REVISED ESTIMATE OF FOOD-BORNE ILLNESS IN CANADA

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Outline

• Purpose and Background
• Methods:
  » Specified Pathogens
  » Unspecified Agents
• Results
• Discussion
Purpose

• To estimate the annual number of cases of food-borne illness in Canada for specified pathogens and unspecified agents

• To identify gaps and potential future research areas

• F/P/T food safety and public health partners, as well as industry and academia, rely on estimates of food-borne illness to inform their activities, including:
  » Set food safety priorities;
  » Create public health policies;
  » Inform research, cost estimates and disease attribution;
  » Contribute to education and advocacy campaigns; and
  » Develop risk assessments
REVISED ESTIMATE OF FOOD-BORNE ILLNESS IN CANADA

UNDER-REPORTING

How many cases are reported to surveillance?

How often are laboratory-confirmed cases reported?

UNDER-DIAGNOSIS

How sensitive are laboratory tests?

How often do laboratories test for a pathogen?

How often are specimens submitted?

How often do ill persons seek medical care?

What is the total estimate of illness in the population?
Background

- 1999 – US CDC publishes estimate of 76 million food-borne illnesses annually (Mead et al)

- 2008 – Public Health Agency of Canada publishes estimate of 11 million food-borne illnesses annually, based in part on results and methods used for US estimate (Thomas et al)

- 2011 – US CDC publishes revised estimate of 48 million food-borne illnesses annually (Scallan et al)
  » More advanced methodology and improved data sources, resulting in a more accurate estimate
Methods

• Estimates established for 30 pathogens and unspecified agents

• 2000-2010 data:
  » Canadian surveillance systems
  » International literature
  » 2006 Canadian census population

• Accounted for under-ascertainment (i.e. under-reporting and under-diagnosis)
Methods

- Probability (PERT) Distribution to describe range of plausible values for model inputs (low, modal, high value)
- Modeled uncertainty for each estimate, resulting in credible intervals for each number
  - Inherent variability of estimates and uncertainty due to lack of knowledge
- Values are generated using monte carlo simulations in @Risk – 100,000 iterations
Methods

- Data sources

<table>
<thead>
<tr>
<th>Pathogen case counts</th>
<th>Under-diagnosis / Under-reporting</th>
<th>Proportion travel related</th>
<th>Proportion food-borne</th>
</tr>
</thead>
</table>
| • Canadian Notifiable Disease Surveillance system (CNDSS)  
  • National Enteric Pathogen Surveillance system (NESP)  
  • Provincial Reportable Disease Surveillance system | • NSAGI population surveys  
  • C-EnterNet Surveillance  
  • Consultation with NML, HC and CPHLN  
  • Literature review | • C-EnterNet Surveillance  
  • BCCDC provincial data  
  • Enhanced Listeriosis surveillance | • Expert elicitation  
  • Literature review |
## Methods

<table>
<thead>
<tr>
<th>1. Pathogens for which laboratory-confirmed illnesses were scaled up</th>
<th>2. Pathogens for which Canadian population scaled down</th>
<th>3. Other methods</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>National reportable disease data</strong></td>
<td><strong>Provincial reportable disease data</strong></td>
<td><strong>E. coli, other diarrheagenic</strong></td>
</tr>
<tr>
<td><em>Brucella</em> spp.</td>
<td><em>Trichinella</em> spp.</td>
<td>ETEC</td>
</tr>
<tr>
<td><em>Campylobacter</em> spp.</td>
<td><em>Listeria monocytogenes</em></td>
<td>VTEC</td>
</tr>
<tr>
<td><em>Clostridium botulinum</em></td>
<td><em>Vibrio parahaemolyticus</em></td>
<td>VTEC non-O157</td>
</tr>
<tr>
<td><em>Cryptosporidium</em> spp.</td>
<td><em>Yersinia enterocolitica</em></td>
<td><em>Bacillus cereus</em></td>
</tr>
<tr>
<td><em>Cyclospora cayetanensis</em></td>
<td></td>
<td><em>Staphylococcus aureus</em></td>
</tr>
<tr>
<td>VTEC O157</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Methods: 30 Pathogens

1. Pathogens for which laboratory-confirmed illnesses were scaled up

**Under-diagnosis multiplier**

- Proportion severe
- Care seeking severe
- Specimen submission severe
- Laboratory testing
- Laboratory sensitivity
- Proportion mild
- Care seeking mild
- Specimen submission mild

**Under-reporting multiplier**

- Lab to local public health
- Local public health to Provincial Public Health

**Estimated annual number of domestically acquired, food-borne illness by pathogen**

10 | PUBLIC HEALTH AGENCY OF CANADA || AGENCE DE LA SANTÉ PUBLIQUE DU CANADA
Example – *Campylobacter*

**Under-diagnosis multiplier**

- Proportion severe
  - Care-seeking severe: 44%
  - Specimen submission severe: 27%
  - Laboratory testing: 97%
- Proportion mild
  - Care-seeking mild: 14%
  - Specimen submission mild: 20%
  - Laboratory sensitivity: 75%

**Under-reporting multiplier**

- Lab to local public health: 96%
- Local public health to Province Public Health: 97%

**Laboratory confirmed illness**

- 10,344

**Proportion TRAVEL acquired**

- 24%

**Estimated annual number of domestically acquired, food-borne illness by pathogen**

- 145,350

**Proportion food-borne**

- 68%
Methods

2. Pathogens for which Canadian population was scaled down
Example - Norovirus

Canadian Population × Rate of symptoms per person per year × Proportion of symptoms related to specific pathogen = Estimated total number of illnesses

32,500,000 × 0.63 × 16.5% = 1,047,733
Methods: Unspecified agents

• Unspecified:
  » Known agents with insufficient data for estimating agent-specific episodes of illness;
    • E.g. *Aeromonas* spp., *Edwardsiella* spp., and *Plesiomonas* spp.
      mushroom and marine biotoxins, metals, and other inorganic toxins
  » Known agents not yet recognized as causing food-borne illness;
    • E.g. *Clostridium difficile* in retail meats
  » Microbes, chemicals, or other substances known to be in food but for which pathogenicity is unproven;
  » Agents not yet described
Methods: Unspecified agents

# of Acute Gastrointestinal Illnesses in Canada

Total # of illnesses estimated for 25 known pathogens that cause acute gastrointestinal illness*

Total # of illnesses related to Unspecified agents

% Domestic for 25 pathogens (97.3%)

% Food-borne for 25 pathogens (20.1%)

# of Domestically acquired Food-borne illnesses related to unspecified agents

# of Domestically acquired Food-borne illnesses from 30 pathogens

Total # Domestic, Food-borne illnesses

* Non AGI pathogens: Brucella, C. botulinum, Hepatitis A, L. monocytogenes, Toxoplasma gondii
Results

- 4.0 million domestically acquired food-borne illnesses annually (90% CrI: 3.1 – 5.0 million)
  - Specified pathogens: 1.6 million (90% CrI: 1.2 – 2.0 million)
  - Unspecified agents: 2.4 million (90% CrI: 1.8 – 3.0 million)

- Approximately 1 in 8 Canadians experiences domestically acquired food-borne illness each year
## Results for 30 Specific Pathogens

### Total domestic food-borne illness in Canada:

<table>
<thead>
<tr>
<th>Pathogens (1-10)</th>
<th>Count</th>
<th>% of Total</th>
<th>Pathogens (11-20)</th>
<th>Count</th>
<th>% of Total</th>
<th>Pathogens (21-30)</th>
<th>Count</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norovirus</td>
<td>1,047,733</td>
<td>64.25</td>
<td>Toxoplasma gondii</td>
<td>9,132</td>
<td>0.56</td>
<td>Shigella spp.</td>
<td>1,202</td>
<td>0.07</td>
</tr>
<tr>
<td>Clostridium perfringens</td>
<td>176,963</td>
<td>10.85</td>
<td>Giardia sp.</td>
<td>7,776</td>
<td>0.48</td>
<td>Vibrio, other spp.</td>
<td>1,112</td>
<td>0.07</td>
</tr>
<tr>
<td>Campylobacter spp.</td>
<td>145,350</td>
<td>8.91</td>
<td>Rotavirus</td>
<td>4,252</td>
<td>0.26</td>
<td>Salmonella Typhi</td>
<td>287</td>
<td>0.02</td>
</tr>
<tr>
<td>Salmonella spp., non-typhoidal</td>
<td>87,510</td>
<td>5.37</td>
<td>ETEC</td>
<td>3,848</td>
<td>0.24</td>
<td>Hepatitis A</td>
<td>271</td>
<td>0.02</td>
</tr>
<tr>
<td>Bacillus cereus</td>
<td>36,269</td>
<td>2.22</td>
<td>Adenovirus</td>
<td>3,739</td>
<td>0.23</td>
<td>Listeria monocytogenes</td>
<td>178</td>
<td>0.01</td>
</tr>
<tr>
<td>Yersinia enterocolitica</td>
<td>25,915</td>
<td>1.59</td>
<td>E. coli, other diarrheogenic</td>
<td>2,565</td>
<td>0.16</td>
<td>Trichinella spp.</td>
<td>63</td>
<td>0.00</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>25,110</td>
<td>1.54</td>
<td>Cyclospora cayetanensis</td>
<td>2,450</td>
<td>0.15</td>
<td>Brucella spp.</td>
<td>22</td>
<td>0.00</td>
</tr>
<tr>
<td>VTEC non-O157</td>
<td>20,523</td>
<td>1.26</td>
<td>Cryptosporidium spp.</td>
<td>2,321</td>
<td>0.14</td>
<td>Clostridium botulinum</td>
<td>14</td>
<td>0.00</td>
</tr>
<tr>
<td>VTEC O157</td>
<td>12,827</td>
<td>0.79</td>
<td>Astrovirus</td>
<td>1,912</td>
<td>0.12</td>
<td>Vibrio vulnificus</td>
<td>1</td>
<td>0.00</td>
</tr>
<tr>
<td>Sapovirus</td>
<td>9,491</td>
<td>0.58</td>
<td>Vibrio parahaemolyticus</td>
<td>1,798</td>
<td>0.11</td>
<td>Vibrio cholerae, toxigenic</td>
<td>0</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Discussion

• US methods generally followed, but with some improvements:
  » Definition of severe included bloody diarrhea or duration > 7 days in Canada vs. bloody diarrhea alone in the US;
  » Estimates for rotavirus, astrovirus and sapovirus were made for the full population in Canada vs. only children < 5 years in the US; and
  » Pathogens were excluded (i.e. Strep Group A and Mycobacterium bovis) and included (i.e. adenovirus) to be more specific to food-borne disease in Canada

• Changes from 2008 Canadian estimate include:
  » Estimating the burden for specific pathogens;
  » Using a specific case definition of acute gastrointestinal illness; and
  » Removing travel-related illness
Discussion - Comparison with the US

- Order of top 5 pathogens
- Viruses account for higher proportion of total in Canada compared to US
- Illness due to unspecified agents lower per 100,000 in Canada compared to US

<table>
<thead>
<tr>
<th>Top 5 Pathogens</th>
<th>Total Domestic Food-borne illness in Canada</th>
<th>Total Domestic Food-borne Illness in the US</th>
</tr>
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<tbody>
<tr>
<td>Norovirus</td>
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</tr>
<tr>
<td><em>Clostridium perfringens</em></td>
<td><em>Salmonella</em> spp., non-typhoidal</td>
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<td><em>Staphylococcus aureus</em></td>
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</table>
Discussion - Comparison with the US

Canada Total Estimates
- 1.6 million known
- 2.4 million unspecified
- 1 in 8 Canadians

US Total Estimates
- 9.4 million known
- 38.4 million unspecified
- 1 in 6 Americans
Discussion - International Comparisons

- US, Australia, the Netherlands, New Zealand, France, UK and Greece have completed national estimates
  » Varying methodology therefore cannot make direct comparisons
- Norovirus – high in US, Australia, the Netherlands, New Zealand and France
- *Campylobacter* and *Salmonella* - high in US, Australia, New Zealand, France, UK and Greece
- *Bacillus cereus*, *Clostridium perfringens* and *Staphylococcus aureus* - top 10 in all countries
Thank you

Questions?

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