Cyanobacteria and Drinking Water:
Occurrence, risks, management and knowledge gaps for public health.

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Current work

- Drinking water evidence review
  - Overview of cyanoblooms
  - Occurrence in Canada
  - Drinking water and health effects
  - Effectiveness of treatment
  - Approaches to management of risks
  - Knowledge and practice gaps for PH
Toxic algae near Kamloops possibly linked to cattle deaths, sick dogs

THE CANADIAN PRESS  Updated: September 7, 2017
Algae kills dialysis patients in Brazil

Thirty eight patients undergoing dialysis at a renal diseases institute in Brazil have died of acute renal failure, a result of contamination of the water used for haemodialysis. The cause of the deaths, which all occurred between 20 February and 19 April, was a mystery initially. But the state secretary of health has reported that the water used for haemodialysis at the institute was contaminated with the toxin microcystin-LR, produced by algae in the reservoir that supplies the water to the institute.

Tatiana Portela, a spokeswoman for the secretary of health, said that the possibility that algae was responsible for the deaths was first raised by the ecobiologist Dr Sandra Oliveira e Azevedo of the Federal University of Paraíba in João Pessoa. Dr Oliveira e Azevedo collected samples from the water used for dialysis and also from the carbon filters of the dialysis machines at the Institute of Renal Diseases in Caruaru, in the north eastern state of Pernambuco. Preliminary tests showed the presence of the algae and the toxin. Additional samples from the water supplies to the dialysis machines and from the liver and blood of patients who had died, were sent to the Wright State University, Ohio, and the Brazilian Centre for Disease Control, to confirm the hypothesis of contamination by algae.
Cyanotoxins

- 2000 species of cyanobacteria (~5% produce toxins)

- Between 25-75% of cyanoblooms may contain toxins/toxin producing bacteria

- Cyanotoxins (> 100 principle toxins and variants)

<table>
<thead>
<tr>
<th>Hepatotoxins</th>
<th>Neurotoxins</th>
</tr>
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<tbody>
<tr>
<td>Microcystins (MC)</td>
<td>Anatoxins</td>
</tr>
<tr>
<td>Cylindrospermopsins</td>
<td>Saxitoxins</td>
</tr>
<tr>
<td>Nodularin</td>
<td>BMAA</td>
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</tbody>
</table>
### Drinking Water Guidelines (µg/L)

<table>
<thead>
<tr>
<th></th>
<th>Microcystins</th>
<th>Cylindrospermopsins</th>
<th>Saxitoxins</th>
<th>Anatoxin-a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Canada MAC</td>
<td>0.4 (infant formula)</td>
<td>-</td>
<td>-</td>
<td>3.7 (Quebec)</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US E.P.A. DWHA*</td>
<td>0.3 (children &lt; 6y)</td>
<td>0.7 (children &lt; 6y)</td>
<td>-</td>
<td>20 (Ohio)</td>
</tr>
<tr>
<td></td>
<td>1.6</td>
<td>3.0</td>
<td>-</td>
<td>3 (Oregon)</td>
</tr>
<tr>
<td>Australia DW Guidelines</td>
<td>1.3</td>
<td>1 (health alert value)</td>
<td>3 (health alert value)</td>
<td>-</td>
</tr>
<tr>
<td>New Zealand Provisional MAC</td>
<td>1.0</td>
<td>1</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>WHO</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Brazil</td>
<td>1.0</td>
<td>15 (guideline value)</td>
<td>3 (guideline value)</td>
<td>-</td>
</tr>
<tr>
<td>CZ, FI, FR, SP</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Variation of limits applied by state
Occurrence in Canada

- Bloom season is typically Jun-Nov
- ~150 reports of affected lakes & reservoirs in 2018
Affected DW sources

- Surface water more at risk than groundwater (lakes/reservoirs)
- Affected drinking water source waters in all provinces except for PEI (groundwater only)
- A source water issue in 4-5% of drinking water treatment plants (Giddings et al. 2012)
Evidence of health effects from drinking water

• Acute poisoning events
  • Canada - 0 from drinking water
    • Study of 267 families in Quebec – some evidence of increase in mild symptoms where DW supplied by affected lake. (Levesque et al. 2014)
  • Globally - 27 drinking water, 3 haemodialysis (1800-2010) (Wood, 2016)

• Chronic illness - less well studied
  • Canada – No evidence of chronic effects, but limited study
  • Globally
    • China – Three Gorges Reservoir/Liver damage in children; Elsewhere, link to cancers
    • Ohio - Evidence of MC carcinogenicity but inadequate data on long-term effects from DW
Challenges to identifying cases

- Non-specific symptoms
- Health provider may not be looking for cyanobacterial illness
- No diagnostic tools
- No formal reporting mechanism
- Unknown exposure levels
- Drinking water user may be unaware of affected supply
- Monitoring may be sporadic, data on historic levels not available
- Unregulated small and private supplies unlikely to test for MC
Effectiveness of drinking water treatment

• Municipal treatment plants
  • 88% of Canadian households
  • Multi-barrier approach
  • Majority have never exceeded the MAC for MCs in treated water
  • But exceedances occasionally occur
    e.g. 31 DNC notifications in Quebec 2006-2012

• Key risks
  • Blooms near intake
  • Pre-treatments that kill cells (release toxins)
  • Inadequate monitoring (varies by utility)
  • Lack of system maintenance (filters)
Small and private treatment systems

- 12% of Canadian households not supplied by municipal supply
- e.g. small communities, rural homes and businesses and seasonal properties located on affected waterbodies
- Disinfection only or no treatment systems most at risk
- Advice during a bloom is usually to seek alternative source
- Key challenges
  - Toxins may be present when bloom not visible
  - Length of advisory – till bloom clears or whole season?
  - Lack of simple monitoring/detection tools
  - Lack of suitable treatment technologies
Managing the risk

• Range of approaches across Canada
• Typically
  • Assess the situation
  • Plan for response
  • Monitor
  • Advisories/risk communication
  • Mitigation/Treatment
Assessing the situation

Challenges

• Who is responsible?
  • MoE
  • Utilities for DW sources
  • Health authorities?

• Which waterbodies are vulnerable?

• Who will monitor, and who will respond if there is an issue?

e.g. Alberta – Drinking Water Safety Plans - incorporating consideration of cyanobacteria.
Planning for response

Challenges

• Multiple agencies involved (who leads?)
• Preparing communication plan
  • For whom? (public, EPH, utility operators etc.)
  • What message? (DNC, adjust treatment, etc.)
• Actions at various alert levels
  • Treatment actions, avoidance, advisory
• Most follow Health Canada’s flowchart, but some have developed own
e.g. BC decision protocols for Rec/DW
Monitoring

Challenges

• Who is responsible?
  • MoE for recreational water bodies (usually)
  • Utilities for raw/treated DW
  • SDWS/PWS?

• Where to monitor/how often/what to measure?
  • Monitoring tools
    • Field tools - Quick but low resolution
    • Lab tests - Accurate but costly and time consuming
    • Real time monitoring

• Need for rapid, cost-effective and accurate field monitoring tools; standard methods, data access
# Waterways confirmed to have blue-green algae in the Sudbury and district area

## 2018

<table>
<thead>
<tr>
<th>Affected waterway</th>
<th>Area</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearwater Lake</td>
<td>Sudbury</td>
<td>July 12, 2018</td>
</tr>
<tr>
<td>Ramsey Lake</td>
<td>Sudbury</td>
<td>August 9, 2018</td>
</tr>
<tr>
<td>Lake Nepawin</td>
<td>Sudbury</td>
<td>August 16, 2018</td>
</tr>
<tr>
<td>Lake Nipissing</td>
<td>Sudbury</td>
<td>August 23, 2018</td>
</tr>
<tr>
<td>Red Deer Lake</td>
<td>Sudbury</td>
<td>August 25, 2018</td>
</tr>
<tr>
<td>Lake Kagawong</td>
<td>Sudbury</td>
<td>September 1, 2018</td>
</tr>
<tr>
<td>McCharles Lake</td>
<td>Sudbury</td>
<td>September 24, 2018</td>
</tr>
<tr>
<td>Kakakiviwanda Lake</td>
<td>Sudbury</td>
<td>October 2, 2018</td>
</tr>
</tbody>
</table>

## What are blue-green algae?

Blue-green algae, technically known as cyanobacteria, are photosynthetic microorganisms that are naturally present in low numbers. In shallow, undisturbed water bodies, they can form blooms that discolor the water and may cause harmful effects to aquatic life and humans.
Advising the public

Challenges

- When to issue and when to rescind?
- Seasonal or event based?
- Different messaging for different groups?
- Getting the message out – what is most effective?
  - Signage
  - Door knocking/letters
  - Social media
  - Provincial websites
- Most advisories are for recreational use.
- Risk communication for DW - usually DNC, Do Not Boil – what about other uses?
Mitigation/Treatment

Challenges

• Reactive vs. Proactive

• Prevention
  • Diffuse and Point Source Pollution (multiple agencies involved)

• Risk communication
  • Engaged residents and communities (messaging?)

• Treatment
  • Nutrient reduction, Aeration, Biological controls, Algaecides, (risks?)

• DW Treatment systems
  • SOPs for utilities, Additional treatment for SDWS/PWS?
Summary of key knowledge and practice gaps identified

- Lack of universal indicators and standard methods of sampling and analysis
- Lack of rapid and reliable field tests affecting timely detection and quantification of risk
- Uncertainty over exposure in SDWS and PWS
- Uncertainty over best practical advice for SDWS and PWS
- Lack of SOPs for water treatment plant operators for various levels of risk
- Coordination of multiple stakeholders could benefit from local champions and organizational leadership

- Need for better access to current and historical monitoring data, and link to health data
- Need for more data on effects of chronic exposure (levels, toxins)
- Research gaps on mechanisms and level of toxicity (toxins and mixtures)
National cyanobacteria in drinking water – knowledge exchange forum/group

• Quarterly forum/discussion session
• Share ideas and information, common issues

• Seeking your feedback....
  • Do you think it is needed?
  • What types of activities?
  e.g
    • Sharing good practice
    • Developing SOPs
    • Improve coordination
    • Develop knowledge of local champions

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Thank you for listening

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Images and Screenshots

- Public Health Sudbury and District. 2018. Blue-green algae and affected waterways. Available at: https://www.phsd.ca/health-topics-programs/water/blue-green-algae-cyanobacteria