Control of Water Related Diseases of the 21st Century
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Candidate Contaminate List 3 (Sept. 2009)

- **Adenovirus**
- **Shigella sonnei**
- Caliciviruses
- **Campylobacter jejuni**
- **Enterovirus**
- **Escherichia coli** (0157)
- **Helicobacter pylori**
- Hepatitis A virus
- **Legionella pneumophila**
- **Mycobacterium avium**
- **Naegleria fowleri**
- Salmonella enterica
How Good is the Tapwater?

• 10 to 42% of groundwater supply wells contaminated with enteric viruses in the U.S. (Reynolds et al 2007)
• 95% of all individual and small groundwater systems violate one or more primary and secondary drinking water standards in AZ (Marrero-Oritz et al 2009)
• 52% of all POU carbon filters contain an enteric organism after 3 months of use in a municipal systems (27% *E. coli* and 6% enteric viruses) (Miles et al 2009).
How much illness from tapwater in the U.S? 

- 12 million cases/yr/diarrhea and municipal systems only (Colford et al 2006)
- 16 million cases/yr/diarrhea and municipal systems only (Messner et al 2006)
- 19.5 million cases/yr/all illnesses and municipal and individual systems (Reynolds et al 2007)
- 5,000 deaths/yr CDC (waterborne organisms)
- 7,000 to 20,000 deaths/yr Gerba 2009 (waterbased organisms)
Future Trends – Microbes and Water

- **Waterborne pathogens** (*Cryptosporidium*) → **Waterbased pathogens** (*Legionella*)

- **Source water** → Treatment → Utility
  Distribution Systems → **Home Distribution Systems** (greatest impact on water quality)

- **Taste and odor undefined/taste panels** → **Microbes involved and molecular basis**
  (genomic identification of organisms/microbial profile defines taste and odor)

- **Historic data on water quality** → **Real time/event monitoring**
  (sensors located in the...
Future Trends – Microbes and Water

– Historic weather patterns → Climate Change

- Climate change will increase the frequency and intensity of rainfall events
- Increasing surface and water distribution systems temperatures will result in an increase in the types and numbers of water-based pathogens. Will also result in an increase in taste and odor problems from expected increase in algal blooms.
Future Trends-Impact of Treatment Technology

• **Biofilms** - Chlorine/chloramines has resulted 80% of the biofilm population = *Mycobacterium* spp
• **Increased use of UV light** has resulted in increased discharge of adenovirus in surface waters
• **Super surviving fraction** – disinfection/microbe inactivation curves are not linear. Rotavirus – no significant inactivation with UV light from 100 to 350 mJ cm². What is the long term risk to low dose exposure to this level of pathogen.
• All **changes in treatment technology** result in changes in the pathogens to which we are exposed i.e. membrane treatment, increased use of saline waters, new disinfectants
Innovations Driving Change

• **Microbial Risk Assessment** – can not only define risks/costs, but benefits of interventions
  
• **Water Quality Sensors**
  – Real time water quality in distribution system

• **Genomics (Mettagenomics/Functional genomics)**
  
  – **Exposure**
    • We know where you came from
    • There is more growing in the tap than you think

  – **Source tracking**
    • It grew in the tap

  – **The cause**
    • You made the water taste bad
    • You made me sick
What’s Needed?

- New indicators – water based pathogens
- Real time sensors
  - Specific (organism identification)
  - Sensitive (1 organism/1-10,000 mL)
  - Viability assessment
What’s Needed

- Technologies for treatment of water/biofilms in the distribution system
- Technologies for treatment at the tap/premise plumbing
- New disinfectants
  - Fewer by-products
  - Synergism effects of existing disinfectants