Recreational Water Illnesses

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National Environmental Health Association
2007 Annual Education Conference & Expo
Atlantic City, NJ
June 18-21, 2007

Learning Objectives

- Why RWI training is important to "Aquatic Specialists"
- How infections occur, spread and the seriousness RWI pathogens are to patrons, clients and employees
- How education, prevention and protection techniques will improve RWI awareness
- Why an Emergency Action Plan is important to properly prepare, respond, document and report outbreaks
- How basic prevention and protection techniques can reduce RWI outbreaks.

Section One
Regulations and Responsibilities

- Regulations
- Guidelines
- Responsibilities
**Regulations and Guidelines**

- **Regulations**
  - Federal
  - US EPA
  - OSHA
  - State
  - Local
- **Guidelines**
  - CDC
  - APSP
  - Other trade associations

Regulations are the law. Failure to follow may result in sanctions. When in conflict follow local codes.

Best practice suggestions written by expert authorities. Although not legally binding these are considered in civil law suits.

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**Who should take this training?**

- Facility directors (especially senior management)
- CPO’s, AFO’s
- Managers, LGI’s, WSI’s
- Service Technicians’
- Coaches
- Any aquatic professional

Each has a responsibility to provide an environment that is safe for
- Patrons
- Staff
- Self
- Clients

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**Do you know that you are covered by the OSHA Standard?**

- The general duty clause states, “That the employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees.” (OSHA, 1970).
- RWI’s are a “recognized hazard”
Section Two
Disease Transmission in Recreational Water

How they are spread.
How disease occur.

Infection occur three ways

RWI’s can be transmitted by
- Ingesting water
- Contact with water
- Air

If you are in or near a pool or spa that is contaminated you will be exposed and subject to infection.

Gastrointestinal illness

Recent Waterpark Cryptosporidiosis Outbreak, Employees and Patrons: California, 2004

75% of employees ill
N=244 patrons 177 employees

Date of illness onset

After hours party

Patron Employee
Gastrointestinal illness
2004 California Waterpark Crypto Outbreak
Key Findings from Employees and Patrons
- Major outbreak associated with an after hours party on 20 August
- Majority of staff were ill before the patrons
- 16 employees reported illness before 21 August
- Staff swam while ill
- Management knew staff were ill and allowed them to continue to swim
- Outbreak was reported by patrons not the facility management
  - Outbreak had been ongoing for weeks before being reported
  - Wheeler et al. 2006 Epidemiol. Infect

Gastrointestinal illness
A hypothetical case
- Accident in 75,000 gallon pool
- One diarrheal accident releases 1 billion E. coli O157:H7 cell or Crypto oocysts
- Fecal matter is uniformly mixed and none is removed by filtration
- Every 30ml (1 ounce) contains 105.8 infectious units - 30 ml is a small swallow of water
- Swallowing as little as 3 ml (0.1 ounce) can cause diarrhea in sensitive individuals
- This amount of E coli/O157:H7 can be fatal to toddlers
- Imagine this in a 5000 gallon wading pool!

The Process of Disease
- The disease process begins when a germ or disease causing pathogen enters the body.
- Generally the body does an efficient job of controlling pathogens through the body’s immune system.
- Certain pathogens however, can overwhelm the body’s immune system causing serious infections and in cases where the immune system is weakened due to physiological causes if untreated can be deadly!
Infections require parts

1. There must be a **pathogen**.
2. There must be a **sufficient quantity** of pathogen to cause disease.
3. There must be an appropriate transmission site or **entry point**.
4. A person must be **susceptible** to the pathogen.

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**Why is disinfection / chlorination necessary?**

*To Protect People From Illness*

- through water contamination
  - by *direct* or *indirect* Contact,
  - or through *direct* Ingestion

- *Is the primary* reason for RWIs training

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**Section Three**

Types of Recreational Water Illnesses

- Statistics on RWI’s
- Common RWI’s
- Uncommon RWI’s
- Sources of RWI Pathogens
The US Centers of Disease Control (CDC) tracks Water Borne Disease Outbreaks (WBDO)

- 2003-4 report
  - 62 outbreaks
  - 26 states and Guam
  - 2,698 people
  - 58 hospitalizations
  - 1 death

- Don’t relax - at best 10% of outbreaks are identified and reported!

CDC recent summary of pool and spa inspections

- Report summarized
- 22,000 inspections
- Report covered
  - Hotel & Motel pools
  - Wading pools
  - Therapy pools
- 21,000 violations noted
  - 11% of the inspections resulted in immediate closure of the facility

Organisms that cause common RWI’s

Treated venues (swimming pools, spas, spray pads, water parks)
- Bacteria
  - E coli
  - Shigella
  - Pseudomonas
  - Legionella
- Parasites
  - Cryptosporidium
  - Giardia
- Viruses
  - Norovirus
  - Adenovirus

Untreated venues (lakes, beaches, rivers)
- Bacteria
  - E coli
  - Shigella
  - Pseudomonas
- Parasites
  - Cryptosporidium
  - Giardia
  - Schistosoma
- Viruses
  - Norovirus
  - Adenovirus
Organisms that cause uncommon RWI’s

**Treated venues** (pools, spas, spray pads, water parks)
- Bacteria
  - Staph aureus

**Untreated venues** (lakes, beaches, rivers)
- Parabasalts
  - Naegleria fowleri
  - Schistosoma

Sources of RWI’s

<table>
<thead>
<tr>
<th>Sources of threat</th>
<th>Methods of introduction</th>
<th>Time to minimal infective dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bathers</td>
<td>Introduced in vomitus and feces</td>
<td>Immediate: organisms in this group do not reproduce in the pool / spa</td>
</tr>
<tr>
<td>Pool / Spa itself</td>
<td>Organisms multiply in pool or spa to high numbers</td>
<td>Long-term: organisms introduced in low levels and must multiply several times</td>
</tr>
<tr>
<td>Environment</td>
<td>From fill / source-water, sewer cross connections, or the environment</td>
<td>Immediate</td>
</tr>
</tbody>
</table>

Section Four
Enteric (GI) illnesses

- Microorganisms
- Infection (what it takes to cause illness)
- Incubation period
- Symptoms
- Treatment
Enteric RWI Illnesses

- “Enteric” refers specifically to the intestines
- Enteric RWI’s caused by numerous microbes
  - Parasites
  - Bacteria
  - Viruses

Gastrointestinal illness
1993-2002 US outbreaks in Treated Venues (N=64)

Chlorine-resistant:
Cryptosporidium 65.6%
Giardia 3.1%
E. coli O157:H7 6.3%
Shigella 7.8%
Norovirus 4.7%
Other 3.1%

Chlorine-sensitive:
Poor pool maintenance
Acute gastro 9.4%
Other includes Campylobacter, Salmonella

Slide courtesy of Michael Beach, CDC

Cryptosporidium – a parasite

- Single-cell protozoa, is the most common reported RWI
- Highly resistant to chlorine
- Infection: ingestion of contaminated water, dose size>10 cysts
- Incubation: 2 to 10 days (average 7 days) after ingestion
- Symptoms: Diarrhea, dehydration, weight loss, stomach cramps, fever, nausea, vomiting
- Treatment: time, nitazoxanide recently approved
**Giardia – a parasite**
- Single-celled protozoa
- Moderately resistant to chlorine
- Infection: ingestion of contaminated water, dose size >10-100 cysts
- Incubation: 1 to 2 weeks (average 7 days)
- Symptoms: Diarrhea, gas, greasy stools, stomach cramps, upset stomach, nausea
- Treatment: time, prescription drugs

**Shigella – a bacterium**
- Single-celled bacteria
- Not resistant to chlorine
- Infection: ingestion of contaminated water, dose size >10-100 cells
- Incubation: 24 to 48 hours
- Symptoms: bloody diarrhea, fever, and stomach cramps
- Treatment: fluid replacement, antibiotics

**E. coli – a bacterium**
- Single-celled bacteria
- Not resistant to chlorine
- Infection: ingestion of contaminated water, dose size >10 cells
- Incubation: 24 to 48 hours
- Symptoms: bloody diarrhea, fever, and stomach cramps
- Strain O157:H7 can cause kidney failure and death in toddlers
- Treatment: fluid replacement, antibiotics
Norovirus— a virus

- A common virus, recent scientific findings reveal that the genus causes around 50% of all gastroenteritis around the world.
- Many cruise ship outbreaks
- Infection: ingestion of contaminate water, dose size >10 particles
- Incubation: 24 to 48 hours
- Symptoms: vomiting, diarrhea, fever, and stomach cramps
- Treatment: fluid replacement, time

Adenovirus— a virus

- Respiratory, conjunctivitis, or rash illness known as “PCF” and others
- Survives well outside of the body
- Direct fecal-oral and waterborne transmission
- In-Direct contact (towels, pillows, clothing)
- Infection: ingestion of contaminate water, dose size >10 particles
- Incubation: 24 to 48 hours
- Symptoms: Watery diarrhea, vomiting, headache, fever, abdominal cramps, infections of eye, tonsils, adenoids or intestines
- Treatment: Only Symptoms can be treated overtime

Section Five
Non-enteric (GI) illnesses

- Microorganisms
- Infection (what it takes to cause illness)
- Incubation period
- Symptoms
- Treatment
Non-Enteric RWI’s

All waters
- *Pseudomonas aeruginosa*
- *Legionella pneumophila* - esp. spas
- Both grow in biofilms
- Untreated waters
- *Schistosoma*
- *Naegleria fowleri*

What is Biofilm?

- A collection of microbes living together on a wet surface
- Each is different, some contain pathogenic microbes
- Examples are dental plaque, sludge in sewer, slime in pool or spa filter

*Pseudomonas aeruginosa* - a bacterium

- Very common in wet areas and on vegetation
- Grows in biofilms
- Not resistant to chlorine
- Causes rashes (folliculitis) and ear aches (swimmer’s ear)
- Grows readily at pH 5.0 to 8.5 and 70°F to 101°F
- Spas are near ideal habitats
- Pools are a less ideal habitat but still quite satisfactory
**Pseudomonas aeruginosa**
- a bacterium

- **Infection:** contact with contaminated water, dose size unknown
- **Incubation:** 2-14 days after exposure
- **Symptoms:** Rash in armpits, groin, abdomen and area covered by bathing suit. Rash may range from 2 mm red dots (like a flea bite) to oozing sores (like poison ivy). Average duration is about 8 days
- **Treatment:** None usually required (infection is “self-limiting”)

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**Pseudomonas aeruginosa**
*Why should you be worried?*

- This bacteria is by far the most common pathogenic microbe in recreational water.
- Because it is so common and seldom causes more than minor infection it is seldom documented by local health departments
- But, where this bacteria grows there are likely to be other more serious ones also, such as *Legionella.*
- This bacteria is very easy to kill.
- **Rash outbreaks are an indicator of poor overall sanitation in the facility.**

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**Legionella pneumophila**
- a bacterium

- **Grows in biofilms**
  - Thrives at 90°F to 106°F and neutral pH
  - Almost all infections from spas.
  - WHO: 50+ outbreaks on cruise ships
- **Not resistant** to chlorine
- **Infection:** inhaled contaminated droplets, dose size unknown
- **Treatment:** antibiotics (Legionnaire’s Disease)

*There are documented cases where individuals became infected simply walking past a contaminated spas with the blowers on.*
Legionellosis:
Two forms of disease

- Legionnaire's Disease: severe form
  - Pneumonia plus fever, chills, cough
  - 5-15% of cases result in fatality
  - Highest death rate in nosocomial cases and among smokers (major risk factor)
- Pontiac fever: less severe symptoms
  - Acute onset (36 hr), flu-like, non-pneumonic
  - Self-limiting disease, seldom diagnosed
  - Recovery in 2-5 days without treatment
  - Most cases (perhaps >90%) of Legionella infections are Pontiac Fever

Schistosoma
- a parasite of lakes and streams

- Not a concern in treated water.
- Warm water lakes become infectious at temperatures from 82-86°F/28-30°C
- Cause of infection: amoeba enters through the nose and travels to the brain and spinal cord while the person is swimming underwater or diving.
- Incubation: short
- Symptoms: Dehydration, weight loss, stomach cramps, fever, nausea, vomiting leading to Primary Amebic Meningoencephalitis (PAM)
- Treatment: PAM is fatal (3-7 days) - no effective treatment.

Naegleria fowleri
(Nuh-Gleer-e-uh)
- a parasite of lakes and streams

- Not a concern in treated water.
- Warm water lakes become infectious at temperatures from 82-86°F/28-30°C
- Cause of infection: amoeba enters through the nose and travels to the brain and spinal cord while the person is swimming underwater or diving.
- Incubation: short
- Symptoms: Dehydration, weight loss, stomach cramps, fever, nausea, vomiting leading to Primary Amebic Meningoencephalitis (PAM)
- Treatment: PAM is fatal (3-7 days) - no effective treatment.
Section Six
Understanding sanitation

- Disinfection v. sanitation
- How fast microbes are killed
- Preventative v. remedial treatments

Disinfection v. sanitation
- Definitions vary between industries
- Terms are reversed in Europe
- APSP definition for pools and spas:
  - Disinfection: elimination of all vegetative cells
  - Sanitation: reduction of microbe concentration to below the threshold for human disease
- Pools and spas are "sanitized" not "disinfected".
- Sanitation programs manage the microbial levels, they do NOT eliminate all microbes!

How fast microbes are killed
- Rate of kill affected by
  - Type of microbe (bacteria, virus, parasite)
  - Type of cell (vegetative, spore, cyst)
  - Type of sanitizer (chlorine, bromine)
  - Concentration of sanitizer
  - pH
  - Organic matter (naked cell, cell buried in feces)
  - Amount of cyanuric acid (at least for Cryptosporidium)
- Optimal water balance parameters result in faster kill rates
How fast microbes are killed

- "Rate of kill" is measured as cT values
- cT value = concentration(c) of free chlorine in ppm multiplied by Time(T) to reach desired kill level in minutes
- Values are developed in a lab under ideal conditions (pH 7.5, 77°F, no organic matter)
- cT values in pools can be higher
- For quicker kills raise c (add more chlorine) or increase T (wait longer)

Example cT calculations

**E. coli**
- cT value 1
- FAC in pool = 1
- Minutes = cT / FAC
- Minutes = 1 / 1
- *E. coli* killed in 1 minute

**Cryptosporidium**
- cT value 9600
- FAC in pool = 3
- Minutes = cT / FAC
- Minutes = 9600 / 1
- Crypto killed in 3200 minutes (2.22 days)
Preventative v. remedial treatments

- Routine treatments: normal operation
  - Maintain the sanitizer at the proper concentration
  - Stops microbes from multiplying
  - Controls most microbes as they are introduced in the water from bathers
- Remedial treatments: fixes a problem
  - Remedial treatments are for specific events
  - Raise the concentration of the sanitizer and hold for a period of time
  - Reduces high numbers of established microbes, or those introduced in large number by vomit or fecal accident, to acceptable levels

Section Seven
Hygiene and RWI Education

- Encourage hygiene practices
- Emphasize hygiene practices
- Enforce hygiene practices
- Educate patron and staff on RWI’s

Encourage hygiene practices

- Provide clean and adequate bathrooms
- Patrons should take a soapy shower
- Use hygiene to reduce the microbes and organic matter introduced by patrons
Emphasize hygiene practices
- Staff must set examples
- Post information
- Schedule bathroom breaks in parks

Enforce hygiene practices
- Prohibit diaper changing poolside
- Don’t rinse diapers or dirty babies in the pool
- Ban swimming for 7 days (14 preferably) after recovering from diarrhea
- Recovered persons still shed microbes for up to 14 days!

Educate Patrons and Staff on RWI’s
- Resources and posters available from CDC.
  - http://www.cdc.gov/healthyswimming/
  - You wouldn’t drink the water you bath in.
  - Why would you drink the water you swim in?
  - There are some things you would rather NOT have.
  - Shower before swimming.
In-Service & Continuing Education is the Key!

“Remember the better informed “Aquatic Specialist’s” are about infectious RWI’s diseases the less likely they or those they are responsible to will become infected or transmit them.”

Educate your Staff

http://www.cdc.gov/healthyswimming/brochure.htm
Section Nine Documentation

- Operational records
- Incident reports
- Additional documentation

Operational records

- Written record of sanitizer concentration
- Water parameters, circulation, flow-rates and service maintenance
- Required records for many facilities

Incident reports

- Written record of accidents
- Injuries and blood spills
- Vomit
- Fecal accidents
- Extremely valuable to public health officials during outbreaks
- Maybe required by some health departments and insurance carriers
Additional documentation

- Standard Operation Practices (SOP’s)
  - SOP’s are the manual for the facility
  - Written documents stating who, what, when and how the facility is run
  - Can be very formal or informal as long it covers all operations.
  - Available to all - especially to night and weekend staff when most outbreaks have been documented by the CDC
- Emergency Action Plan (EAP)
  - Instruction for staff during and after an incident
  - Written plan stating who, what, when and how
  - Must include after hours phone contact list for key personnel
- SOP’s and EAP’s are strongly encouraged

Reporting an exposure / outbreak

- Local, state, CDC obligations
  - Helpful Tips for Recreational Water Outbreak Response
  - Generic Pool-Related Outbreak Case and Control Questionnaires
  - Environmental Health Outbreak Investigation Report: Swimming Pool
  - Venue Waterborne Diseases Outbreak Report Form
  - Sample Letters
Section Ten
Accident Response

- Concept of treatment
- Blood
- Vomit
- Formed feces
- Diarrhea

Concept of remedial treatment

- Based treatment of individual incident
- Assume the worse case scenario - what is the most difficult to treat microbe likely to be present?
- Treat for worst case - all microbes that are more sensitive will also be killed

Health threat assessment

<table>
<thead>
<tr>
<th>Accident</th>
<th>Pathogens (list not inclusive)</th>
<th>Most resistant (correct target)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood</td>
<td>HIV, Hep B, Hep C</td>
<td>All similar</td>
</tr>
<tr>
<td>Vomit</td>
<td>E coli, Norovirus, Hep A</td>
<td>Noro and Hep A</td>
</tr>
<tr>
<td>Formed feces</td>
<td>E coli, Norovirus, Giardia</td>
<td>Giardia</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>E coli, Norovirus, Giardia, Cryptosporidium</td>
<td>Cryptosporidium</td>
</tr>
</tbody>
</table>
Vomit Accident Response

- Norovirus and Hepatitis A biggest health threats from vomit
- Vomit may contain up to 1 billion Norovirus particles (it takes as few as 10 particles to cause infection)
- Norovirus and Hepatitis A have Ct values similar to Giardia (see fecal response)
- Treat vomit the same as formed fecal accidents

CDC “Vomit and Blood Contamination of Pool Water”

Fecal Accident Response: Formed feces

1. Clear and close pool at once
2. Scoop or net out feces - flush down toilet
3. Raise the Chlorine level to 2.0 ppm for 30 minutes
4. Maintain pH at 7.2-7.4 ppm
5. Re-open pool
6. Soak net in bucket of chlorine (100 to 500 ppm FAC)
7. Document each fecal accident by recording date and time of the event, note whether formed stool or diarrhea, and note the chlorine levels at the time or observation of the event.

Fecal Accident Response: Diarrhea

1. Close pool at once
2. Scoop or net out feces - flush down toilet
3. Raise chlorine to 20 ppm for 8 hours
4. Maintain pH at 7.2-7.4 ppm
5. Filter continuously
6. Backwash filter
7. De-chlorinate to 1 to 4 ppm free chlorine
8. Re-open pool
9. Soak net in bucket of chlorine (100 to 500 ppm FAC)
10. Document each fecal accident by recording date and time of the event, note whether formed stool or diarrhea, and note the chlorine levels at the time or observation of the event.
The correct use of hyperchlorination for *Crypto*

![Graph showing the correct and incorrect use of hyperchlorination for Cryptosporidium]

Keep the HOCl at 20 ppm for ENTIRE 8 hour period

Section Eleven
Resources and References
- CDC Healthy Swimming @ www.cdc.gov/healthywater/
- CDC Cruise ship manual @ www.cdc.gov/
- EPA Legionella: Human Health Criteria Document @ www.epa.gov
- EPA Drinking Water Health Advisory @ www.epa.gov
- Guidelines for Canadian Recreational Water Quality @ www.hc-sc.gc.ca
- Management of Spa Pools @ www.hpa.org.uk/
- Guideline for drinking water quality: Addendum: Microbiological agents in drinking water, 2nd ed. @ www.who.org
- The Association of Pool and Spa Professionals @ www.theAPSP.org
- National Swimming Pool Foundation @ www.nspf.org
- National Recreation and Park Association @ www.nrpa.org