Enteric Outbreak Investigations

Stephen Moore
Yvonne Whitfield
September 19, 2012
Outline

• PHO Role in Outbreak Investigations
• Descriptive Epidemiology of Enteric Disease in Ontario
• Looking Forward
# Public Health Architecture

## OAHPP functions:
- Surveillance
- Outbreak investigation
- Advice on outbreak control measures
- Scientific and technical advice and support on communicable disease and environmental health matters
- Public health library services
- Retains other legislated functions (e.g., research, laboratory services, professional development, knowledge exchange)

## MOHLTC functions:
- Policy and program development
- Legislation and regulatory development
- Standards, compliance and accountability
- Monitoring, reporting and overseeing performance
- Public health human resources strategy development
- Provincial-level outbreak control
- Long-term planning and setting strategic direction
Who: Enteric Outbreaks at PHO

- Communicable and Infectious Diseases (Dr Natasha Crowcroft)
  - Dr Colin Lee, Dr Liane MacDonald

- Communicable Disease Prevention & Control (Jason Garay)
  - Surveillance Services Unit
    - Anne Winter, Tina Badiani, Brenda Lee, Ellen Chan, Ryan Walton
  - Enteric Zoonotic & Vector Borne Diseases Unit
    - Stephen Moore, Jackson Chung, Christina Lee, Dr Dean Middleton, Yvonne Whitfield

- Emergency Preparedness (Dr Brian Schwartz)
  - Incident Response
    - Lisa Fortuna, Dr Mark Nelder, Amrita Maharaj

- Environmental & Occupational Health (Dr Ray Copes)
  - Akbar Ali, Naghmeh Parto, Alison Samuel

- PHO Laboratories
  - Dr Vanessa Allen, Dr Tony Mazzuli, Dr Anna Majury, Anne Maki, Erik Kristjanson, Peter Boleszczuk, Analyn Peralta, Suzanne Lombardi
What We Do: Provincial Outbreaks


* As of Mar. 9, 2012
How We Detect Provincial Outbreaks

• Laboratory Line List Review
• National Enteric Surveillance Program (NESP) algorithms
• Early Aberration Reporting System (EARS) flags
• Notifications from partners
• Informal communications with partners
Outbreak Communications & Coordination

- Daily Situation Report & Morning Rounds
- Public Health Alerts
- Enhanced Surveillance Directive
- Important Health Notices
- Outbreak Central
- Outbreak reports
- Ontario Outbreak Investigation Coordination Committee

Notifications of suspect and confirmed Botulism cases in Ontario

Communications Issued
Outbreak Investigation

Hypothesis Generation

- Standardized questionnaires
- Food Frequency tables & comparisons to reference values
- Field Epidemiologist (Centralized Interviewing)
- Laboratory sub-typing

Hypothesis Testing

- Loyalty Card Data
- Trace back and trace forward
- Environmental sampling
- Case Control Study

Microbiology → Food Safety Investigation → Epidemiology → Weight of Evidence → Health Risk Assessment → Action
Who Takes Public Health Action

- Health Units
- MOHLTC
- Canadian Food Inspection Agency
  - Product Tracing Investigations
  - Environmental Testing
  - Collates evidence for submission to Health Canada for a Health Risk Assessment
  - Voluntary Recalls (company initiated or CFIA requested)
  - Mandatory Recalls by Ministerial order (rare)
Health Canada

• Epidemiology, Microbiology, Product Tracing
• Comments on Intact vs Non-Intact samples
• Content & Format of a Health Risk Assessment (HRA)
• Information needed for a HRA
• Health Risk Definitions

Public Health Agency of Canada

• Leadership and coordination in national outbreaks

• In provincial outbreaks
  • Can do jurisdictional scans to identify similar clusters in other provinces or countries
  • Can supply field epidemiologists if required
  • Develops common platforms to aid outbreak investigation (CNPHI, CIOSC, etc)
  • Reviews strength of outbreak epidemiological evidence to give opinion to Health Canada during the health risk assessment process
Our Provincial Colleagues

Ministry of Health and Long Term Care (MOHLTC)

- Policy and programs
- Provincial Outbreak Leadership
- Public Health Action

Ontario Ministry of Agriculture Food & Rural Affairs (OMAFRA)

- Meat Inspection Program, Dairy Food Safety Program, Foods of Plant Origin
- Monitor compliance with standards, licensing, inspection, audit, advisory, education
- Detention, seizure, disposal but not recall authority
- Licensed meat and dairy facilities can have licenses suspended or revoked
- Areas like minimally processed foods and niche milk products not well covered by existing legislation

Ministry of Natural Resources (MNR)

- Interim food fish safety program
- Seizure of product possible but no recall authority and no ability to close operations
PHO Functions in Enteric Outbreaks

- **Incident Response**
  - Communications with partners
  - Briefing of CMOH and other Senior Management

- **Enteric, Zoonotic, and Vector Borne Diseases Unit**
  - Outbreak detection through lab surveillance and external notifications
  - Investigation of clusters
  - Technical advice on case related aspects of investigations
  - Information gathering, hypothesis generation, planning
  - Public Health Alerts

- **Surveillance Services Unit**
  - iPHIS based outbreak detection
  - Formal data analysis (food frequency tables, etc)
  - Questionnaire design
  - Enhanced Surveillance Directives

- **Environmental and Occupational Health Department**
  - Product tracing investigations
  - Scientific and technical advice related to environmental aspects of investigations

- **Communicable and Infectious Diseases Department**
  - Medical consultative advice as required

- **PHO Laboratories**
  - Testing & Subtyping of clinical specimens
  - Testing & Subtyping of environmental isolates
  - Facilitating and arranging testing and subtyping at federal labs where assays are not available provincially
  - Medical Microbiologists interpretation of laboratory results
  - Guidance on sample collection and submission
Guidance Documents

• **2004:**
  • *Canada Foodborne Illness Outbreak Response Protocol to Guide a Multi-Jurisdictional Response*

• **2006:**
  • *Ontario Foodborne Health Hazard and Illness Outbreak Investigations Memorandum of Understanding (MOU)*

• **2010:**
  • *Canada’s Foodborne Illness Response Protocol (FIORP)*
  • The Ontario Multi-Agency Foodborne Outbreak/Food Recall Working Group organizes a Subgroup to develop *Ontario’s Foodborne Illness Outbreak Response Protocol (ON-FIORP)*

• **Other Guidance Documents**
  • Food Premises Plant Investigation
  • Traceback Traceforward
  • Effectiveness Checks for Food Recalls
  • CFIA Verification Procedures
The Value of Your Work in Provincial Outbreaks

• Thorough case exposure ascertainment generates strong hypotheses
• Timely entry of cases assists with early outbreak detection
• Notification of situations of interest can help determine if subtyping would be useful
• Environmental specimen collection and handling can make or break an HRA
• Specific product details are critical for recall action to occur
• Your input in outbreak debriefs improves future investigations
A DESCRIPTIVE STUDY OF REPORTABLE GASTROINTESTINAL ILLNESSES (GI) IN ONTARIO, CANADA, FROM 2007 TO 2009

Linda Vrbova, Karen Johnson, Yvonne Whitfield, Dr. Dean Middleton, PHO Surveillance and Epidemiology Team
Study Purpose

• Conduct analysis of the Integrated Public Health Information System (iPHIS) data for reportable Gastrointestinal Illness (GI) for the period of January 2007 – December 2009

• Examine the incidence of each disease, demographics, outcomes, seasonality, likely sources of infection and exposure settings
Flow diagram of reported GI illnesses 2007 to 2009

Reported confirmed GI cases for 14 reportable diseases (n=29,897)

Not Successfully Followed Up:
- Lost to Follow Up (3,588)
- Untraceable (171)
- Pending (1,612)
- No Exposure Information (4,464)

Cases successfully followed up (n=20,062, 67.1% of all cases)

Exclusions by Exposure Information:
- Multiple exposures (460)
- Unclear/Unclassifiable Exposures (559)

Cases with exposure information (n=19,043, 63.7% of all cases)

Travel and Outbreak Exclusions:
- Relevant travel history outside of Ontario (5,248; 17.6% of all cases)
- Non-index case in an outbreak (454)

Sporadic endemic GI cases (n=13,341, 44.6% of all cases)

Cases not followed up or excluded based on unclassifiable exposure information

Cases excluded due to travel or for being part of an outbreak

Data source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2012/04/01]
## Results: Incidence by Illness

### Reportable gastrointestinal illnesses in Ontario by year, 2007 to 2009.

<table>
<thead>
<tr>
<th>Reportable Disease</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N¹</td>
<td>Incidence /100,000²</td>
<td>N¹</td>
<td>Incidence /100,000²</td>
</tr>
<tr>
<td>Amebiasis</td>
<td>814</td>
<td>6.4</td>
<td>761</td>
<td>5.9</td>
</tr>
<tr>
<td>Campy</td>
<td>3,883</td>
<td>30.3</td>
<td>3,789</td>
<td>29.3</td>
</tr>
<tr>
<td>Giardiasis</td>
<td>1,612</td>
<td>12.6</td>
<td>1,610</td>
<td>12.4</td>
</tr>
<tr>
<td>Salmonellosis</td>
<td>2,819</td>
<td>22.0</td>
<td>2,385</td>
<td>18.4</td>
</tr>
<tr>
<td>VTEC</td>
<td>317</td>
<td>2.5</td>
<td>278</td>
<td>2.1</td>
</tr>
<tr>
<td><strong>Total Overall</strong></td>
<td>10,746</td>
<td>84.0</td>
<td>10,125</td>
<td>78.3</td>
</tr>
</tbody>
</table>

Data source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2012/04/01]
Reportable gastrointestinal illnesses in Ontario by travel, outbreak, hospitalization, and mortality

Top Travel-related GI
- Paratyphoid Fever
- Typhoid Fever
- Cyclosporiasis
- Hepatitis A

High Hospitalization Rates
- Botulism
- Listeriosis
- Typhoid Fever
- VTEC /Paratyphoid Fever
## Results: Reported Exposure Source, Ontario, 2007-2009

<table>
<thead>
<tr>
<th>Reportable Disease</th>
<th>Primary Source (%)*</th>
<th>n</th>
<th>Animal</th>
<th>Food</th>
<th>Person</th>
<th>Water</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amebiasis</td>
<td></td>
<td>120</td>
<td>1.7%</td>
<td>8.3%</td>
<td>82.5%</td>
<td>5.8%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Campylobacteriosis</td>
<td></td>
<td>1,272</td>
<td>26.9%</td>
<td>63.1%</td>
<td>6.0%</td>
<td>2.8%</td>
<td>1.3%</td>
</tr>
<tr>
<td>Giardiasis</td>
<td></td>
<td>344</td>
<td>14.2%</td>
<td>5.5%</td>
<td>36.0%</td>
<td>40.7%</td>
<td>3.5%</td>
</tr>
<tr>
<td>Hepatitis A</td>
<td></td>
<td>54</td>
<td>0.0%</td>
<td>7.4%</td>
<td>87.0%</td>
<td>0.0%</td>
<td>5.6%</td>
</tr>
<tr>
<td>Listeriosis</td>
<td></td>
<td>12</td>
<td>8.3%</td>
<td>75.0%</td>
<td>8.3%</td>
<td>8.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Paratyphoid Fever</td>
<td></td>
<td>2</td>
<td>0.0%</td>
<td>50.0%</td>
<td>50.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Salmonellosis</td>
<td></td>
<td>1,148</td>
<td>15.2%</td>
<td>73.1%</td>
<td>9.9%</td>
<td>1.3%</td>
<td>0.4%</td>
</tr>
<tr>
<td>Shigellosis</td>
<td></td>
<td>90</td>
<td>0.0%</td>
<td>16.7%</td>
<td>80.0%</td>
<td>0.0%</td>
<td>3.3%</td>
</tr>
<tr>
<td>Typhoid Fever</td>
<td></td>
<td>2</td>
<td>0.0%</td>
<td>0.0%</td>
<td>50.0%</td>
<td>0.0%</td>
<td>50.0%</td>
</tr>
<tr>
<td>VTEC-illness</td>
<td></td>
<td>158</td>
<td>18.4%</td>
<td>49.4%</td>
<td>19.6%</td>
<td>10.8%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Yersiniosis</td>
<td></td>
<td>84</td>
<td>15.5%</td>
<td>81.0%</td>
<td>1.2%</td>
<td>0.0%</td>
<td>2.4%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>3,466</td>
<td>19.8%</td>
<td>54.2%</td>
<td>16.0%</td>
<td>7.6%</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

*Data source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2012/04/01]*
### Results: Sporadic domestic reportable GI Ontario, 2007-2009

<table>
<thead>
<tr>
<th>Reportable Disease</th>
<th>Primary Setting (%)†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
</tr>
<tr>
<td>Amebiasis</td>
<td>15</td>
</tr>
<tr>
<td>Campylobacteriosis</td>
<td>796</td>
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<tr>
<td>Cryptosporidiosis</td>
<td>92</td>
</tr>
<tr>
<td>Cyclosporiasis</td>
<td>10</td>
</tr>
<tr>
<td>Giardiasis</td>
<td>164</td>
</tr>
<tr>
<td>Hepatitis A</td>
<td>16</td>
</tr>
<tr>
<td>Listeriosis</td>
<td>9</td>
</tr>
<tr>
<td>Salmonellosis</td>
<td>754</td>
</tr>
<tr>
<td>Shigellosis</td>
<td>28</td>
</tr>
<tr>
<td>VTEC-illness</td>
<td>106</td>
</tr>
<tr>
<td>Yersiniosis</td>
<td>65</td>
</tr>
</tbody>
</table>

Data source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2012/04/01]
Incidence of Reportable Disease by Age, Ontario, 2007-2009

Data source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2012/04/01]
Endemic & Travel-Related Seasonal Trends, Ontario, 2007-2009

Data source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2012/04/01]
Endemic and Travel Related Illness, Ontario, 2007-2009

Hepatitis A (n=199)

Yersiniosis (n=197)

Data source: Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database, extracted by Public Health Ontario [2012/04/01]
Discussion

- Approximately 9000 to 10,700 cases of GI are reported annually
- A slight decrease in the overall numbers was detected when compared to data from 1997 to 2003
- Disease with highest incidence is campylobacter followed by salmonellosis
- Salmonella outbreaks accounted for 42% of outbreaks reported
- 27 per cent of GI cases were acquired outside of the province, with marked variation by pathogen
- Food was identified as the primary source (54%) of GI reported for all pathogens combined
Discussion

• Contact with animals accounted for 19.8% of all GI

• The private home was the most common (45.5%) primary exposure setting reported for all sporadic endemic cases for nine of 14 diseases

• Exposure to food premises accounted for 29.7% of GI illness cases during the study period

• The following diseases followed a seasonal distribution of cases: campylobacteriosis, cryptosporidiosis, giardiasis, salmonellosis and *E. coli* infections
Study Limitations

• iPHIS is a passive, dynamic surveillance system

• 34.8 per cent of cases were not successfully followed up by public health due lost to follow-up, case refusing to be interviewed etc.

• Disease follow-up is often prioritized by risk of transmission and/or severity of the disease. Not all diseases are “treated equally”

• Follow-up of reportable diseases varies by health unit

• Exposure and risk setting data are based on the recall of the cases and on the assessment of the public health investigators

• A large proportion of exposures are not reported because of difficulties in identifying the source of infection and/or missing data
Conclusions

• Reportable GI continues to be a burden in Ontario

• Food, animal contact and contact with ill persons are the most commonly reported sources of illness

• Food premises and private homes are the most commonly reported risk setting

• International travel is an important risk factor for most GI, with travel-related cases presenting distinct seasonal patterns from endemic cases.

• These findings underscore the ongoing need for public education on safe handling of food and animals as well as proper hand hygiene practices.
LOOKING FORWARD
Centralized Interviewing

- Numerous interviewers do not allow for:
  - Effective hypothesis generation through informal information gathered from cases by a single interviewer
  - Timely follow-up/testing of hypotheses

- Numerous interviewers introduce:
  - Variation in interviewing style
  - Variation in questionnaires used
  - Variation in data recording on questionnaires

- History in Ontario:
  - December 2000 *Salmonella Enteritidis* PT30 associated with almonds
  - Numerous Federal Field Epidemiologists
  - August 2010: Minnesota model
  - Today: Increasingly widely applied model across US
Enteric Exposure Data

- Web Based Data Capture
  - Real-time access to questionnaire data
  - Centralized database
    - Entry from multiple sites
    - Entry from multiple users simultaneously
    - No/limited need for data entry at PHO
  - Self-administered questionnaires?

- Advantages of Fluid Surveys
  - Data stored on Canadian servers
  - Wide variety of question types (branching, skip patterns)
  - User-friendly interface (no/limited training requirements)
  - Small company open to collaboration/opportunities to develop tools
Improving Efficiency

- Review Lab Line List
- Monitor iPHIS based EARS Flags
- Monitor Lab based NESP Flags

- Review iPHIS Exposure Data
- Request Exposure Data from HUs
- Call Health Units to discuss cases
- Preliminary Conference Call

- Public Health Alert
- OOICC or OICC
- Enhanced Surveillance Directive
- Field Epi (Single Interviewer)
- Data Entry
- Hypothesis Generation & Testing

- Effective infection control measure
- Food Recall
Under Reporting

Days Post Exposure = Recall Bias

What Can We See?

- Exposure Data Received at PHO
- iPHIS (About 9,000 enteric cases/year)
- Lab Line List (Crystal Reports/NESP)
- Emergency Room/Physician Visits
- Over the Counter Pharmaceutical Purchases
- Telehealth (600 per Wk)
- Google Search Terms/Social Media
- Loyalty Cards

Person Consumes Exposure of Interest
Case Experiences Symptoms/Illness Onset
Case Seeks Care
Sample Obtained
Lab Confirmed Case
Case Reported to Public Health
Case Interviewed
Cluster
Exposure Based Aberration Detection
Optimizing Questionnaire Design

3 days before illness (interviewer, record date: d___ / m___ / y______;
(☐ M ☐ T ☐ W ☐ Th ☐ F ☐ Sat ☐ Sun )

(Interviewer note: please probe regarding where foods were eaten and how prepared, e.g. prepared and eaten at home, eaten at a restaurant, take-out, ready-to-eat meal, frozen dinner, etc)

<table>
<thead>
<tr>
<th>Breakfast</th>
<th>Lunch</th>
<th>Dinner</th>
<th>Snacks</th>
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</tbody>
</table>

The Shotgun

- 12 of 18 pages

<table>
<thead>
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<th>Y</th>
<th>P</th>
<th>N</th>
<th>DK</th>
</tr>
</thead>
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<td></td>
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<td>White</td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>DK</td>
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<tr>
<td>Yellow</td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>DK</td>
</tr>
<tr>
<td>Green (scallions)</td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>DK</td>
</tr>
<tr>
<td>Red</td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>DK</td>
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<td>Shallots</td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>DK</td>
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<tr>
<td>Leeks</td>
<td>Y</td>
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<td>DK</td>
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<tr>
<td>Other onions</td>
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<td></td>
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<tr>
<td>If yes, specify:________</td>
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</table>