



Recreational Water Illness Prevention

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Dr. Vore is an aquatics consultant specializing in public health, recreational water illness management, water chemistry, and regulatory issues. Since 1991 he has concentrated most of his work on the microbiology of swimming pools and spas. Roy received his Ph.D. in bacterial physiology from the University of Arkansas and his masters and bachelors in microbiology from Pittsburg State University, Pittsburg Kansas. Roy is an active contributor to training and standards development for the recreational water industry. He was a key author in developing the RWI portion of the current NSPF Pool & Spa Operator Handbook and the RWI module for the APSP. He is currently serving on the Water Quality Technical Committee of the CDC's Model Aquatic Health Code task force. He is a frequent invited speaker at the National Swimming Pool Foundation's World Aquatic Health Conference, the Canadian Pool & Spa Conference, as well as for the Association of Pool and Spa Professionals (APSP), the Northeast Spa & Pool Association (NESPA), and the Florida Swimming Pool Association (FSPA). Roy has over 60 scholarly papers and presentations on the microbiological of swimming pools and spas, the selection and use of industrial biocides, biocide testing methodology, and the governmental regulation of biocides. He is a certified pool management instructor (NSPF®I) as well as a certified pool operator (CPO®).

Abstract

Recreational water illnesses (RWIs) can be greatly reduced, if not completely prevented, by appropriate management of the disinfecting and circulatory systems. The microorganisms that cause infectious RWIs are well known and the conditions that permit outbreaks are also well known. It is also understood by nearly all that these same infectious agents are readily killed by >1 ppm free chlorine. Yet the outbreaks continue to occur. Mandatory training for facility management and operators is needed but a one-size-fits-all approach may not work. The published reports clearly show that some types of facilities are more likely to have certain kinds of infectious outbreaks. These differences are due to the nature of the microbes themselves, the behaviors of the bathers, and lapses in disinfection that occur during second or third shift supervision. The soon to be released CDC Model Aquatic Health Code will mandate that some high risk facilities use a supplement disinfection system but this by itself will not stop all preventable RWIs.

Measuring and controlling the health from chemical-induced RWIs is even more problematic. In nearly all cases the skin, eye, and respiratory complaints are due to excess levels of disinfection byproducts (DBPs). There are >600 known DBPs and these vary in both their persistence and ability to cause illness. With present existing technology is not possible to determine which of the DBPs are present at any one time. This is further complicated by the continuous generation and eliminate of DBPs. While some facilities operate routinely with low levels of combined chlorine other facilities may need to employ additional steps to prevent rash and respiratory complaints. While mandatory showering may be helpful other procedures including routine water replacement, improved ventilation design, supplement non-halogen oxidation, and modification of superchlorination practices may be more fruitful.

By closely examining the pattern of known outbreaks it is possible to develop a management system that is tailored to the type of RWIs that are likely to occur in one's own aquatic facility. A customized and comprehensive risk management system is the best way to minimize both infectious and chemically-induced RWIs.

Recreational Water Illness (RWI) Prevention

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RWIs – guiding thoughts

1. RWIs are preventable diseases
2. Proper management can significantly reduce, if not completely eliminate, RWIs
3. Operators are responsible for providing a facility that is as safe as practically possible
4. Outbreaks can lead to serious legal issues

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RWIs – a status check

- The current status is:
 - The number of RWIs is increasing
 - One-third of the serious RWIs between 1999 and 2006 could have been prevented if the operator followed current disinfection guidelines
- Are we satisfied with the current number and kinds of RWIs?

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Operations – a status check

- Current regulations vary from state to state
- Within some states there are local variations
- Regulations frequently lag
 - The introduction of new facility designs
 - The introduction of new treatment methods
 - The recognition of new health threats
- Training requirements also vary from state to state

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Does one-size-fits all work?

- Can you swap shoes with a random stranger and be comfortable?
- Can you swap glasses with a random stranger and see clearly?
- Do all aquatic facilities face the exact same infectious microorganisms?
- Can all infectious microorganisms be controlled using the same disinfection treatment?
- Is the patron population at every aquatic facility equally sensitive to the same RWVs?
- Does a lap pool have the same potential for outbreaks as a splash pad? A health club spa? A lazy river?

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Steps in developing a risk management system

1. Identify, characterize, and assess the health threats from various agents that can lead to illness
2. Assess the vulnerability to specific health threats in the aquatic community
3. Determine the risk (i.e. the expected consequences of specific types of outbreaks)
4. Identify ways to reduce those risks
5. Prioritize risk reduction measures based on a strategy

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The Risk Assessment Equation

$$R = H \times DR \times E$$

Where:

R = Risk

H = Hazard identification

DR = Dose Response

E = Exposure assessment

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Hazard identification

- What are the agents that cause RWIs?
 - Infections by bacteria, parasites and viruses
 - Acute illness due to chemicals
- What is a convenient way to group them?
 - Gastrointestinal
 - Dermal
 - Respiratory
- How serious is the disease caused by each group or agent?

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Hazard identification: agents

Illness type	Type of agent	Specific agent(s)	Severity of illness
Gastro-intestinal	Bacteria	<i>E. coli</i> <i>Shigella</i>	High, some can be severe or life threatening
	Parasites	<i>Giardia</i> <i>Crypto</i>	
	Viruses	Norovirus	
Dermal	Bacteria	<i>Pseudomonas</i>	Low (but what if . . .)
	Chemical	CCs and DBPs	Low (but what if . . .)
Respiratory	Bacteria	<i>Legionella</i>	Low(PF) to high (LD)
	Chemicals	CCs and DBPs	Low to high

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Source of hazards

Category	Sub-category	Source
Infectious agents	Gastrointestinal	Bathers
	Dermal	Biofilm in plumbing
	Respiratory	Biofilm in plumbing
Chemical agents	Treatment chemicals	Mishandling
	Combined chlorine and other disinfection byproducts	Formed in the water

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Dose response

- What is the minimum amount of a pathogen or a chemical that will cause illness?
 - Pathogens and chemicals with low minimum doses require more attention
- Is everyone equally sensitive or are some groups more sensitive?
 - Sensitive groups may require modified management practices

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Dose response: minimum dose required for illness

Illness type	Specific agent	Minimum dose
Gastro-intestinal	<i>E. coli</i>	10 cells
	<i>Giardia</i>	10-100 cysts
	<i>Crypto</i>	10 cysts
	Norovirus	10 particles
Dermal	<i>Pseudomonas</i>	High (but . . .)
	CCs and DBPs	>0.2 ppm (but . . .)
Respiratory	<i>Legionella</i>	High (but . . .)
	CCs and DBPs	It depends ? ? ?

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Exposure assessment

- What is the route of exposure?
 - Different RWIs have different routes of exposure
 - Infectious agents have one preferred entry into the body
- How does the facility type impact the route of exposure?
 - Lap pools don't create aerosol = no *Legionella*
 - Spa users swallow little water = no gastrointestinal illnesses

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RWI exposure assessment: overall view

Type of illness	Route of exposure	Likelihood of exposure in pools	Likelihood of exposure in spas
Gastro-intestinal	Ingestion	High (based on outbreaks)	Very low (based on outbreaks)
Dermal	Contact with water	Extreme	Extreme
Respiratory	Inhalation	Low if outdoor; Moderate with some features; High if indoor	Extreme

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RWI exposure assessment: Public vs. private venues

	Pools	Spas
Public facilities including hotels, condos and health clubs	Gastrointestinal	
	Dermal (<i>Pseudomonas</i> ; CCs and DBPs)	Dermal (<i>Pseudomonas</i> ; CCs and DBPs)
	Respiratory (CCs and DBPs at indoor facilities)	Respiratory (<i>Legionella</i> ; CCs and DBPs in indoor pools)
Residential (private homes)	Dermal (<i>Pseudomonas</i> ; CCs and DBPs)	Dermal (<i>Pseudomonas</i> ; CCs and DBPs)
	Respiratory (CCs and DBPs at indoor pools)	Respiratory (<i>Legionella</i> ; CCs and DBPs in indoor pools)

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High risk situations

- Different types of facilities have different RWIs
- Some individuals have increased sensitivity to some RWIs
- Greater loading increases the potential for an ill person introduce an AGI or for the presence of a sensitive person
- Adoption of treatment above the minimum specified in the current state/local code is a risk management decision

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High risk facilities

Facility type	Threat	Reason
Wading, water activity pools; interactive water features with no standing water; spray pads; venues for <7yr old	Gastrointestinal	Incontinence coupled with more ingested water
	<i>E. coli</i> O157:H7	Young children are particularly sensitive to kidney failure caused by <i>E. coli</i> O157:H7
Therapy pools	All infections	Reduced immunity
Spas	<i>Legionella</i>	Legionnaires' Disease
Indoors (all venues)	Volatile CCs and DBPs	Poor ventilation

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Components of an RWI Risk Management System

An effective RWI risk management system must include a four-pronged approach:

1. Train all operators in proper water management
2. Maintain a disinfection levels to protect users and staff
3. Enhance disinfection for high-risk populations or in high-risk facilities
4. Educate users so they may adopt behaviors that decrease the risk of illness. While user education is important it is typically less effective compared to implementing engineering controls.

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Management: Training

- Have at least one certified operator on staff
- Provide training to 2nd shift
 - Basic training such as NSPF® Pool Operator Primer™
 - Be able to recognize imminent threats that should result in closure of the facility
 - Be familiar with written facility procedures
- Include continuing education

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Treatment: infectious RWIs

- *E. coli*, *Shigella*, *Pseudomonas*, *Legionella*, and *Giardia* are easily killed by chlorine and bromine
 - Minimum concentration of free chlorine is 1.0
 - Minimum concentration of bromine is >2.0 but the exact value is not known
- Disinfection must be continuous to control *Pseudomonas* and *Legionella*
- Consider remote alarming

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Treatment: chemical RWIs

- Evaluate other treatment options
 - Use routine partial water replacement
 - Use breakpoint treatments appropriately
 - Install an ultraviolet (UV) system
 - Install an ozone system
 - Use potassium monopersulfate weekly
 - Make showers mandatory
 - Improve both the ventilation system and the water-air gas exchange

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High risk facilities: infectious RWIs

- Enhanced disinfection should be used
 - Supplemental disinfection systems such as ozone and UV should be installed ASAP to limit the duration of *Crypto* outbreaks
 - Slightly elevated levels of chlorine or bromine can be used to control all other infections

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Bather education: change societal behaviors

- Bathers must accept some responsibility
 - Don't swim while ill with diarrhea
 - Take frequent bathroom breaks
 - Report incidents or unusual conditions promptly
 - In unguarded facilities test the water
 - Take a shower with soap before entering
- Bathers must accept some risk
 - All activities have some amount of risk

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Additional information

- CDC Healthy Swimming @ www.cdc.gov/healthyswimming/
 - You can find RWI information, accident response information, and Model Aquatic Health Code (MAHC)
- National Swimming Pool Foundation @ www.NSPF.org
 - (Certified Pool/Spa Operator "CPO" classes)
- World Aquatic Health Conferences @ www.NSPF.org
 - All this years as well as previous years talks

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