E. coli O157:H7 shedding in beef cattle

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Overview

Background on *E.coli* O157:H7

Supershedding of *E.coli* O157:H7

Overview of collaborative study - MLA

Future research
Background

- *Escherichia coli* are part of the normal flora in many animals

- Most strains do not cause disease in humans

- Some do cause disease
  
  - Shiga-toxin-producing *E.coli* (STEC)
  - Enterohaemorrhagic *E.coli* (EHEC)
Background

- *E. coli* O157:H7 is the prototype EHEC serotype - it is the most commonly identified EHEC serotype worldwide

- Other EHEC serotypes (the big six)
  - O26, O45, O103, O111, O121 and O145

  - USA has required port-of-entry (POE) testing for *E. coli* O157 since 2002 and the big 6 since 2012.
**E. coli O157:H7**

- first identified as a pathogen in 1982
- commonly identified in outbreak investigations
- severe stomach cramps, diarrhea (often bloody), vomiting
- incubation period ~3-4 days (1–10 days)
- minimum infective dose as low as 10 bacteria
- ~5–10% of cases hemolytic uremic syndrome (HUS):
  - hemolysis, renal failure, death ~7 days post-exposure
- very young children, the elderly more likely to develop HUS
**E. coli** O157:H7

- potential exposures:
  - contaminated food, non-disinfected water
  - contact with faeces of infected people
  - **contact with cattle**
  - recreational

- high-risk foods
  - unpasteurized (raw) milk
  - soft cheeses from raw milk
  - unpasteurised apple cider
  - **undercooked hamburger**
  - contaminated vegetables

[www.cdc.gov/nczved/dfbmd/disease_listing/stec_gi.html#3]
### STEC cases – incidence by country

<table>
<thead>
<tr>
<th>Country</th>
<th>Incidence / 100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scotland (O157 only)</td>
<td>4.3</td>
</tr>
<tr>
<td>Ireland (O157 only)</td>
<td>3.9</td>
</tr>
<tr>
<td>New Zealand</td>
<td>3.3</td>
</tr>
<tr>
<td>Sweden</td>
<td>3.3</td>
</tr>
<tr>
<td>Canada (O157 only)</td>
<td>2.7</td>
</tr>
<tr>
<td>South Australia</td>
<td>2.4</td>
</tr>
<tr>
<td>UK (O157 only)</td>
<td>1.9</td>
</tr>
<tr>
<td>USA (O157 only)</td>
<td>1.12</td>
</tr>
<tr>
<td>South Australia (O157 only)</td>
<td>1.5</td>
</tr>
<tr>
<td>Australia</td>
<td>0.12</td>
</tr>
</tbody>
</table>
**E.Coli O157 shedding in cattle**

- Variation between herds
  - Most, if not all, farms and feedlots have positive animals at some time

  - Estimates of prevalence in Australia range from 1.9 – 15%
    - Barlow *et al* (2010)

- Factors associated with O157 carriage in cattle:
  - Young age, Diet, Season, Day length, Group housing, Transport
E. Coli O157 shedding in cattle

- Variation between animals
  - Effect of individual animals on overall prevalence

- Relatively few cattle responsible for the majority of E. coli O157 shed (Matthews et al., 2006)
E. Coli O157 shedding in cattle

- **Supershedding**
  - when an animal sheds the pathogen at markedly higher levels than others (≥10³ CFU/gram faeces)
  - risk factor for increased herd-level faecal prevalence, hide prevalence and hide load
E. Coli O157 shedding in cattle

- Lack of longitudinal studies to track the within animal variation in shedding and quantity of pathogen shed

- What factors, if any, contribute to the development of shedding, or to the occurrence of a supershedding event?
Project A.MFS.0247

- *E.coli* O157 colonisation and shedding in cattle
  - time frame April 2011 – April 2015
  - review available microbiological techniques for detection
  - identify effective and efficient detection methodology
  - estimate frequency of occurrence and predictors of shedding and supershedding
Project A.MFS.0247

A. Literature review

B. Technical training and pilot study

C. Laboratory skills validation

D. Longitudinal study

E. Expert opinion exercise

F. Simulation modelling

G. National Forum
Project A.MFS.0247 – longitudinal study

- Study individual and population transmission dynamics of *E. coli* O157:H7

- Identify and quantify risk factors for shedding

**Field work**

- October 2012 – June 2013

- Herd of 23 grass-fed Herefords
## Methods

### Data collected

<table>
<thead>
<tr>
<th>Explanatory variables</th>
<th>Outcome variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual variables</td>
<td>Shedding (Y/N)</td>
</tr>
<tr>
<td>Temperature, faecal consistency, hide contamination, weight, body condition score, faecal cortisol levels</td>
<td></td>
</tr>
<tr>
<td>Environmental variables</td>
<td></td>
</tr>
<tr>
<td>Rainfall, temperature, daylight duration, humidity, hours of sunshine</td>
<td></td>
</tr>
<tr>
<td>Pasture type, quantity, quality</td>
<td></td>
</tr>
<tr>
<td>Contamination of the drinking water</td>
<td></td>
</tr>
</tbody>
</table>
Results

Descriptive results

• 172/1326 (13.2%) positive samples

• 152/172 (88.4%) <10^2 CFU per g of faeces

• 10/172 (5.8%) between 10^2 – 10^3 CFU per g of faeces

• 10/172 (5.8%) \geq 10^3 CFU per g of faeces
### Results cont.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>Proportion of animals</th>
<th>OR (95%CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faecal consistency</td>
<td>1</td>
<td>58/1335</td>
<td><strong>0.4 (0.14-0.98)</strong></td>
<td><strong>0.04</strong></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>860/1335</td>
<td><strong>0.4 (0.14-0.98)</strong></td>
<td><strong>0.04</strong></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>384/1335</td>
<td>0.5 (0.16-1.33)</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>33/1335</td>
<td>0.5 (0.13-2.24)</td>
<td>0.40</td>
</tr>
<tr>
<td>Calf-at-foot</td>
<td>yes</td>
<td>588/1339</td>
<td><strong>10.1 (4.02-25.44)</strong></td>
<td><strong>&lt;0.001</strong></td>
</tr>
<tr>
<td></td>
<td>no</td>
<td>751/1339</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasture quantity</td>
<td></td>
<td></td>
<td><strong>0.997 (0.996-0.998)</strong></td>
<td><strong>&lt;0.001</strong></td>
</tr>
<tr>
<td>Rainfall in previous week (ml)</td>
<td></td>
<td></td>
<td><strong>1.04 (1.01-1.08)</strong></td>
<td><strong>0.02</strong></td>
</tr>
</tbody>
</table>
Conclusion

• First study to look at change in shedding in animals over a prolonged period of time

• Faecal consistency, nursing, rainfall and pasture quantity are the 4 main factors associated with O157 shedding in this model
  - different to findings in dairy herd...

• Day-to-day variability has a greater effect than cow-to-cow variability on O157 shedding
  - shedding is not more likely to occur from one individual than another
Conclusion

• if this was true for supershedding as well it would support the fact that we should look to control supershedding **events** rather than supershedding **animals**

• Remember this study was performed in a single herd and is subject to the variation in weather (or lack thereof) that occurred during the time period studied
Future research

Short intensive study

• Focus on the individual animal
  - allow reduced time intervals for data collection

• Repeat longitudinal study in a population that allows identification of risk factors associated with supershedding
Future research

Expert opinion exercise
• Gather group of experts

Simulation modelling
• Include data that reflects within animal variation in previous models
• Assess likelihood of identifying positive animal if it is present in the herd

National Forum
• Dissemination of results
• Discussion about control
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