Water-borne Disease Outbreaks in Canadian Small Drinking Water Systems

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BC Centres for Disease Control and the National Collaborating Centre for Environmental Health
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National Collaborating Centres for Public Health
Goals of all NCCs

- Synthesize and translate evidence-based knowledge
- Identify gaps in the use of evidence in public health practice and policy making
- Strengthen national profile and networking across Canada
- Consult with front-line public health practitioners to identify promising practices, policy options and research
National Collaborating Centre for Environmental Health (NCCEH)

- Focus on the health risks associated with the physical environment (natural and built) and identify evidence-based interventions to reduce those risks
- Act as a resource for environmental health practitioners and policy-makers across Canada
Major Project Areas

- Built environment
- Drinking water
- Heat advice
- Outdoor air
- Personal service establishments

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Small Drinking Water Systems Project

- Collaborative effort among the NCCs
- The purpose is to improve small drinking water systems by identifying gaps and providing the necessary evidence to inform policy and practice
- SDWS defined as serving a population of < 5,000
- Forums, workshops and an online survey to gather input from front line practitioners, policy-makers, local drinking water officials and other experts in water safety

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NCCEH Water-borne Events Retrospective Study

- Lack of systematic information on characteristics and causes of water-borne disease events (WBE)
- Outbreaks provide opportunity to look into sources, health impacts and contributing factors to water-borne illness
- No national surveillance system in Canada for WBE; approaches to collection of information on outbreaks are not standardized
- Information collected is often not published or distributed and often incomplete

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NCCEH Water-borne Events Retrospective Study

Objectives of Study

- Determine the characteristics of WBEs
- Water source characteristics
- Water Treatment and distribution
- Demographic information and health outcomes

- Obtain information of direct relevance to prevention policies and programs

http://www.ncceh.ca/en/practice_policy/ncceh_reviews/dw_illnesses_surveillance

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Retrospective WBE Study

- 1993-2008, 48 events, based on interview data with relevant front-line environmental health professionals
- Most outbreaks happened in small systems (< 5,000 population)
- Data reanalysed to focus on SDWS and combined with other studies
  - Schuster et. al. (2005)
WATER-BORNE DISEASE OUTBREAKS IN CANADIAN SMALL DRINKING WATER SYSTEMS

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Water-borne Disease Events

- Preventable
- However limited knowledge of factors
- Investigations difficult
  - Rare
  - Can be transmitted via multiple routes
  - GI illness frequently under-reported
WBE Report Objectives

- Provide a brief overview of Canadian drinking water systems
- Describe trends of past water-borne disease outbreaks
- Describe characteristics and factors contributing to outbreaks in small drinking water systems
- Discuss practices for preventing water-borne disease outbreaks in small drinking water systems

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Overview of Canadian DWS

- Classification
  - Ownership
    - Private
    - Semi-private
    - Public
  - Number of connections
  - Population served

- Approximately 5 million served by SDWS

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Overview of Canadian DWS

- **Source water**
  - Majority (92%) of Canadians with *private* water supply from groundwater sources
  - Majority (85%) of Canadians with *public* water supply from surface water sources

- **Treatment practices**
  - 55% of treated water from conventional or direct filtration serving about half the population (Stats Can 2007)
  - 8.7% of drinking water systems serving communities of 300 or more do not utilize any treatment process (Stats Can 2007)

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Recent Investigations of WBE

- Novometrix, 2009
  - 1993-2008, collected through standardized questionnaire and interviews with public health representatives
  - 48 events identified
  - Limitations: retrospective, recall bias, incomplete records, biased towards larger events?, non-response rate was 29%

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Recent investigations of WBE

- Hrudey and Hrudey, 2004
  - In-depth case studies of water-borne disease outbreaks in Canada and industrialised countries
  - Summary of important themes and broader context of themes
Recent investigations of WBE

- Schuster et. al, 2005
  - 1974-2001, collected through outbreak summary reports (HC, Quebec), academic and grey lit
  - 288 *definite, probable, and possible* water-borne disease outbreaks
  - Greater number of events but not all maybe water-borne and less specific information about event and size of population

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Defining WBE

- Schuster – incident in which more than 2 cases of illness occurred after ingestion from the same water source
- Novometrix – suspected or confirmed acute illness involving 2 or more and included events involving individual where clear point source
- Both Novometrix and Schuster report a high proportion of outbreaks in Quebec due to enhanced surveillance

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“Definitely”, “probably” and “possibly” WBE from 1974 - 2001


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### Number of water-borne disease events (1993-2007)

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of water-borne disease events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>5</td>
</tr>
<tr>
<td>1994</td>
<td>5</td>
</tr>
<tr>
<td>1995</td>
<td>8</td>
</tr>
<tr>
<td>1996</td>
<td>5</td>
</tr>
<tr>
<td>1997</td>
<td>2</td>
</tr>
<tr>
<td>1998</td>
<td>5</td>
</tr>
<tr>
<td>1999</td>
<td>0</td>
</tr>
<tr>
<td>2000</td>
<td>7</td>
</tr>
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<td>2001</td>
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</tr>
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<td>2005</td>
<td>1</td>
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<tr>
<td>2006</td>
<td>2</td>
</tr>
<tr>
<td>2007</td>
<td>2</td>
</tr>
<tr>
<td>No date reported</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>48</strong></td>
</tr>
</tbody>
</table>


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Distribution of WBE investigated by according to size of population served


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### Number of infectious disease outbreaks (1974-2001)

<table>
<thead>
<tr>
<th>Source</th>
<th>Public</th>
<th>Semi-public</th>
<th>Private</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definitely water-borne</td>
<td>59</td>
<td>28</td>
<td>12</td>
<td>99</td>
</tr>
<tr>
<td>Probably water-borne</td>
<td>17</td>
<td>25</td>
<td>19</td>
<td>61</td>
</tr>
<tr>
<td>Possibly water-borne</td>
<td>23</td>
<td>85</td>
<td>20</td>
<td>128</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>99</strong></td>
<td><strong>138</strong></td>
<td><strong>51</strong></td>
<td><strong>288</strong></td>
</tr>
</tbody>
</table>

Distribution of infectious disease outbreaks in *public* water systems by size of population served

<table>
<thead>
<tr>
<th>Population size</th>
<th>Number of outbreaks</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 – 999</td>
<td>6</td>
</tr>
<tr>
<td>1,000 – 1,999</td>
<td>15</td>
</tr>
<tr>
<td>2,000 – 2,999</td>
<td>9</td>
</tr>
<tr>
<td>3,000 – 3,999</td>
<td>7</td>
</tr>
<tr>
<td>4,000 – 5,000</td>
<td>6</td>
</tr>
<tr>
<td>5,001 or more</td>
<td>44</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>87</strong></td>
</tr>
</tbody>
</table>

50%


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Type of water treatment by water source at time of SDWS infectious disease outbreaks

<table>
<thead>
<tr>
<th>Type of treatment</th>
<th>Groundwater</th>
<th>Surface water</th>
<th>Mixed</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>10</td>
<td>5</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Disinfection only</td>
<td>5</td>
<td>8</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Disinfection and filtration</td>
<td>0</td>
<td>1*</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
<td><strong>14</strong></td>
<td><strong>2</strong></td>
<td><strong>31</strong></td>
</tr>
</tbody>
</table>

*Failure of Filtration


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Factors contributing to outbreaks

- Lack of source water protection
- Precipitation, spring thaw and high turbidity
- Inadequacy or failure of water treatment
- Malfunctioning distribution system
- Other..
Current event detection and prevention practices

- Event detection
  - Patients, physician and lab, water quality monitoring, epidemiological investigations…
- Advisories
  - Issued as response to outbreak but not always effective
- Changes to system management
  - Improvements, change water source
- Monitoring water quality

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### Monitoring program in SDWS reported by Novometrix (1993-2007)

<table>
<thead>
<tr>
<th>Water monitoring program in place?</th>
<th>Private responsibility (alone)</th>
<th>Government responsibility (alone or in combination with private)</th>
<th>Unknown responsibility</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>5</td>
<td>11</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>No</td>
<td>11</td>
<td>0</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Unknown</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17</strong></td>
<td><strong>14</strong></td>
<td><strong>2</strong></td>
<td><strong>33</strong></td>
</tr>
</tbody>
</table>


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Monitoring

- System owners responsible
  - Many private owners not monitoring
  - Only 35% of HH testing drinking water (Stats Can)
  - 21% had never tested (Jones et al 2006)
  - Only 8% tested as prescribed by guidelines
  - Inconvenience, lack of problems

- Programs more likely to be implemented and maintained when governmental bodies involved
Themes of drinking water provision

- Pathogens pose greatest risk to drinking water safety
- Robust, effective, multiple barriers to drinking water contamination are needed
- Trouble is usually preceded by change
- Operators must be capable and responsive
- Drinking water professionals must be accountable to consumers
- Ensuring safety is an exercise in risk management

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Conclusions

- Small and private drinking water systems may be more vulnerable
- Novometrix: (75%) of water-borne disease outbreaks
  SDWS
- Schuster et al., a high proportion of events occurred in SDWS classified as semi-public (48%) and private (18%) water systems
- Approximately 34% of the enteric disease outbreaks occurred in public water systems ~ 50% in systems serving populations of < 5,000 people

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Unanswered questions

- Resistance, adaptation and tolerance to enteric pathogens
- How many water-borne outbreaks are under-reported?
- What role does public opinion play in inadequate treatment practices?
- How does the collaborative management of systems affect system operations?
Thank you!
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