Recommendations for reducing *Cryptosporidium* infection risk at swimming pools

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Objectives

Understand why there is risk of *Cryptosporidium* infection at swimming pools

Explore methods for reducing *Cryptosporidium* infection risk at swimming pools

Discuss the most feasible methods for Environmental Health Specialists to reduce *Cryptosporidium* infection risk at swimming pools

Why is there risk of *Cryptosporidium* infection at swimming pools?

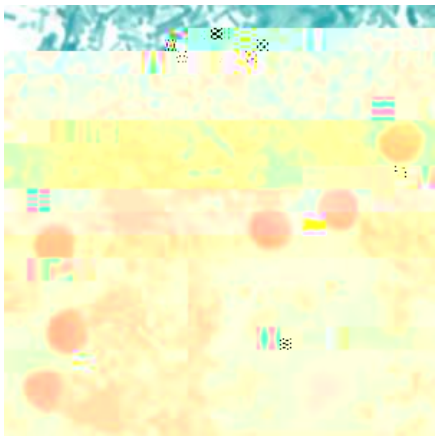
Cryptosporidiosis

- Vomiting, diarrhea, nausea, death
- Immunocompromised
  - 20% of U.S. population
  - Including children

Cryptosporidium caused 50% of treated recreational water-associated outbreaks between 2011-2012

Treated recreational water venues are ideal for *Cryptosporidium* outbreaks:

- Oocysts highly resistant to chlorine (inactivation: 20 ppm for 12.75 hr)
- Swimming =“community bathing”
- Bathers can excrete 10^9 oocysts/fecal release
- *Cryptosporidium* has low infectious dose
- Oocyst release up to 50 days post-diarrhea cessation
- Swimmers perceive pool water is sterile
- Swimming pool water is recirculated



Cryptosporidium oocysts (CDC, 2013)

What do we know about *Cryptosporidium?*

Number of outbreaks associated with recreational water, by year - United States, 1978 - 2012

Hlavsa et al. 2015

What do we know about *Cryptosporidium?*

Risk of *Cryptosporidium* infection in one year of swimming pool visits:

29 inf Å

Methods for reducing *Cryptosporidium* infection risk

How can we reduce *Cryptosporidium* infection risk at swimming pools?

Treated water venues are ideal for *Cryptosporidium* outbreaks:

Oocysts highly resistant to chlorine (inactivation: 20 ppm for 12.75 hr)	Use alternative disinfectants
Swimming =“community bathing” Bathers can excrete 10^9 oocysts/fecal release *Cryptosporidium* has low infectious dose Oocyst release up to 50 days post-diarrhea cessation Swimmers perceive pool water is sterile	Stop introduction of oocysts
Swimming pool water is recirculated	Use more effective filtration techniques

Use alternative disinfectants

Current free chlorine levels recommended in the Model Aquatic Health Code (MAHC) will not inactivate *Cryptosporidium* in a timeframe that reduces swimmer risk

Use alternative disinfectants

Problems with using hyperchlorination as a method to inactivate *Cryptosporidium*:

- Must use *a lot* of chlorine
  - Expensive
    - Chlorine product
    - Closure time (CDC guidelines: 20 ppm chlorine for 12.75 h)
- Must maintain 20 ppm the entire 12.75 h
  - Employee overtime
  - Test kit capability and reliability
  - Operator error
- Must know if and when fecal incident occurred
- Hyperchlorination does not work well in pools with high cyanuric acid concentrations

Use alternative disinfectants

Use alternative disinfectants

2016 CDC fecal incident response guidelines

	No cyanuric acid	1 - 15 ppm cyanuric acid	15 + ppm cyanuric acid:
Chlorine (ppm)	20	20	20
pH	≤7.5	≤7.5	≤7.5
Temperature (°F)	≥77	≥77	≥77
Time (h)	12.75	28	28

CDC, 2016

Use alternative disinfectants

Stop introduction of oocysts

Is *stopping* introduction possible? Probably not, but we can *reduce* contamination by controlling

Stop introduction of oocysts

Elimination

Substitution

Administrative

Engineering

Personal Protective Equipment

Elimination controls

- Do not allow ill swimmers into the pool
- Do not allow previously-ill swimmers into the pool
  - Signage – do not swim if you have diarrhea
  - Group education on recreational water illness – swim teams, water aerobics, swim classes
  - Waivers – open swim, fitness facility users, swim classes, swim teams, water aerobics

Stop introduction of oocysts

- Engineering/PPE controls
  - Separate children and adults
    - Build separate pools for adults and children
      - Perhaps easier to control *Cryptosporidium*
        - Child pool, routine treatment to remove *Cryptosporidium* from pool water
  - Make better swim diapers
    - Current swim diapers release 50 – 97% of *Cryptosporidium* oocysts into pool water within 5 min of swimming after diarrhea

Amburgey, Anderson and Brian, 2011

Use more effective filtration techniques

- Swimming pool water is recirculated
  - Use secondary disinfection (UV or ozone)
  - Maximize efficiency of the pool filter
    - Sand
      - Polyaluminum chloride coagulants at appropriate flow rates with deep sand
      - Add thin layer of precoat media

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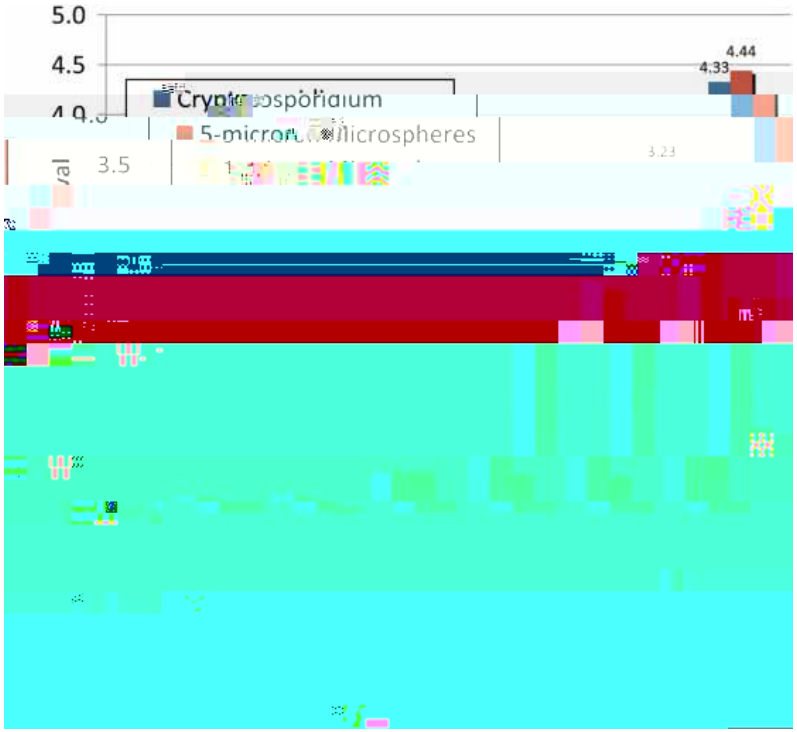
    - Precoat media
      - Perlite media
      - Diatomaceous Earth

Log particle removal for different filtration scenarios



Amburgey et al., 2012

Amburgery, 2011; Amburgey et al., 2012; Lu and Amburgey, 2016

What are the most feasible methods for Environmental Health Specialists to reduce *Cryptosporidium* infection risk?

What are the most feasible methods for reducing *Cryptosporidium* infection risk?

A combination of controls must be used to reduce risk of *Cryptosporidium* infection:

What are the most feasible methods for reducing *Cryptosporidium* infection risk?

- Waivers as a form of education
  - Environmental Health Specialists
    - Provide waiver examples to aquatic facility staff
      - By swimming in this pool, you agree not to:
        - Swim until two weeks after diarrhea has stopped
        - Intentionally swallow pool water
        - Allow children with diarrhea to swim in bathing suits or swim diapers since neither control diarrheal releases
        - Intentionally pee or poop in the pool water
        - Splash other swimmers in the face (associated with pool water ingestion)
        - Enter the pool without showering for at least 60 sec. (recommended minimum pre-swim shower length)
        - Fail to report a diarrheal release into pool water

Keuten et al. 2014; Suppes et al. 2014

What are the most feasible methods for reducing *Cryptosporidium* infection risk?

Environmental Health Specialists can also:

- Require pool facilities provide swimmers with test strips and handouts or signage on pool water quality standards
- Suggest implementation of mandatory breaks for open swim or swim

Amburgey, J. E. (2011). Removal of Cryptosporidium-Sized Polystyrene Microspheres