Public Health Impact of Leptospirosis in New Zealand

Cord Heuer

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Agenda

- Surveillance of human cases
- Leptospira ecology
- Human exposure and infection
- Public health impact
New Zealand at top of OECD countries

Leptospirosis Case Incidence (per 100,000)

New Zealand

Australia

USA
Annual, notified human leptospirosis cases

Shedding 2010/11:
- 30% dairy herds
- 4% dairy cows

Vaccination of dairy herds
• ESR Surveillance
  – Passive

• Reasons for underreporting
  – GP awareness
  – ELISA screening + MAT confirmation
  – ACC case definition (MAT ≥ 800 or 4-fold rise in titre)
  – Cost
Leptospira ecology
Wildlife

- Hedgehog: Ballum, Pomona
- Rat/mouse: Ballum, Pomona
- Possum: Balcanica
- Rabbit: ??

Soil and water

Livestock

- Hardjobovis, Pomona, (Copenhageni, Ballum, Arborea)
- Hardjobovis, Pomona, (Copenhageni, Ballum)
- Hardjobovis, (Pomona, Ballum)

Hardjobovis 46%
Pomona 23%, Ballum 18%, Tarassovi 8%
Sero-prevalence of 2,758 lambs at slaughter (1 plant)

± standard error

‘peace years’ 2 – 3%
‘outbreak years’ 5 – 15%

Dorjee et al., NZ Vet. J. 56(4), 164-170, 2008
Human exposure and infection
Contact rate of sheep-abattoir workers with infectious carcasses: how much exposure?

Handling offal: 17 vs 50 per day
Evisceration: 6 vs 16 per day
Meat inspection: 5 vs 10 per day

Handling offal

‘peace year’  ‘outbreak year’

Daily exposure risk to shedding carcasses

Dorjee et al., Epid&Inf 139(5):797-806, 2011
Sero-conversion study 2009-10: exposure -> infection?

384 sheep abattoir workers
- sampled twice with 1 year interval -

47 (12%) infected
- 22 (47%) flu-like illness (4.4 days)
- 3 (14%) severe leptospirosis (lab-confirmed)

337 (88%) not infected
- 25 (53%) no illness
- 255 (76%) no illness
Prevalence and incidence of abattoir workers (sheep, cattle, deer abattoirs)

Benschop et al. 2009, NZMJ, 122, 1-9;

Prevalence 8-22%
New infections/year 0-13%

Annual population incidence:

mild disease$_{\text{PAR}}$ 2.0%
severe disease$_{\text{PAR}}$ 0.8%
total$_{\text{PAR}}$ 2.8%

Proportion clinical when infected 22%
Lag effect of outbreaks: Lamb + ewe prevalence
[Mathematical model of infection dynamics]
Lag effect of outbreaks: Lamb + ewe prevalence
[Mathematical model of infection dynamics]
Public health impact
# Population demographics

<table>
<thead>
<tr>
<th>Population strata</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Abattoir workers</td>
<td></td>
</tr>
<tr>
<td>sheep</td>
<td>14,000</td>
</tr>
<tr>
<td>cattle</td>
<td>8,000</td>
</tr>
<tr>
<td>deer</td>
<td>2,000</td>
</tr>
<tr>
<td></td>
<td>24,000</td>
</tr>
<tr>
<td>Veterinarians and vet. assistants</td>
<td>2,832</td>
</tr>
<tr>
<td>Farmers and farm workers</td>
<td>579,080</td>
</tr>
<tr>
<td>Total rural:</td>
<td>(14%)</td>
</tr>
<tr>
<td></td>
<td>605,912</td>
</tr>
<tr>
<td>Total urban population:</td>
<td>(86%)</td>
</tr>
<tr>
<td></td>
<td>3,722,032</td>
</tr>
</tbody>
</table>
Estimating incidence from prevalence

<table>
<thead>
<tr>
<th>DATA</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P$ abattoir workers:</td>
<td>13.0%</td>
</tr>
<tr>
<td>$\text{Inc}$ abattoir workers:</td>
<td>8.6% $\rightarrow$ titre duration $D = \frac{P}{((\text{Inc} \times (1-P))}$</td>
</tr>
<tr>
<td>Veterinarians:</td>
<td>4.6% $\rightarrow$ incidence $\text{Inc} = \frac{P}{[D \times (1-P)]}$</td>
</tr>
<tr>
<td>Farmers (approx.):</td>
<td>5.0%</td>
</tr>
</tbody>
</table>

- Rural population: incidence weighted by pop-stratum size
- Urban population: notified cases ratio rural:urban=154:1

Assumptions:
- days ill 4.4d mild, 28d severe illness
- cost per working day $500
- cost of treatment $100/d for mild, $500/d severe illness
Rate of under-reporting

• Number of people affected each year:

<table>
<thead>
<tr>
<th></th>
<th>Rural</th>
<th>Urban</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population size</td>
<td>605,912</td>
<td>3,722,032</td>
<td>4,327,944</td>
</tr>
<tr>
<td>Mild illness</td>
<td>3,374</td>
<td>135</td>
<td>3,509</td>
</tr>
<tr>
<td>Severe illness</td>
<td>1,338</td>
<td>54</td>
<td>1,392</td>
</tr>
<tr>
<td>Total illness</td>
<td>4,712</td>
<td>189</td>
<td>4,901</td>
</tr>
</tbody>
</table>

• Under-reporting rate (UR):
  – Notified cases =113 in 2012
  – Estimated total cases = 4,901 → UR = 43 x
  – Estimated severe cases = 1,392 → UR = 12 x
Years lost due to disability (YLD)

**Years lost because of lower 'quality of life'**

<table>
<thead>
<tr>
<th></th>
<th>Days per episode</th>
<th>Rural (years)</th>
<th>Urban (years)</th>
<th>Population (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild illness</td>
<td>4.4</td>
<td>41</td>
<td>2</td>
<td>43</td>
</tr>
<tr>
<td>Severe illness</td>
<td>(28)</td>
<td>103</td>
<td>4</td>
<td>107</td>
</tr>
<tr>
<td>Total illness</td>
<td></td>
<td>144</td>
<td>6</td>
<td>150</td>
</tr>
<tr>
<td>Years ill (YLD)</td>
<td>per 100,000</td>
<td>36.0</td>
<td>0.2</td>
<td>5.2</td>
</tr>
</tbody>
</table>

- Comparison worldwide (*Lancet 2012; 380: 2197–223*)

  - Cryptosporidiosis: 122 per 100,000
  - Cholera: 65 per 100,000
  - Leptospirosis/rural pop NZ: 36 per 100,000
  - Amoebiasis: 35 per 100,000
  - Diphtheria: 3 per 100,000
Economic impact

• Leptospirosis associated cost:

<table>
<thead>
<tr>
<th></th>
<th>Unit</th>
<th>Rural</th>
<th>Urban</th>
<th>Total Pop.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lost work days</td>
<td>$500/day</td>
<td>$17.9m</td>
<td>$0.7m</td>
<td>$18.6m</td>
</tr>
<tr>
<td>Treatment/mild</td>
<td>$100/day-ill</td>
<td>$1.0m</td>
<td>$0.04m</td>
<td>$1.0m</td>
</tr>
<tr>
<td>Treatment/severe</td>
<td>$400/day-ill</td>
<td>$10.3m</td>
<td>$0.4m</td>
<td>$10.7m</td>
</tr>
<tr>
<td>Total cost</td>
<td>$</td>
<td>$29.2m</td>
<td>$1.2m</td>
<td>$30.4m</td>
</tr>
</tbody>
</table>

• Not yet considered: impact on livestock productivity
Conclusions

• Ecological specificity of host-serovar interactions
  – Role of wildlife and house rodents still unclear

• Disease dynamics likely to vary between endemic and outbreak situations
  – Modelling a potentially powerful tool for evaluating the public health impact

• Leptospirosis is not an insignificant disease in the NZ rural population
  – Underreporting estimated 12-fold
  – Burden on rural population: human + livestock
  – Contrast economic loss to cost of prevention
Acknowledgement

- Abattoir workers, farmers, vets
- Neville Haack, Heather Ducket
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  - SSF – FLAG
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