Surveillance of Zoonotic Diseases
Foodborne Zoonoses

National Zoonoses Conference
Zoonoses: Advancing Collaboration and Control

Dr. Paul McKeown
Introduction

• History
• Emerging Zoonoses
• Surveillance
• Foodborne Zoonoses
  – Campylobacter
  – VTEC
  – Salmonella
• Addressing the Threat
Zoonoses

Deuteronomy 14:8

“And the swine, because it divideth the hoof, yet cheweth not the cud, it is unclean unto you: ye shall not eat of their flesh, nor touch their dead carcase.”

King James Bible (Standard Version)
Zoonoses

- Zoonoses are infectious diseases transmitted from vertebrate animals to man
- Term “zoonosis” coined by Rudolph Virchow – working with *Trichinella* (1855)
- “[What is necessary is] one medicine linking the study of human afflictions and its veterinary counterpart.”
- Recognised as a disease category by FAO and WHO in 1959
Human Diseases of Animal Origin

<table>
<thead>
<tr>
<th>Human Disease</th>
<th>Probable Animal Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles</td>
<td>Rinderpest (poss. Distemper)</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td><em>M. bovis</em> (cattle)</td>
</tr>
<tr>
<td>Smallpox</td>
<td>Cowpox</td>
</tr>
<tr>
<td>Influenza</td>
<td>Pigs/wild ducks</td>
</tr>
<tr>
<td>Pertussis</td>
<td>Pigs/dogs</td>
</tr>
<tr>
<td>Malaria</td>
<td>Waterfowl</td>
</tr>
</tbody>
</table>

Emerging Zoonoses

“Those diseases with incidence rates that have increased within the last two years or those with the potential of increasing in the future”

*Institute of Medicine, 1992*

- More than 1800 pathogenic agents known
- 500+ have emerged in the last 30 years
- Two-thirds are zoonotic
INFECTIONOUS DISEASES TRANSMISSIBLE BETWEEN ANIMALS & HUMANS

SOURCE: Nature
Infectious Disease Emergence

• Urbanisation (47% in 2000; 60% in 2030)
• Increasing middle class
• Industrialisation of food supply/delivery
• Increased Western farming and eating habits in Asia/Latin America
• Globalisation of trade/travel

• Medical success → immunosuppression
• Encroachment into natural environment
• Beginnings of reversal of ID mortality
• Antimicrobial resistance
• 75% of emerging infectious diseases are zoonotic

![Graph showing the trends of Typhoid fever and Non-typhoid salmonellosis](chart.png)

- **Sewerage, water treatment, pasteurization of milk**
- **Industrialization of food supply**
  - \textit{Salmonella enterica}
  - \textit{E coli O157}
  - \textit{Campylobacter}

Source: CDC, National Notifiable Diseases surveillance data – collated by Robert Tauxe
ID Regulations 2003
Zoonotic Diseases

- Anthrax
- Botulism
- Brucellosis
- Campylobacteriosis
- nvCJD
- Cryptosporidiosis
- Echinococcosis
- Enterohaemorrhagic Escherichia coli
- Giardiasis
- Influenza
- Leptospirosis
- Listeriosis
- Plague
- Q Fever
- Rabies
- Salmonellosis
- SARS
- Toxoplasmosis
- Trichinosis
- Tuberculosis
- Tularaemia
- Typhus
- Viral Haemorrhagic Fevers
- Yersiniosis

= Potentially Foodborne
ID Notification

Guidance/Research

Weekly Reports

Annual Reports

hpsc

hpsc

12 12
Campylobacteriosis

- The commonest bacterial cause of IID
- Quite low infectious dose (<500)
- Mostly foodborne
  - undercooked poultry
  - unpasteurised milk or dairy products
  - contaminated/untreated water supplies
- Contact with pets, especially puppies
- Little person-to-person transmission
- Few outbreaks (mostly sporadic or family outbreaks)
- Significant antimicrobial resistance: ↑quinolones/fluoroquinolones
Campylobacter Notifications
Ireland: 2004-2009

One third are *C. jejuni* (where known)

* provisional data
Campylobacteriosis

Clinical Features*

- Severe symptoms
- Adults visiting GP
  - abdominal pain → 92%
  - bloody diarrhoea → 17%
  - high temperature → 86%
- Median duration of diarrhoea → 6 days

- Children visiting GP
  - bloody diarrhoea → 31%
  - abdominal pain → 81%
  - high temperature → 77%
  - headache → 50%
  - vomiting → 20%
- Median duration of diarrhoea → 7 days

Guillain-Barré Syndrome

- 1:1000 Campylobacter cases
- Campylobacter suspected in up to 30% of all cases of GBS

Campylobacteriosis-Ireland
Case Control Study

• Male, <5
• Foreign travel (esp outside Europe x 18)
• Chicken x 3 (undercooked chicken x 9.5)
• Red meat, fish and dairy produce tended to be protective
• Other risks (not significant- small numbers)
  – Well water
  – Pet ownership
  – Sheep/lambs
  – Swimming in the sea
  – Gardening
  – Having stomach ulcer, hiatus hernia, lower bowel problems
  – Taking ulcer medication

# Campylobacter in Retail Foods in Ireland, 2002

<table>
<thead>
<tr>
<th>Food</th>
<th>Percent positive</th>
<th>C. jejuni (%)</th>
<th>C. coli (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken</td>
<td>50</td>
<td>85</td>
<td>15</td>
</tr>
<tr>
<td>Duck</td>
<td>46</td>
<td>82</td>
<td>18</td>
</tr>
<tr>
<td>Turkey</td>
<td>38</td>
<td>85</td>
<td>15</td>
</tr>
<tr>
<td>Lamb</td>
<td>12</td>
<td>87</td>
<td>13</td>
</tr>
<tr>
<td>Pork</td>
<td>5</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>Beef</td>
<td>3</td>
<td>86</td>
<td>14</td>
</tr>
</tbody>
</table>

Human VTEC Infection

• Low infectious dose (<10)
• Transmission
  – Food (undercooked beef burgers, salad vegetables and unpasteurised milk)
  – Water (esp unprotected sources inc private wells)
  – Person-to-person spread
  – Contact with farm animals or their faeces
• Leads to HUS in up to 10% of cases
• Considerable morbidity and mortality
• VTEC O157 most common - also O26, O111
Number of confirmed and probable VTEC notified: 1999-2010*

Source of data: HPSC and DML PHL
*note 20010 data provisional
## Incidence Human VTEC infection:
EU Member State, EU 2007

<table>
<thead>
<tr>
<th>Country</th>
<th>CIR/100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>1</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.4</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>0</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.2</td>
</tr>
<tr>
<td>Estonia</td>
<td>0.2</td>
</tr>
<tr>
<td>Finland</td>
<td>0.1</td>
</tr>
<tr>
<td>France</td>
<td>0.1</td>
</tr>
<tr>
<td>Germany</td>
<td>0.1</td>
</tr>
<tr>
<td>Greece</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Hungary</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Ireland</td>
<td>2.7</td>
</tr>
<tr>
<td>Italy</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Latvia</td>
<td>0</td>
</tr>
<tr>
<td>Lithuania</td>
<td>0.2</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>1</td>
</tr>
<tr>
<td>Malta</td>
<td>0.5</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.1</td>
</tr>
<tr>
<td>Poland</td>
<td>0.2</td>
</tr>
<tr>
<td>Slovak Republic</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Slovenia</td>
<td>0.2</td>
</tr>
<tr>
<td>Spain</td>
<td>0.1</td>
</tr>
<tr>
<td>Sweden</td>
<td>2.9</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1.9</td>
</tr>
<tr>
<td>EU total</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Data source: EU Community Zoonosis Report 2007 (includes only those MS who reported data on this disease to EFSA in 2007). Includes only confirmed cases.
Human VTEC Infection – Clinical*

• Severe symptoms
• Adults visiting GP
  – abdominal pain → 93%
  – Severe diarrhoea → 60%
  – Bloody diarrhoea → >1/3
  – Vomiting → 11%
  – Fever not so prominent
• Median duration of diarrhoea → 9 days

• Children visiting GP
  – Bloody diarrhoea → 25%
  – Abdominal pain → 75%
  – Loss of appetite → 100%
  – High temperature → 88%
  – Headache → 50%
  – Muscle aches → 29%

## Clinical features VTEC O157
### Ireland: 1999-2008 (%)

<table>
<thead>
<tr>
<th>Year</th>
<th>HUS</th>
<th>Bloody Diarrhoea</th>
<th>Diarrhoea</th>
<th>Asymptomatic</th>
<th>NK</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>7.7</td>
<td>38.5</td>
<td>44.2</td>
<td>9.6</td>
<td>0</td>
</tr>
<tr>
<td>2000</td>
<td>11.9</td>
<td>47.6</td>
<td>38.1</td>
<td>2.4</td>
<td>0</td>
</tr>
<tr>
<td>2001</td>
<td>7.7</td>
<td>42.3</td>
<td>28.8</td>
<td>21.2</td>
<td>0</td>
</tr>
<tr>
<td>2002</td>
<td>8.6</td>
<td>37.1</td>
<td>41.4</td>
<td>12.9</td>
<td>0</td>
</tr>
<tr>
<td>2003</td>
<td>4.5</td>
<td>33.0</td>
<td>40.9</td>
<td>17.0</td>
<td>4.5</td>
</tr>
<tr>
<td>2004</td>
<td>3.8</td>
<td>40.4</td>
<td>30.8</td>
<td>17.3</td>
<td>7.7</td>
</tr>
<tr>
<td>2005</td>
<td>12.0</td>
<td>32.4</td>
<td>25.9</td>
<td>25.0</td>
<td>4.6</td>
</tr>
<tr>
<td>2006</td>
<td>11.4</td>
<td>32.5</td>
<td>26.8</td>
<td>25.2</td>
<td>4.1</td>
</tr>
<tr>
<td>2007</td>
<td>1.4</td>
<td>24.8</td>
<td>59.3</td>
<td>11.0</td>
<td>3.4</td>
</tr>
<tr>
<td>2008</td>
<td>4.3</td>
<td>37.0</td>
<td>30.2</td>
<td>26.5</td>
<td>1.9</td>
</tr>
</tbody>
</table>
Clinical Spectrum VTEC Ireland 2009

• In 2008 and 2009 Ireland → highest VTEC rate in EU
• 241 confirmed and probable cases of VTEC (CIR=5.7/100,000)
• 154 symptomatic
• Reported symptoms/outcomes
  – Bloody diarrhoea → 76 (39%)
  – HUS → 24 (11%).
  – Hospitalised → 90 (37%)
  – Deaths → 1
Salmonellosis

- Large infectious dose – 1000+
- Mostly foodborne
  - undercooked poultry meats
  - eggs
  - Non-poultry meat including pork
- Direct contact with infected animals or their faeces
- Person-to-person transmission
- Infected food handlers
- Nosocomial infection
Salmonellosis
Clinical Features*

• Severe symptoms
• Adults visiting GP
  – abdominal pain → 92%
  – loss of appetite → 94%
  – bloody diarrhoea → 20%,
  – high temperature → 86%
  – headache → 73%
  – muscle ache → 72%
• Median duration of diarrhoea → 6 days
  – 25% still had diarrhoea at 14 days

• Children visiting GP
  – bloody diarrhoea → 25%
  – abdominal pain → 75%
  – loss of appetite → 100%
  – high temperature → 88%
  – headache → 50%
  – myalgia → 29%

Salmonella Clinical Notifications in Ireland: 1995-2010

Data Source: CIDR, HPSC

* provisional data
Serotypes of *Salmonella enterica*
Ireland, NSRL: 2004 – 2010*

<table>
<thead>
<tr>
<th>Serotype</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enteritidis</td>
<td>173 (41)</td>
<td>145 (41)</td>
<td>158 (37)</td>
<td>179 (39)</td>
<td>122 (27)</td>
<td>87 (24)</td>
<td>70 (19)</td>
</tr>
<tr>
<td>Typhimurium</td>
<td>125 (30)</td>
<td>85 (24)</td>
<td>101 (23)</td>
<td>101 (22)</td>
<td>135 (30)</td>
<td>87 (24)</td>
<td>113 (31)</td>
</tr>
<tr>
<td>Unnamed</td>
<td>3 (1)</td>
<td>7 (2)</td>
<td>15 (3)</td>
<td>11 (2)</td>
<td>13 (4)</td>
<td>12 (3)</td>
<td>10 (3)</td>
</tr>
<tr>
<td>4,5,12:i:-</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>13 (3)</td>
<td>4 (1)</td>
<td>31 (9)</td>
<td>19 (5)</td>
</tr>
<tr>
<td>Virchow</td>
<td>10 (2)</td>
<td>9 (3)</td>
<td>10 (2)</td>
<td>5 (1)</td>
<td>10 (2)</td>
<td>5 (1)</td>
<td>4 (1)</td>
</tr>
<tr>
<td>Newport</td>
<td>6 (1)</td>
<td>5 (1)</td>
<td>9 (2)</td>
<td>13 (3)</td>
<td>6 (1)</td>
<td>4 (1)</td>
<td>8 (2)</td>
</tr>
<tr>
<td>Typhi</td>
<td>5 (1)</td>
<td>5 (1)</td>
<td>7 (2)</td>
<td>8 (2)</td>
<td>5 (1)</td>
<td>11 (3)</td>
<td>8 (2)</td>
</tr>
<tr>
<td>Infantis</td>
<td>1 (1)</td>
<td>3 (1)</td>
<td>11 (3)</td>
<td>8 (2)</td>
<td>5 (1)</td>
<td>3 (1)</td>
<td>17 (5)</td>
</tr>
<tr>
<td>All Others</td>
<td>96 (23)</td>
<td>98 (27)</td>
<td>119 (28)</td>
<td>119 (26)</td>
<td>147 (33)</td>
<td>126 (34)</td>
<td>114 (32)</td>
</tr>
<tr>
<td>Total</td>
<td>419</td>
<td>357</td>
<td>430</td>
<td>457</td>
<td>447</td>
<td>366</td>
<td>363</td>
</tr>
</tbody>
</table>

* provisional data

*Source*: National Salmonella Reference Laboratory
## Salmonella Ireland

### Travel History

<table>
<thead>
<tr>
<th>Continent</th>
<th>Country of Infection</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Egypt</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Other Africa</td>
<td>17</td>
</tr>
<tr>
<td>Africa Total</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Asia</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thailand</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Turkey</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Other Asia</td>
<td>10</td>
</tr>
<tr>
<td>Asia Total</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Europe</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spain</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Portugal</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Greece</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Italy</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Other Europe</td>
<td>14</td>
</tr>
<tr>
<td>Europe Total</td>
<td></td>
<td>59</td>
</tr>
<tr>
<td>Americas &amp; Caribbean</td>
<td>Americas &amp; Caribbean</td>
<td>13</td>
</tr>
<tr>
<td>Americas &amp; Caribbean Total</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td>127</td>
</tr>
</tbody>
</table>

**Source:** Indigenous salmonellosis low in Ireland EPI -Insight volume 11 issue 3 March 2010
EU Zoonoses Legislation

- Made EFSA responsible for examining zoonoses data from MS
- Publication of an Annual Summary Report
- Transposed in Ireland
- Data collected on
  - Zoonoses and zoonotic agents in food, feedstuffs and animals
  - Antimicrobial resistance
  - Foodborne outbreaks
  - Animal populations

- Data collection mandatory for eight zoonoses:
  - Brucellosis
  - Campylobacteriosis
  - Echinococcosis
  - Listeriosis
  - Salmonellosis
  - Trichinellosis
  - Tuberculosis due to *Mycobacterium bovis*
  - Verotoxigenic *Escherichia coli*
Addressing the Threat

• Greater interdisciplinary working (including industry)
• Greater interdisciplinary understanding
• Improved surveillance
  – Human
  – Animal – sampling systems/protocols
  – Food/Feed – sampling systems/protocols
  – Human-animal-ecosystem interface
  – Evidence-based/adoption of best practice elsewhere
• More research
  – Disease (pathogens/hosts/transmission pathways)
  – Ecosystems
Addressing the Threat

• More effective sharing/combination of data
  – Enabling “safer” datasharing
  – Describing the entire ecopicture

• Improved laboratory diagnostics
  – Reference
  – Clinical/animal/food/feed/industry

• Horizon scanning for emergence
  – Ensuring we see the next threat as early as possible
  – Identify ecological/environmental “drivers” of disease emergence
Addressing the Threat

• Improved biosecurity
  – Should be an integral part of safe food production
  – Evidence based

• Effective ways to motivate behavioral change
  – Consumers/Industry/Professionals

• Greater understanding of ecosystems
  – Land use
  – The further industrialisation of food production
  – Protecting ecosystems
  – Vectors (flies and bees)