend

DEP Orders Boil Water Advisory for Greenville

DEP this week ordered Greenville Municipal Water Authority, Mercer County, to issue a boil water advisory after bacteria was discovered in a portion of the water system, according to DEP Regional Director Steve Beckman.

"Greenville notified us over the weekend that the water coming from the Hadley Road water tank in Hempfield Township tested positive for total coliform, which is an indicator that there is bacteria in the water," Beckman said. "It is important to note that the samples were negative for fecal coliform, or E-coli. The boil water advisory was issued as a precautionary measure since the situation is not an imminent

Boil water order based on:

- Total Coliform “+” (Initial and Repeat)
- Fecal Coliform “–”
- E. Coli “-”

Investigation Elements:

- Identification/Training
- Surveillance
- Reporting

Recommendations from 1998 EPA Workshop on Investigation of WBDOs*

**Craun FG, Frost FJ, Calderon RL, et al. International JEH Research 2001*

- Improve surveillance and reporting of illness/infections
- Develop local formal plan for investigation with collaboration between epidemiologists, environmental engineers, and water specialists
- Ensure that laboratory support is available
- Additional resources needed for investigation; additional training needed for all partners; CDC and EPA should take initiative to improve training and investigation
- Epi investigations should be improved, including using standardized questions (CDC/EPA/CSTE can help facilitate)

Source: Duc Vugia, CA Dept of Health, CSTE-2007, Nashville, TN

CSTE Position Statement 06-ID-12 Desired Actions to be taken

1. CDC and EPA work with CSTE to develop training for WBDO investigation targeted at local and state/territorial public and environmental health workers responsible for WBDO detection, investigation, and reporting.

2. CDC and EPA work with CSTE to develop national WBDO investigation and surveillance guidelines.

3. Starting in 2007, states make WBDOs nationally notifiable and reportable to CDC via WBDOSS. CDC will develop electronic surveillance for WBDOs using an existing system (e.g., the CDC eFORS).

Source: Duc Vugia, CA Dept of Health, CSTE-2007, Nashville, TN

Questions?