One Health and Food Safety – the Canadian Experience:

A holistic approach towards enteric bacterial pathogens and antimicrobial resistance surveillance

Presented by
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Health System in Canada

The Federal Government:
• Facilitates health system preparedness
• Provides national leadership, and guidance/best practices to promote health and prevent and control disease and injury
• Regulates and approves health products
• Responds to national health emergencies

The Provinces/Territories (P/Ts):
• Deliver health care and public health services to the population
One World One Health - Winnipeg 2009

- Public Health Agency of Canada hosted an international expert consultation on One Health
- Included 120 participants from 23 countries
- Contributed to “A Strategic Framework for Reducing Risks of Infectious Diseases at the Animal-Human-Ecosystems Interface”, released by WHO, OIE, FAO, UNICEF, UNSIC and World Bank
- Watershed event for Canada internationally, federally, and with Provinces and Territories
National Engagement in One Health

- Canada’s Provinces and Territories are embracing the One Health concept and acknowledge the value of innovative partnerships

- Developing strategies using a One Health approach:
  - Manitoba has a primer on One Health and food safety and developed an animal health and food safety strategy for the future (“Protecting Animals, Food and People”)
  - Quebec has an animal health and welfare strategy (“One Health, Health for All”)
  - Ontario program is in development
One Health Context

- Strategic value is in risk identification, assessment, avoidance, and mitigation
- Approach recognizes linkages among people, animals and many environments (natural, economic, etc…)
- Entry point can be from any of the compartments
The Food Safety Scene in Canada

- Increasing industrialization of animal production
- Increasing rate of detection of pathogens in food production and food products
- Major policy impact of Listeriosis outbreak in 2008
- Reduced ability to treat foodborne illness due to emerging novel pathogens and antimicrobial resistance
- Food safety outbreaks have had high economic impact
Economic Impact of Zoonotic Infectious Diseases

Economic Impact of Selected Infectious Disease Outbreaks

- **SARS**
  - China, Hong Kong, Singapore, Canada
  - $30-50bn

- **H1N1**
  - Worldwide
  - $45-55bn

- **H5N1 Avian Flu**
  - Worldwide
  - $30bn

- **Foot & Mouth**
  - Taiwan, $5-8bn

- **BSE**
  - UK, $5bn

- **Nipah**
  - SE Asia
  - $550-650m

- **Lyme Disease**
  - US, $2bn

- **BSE**
  - Canada
  - $3bn

- **BSE**
  - US
  - $3.5bn

- **E. Coli**
  - US
  - $1.8bn

- **MRSA**
  - US
  - $5-10bn

Figures are estimates and are presented as relative size.
Approach to One Health in Food Safety

• Health program optimization
  – Targeted science and research
  – Surveillance of AMR & foodborne pathogens
  – Food safety epidemiology
  – Risk assessment
  – Inspection and regulation
  – Population and environmental determinants of foodborne zoonoses
  – Food system modeling
  – Knowledge translation
  – Risk communication

• Increased collaboration among vested interest sectors
AMR as a Focus in One Health

• Impacts of particular practices
  – Antimicrobial use (AMU) in humans and animals is a major driver of Antimicrobial Resistance (AMR)

• AMR impairs ability to treat infections

• Endangers the long term efficacy of antimicrobial drugs available to human and veterinary medicine

• Complex relationships with many interfaces at biological and system levels
Transfer Model for Antimicrobial Resistance Genes

1. Infection with an antimicrobial-susceptible pathogenic bacterium
2. Horizontal transfer
3. Gastro-intestinal flora
4. Gastro-intestinal flora containing antimicrobial resistance gene
5. Antimicrobial-resistant pathogenic bacterium
6. Non-pathogenic bacterium carrying a resistance gene
7. Host gastrointestinal tract
EPIDEMIOLOGY OF ENTERIC PATHOGENS AND ANTIMICROBIAL RESISTANCE

FOOD ANIMALS
- SHEEP
- CATTLE
- SWINE
- VEAL CALVES
- Poultry
- Other Farmed Livestock

ANIMAL FEEDS

Rendering

Land Fill

Evaporation

Rivers and Streams

Drinking Water

Sea / Lakes

Industrial & Household Antibacterial Chemicals

Sewage

Vegetation, Seed Crops, Fruit

WILDLIFE

HUMAN
- Community - Urban - Rural
- Hospitalized
- Extended Care Facilities
- Travellers

Handling Preparation Consumption

Meat

Commercial Abattoirs / Processing Plants

Direct Contact

Animal Feeds

Companion Animals

IMPORTS

after Linton AH (1977), modified by Irwin RJ
Food Safety/AMR Surveillance in Canada

• Two primary complementary programs:
  – Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) – modeled after NARMS (US) and DANMAP (Denmark)
  – National Integrated Enteric Pathogen Surveillance Program (C-EnterNet) - modeled after FoodNet (US) and OzFoodNet (Australia)

• Other data sources:
  – PulseNet (Canada and US)
  – Global Public Health Information Network (GPHIN)
  – International Health Regulation notification
  – Health information from provincial and territorial health systems
  – Informal reporting from regional and local health centres
Food Safety Data Integration

- Primary goal is linking source and human illness, and ultimately attribution
- Goal is to integrate:
  - Laboratory and epidemiology information
  - Routinely across sources
  - Other information sources
CIPARS

- Monitors trends in AMU and AMR in selected bacteria from humans, animals and food across Canada

- Objectives:
  - Provide unified approach to monitor trends in antimicrobial resistance and antimicrobial use in humans & animals
  - Disseminate timely results
  - Facilitate assessment of the public health impact of antimicrobials used in humans & agriculture
  - Allow accurate comparisons with other countries that use similar surveillance systems
C-EnterNet is an integrated program designed to monitor human infectious enteric illness and to inform food & water safety policy

**Core Objectives:**

- **Surveillance:** Detect changes in **trends** of human enteric disease incidence and pathogen **exposure** levels from food, animal and water sources

- **Source attribution:** determine the proportion of human cases that are due to water, food & animal contact and determine statistically significant risk factors for enteric illness
C-EnterNet: One Health in Action

Human case information and enhanced risk factor information collected through standardized questionnaires

Enhanced Lab Testing

Retail Food sampling
- raw pork chops
- ground beef
- chicken breasts
- bagged lettuce, berries

Enhanced Lab Testing

Animal / Farm sampling
- Beef
- Swine
- Dairy
- Poultry

Enhanced Lab Testing

Surface Water testing
- Physical parameters and pathogens

Enhanced Lab Testing
C-EnterNet Framework

Sentinel Sites across Canada

*similar to but broader than CDC FoodNet
CIPARS – C-EnterNet Intersection and AMR

**CIPARS:**
Zoonotic enteric pathogens and commensals, and antimicrobial use

**ENTERIC AGENTS**
(virus, bacteria, protozoa, parasites)
- Commensal organisms
- Pathogens

**ANIMAL**
- Companion
- Food animals
- Wildlife

**HUMAN**
- Healthy
- Young/Elderly
- Immuno-suppressed
- Occupational exposure

**ENVIRONMENT**
- Political
- Antimicrobial Use
  - Physicians
  - Veterinarians
  - Farmers
- Animal Husbandry and Management
- Population density

**C-EnterNet:**
Zoonotic enteric pathogens

**AMR**
- Antimicrobial resistance
- CIPARS focus
- C-EnterNet focus

**Social/cultural**
- Travel
- Natural
  - Soil
  - Water

**Economic/Trade**
CIPARS Success Example

• Identification of a link between use of an important antimicrobial to human health (ceftiofur) in poultry and resistant bacterial isolates in people and chicken meat in Québec

• Communication of this information lead to a voluntary ban on the use of ceftiofur in 2005
  – Evidence that changing AMU patterns affect bacterial resistance in human and animal isolates
Year, number of chicken retail samples tested for *E. coli* and *Salmonella* by province
C-EnterNet Success Example

• Travel is an important source of disease caused by enteric pathogens in Canada
• 1 out of 4 reported food safety illness cases are travel-related
  – 1 hospitalization out of 5 reported cases
• Subgroups of travel-related cases (TRC) identified & associated with certain diseases
• Further work is needed to better understand the burden of TRC in Canada and inform prevention and control measures within a One Health framework
Burden of Travel-related Enteric Disease in Canada from C-EnterNet ‘Snapshot’

Overall ~ 30% of all enterics travel-related

- S. Enteritidis: 43%
- S. Typhimuirum: 8%
- S. Heidelberg: 0%

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>% Travel-related</th>
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<tbody>
<tr>
<td>Listeria</td>
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<tr>
<td>Cyclospora</td>
<td></td>
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<tr>
<td>T/PT fever</td>
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<td>Shigella</td>
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<td>Yersinia</td>
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<tr>
<td>Cryptosporidium</td>
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<td>E. coli</td>
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<tr>
<td>Amoebiasis</td>
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<td>Giardia</td>
<td></td>
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<tr>
<td>Salmonella</td>
<td></td>
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<tr>
<td>Campylobacter</td>
<td></td>
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<tr>
<td>Total</td>
<td></td>
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Conclusions

• One Health approach useful to frame complex food safety-related health issues.
• CIPARS and C-EnterNet together provide Canada with a national structure for integrated surveillance.
• Examination of the multi-factor drivers (socio-economic, geopolitical zoonotic and environmental) of foodborne illness is essential for risk based decision-making.
• Enteric disease and AMR are complex issues that demand an integrated and flexible approach that is able to capture information from a variety of sources.
• One Health approach allows dynamic adaptation to ever-changing local and global animal, environmental and public health systems and practices.
Contributors

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