

A Toolbox Approach to Pathogen Tracking

*Pamela Staton, Ph.D.
Marshall University
Forensic Science Center
Huntington, West Virginia*



Clean Water and Safe Drinking Water Act



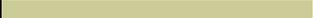
- ◆ Important strides made in water quality
- ◆ High reliance on microbial indicator systems
- ◆ Renewed emphasis on accurate, reliable and scientifically defensible methods
- ◆ Renewed interest in waterborne pathogens (WBP)

The Perils of the Indicator Paradigm

- ◆ Bacterial indicators may not be universally protective
- ◆ *Are Indicator Systems really accurate, reliable, and scientifically defensible?*



Identifying Pathogens in the Post-9/11 Era



- ◆ Anthrax Mystery
- ◆ America's worst case of bioterrorism
- ◆ Deliberate use of pathogens as weapons

Terrorist Acts Targeting the Food or Water Supply

Terrorism defined

- ◆ Attack
- ◆ Creating fear
- ◆ Inflicting harm
- ◆ Destabilizing societies
- ◆ Destroying economic well being

Microbial Forensics

- ◆ Bio- or Agro-terrorism acts
- ◆ Inadvertent release
- ◆ For purposes of attribution
- ◆ “*Who committed the crime?*”



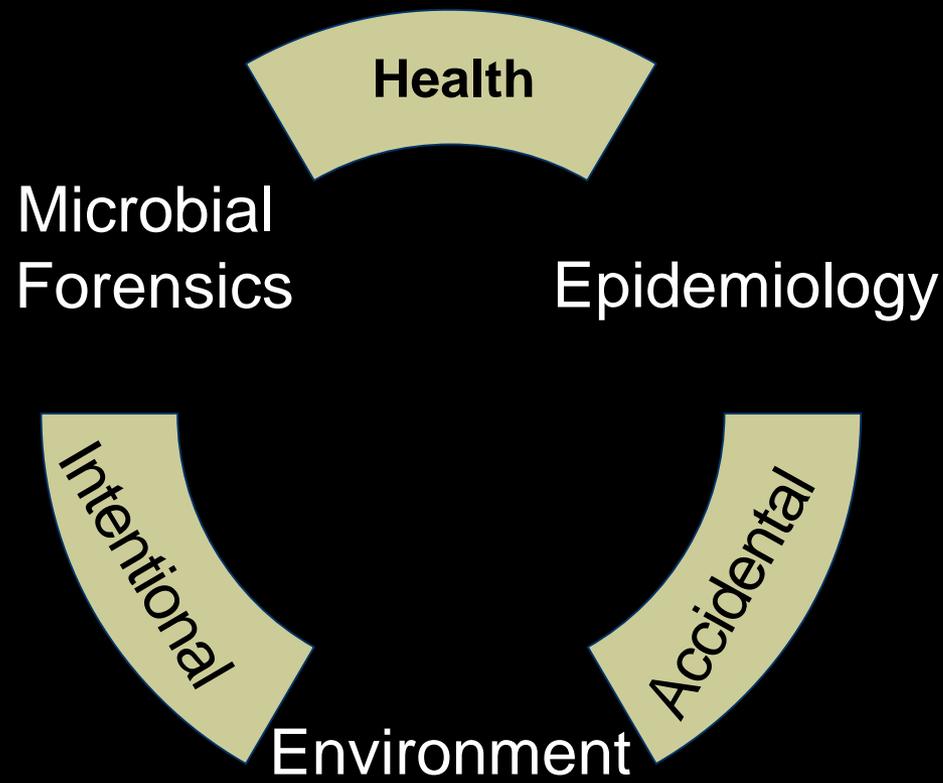
Health Effect Assessment



Epidemiology of Waterborne Disease

- ◆ Prevention
- ◆ Transmission
- ◆ Control
- ◆ Remediation

Essential Pathogen Linkages



WBP Outbreak Reporting Systems

- ◆ Real-time reporting
- ◆ Integrated GIS & GPS tracking systems
- ◆ Linking federal, state and local agencies
- ◆ Linking public health, forensics,
environmental and agricultural testing
- ◆ CDC's PulseNet template
- ◆ EpiNet

Pathogen Testing Challenges

- ◆ Cost to assay many pathogens, cost of equipment and reagents, and training personnel
- ◆ False positive/negatives associated with complex water mixtures
- ◆ Low abundance and the need to concentrate large-volume samples
- ◆ Time-consuming and potentially hazardous

BSL 3 Public Health Approach to Pathogen Detection

- ◆ Focus on molecular technologies

Bacillus anthracis

Yersinia pestis

Francisella tularensis

Influenza A & B

West Nile Virus

Salmonella spp.

E. coli O157:H7

Listeria monocytogenes

Enterobacter sakazakii

Variola and poxviruses

Bordetella pertussis

Noroviruses

La Crosse Encephalitis virus

St. Louis Encephalitis virus

Eastern Equine Encephalitis virus

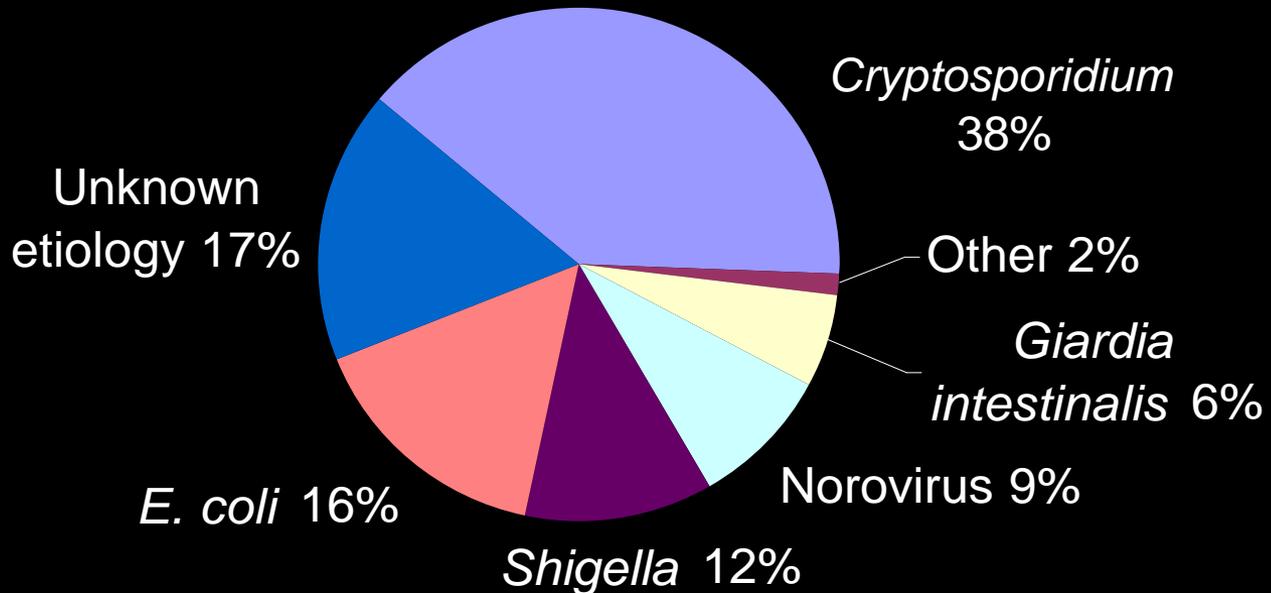
Western Equine Encephalitis virus

Brucella spp

Burkholderia spp

Ricin toxin

Waterborne Pathogens & Gastrointestinal Illness



CDC Morbidity and Mortality Weekly Report, Surveillance for Waterborne-Disease Outbreaks Associated with Recreational and Drinking Water, 2001-2002

Direct Pathogen to Microbial Indicator Studies

- ◆ Direct pathogen to indicator monitoring
Measurements based on
 1. infectivity or viability (culturability)
 2. physical presence (microscopy)
 3. detection of microbial components (nucleic acids, proteins, or specific antigens)
- ◆ Measurements must detect levels of “infectious” microorganisms that pose human, plant or animal health risks



Water Processing, Concentration, and Miniaturization Technologies



- ◆ Micro- and nano-technologies
- ◆ Microfluidics
- ◆ Microelectromechanical systems
- ◆ Tangential flow and hollow fiber filters

WBP Surveillance Systems

- ◆ Rapid, high throughput technologies, robotics
- ◆ Microarray technologies, “lab-on-a-chip”
- ◆ Multiplex assays for class pathogens and indicators
- ◆ Adaptable to field testing, e.g. handheld nucleic acid analyzers

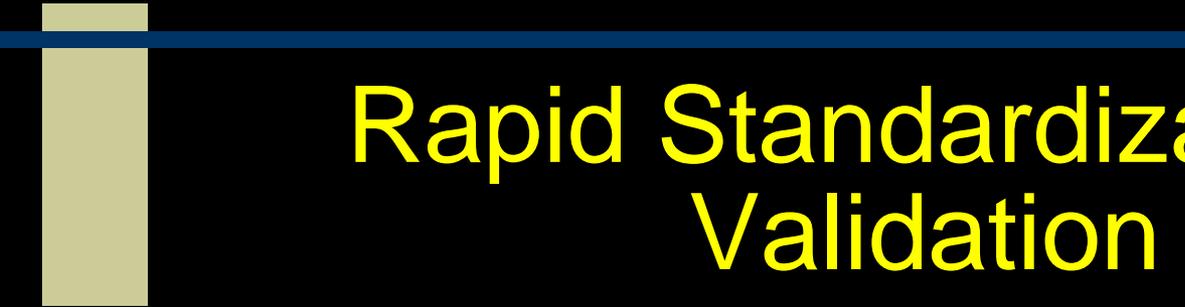
Pathogen Source Tracking

- ◆ Real-time PCR
- ◆ NASBA
- ◆ SNP analysis
- ◆ Short-range sequencing
- ◆ Genotyping: PFGE, ribotyping, rep-PCR, MLST, etc.
- ◆ Mass spectroscopy

Data Management Systems

- ◆ Management of continuous data streams coming from sensor networks

*Data analysis,
intelligent decision making,
and archiving*



Rapid Standardization & Validation



- ◆ American Society for Testing and Materials International (ASTM)
- ◆ National Institute of Standards and Technology (NIST)
- ◆ Association of Analytical Communities (AOAC)
- ◆ International Organization for Standardization (ISO)
- ◆ American Society for Microbiology (ASM)

Challenges and Opportunities

- ◆ So much water
- ◆ So many pathogens
- ◆ So many technologies
- ◆ challenges
- ◆ opportunities

Pamela Staton, Ph.D.

***Marshall University Forensic Science Center
Huntington, West Virginia***

