



Emerging Microbial Issues

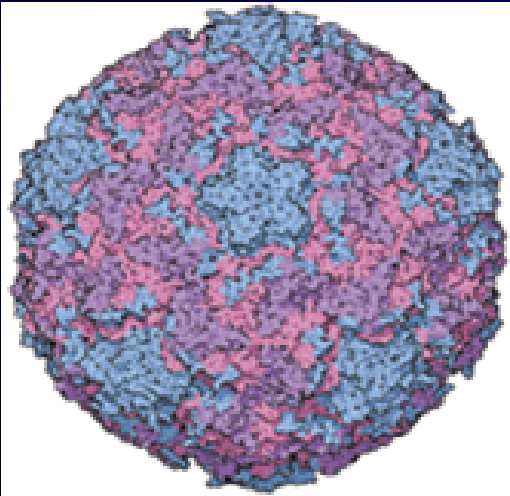


Soil, Water and Environmental Science



Average One New Waterborne pathogen discovered every year for the past 30 years

Viruses



Bacteria



Parasites



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)
- 5,000,000 of diarrhea from infiltration into the distribution system (Colford et al 2012)

Future Trends – Microbes and Water

- Waterborne pathogens (*Cryptosporidium*) → **Waterbased pathogens** (*Legionella*)
- Acute infections (diarrhea) → **Chronic infections** (reactive arthritis, irritable bowel)
- Source water → Treatment → Utility Distribution Systems → **Home Distribution Systems** (greatest impact on water quality)
- Outbreaks → **Endemic disease** (100% safe water cannot be delivered 100% of the time)

Chronic Waterborne Diseases

- Auto-immune – reactive arthritis, joint pain – 2 months after a waterborne outbreak (*Campylobacter*, others?) Laine et al 2011
- Irritable bowel and Chronic fatigue Syndrome – 3 years after waterborne outbreak – (*Giardia*) Knut-Arne et al 2012
- Hypertension, cardiovascular disease and reduced kidney function (*E. coli* 0157:H7; *Campylobacter*) 10 years after a waterborne outbreak – Clark et al 2010

Future Trends – Microbes and Water

- Impacts on general population → **Special populations** (children elderly, immunocompromised)
- 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 distribution systems)
- Epidemiology (costly/difficult) → **Risk Assessment** (cheap and validated by outbreak data)

Future Trends – Microbes and Water

– Historic weather patterns → **Climate Change**

- 60 to 80% of all surface and ground water outbreaks in the world are associated with above normal rainfall events
- 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 waterbased 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 (Metagenomics/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

Issues specific to Arizona

- *Naegleria fowleri* – (fatal brain damage) occurs in well water and recreational lakes
- *Vibrio cholerae* non-01 - (cussed wound infections) – common in rivers during summer
- Increased use of UV light for reclaimed waters (issues with adenovirus removal and growth of water based pathogens)
- Microbial standards for irrigation waters used for produce