Risk and Severity of Recreational Water Associated Infections

Ryan H. Dwight, PhD
Overview

1. Sources of pathogens in recreational waters
2. The diversity of pathogens
3. Types and severity of infections
4. Epidemiology of recreational waters
5. Water quality standards and public risk
6. Recreational exposure patterns
7. Exposure to toxins
8. My research around this area
Sources of Pathogens

- Human waste, but also animal waste
- Treated domestic sewage discharged off-shore and into rivers.
- Urban runoff is a primary contributor
  - Decaying infrastructure, illegal discharges, accidental spills, pet waste, agricultural waste, etc.
  - North Orange County coastal waters receive runoff from three rivers (3,000 sq/mi urbanized watershed)
  - Millions of gallons per day of untreated runoff discharges directly onto recreational beaches
Combined Watershed Areas for the Los Angeles, San Gabriel and Santa Ana Rivers

- Los Angeles River
- San Gabriel River
- Santa Ana River
- Orange Co.
- San Bernadino Co.
- Riverside Co.
- San Pedro Bay
- Santa Monica Bay

© 2005 Ryan Dwight
Santa Ana River

Urban Runoff

Urban Flush

© 2005 Ryan Dwight
Santa Ana River Pollution Plume

Santa Ana River

Newport Beach
Santa Ana River Pollution Plume
Chocolate brown water and people surfing
Pathogen Profile

• **Bacteria**
  - Streptococci
  - Staphylococci
  - E. coli
  - Shigella
  - Eromonas
  - Salmonella
  - Leptospira
  - Legionella
  - Pseudomonas
  - Vibrio cholerae
  - Campylobacter

• **Viruses**
  - Enteroviruses
  - Norwalk-like viruses
  - Rotaviruses
  - Hepatitis A
  - Adenoviruses
  - Cocksackie
  - Poliovirus

• **Parasites**
  - Giardia
  - Cryptosporidium
  - Cyclospora
  - Toxoplasma gondii
Infections and Severity

Range of infections due to full body exposure. Most are self-limiting – few require medical care.

- Gastrointestinal infections
- Respiratory infections (upper & lower)
- Ear infections
- Eye infections
- Skin infections
Rare yet Severe Illnesses

- Hepatitis
- Cholera
- Typhoid
- Meningitis
- Necrotizing fasciitis (Flesh-eating disease)
FLORIDA

Teen Falls Seriously Ill From Bacteria in Lake.

A 15-year-old boy remained in critical condition with a rare bacterial infection he contracted while swimming in a lake.

The boy was swimming July 20 in Lake Talmadge, northeast of Orlando, when a bacteria known as Chromobacterium violaceum entered his body through a cut on his leg, officials said.

A 12-year-old boy died Friday of a rare brain infection after he contracted primary amebic meningoencephalitis while swimming in another group of Florida lakes.

From Times Wire Reports
The Epidemiology

• Numerous epi studies in recreational marine waters correlating health risk and water quality
  – Most found a dose-response between pathogen densities & risk
  – Meta-analysis conclude *enterococcus* is the best indicator to predict risk of GI infection
Water Quality Standards

- “Acceptable” illness rate for GI = 1.9%
  - 0.8% for freshwater
- Based on indicator bacteria not viruses
- Risk level set for adults
- Risk measured for GI only
- Testing efficacy questionable
- Adopted by California in 1998
- No surveillance of illnesses or outbreaks
Exposure Patterns

- **Temporal Variations**
  - Hourly: low use in morning, high use mid-day, low in evening
  - Daily: high use on weekend and holidays, low use in mid-week
  - Monthly: Summer months high use by large population (water quality good); Winter months low use by small population (water quality poor)

- **Spatial Variations**
  - Rivers, creeks and storm drains are hot spots
  - Kiddie beaches and harbors
Toxins

• Urban runoff concentrates and transports toxins
• Coastal sediments can load toxins
• Public can be exposed to toxins of all types
  – Oils, heavy metals, PCBs, PAHs, DDT, Perchlorate, etc…..
  – Stories of wetsuit threads disintegrating, instant rashes, to skin peeling away.
• Cancer clusters? *Santa Monica & Newport Beach*??
• Pathogens and toxins can concentrate in food chain
  – Bio-accumulation and bio-magnification
Public Exposure

• **How many people are exposed?**
  - 5.5 million exposures/year in Newport and Huntington Beaches alone
  - No standardized data collected

• **Who’s swimming at the beach?**
  - 48% of summer beach-swimmers children (more susceptible to pathogens)
  - 78% are families
  - 88% are Californians
Children playing in the Santa Ana River
Public Health Burden

• How many people are getting sick?
  – Findings calculated >36,000 GI illness events per year in Huntington and Newport Beaches
  – Coastal water quality well below the standard

• How much are the illnesses costing?
  – Findings estimated health costs to be $3.3 million per year in Huntington and Newport Beaches

- Cross sectional health study of illness rates in North Orange County and Santa Cruz County
- Surfers as subjects because of high exposure
- Team of interviewers at beaches
  - 1998 (El Nino winter)  n= 853
  - 1999 (La Nina winter)  n= 1,020
Combined Watershed Areas for the Los Angeles, San Gabriel and Santa Ana Rivers

- Los Angeles River
- San Gabriel River
- Santa Ana River
- Orange Co.
- San Bernadino Co.
- Riverside Co.
- Los Angeles Co.
- Santa Monica Bay
- San Pedro Bay

© 2005 Ryan Dwight
San Lorenzo River Watershed: Santa Cruz, California
North Orange County interviews
Santa Cruz County interviews
Mean Total Coliform Counts

Winter Study Months

North Orange County
Santa Cruz County

© 2005 Ryan Dwight
### Adjusted Odds Ratios for Reported Symptoms:
North Orange County vs Santa Cruz County

<table>
<thead>
<tr>
<th>Symptom</th>
<th>1998 OR</th>
<th>1999 OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Symptom</td>
<td>1.9*</td>
<td>1.2</td>
</tr>
<tr>
<td>Fever</td>
<td>1.7*</td>
<td>0.9</td>
</tr>
<tr>
<td>Stomach Pain</td>
<td>2.6*</td>
<td>0.9</td>
</tr>
<tr>
<td>Vomit</td>
<td>2.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>2.1*</td>
<td>1.1</td>
</tr>
<tr>
<td>Sinus</td>
<td>1.4*</td>
<td>1.3</td>
</tr>
<tr>
<td>Cough</td>
<td>1.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Sore Throat</td>
<td>2.0*</td>
<td>1.5*</td>
</tr>
<tr>
<td>Eye Infection</td>
<td>2.5*</td>
<td>1.4</td>
</tr>
<tr>
<td>Ear Infection</td>
<td>1.3</td>
<td>1.6*</td>
</tr>
<tr>
<td>Skin Infection</td>
<td>2.0*</td>
<td>0.7</td>
</tr>
</tbody>
</table>

* = adjusted odds ratio is significant at $P < 0.05$ level
Resources

• CDC
  – cdc.gov/healthyswimming

• U.S. EPA
  – epa.gov/surf