The Campylobacter control programme in New Zealand

Prof. Steve Hathaway
MPI Campylobacter team

- Steve Hathaway and Peter van der Logt: Science and risk assessment
- Judi Lee and Sharon Wagener: Standard development
- Gail Duncan: National microbiological database
- Sonja Taege and Catherine Sheerin: Verification
- Sharon Wagener and others: Compliance Response Team
- Craig Thornley: Public health
- Nigel French and Petra Muellner: Source attribution
Campylobacteriosis in New Zealand (all causes) at start of control programme

Cases
= 380 / 100,000 pop.
Campylobacter Risk Management Strategy 2007 -

- Source attribution studies
- Operational research for effectiveness of different interventions e.g. freezing, and data gaps e.g. risk factors at farm level
- Develop Biosecurity Manual (growing farms)
- New code of practice for primary and secondary processing
- Establish National Microbiological Database (NMD) and test different methodologies an monitoring strategies
- Review HACCP-based Risk Management Plans at premises level
- Establish five-year public health goal and reporting
- Develop regulatory performance target and response
- Develop risk assessment models to inform decision-making
Development of the NMD

- 2007: Caecal sampling and carcass sampling; proposal for mandatory target rather than mandatory interventions (good performers should not be penalised!)
- 2008: Performance target with escalating (regulated) responses
- 2009: Caecal sampling ceases as limited value
- 2013: Revised performance target
Testing programme

- Accredited laboratories
- Trained samplers
- Approved methods
- Regulator can see all premises’ results
- Each premises can only see own results
- Quarterly ranking and reporting
Microbiological performance target

- Represents an approximate one log reduction in level of hazard control cf. 2007 national 80th percentile baseline (4.08 to 3.08 logs)
- System accredited and verified by MPI
- Moving window, high count limit and quarterly limit
- Moving window failure when seven or more out of 45 samples from three successive processing periods are greater than $3.78 \log_{10} \text{cfu/carcass}$
- Low throughput premises
- Integrated industry and regulator response in case of non-compliance, with possible escalation to premises closure
Subsequent changes to target

- Moving window failures have effectively managed poor performers ✓ Kept
- Hardly any failures against high count (> 5.88 log_{10} / rinsate) or quarterly limits ✗ Removed
- Mandatory responses too restrictive:
  - amended to be more flexible
  - increased reporting
- Compliance Response Team visits very effective ✓ Kept
Source attribution
Approaches to attribution

- Analytical epidemiology
- Comparative exposure / risk assessment
- Expert opinion
- Molecular epidemiology
  - microbial subtyping e.g. PCR, source tracking, population genetics and epidemiological modelling add powerful tools
  - rMLST (new generation) uses high throughput sequencing of whole genomes to analyse many more genomic loci
Modelling approach

Information to inform policy for reducing campylobacteriosis
Massey University EpiLab 2005 -

- Manawatu sentinel site
- Identify genotypes common to particular sources
Assigning the source of human campylobacteriosis in New Zealand: A comparative genetic and epidemiological approach

Petra Mullner, Simon E.F. Spencer, Daniel J. Wilson, Geoff Jones, Alasdair D. Noble, Anne C. Midwinter, Julie M. Collins-Emerson, Philip Carter, Steve Hathaway, Nigel P. French
Campylobacter source attribution

2005 / 2006

2011 / 2012
Operational research
Operational research on-farm

- On-farm risk factors for *Campylobacter* infection of broilers under New Zealand conditions
- Potential dissemination of *Campylobacter* by farmers’ overalls in broiler farms
- Effect of caprylic acid on *Campylobacter* concentration in broiler caeca
On-farm

Risk factors

- Environment
- Pests
- People
- Equipment

Voluntary Biosecurity Manual

- Environmental hygiene
- Entry procedures
- Minimise partial depopulations
- Catching procedures
- Crate washing, drying and sanitation
- Education and commitment of growers

Contaminated birds

Cross contamination during live bird transport to processing
On-farm biosecurity; *Campylobacter* cf. *Salmonella*

**Break *Salmonella* cycle on-farm:**
- heat treat feed
- treat drinking water
- controls for grandparents, parents, hatcheries
- strict farm biosecurity

**Minimise *Campylobacter* on Farm:**
- farm biosecurity

**Manage *Campylobacter* at Primary Processing**
-
Code of practice for primary processing
Operational research at primary processing

- Surveys: Broilers, end-of-lay, breeders, turkeys, ducks, free-range poultry
- Quantification of *Campylobacter* from internal and external carcass rinses
- Longitudinal mapping of *Campylobacter* on carcasses
- *Campylobacter* recovery from carcasses
- NMD: Investigation of “Not Detected” rinsates
- Chlorinated compounds formed during chlorine wash of chicken meat
- Immersion chilling: Effect of washing and chlorination
Operational research: Effect of temperature

- Effect of low temperature on *Campylobacter* on poultry meat e.g. crust freezing
- Domestic food practices: Refrigerator survey and meat handling survey
- Domestic food practices: Quantifying the reduction of *Campylobacter* on skin-on chicken breasts frozen and stored up to 10 weeks at -12°C
Primary processing

Risk factors

- Defeathering
- Evisceration
- Post-mortem examination
- Initial chilling (immersion chillers)

Industry actions / Control measures

- New equipment / equipment set up
  - Equipment rinse
  - Post-defeathering rinse (total bird)
- Equipment set up (bird size dependent if automated)
  - Equipment rinses
  - Multiple bird rinses (total bird)
- Personal hygiene
  - Hand and knife wash stations
- Pre-chill tank (remove organic matter)
- Effective immersion chiller operation
  - High flow rate (counterflow)
  - Chlorine control
  - pH correction
  - Contact time
- Additional post-chill antimicrobial dips
Primary processing

- Free-range birds have higher initial levels of *Campylobacter* than fully housed birds.
- In-line washing and immersion washing decreases loads by at least one log.
- Chlorine immersion decreases loads by at least a further log.
- Higher levels of organic contamination lessens effect of chlorine (value of pre-chill tank wash).
Operational research: Secondary processing and consumer

- Effect of secondary processing on contamination
- Contamination of offal and mechanically separated meat products
- Contamination on carcasses and portions at retail
- *Campylobacter* in drips trapped in leak-proof packaged retail poultry
- Burden of disease and cost-benefit
Results
Percentage $> 3.78 \log_{10} \text{cfu/carcass}$

Monthly percentage of samples $> 3.78 \log_{10} \text{CFU}$
The premises effect: % positive rinsates

Campylobacter positive rinsates of different poultry premises
Variable performance at processing steps

Mean counts (log10 CFU/rinsate) of the outside of the carcasses

- Before evisceration
- After evisceration
- After immersion chilling

NZ MPI Campylobacter in poultry programme
Association between human cases and % positive carcasses
Association between human cases and $\% > 3.78 \log_{10} \text{cfu/carcass}$
## Examples: Compliance Response Team

<table>
<thead>
<tr>
<th>Issue</th>
<th>Regulatory action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher loading (free range), gut breakage, insufficient carcass washing, sub-optimum management of chemical decontamination steps</td>
<td>Follow up by VA</td>
</tr>
<tr>
<td>Large bird contamination (line speeds), sub-optimum management of chemical decontamination steps</td>
<td>Follow up by VA</td>
</tr>
<tr>
<td>Poor separation between kill and EV rooms, plucker splatter, organic so needed extra wash steps and use of approved chemical in multiple decontamination steps</td>
<td>CRT visit&lt;br&gt;Direction to freeze product, CRT visit, CRT visit</td>
</tr>
<tr>
<td>General hygiene issues, line speed too high, lack of staff, poor evisceration equipment set up, lack of washing (post pluck, post EV) /chemical decontamination steps</td>
<td>CRT visit&lt;br&gt;Direction to freeze product&lt;br&gt;Direction to add chemical intervention</td>
</tr>
<tr>
<td>General hygiene issues, poor evisceration equipment set up, lack of control of salting, lack of washing (post pluck, post EV) /chemical decontamination steps</td>
<td>CRT visit&lt;br&gt;Direction to freeze product</td>
</tr>
<tr>
<td>Insufficient samples, incorrect testing, lack of washing (post pluck, post EV), poor separation between kill and EV rooms, plucker splatter, poor control of chemical decontamination steps</td>
<td>CRT visit</td>
</tr>
</tbody>
</table>


Progress against public health goal
Risk management
Risk management option: Tightening performance target

- Increased stringency could focus on a further improvement in national performance and/or an improvement in poorest performing premises.
- Target could incorporate tighter acceptance number, tighter limit etc.
- Risk assessment needed to inform decision but note that a target does not represent actual performance of industry.
Risk assessment tools

- **Simple pathway model**: Estimates changes in NMD results with different interventions at the premises level
- **Simple regression model**: Estimates human health risk using NMD data at national level (noting that it is not possible to directly model the CPT)
- **Alert tool**: Simulates alerts and responses for individual premises using retrospective data and different inputs to the CPT)
### Simple pathway model: Screen shot

<table>
<thead>
<tr>
<th>Step</th>
<th>Unit</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data entry</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Changes to routine process</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Level immediately after processing step</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>On farm (Caecal prevalence)</strong></td>
<td>50%</td>
<td>Percentage</td>
</tr>
<tr>
<td>Change</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td><strong>Pre scalding</strong></td>
<td>8.21 CFU log&lt;sub&gt;10&lt;/sub&gt; \ rinsate</td>
<td>Triangular</td>
</tr>
<tr>
<td>Additional Change</td>
<td>CFU log&lt;sub&gt;10&lt;/sub&gt; \ rinsate</td>
<td></td>
</tr>
<tr>
<td><strong>Scalding and defeathering Effect</strong></td>
<td>-1.67 CFU log&lt;sub&gt;10&lt;/sub&gt; \ rinsate</td>
<td>Triangular</td>
</tr>
<tr>
<td>Additional Change</td>
<td>CFU log&lt;sub&gt;10&lt;/sub&gt; \ rinsate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.54</td>
<td></td>
</tr>
<tr>
<td><strong>Evisceration Effect</strong></td>
<td>-0.18 CFU log&lt;sub&gt;10&lt;/sub&gt; \ rinsate</td>
<td>CDF-Based indepex</td>
</tr>
<tr>
<td>Additional Change</td>
<td>CFU log&lt;sub&gt;10&lt;/sub&gt; \ rinsate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.36</td>
<td></td>
</tr>
<tr>
<td><strong>Spin chilling Effect</strong></td>
<td>-2.71 CFU log&lt;sub&gt;10&lt;/sub&gt; \ rinsate</td>
<td>CDF-Based indepex</td>
</tr>
<tr>
<td>Additional Change</td>
<td>CFU log&lt;sub&gt;10&lt;/sub&gt; \ rinsate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.65</td>
<td></td>
</tr>
</tbody>
</table>
Regression model for human illness (1)

NMD % samples
> $3.78 \log_{10} \text{cfu/carass}$

Feb 2007 – Jan 2012: 8%

April 2007 – March 2008: 22%

Campylobacteriosis notification rate (per 100,000)

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>20%</td>
<td>208</td>
</tr>
<tr>
<td>15%</td>
<td>187</td>
</tr>
<tr>
<td>10%</td>
<td>166</td>
</tr>
<tr>
<td>5%</td>
<td>146</td>
</tr>
<tr>
<td>3%</td>
<td>135</td>
</tr>
<tr>
<td>1%</td>
<td>129</td>
</tr>
</tbody>
</table>
Regression model for human illness (2)

NMD % positive samples

<table>
<thead>
<tr>
<th>NMD %</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>75%</td>
<td>283</td>
</tr>
<tr>
<td>70%</td>
<td>268</td>
</tr>
<tr>
<td>65%</td>
<td>252</td>
</tr>
<tr>
<td>60%</td>
<td>236</td>
</tr>
<tr>
<td>55%</td>
<td>220</td>
</tr>
<tr>
<td>50%</td>
<td>204</td>
</tr>
<tr>
<td>45%</td>
<td>188</td>
</tr>
<tr>
<td>40%</td>
<td>173</td>
</tr>
<tr>
<td>35%</td>
<td>157</td>
</tr>
<tr>
<td>30%</td>
<td>141</td>
</tr>
<tr>
<td>25%</td>
<td>125</td>
</tr>
<tr>
<td>20%</td>
<td>109</td>
</tr>
</tbody>
</table>

Campylobacteriosis notification rate (per 100,000)

April 2007 – March 2008: 50%

Feb 2011 – Jan 2012: 39%
Alert modelling tool: screen shot

Acceptance number

<table>
<thead>
<tr>
<th>20</th>
<th>MW_Positives</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>MW_&gt;3.78</td>
</tr>
</tbody>
</table>

NMDxyz

- Pos_alert
- >3.78_alert
- Combined

Acceptance number 20 6

MW_Positives MW_>3.78
Revised performance standard: 2013 -

<table>
<thead>
<tr>
<th>Premises</th>
<th>Enumeration Failure (EF)</th>
<th>Detection Failure (DF)</th>
<th>Escalation of Responses</th>
<th>Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST: &gt; 1,000,000 birds per annum</td>
<td>When <strong>7 or more</strong> out of 45 samples are &gt; 3.78 log_{10}CFU/ carcass</td>
<td>When <strong>30 or more</strong> out of 45 samples are ≥ 2.30 log_{10}CFU/ carcass</td>
<td>If the premises has an EF, a DF or both it is counted as one non-compliant window.</td>
<td>To clear the non-compliance a moving window without an EF and without a DF is required. The database then resets to zero to show that the premises is compliant.</td>
</tr>
<tr>
<td>VLT: All others</td>
<td>When <strong>2 or more</strong> out of 9 samples are &gt; 3.78 log_{10}CFU/ carcass.</td>
<td>When <strong>6 or more</strong> out of 9 samples are ≥ 2.30 log_{10}CFU/ carcass.</td>
<td>Responses escalate according to the number of consecutive non-compliant moving windows.</td>
<td></td>
</tr>
</tbody>
</table>
Campylobacteriosis cases per quarter

- Strategy started Aug 2006
- Poultry NMD started April 2007
- Poultry processing targets set April 2008
- Poultry NMD detection limit added Jan 2013

Year, quarter:

- Number of cases in quarter:
  - 2004: [Value]
  - 2005: [Value]
  - 2006: [Value]
  - 2007: [Value]
  - 2008: [Value]
  - 2009: [Value]
  - 2010: [Value]
  - 2011: [Value]
  - 2012: [Value]
  - 2013: [Value]
Association between human cases and % positive carcasses
Association between human cases and $\% > 3.78 \log_{10} \text{cfu/carcass}$
Changing epidemiology presents challenges
Changing epidemiology presents challenges
Discussion

- Achieving gains based on biosecurity is a challenge
- New Zealand control programme focuses strongly on controlling contamination at primary processing by use of a mandated target rather than mandated interventions
- Working closely with industry to improve situation
- Must be a consequence for poor performance
- Washing of carcasses has demonstrable effect and chemical decontamination used where necessary
- Further stringency in performance target must be driven by transparent risk management decisions
Campylobacteriosis: A prime example for a risk-based approach!

Thank you