Water Testing During Foodborne, Waterborne, and Zoonotic Disease Outbreak Investigations

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OutbreakNet Meeting
August 30, 2012
We contact water every day
Water testing is an investigative tool

- Water testing can be an effective component of epidemiological investigations
  - Confirming water source associated with an outbreak
  - Identifying source of fecal contamination
  - Identifying system deficiencies contributing to an outbreak
  - Adding confidence to the conclusions of an epidemiological investigation
Effective investigations need effective methods

Number of waterborne disease outbreaks associated with drinking water, United States, 1971-2008 [Brunkard JM et al (2011) MMWR, 60(12):38-75]
CDC Capabilities for Collaborative Investigations

- Sampling
- Sample processing
- Rapid pathogen testing via real-time PCR
- General water quality testing (e.g., *E. coli*)
- Molecular epidemiology testing
  - PFGE (from culture isolates)
  - Sequencing (pathogen identification, subtyping)
Sampling

- **Grab samples**
  - 100 - 300 mL → water quality testing, microbial indicators
  - 1 - 4 L → swimming pool backflush samples

- **Large-volume filtration**
  - Pre-2004, used microfilter cartridges for viruses and parasites
  - Currently, use ultrafiltration
    - Hollow-fiber ultrafilters (dialysis filters)
    - Dead-end ultrafiltration
    - Performed in field, ultrafilters shipped to lab
Local preparedness facilitates rapid response

- Epidemiology and Laboratory Capacity in Infectious Disease (ELC) Program

- 2011-2012: Assisted 5 states to develop “Water Sampling Kits”
  - Peristaltic pump
  - Chlorine test kit
  - Coolers and supplies
    - Ultrafiltration (filters, tubing, connectors)
    - Grab sample bottles
    - Sodium thiosulfate
    - Gloves, scissors, ice packs, ziploc bags, markers, data sheets
Sample processing: linking collection to analysis

- Membrane filtration $\rightarrow$ bacteria
- Centrifugation $\rightarrow$ parasites
- Precipitation $\rightarrow$ viruses
- DNA/RNA extraction $\rightarrow$ PCR/RT-PCR
Rapid screening using real-time PCR

- Faster turnaround times vs. conventional PCR
- Potentially enables quantitation ("qPCR")
- Bacteria → culture first, then PCR
- Viruses → direct analysis by RT-qPCR
- Parasites → direct analysis by qPCR
  - For Cryptosporidium and Giardia, can also perform fluorescence microscopy for confirmation, quantitation
Supporting molecular epidemiology

- **Bacteria** → match PFGE patterns (PulseNet)
- **Viruses** → match nucleic acid sequences (CaliciNet)
- **Parasites** → compare sequences, subtypes (CryptoNet)
Water testing: supporting public health response

- **Milwaukee (1993)**
  - Human “C. parvum” genotype (later named *C. hominis*) identified in patient stools in 1998 and in Milwaukee wastewater in 2000, confirming that waste source was primarily from sewage system
  - Spurred improvements in filtration and disinfection (ozonation); also Milwaukee’s water treatment plant intake pipe was extended 4,200 ft further into Lake Michigan

- **Oklahoma (2008)**
  - Norovirus GI.4 identified in stool samples and a water sample from the well that served a condominium complex.
  - The complex was eventually connected to the public water supply

- **Alamosa, CO (2008)**
  - *Salmonella Typhimurium* detected throughout non-disinfected public water supply system
  - System shut down until new chlorination plant brought online

- **Louisiana (2011):** Water testing confirmed presence of *Naegleria fowleri* in tap water used by cases for nasal rinsing
Working together to investigate WBDOs

- Support for outbreak investigations
- Training (e.g., sampling)
- Technology transfer (e.g., molecular testing)
- Surveillance: CryptoNet
NOTE: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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