Recreational Exposure to Microcystins During Algal Blooms in Small Lakes

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Overview

- Define harmful algal blooms (HABs)
- HABs: Epidemiologic studies
Harmful Algal Blooms (HABs)

- Microscopic algae
  - Dinoflagellates
  - Diatoms
  - Blue-green algae

- Bloom is a proliferation of these organisms

- “Harm”
  - Toxin production
  - Oxygen deprivation
  - Light deprivation
Algal Toxins and Human Health: Marine Toxins

• Shellfish Poisonings
  – Diarrheic Shellfish Poisoning (DSP)
  – Neurotoxic Shellfish Poisoning (NSP)
  – Paralytic Shellfish Poisoning (PSP)
  – Amnesic Shellfish Poisoning (ASP)
• Ciguatera fish poisoning
• Fugu (Pufferfish) poisoning (tetrodotoxin)
• Pufferfish poisoning (saxitoxin)
• Respiratory illness (brevetoxins)
Algal Toxins and Human Health: Cyanobacterial Toxins

- Skin rashes, allergic reactions
- Neurologic effects
- Liver damage
- Genotoxic
- Tumor promoting
What do we know?

- Algal toxins are some of the most potent natural toxins known.
- Algal toxins can be in our drinking and recreational waters.
- They can cause harm to animals, the local ecosystems, and sometimes to people.
What are the important Public Health questions?

• Are people exposed to toxins when they use the lakes for recreation during algal blooms?
• What amounts of algal toxins in drinking and recreational waters do we need to worry about?
There is little guidance to address this question

- No U.S. Federal (EPA) guidelines or regulations for drinking water or recreational waters for cyanobacteria or their toxins.
World Health Organization (WHO) guidelines

- The guideline for lifetime exposure in *drinking water* is 1 µg/liter.
- The guideline for recreational waters is based on estimated health risk.
  - Low risk: 4 µg/liter
  - Moderate risk: 20 µg/liter
  - High risk: Scums on surface
What we know about toxins in recreational water and human health effects

Algal toxins can be harmful

Toxins are in the water

People may come in contact with toxins by swallowing water, getting water on their skin, or inhaling water droplets.

Can these toxins cause human health problems?

What happens to the toxins inside people’s bodies?

Do toxins get inside people’s bodies?
Exposure to Microcystins in Recreational Waters
States must develop their own criteria

• Drinking water
  – Oregon state limit for microcystins in finished drinking water is 1 µg/liter

• Recreational waters
  – California guideline for warning people about recreational exposure is 8 µg/liter.
  – Washington state provisional guideline for recreational waters is 6 µg/liter.
Hepatotoxic Cyclic Peptides
Collaborators

- National Center for Environmental Health, CDC
- National Center for Infectious Diseases, CDC
- Mote Marine Laboratory
- Greenwater Laboratory
- Lovelace Respiratory Research Institute
- Wright State University
- Other Federal Agencies (NOAA)
- State and local public health agencies
- Officials or others at study site
Epidemiology Study Design

- Study population
  - Planning recreational activities in lake with a HAB (exposed)
  - Planning recreational activities in lake with no HAB (control)
- Recruited in person
Environmental Data Collection

• Water samples (24)
  – Viruses
  – Water quality
  – Algal taxonomy
  – Microcystins
Environmental Data Collection: New Methods

• Air samples
  – 3 High-volume
    • Particle size
    • Mircocystins

• 50 personal air samples
  – Microcystins
Health-related Data Collection

- Recruited 104 people
- Questionnaires
  - Pre-exposure
  - Post-exposure
  - Follow-up (7-10 days later)
- Post exposure plasma samples
  - Mircocystins
Outcome Measures

• Compare plasma levels of microcystins in control and exposed groups
• Compare symptom reports
## Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unexposed N = 7</th>
<th>Exposed N = 97</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcystin in water (µg/L)</td>
<td>&lt; LOD, LOD = 0.15</td>
<td>3-5</td>
</tr>
<tr>
<td>Microcystins in air (ng/m³)</td>
<td>NA</td>
<td>&lt; LOD – 0.14, LOD = 0.0037</td>
</tr>
<tr>
<td>Microcystins in blood (µg/L)</td>
<td>&lt; LOD, LOD = 0.147 µg/L</td>
<td>&lt; LOD</td>
</tr>
<tr>
<td>Symptoms</td>
<td>No change</td>
<td>No change</td>
</tr>
</tbody>
</table>
Collaborators

• National Center for Environmental Health, CDC
• California Department of Health
• Siskiyou County
• Mote Marine Laboratory
• Greenwater Laboratory
• National Center for Infectious Diseases, CDC
• Lovelace Respiratory Research Institute
• Karuk Tribe
• Pacific Corporation
Health-Related Data Collection

• Added nasal swabs
  – Microcystins
## Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unexposed N = 7</th>
<th>Exposed N = 88</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcystin in water (µg/L) (total microcystins)</td>
<td>&lt; LOD</td>
<td>23 – 357</td>
</tr>
<tr>
<td>Microcystins in air (ng/m³)</td>
<td>NA</td>
<td>0.2 – 0.4</td>
</tr>
<tr>
<td>Microcystins in blood</td>
<td>&lt;LOD</td>
<td>&lt;LOD</td>
</tr>
<tr>
<td><strong>Microcystins on nasal swabs</strong></td>
<td>NA</td>
<td>&lt; LOD - 0.4 ng</td>
</tr>
<tr>
<td>Symptoms</td>
<td>No change</td>
<td>No change</td>
</tr>
</tbody>
</table>
What have we learned about microcystin exposure?

• Aerosols generated in lakes with blue-green blooms producing microcystins contain measurable concentrations of this toxin in the water, in the air and on nasal swabs
  – Potential for exposure
  – Potential for public health impact
What’s Next?

• Refine exposure assessments
• Develop biological markers for very low dose exposures (acute and chronic)
• Laboratory studies to assess effects at the molecular level
WARNING
LIFEGUARD, BACTERIOLOGIST, MICROBIOLOGIST, TOXICOLOGIST NOT ON DUTY
SWIM AT YOUR OWN RISK