Surveillance for *Trichinella* and bovine cysticercosis - The point of view of the meat industry

Lis Alban
DVM, PhD, DipECVPH, DipPHM
Chief Scientist, Danish Agriculture & Food Council
Adjunct Professor, University of Copenhagen

9th Workshop of National Reference Laboratories for Parasites
Istituto Superiore di Sanità, Rome, May 20, 2014

Outline of presentation
1. Meat inspection and the needs of the industry
2. Status for the modernization process
3. Risk-based surveillance
4. *Trichinella* spp
5. *C. bovis*
6. Discussion

Organization of meat industry

Two organizations represent the industry in EU

UECBV
Slaughterhouses

Clitravi
Meat processors

Danish Agriculture & Food Council are members of both

*Trichinella* – a zoonotic parasite

*Trichinella spiralis* has a wide range of hosts
- Mainly pigs but also wild fauna incl. foxes and wild boar
- Humans become infected by eating raw or undercooked meat containing *Trichinella* larvae

Human cases in EU caused by
- Meat from outdoor or backyard pigs
- Horse meat and game

Human infection can be life-threatening
C. bovis – also a zoonosis

Bovine cysticercosis is a skeletal and cardiac muscle infection in cattle

Larvae → Cysticercus bovis
Tapeworm → Taenia saginata in humans

No consequences of infection in cattle

Human infection
- Not associated with pain or discomfort
- But considered disgusting among consumers to get a tapeworm
- Neurocysticercosis only an issue for T. solium (pigs/pork)

Current EU regulation - 1

Meat inspection regulated through Regulation 854/2004

Aim of Regulation is to ensure safety
- And to allow/ensure trade

Very prescriptive regulation
- About what to palpate/incise

All pigs are to be tested for Trichinella
- No positives found in herds with high biosecurity

Current EU Regulation - 2

Bovine carcases > 6 weeks of age are to be inspected for C. bovis
- Incisions into masseter and pterygoid muscles as well as heart muscles
- Time-consuming and costly
- Value in countries with low prevalence?

Meat inspection is up for debate

Current discussion about how to make meat inspection more risk-based
- Targetting the hazards that make people ill
- Industry view: authorities need to make inspection and control more cost-effective

EU Council has asked EU Commission for new rules
EU Commission has asked EFSA for advice
EFSA has organised working groups
Member States and industry are providing input
Pigs: New EU legislation - 1

June 1, 2014: Visual-only inspection will be the rule
- For both finishers, sows and boars
- Irrespective of production form

Requirements
- Exchange of Food Chain Information in place
- No irregularities observed during ante mortem inspection (or post mortem)
- No geographical/epidemiological data indicating that there is a risk

Pigs: New EU legislation - 2

Trichinella Regulation changed by June 1, 2014
- No routine testing of sows, boars and finishers required from herds with high level of biosecurity
  - In these herds 10% of swine are to be tested
    - except in Denmark and Belgium (Negligible risk status)
  - 100% testing of all other swine

Requirements
- Auditing of biosecurity should be in place

Controlled housing
- Concept put in place in EU to describe level of biosecurity

Controlled housing - yes/no

- Means a type of animal husbandry, where swine are kept at all times under conditions controlled by the food business operator with regard to feeding and housing (COMMISSION REGULATION (EC) No 2075/2005, ANNEX IV)
- Implies high biosecurity e.g. prevention entry of rodents
- Use of concept for other livestock species?

Controlled housing can be checked by a private product standard

Indoor units
- High biosecurity
- Prevention of entry by rodents

Outdoor units
- Low level of biosecurity
- Possibility of contact to wildlife
Private Product Standards

Provides documentation for
- Traceability
- Feed
- Herd health and use of medicine
- Animal welfare
- Housing and equipment
- Management
- Delivery of pigs

More and more issues will be covered in private standards

Danish Product Standard

Aim
- Assurance and documentation that Danish pig farms comply with Danish legislation and industry agreements

Audits
- Minimum every 3rd year
- Controlled housing is verified by the authorities

Similar standards in other countries

Link
http://vsp.lf.dk/~media/Files/DANISH/DANISH%20produktstandard/Produkt_Standard_UK.pdf

Status 2014

Meat inspection of swine will be visual and Trichinella testing will be risk-based from June 1, 2014

What about meat inspection of bovines?
- Will be decided by the EU Commission and the EU Parliament in the coming years

Industry throughout EU has a need for cost-effective meat inspection
- To ensure consumer confidence and hereby trade
- At the lowest costs to maintain profitability

EFSA opinion - bovines

Identification of hazard to be covered by meat inspection

BIOHAZ Panel:
Salmonella and VTEC

AHAW Panel:
Bovine TB and C. bovis

Undetermined hazards:
ESBL/AmpC and T. gondii
**C. bovis - prevalence**

Cysts can only be found at meat inspection

Prevalence in Denmark estimated to 0.1 – 0.7%
  • According to Kyvsgaard et al., 1990

In Denmark, cattle are typically lightly-infected
  • Up to 4 cysts per carcass
  • Low sensitivity (15%) of meat inspection of these animals
    • According to Kyvsgaard et al. (1990)

**C. bovis - surveillance**

Would it be possible to make meat inspection more risk-based?
  • By targeting inspection?

Project initiated between University of Copenhagen and Danish Agriculture & Food Council

**Objective of project**

To study how meat inspection can be made risk-based with respect to bovine cysticercosis
  • Part I: Identification of risk factors
  • Part II: Scenario tree modeling

Ph.D.-project 2010-2013
  • Student: Francisco Calvo-Artavía
  • Main supervisor: Liza Rosenbaum Nielsen

Other supervisors
  • Lis Alban (Epidemiology)
  • Flemming Thune-Stephensen (UECBV)
  • Jaap Boes (Parasitology)

**Risk-based surveillance - 1**

Implies targeting subpopulations with higher risk of infection compared to the whole population
  • For Trichinella: swine from non-controlled housing

DK obtained EU status of negligible risk by use of extensive testing and two approaches (Martin & Cameron)
  1. Disease Freedom
    • True free situation in low-risk compartments
  2. Historical Discounting
    • Value of prior surveillance data taken into account
    • Could be considered for Echinococcus surveillance in countries that find themselves free
Risk-based surveillance - 2

But which subpopulations have higher risk for C. bovis?

=> We looked for risk factors

And how can we be sure to identify high- and low-risk herds correctly?

=> We evaluated the issue carefully with stakeholders and experts

Part I – Risk factor studies

Objective
- To identify risk factors for C. bovis infection in cattle

Two study types used
- Case-control study
- Telephone interview (77 cases and 231 controls)
- Retrospective cross-sectional study
- Covering 18,223 herds from 2006-2010

Data sources
- Danish Cattle Database
- Meat inspection database
- Questionnaire survey
- Literature and expert opinion

Life cycle of C. bovis / T. saginata used for development of questionnaire

Location of case and control herds

77 cases and 231 controls

Definition: Case herd had ≥1 animal diagnosed with C. bovis at meat inspection between 2006 and 2010

Sporadic prevalence

A total of 328 herds in retrospective cross-sectional study lasting from 2004 to 2011
- 20 herds had 2 cases
- 308 herds had 1 case only

Results of case-control study

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Risk group</th>
<th>RR</th>
<th>Proportion</th>
<th>AR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Female</td>
<td>4.7</td>
<td>0.5</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>1</td>
<td>0.5</td>
<td>0.3</td>
</tr>
<tr>
<td>Grazing</td>
<td>Grazing</td>
<td>3.6</td>
<td>0.4</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Not grazing</td>
<td>1</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Access to risky water</td>
<td>Access to</td>
<td>3.1</td>
<td>0.1</td>
<td>2.6</td>
</tr>
<tr>
<td>source</td>
<td>risky water source</td>
<td>1</td>
<td>0.9</td>
<td>0.8</td>
</tr>
</tbody>
</table>

*a High-risk group
*b Low-risk group

Results of cross-sectional study

80 test + herds — 5,626 dairy herds
51 test + herds — 12,597 beef herds

Apparent animal prevalence at slaughter 0.009%
⇒ Adult animal true prevalence 0.06%
  - Much lower than results from Kyvsgaard et al., 1990

Risk factors revealed
- Dairy cattle
  - Herd size and farming type (organic a risk factor)
- Beef cattle
  - Herd size
  - Average annual number of purchased animals

Using multivariable logistic regression analysis

Observed age distribution

<table>
<thead>
<tr>
<th>Age</th>
<th>Distribution of cases (%)</th>
<th>Distribution of total population (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>12</td>
<td>29</td>
</tr>
<tr>
<td>&gt;1-2</td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td>&gt;2-3</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>&gt;3-4</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>&gt;4-5</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>&gt;5-6</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>&gt;6</td>
<td>26</td>
<td>11</td>
</tr>
</tbody>
</table>

Calvo-Artavia et al., 2012
Gender distribution

<table>
<thead>
<tr>
<th>Gender</th>
<th>Cases (%)</th>
<th>Total population (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>77</td>
<td>50</td>
</tr>
<tr>
<td>Male</td>
<td>23</td>
<td>50</td>
</tr>
</tbody>
</table>

Production system

<table>
<thead>
<tr>
<th>System</th>
<th>Cases (%)</th>
<th>Total population (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Conventional</td>
<td>89</td>
<td>94</td>
</tr>
</tbody>
</table>

Part II – Scenario tree modeling

Objective
- To study how meat inspection can be made risk-based with respect to bovine cysticercosis

Specific aim
- To evaluate the performance of alternative surveillance systems in comparison with the current

Part II – Methods and materials

Method
- Scenario tree modeling
- Population of slaughtered cattle divided into subpopulations
  - High risk
  - Low risk
- For each scenario, only one risk factor was chosen

Materials
- Expert opinion about various economic values
- Made use of data collected in Part I of project
  - Specifically about risk factors

Scenario tree model

Source: Calvo-Artavía et al., 2012
Scenario evaluation and comparison

For all scenarios assumed that
• High-risk cattle undergo invasive inspection
• Low-risk undergo visual inspection

The sensitivity of the surveillance system (SSCSe) was assessed as

\[
SSCSe = \frac{nDC}{C_{Inf}}
\]

Where
\(nDC\) = Number of detected cases
\(C_{Inf}\) = Number of expected cattle infected

Economic analysis

The following parameters were assessed for each scenario
• Money saved due to reorganization of the slaughter line
• Money gained on increased price of masseter muscle not incised
• Cost-effectiveness ratio (CE)
• Change in sensitivity of the entire surveillance system
• Net monetary gain due to visual inspection

Scenarios were then compared

Results of simulation

<table>
<thead>
<tr>
<th>Risk factor and scenarios</th>
<th>Number of detected cases (95% CI)</th>
<th>Sensitivity of surveillance (95% CI)</th>
<th>Number of cattle visually inspected</th>
<th>Net gain in million €/year (95% CI)</th>
<th>Cost-effectiveness ratio in million €/year (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current surveillance</td>
<td>44 (15, 95)</td>
<td>0.15 (0.07, 0.22)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gender</td>
<td>36 (12, 78)</td>
<td>0.12 (0.06, 0.18)</td>
<td>251,327</td>
<td>0.7 (0.6, 0.8)</td>
<td>28.3 (17.1, 52.7)</td>
</tr>
<tr>
<td>Grazing</td>
<td>31 (10, 87)</td>
<td>0.10 (0.05, 0.16)</td>
<td>299,374</td>
<td>0.8 (0.7, 0.9)</td>
<td>20.3 (12.3, 37.9)</td>
</tr>
<tr>
<td>Access to risky water source</td>
<td>11 (4, 24)</td>
<td>0.04 (0.02, 0.09)</td>
<td>449,061</td>
<td>1.2 (1.1, 1.3)</td>
<td>12.1 (7.3, 22.5)</td>
</tr>
</tbody>
</table>

Source: Calvo-Artavia et al., 2012

Discussion

Assumption: possible to reorganize work at abattoir
• Is it close to reality?

Food Chain Information (FCI) system
• Feasibility of collecting relevant data?

Compromising food safety?
• How much if we are not inspecting low-risk animals?
• Necessary to assess public health burden
  • Is undertaken currently in FAO/WHO/Codex project group
Prioritization: human cases of zoonotic infections in EU, 2010

<table>
<thead>
<tr>
<th>Disease</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rabies</td>
<td>7</td>
</tr>
<tr>
<td>Kvæg-TB</td>
<td>122</td>
</tr>
<tr>
<td>Brucella</td>
<td>304</td>
</tr>
<tr>
<td>Trichinella</td>
<td>529</td>
</tr>
<tr>
<td>Echinococcose</td>
<td>1.661</td>
</tr>
<tr>
<td>Listeriose</td>
<td>1.414</td>
</tr>
<tr>
<td>Q-feber</td>
<td>41</td>
</tr>
<tr>
<td>VTEC</td>
<td>9,000</td>
</tr>
<tr>
<td>Yersiniose</td>
<td>8.776</td>
</tr>
<tr>
<td>Campylobacteriose</td>
<td>93,030</td>
</tr>
<tr>
<td>Salmonella</td>
<td>272,084</td>
</tr>
</tbody>
</table>

Burden of Disease depends upon:
- Number of human cases
- Impact of infection on individual case

Conclusions - 1

Meat inspection is up for discussion

For swine in the EU, inspection will be visual-only and no testing for Trichinella will be required for swine from controlled housing (June 1, 2014)

However, testing will continue for Member States exporting to countries outside the EU
- Therefore necessary to obtain international agreement on how to document risk-based surveillance for Trichinella
- Else industry cannot make benefit of the new legislation

Conclusions - 2

EU Commission is discussing how to modernize meat inspection for bovines
- Risk-based approaches to C. bovis and Bovine TB possible?

Gender best indicator for C. bovis in DK
- To differentiate between high-risk and low-risk cattle
- Information available from the Danish Cattle Database

Same number of undetected cases in risk-based and current surveillance
But only 50% of the cattle will be inspected
- Hence, savings can be made

What is in the pipeline?

Several scenarios on the agenda for C. bovis
1. Not change anything
2. Loosening meat inspection
   - Such as not cutting into masseter and pterygoid muscles
3. Visual only inspection of low-risk cattle
   - Requires identification of risk factors/indicators
4. Visual only inspection of all cattle

Necessary to evaluate effect of scenarios
- Public health burden
- Is undertaken currently in FAO/WHO/Codex project group
- What about high-risk and low-risk countries?
- Different strategies?
Industry’s wishes

- Cost-effective approach
  - Through risk-based surveillance
  - With focus on what makes animals and people ill today
  - Science-based with focus on feasibility
- Harmonized approach to obtain international acceptance
  - We do not want 28 individual solutions
- Aim: ensure consumer confidence and allow trade
  - This will make it possible to have a profitable European livestock production in the future

Papers referred to in presentation

