Trichinella Transmission and Control

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Trichinella spp

Cosmopolitan distribution

People who eat raw or undercooked meat (pig/horse) at risk – especially those who eat wild carnivore meat

Major wildlife sources: walrus, seal, wild boar, wart-hog, bear

Encysted larvae in muscles
Countries with trichinellosis from 1986 to 2009
Comparison of WHO Regions
Relative Distribution of Cases
Life Cycle of *Trichinella spiralis*

- Larvae are ingested in raw or undercooked meats
- Larvae are released from Nurse cells in stomach
- Larvae enter small intestine
- Adults mature and live in small intestine
- Larva matures in muscle
- Newborn larvae are carried throughout bloodstream
- Newborn larva enters skeletal muscle cell
- Female sheds newborn larvae that enter lymph or blood

PATHOLOGY
- Heart failure
- CNS damage
Adult worms survive 2-? weeks in the intestine
Newborn larvae are shed live
Encapsulated Larvae

Non-Encapsulated Larvae
CLINICAL FEATURES

Enteric Phase: Mild in majority of cases - nausea, vomiting, colic, diarrhoea, sweating

Migratory (Invasive phase):
Immunopathology, fever, peri-orbital edema, eosinophilia, myalgia
peri-orbital edema
Encystment Phase:
Fever, edema, dehydration usually subsides (2 months after infection), eosinophilia subsides but remains elevated, elevated IgE antibodies.

Prognosis:
Low mortality (heart failure), self-limiting (depending on infection load).
Frequency of Clinical Symptoms

No. with symptoms

- Total Cases: 5069
- Diarrhea: 1198
- Myalgia: 3452
- Fever: 2617
- Facial/Ocular Edema: 2720
- Headache: 867
- Eosinophilia: 2711
Age-Specific Infections In Euro and AMRO Outbreaks (1,188 people)
Overall summary of clinically confirmed cases of trichinellosis in humans documented in the WHO regions from 1986 to 2009

<table>
<thead>
<tr>
<th>WHO region (No. of countries)</th>
<th>No. of countries with trichinellosis (%)</th>
<th>Documented human infections (%)</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFRO (46)</td>
<td>1 (2.2)</td>
<td>28 (0.04)</td>
<td>1</td>
</tr>
<tr>
<td>AMRO (12)</td>
<td>5 (41.7)</td>
<td>7,179 (10.90)</td>
<td>10</td>
</tr>
<tr>
<td>EMRO (22)</td>
<td>2 (9.0)</td>
<td>50 (0.07)</td>
<td>0</td>
</tr>
<tr>
<td>EURO (50)</td>
<td>29 (58.0)</td>
<td>56,911 (86.46)</td>
<td>24</td>
</tr>
<tr>
<td>SEARO (11)</td>
<td>1 (9.0)</td>
<td>219 (0.33)</td>
<td>1</td>
</tr>
<tr>
<td>WPRO (27)</td>
<td>3 (11.1)</td>
<td>1,344 (2.04)</td>
<td>6</td>
</tr>
<tr>
<td>Other*</td>
<td>-</td>
<td>86 (0.13)</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total (168)</strong></td>
<td><strong>41 (24.4)</strong></td>
<td><strong>65,817</strong></td>
<td><strong>42 (0.05%)</strong></td>
</tr>
</tbody>
</table>

*Infections acquired in countries other than the one in which diagnosis occurred
Transmission of Trichinella spiralis

Domestic Cycle

Sylvatic Cycle

Domestic Cycle
And Cannibalism !!
Role of sylvatic hosts as reservoirs of domestic trichinellosis (primarily *T. spiralis*)
## Species of *Trichinella*

<table>
<thead>
<tr>
<th>Species</th>
<th>Hosts</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>T. spiralis</em></td>
<td>Pigs, Wildlife</td>
<td>Worldwide</td>
</tr>
<tr>
<td><em>T. nativa</em></td>
<td>Wildlife</td>
<td>Arctic, freeze resistant</td>
</tr>
<tr>
<td><em>T. britovi</em></td>
<td>Wildlife, (pigs)</td>
<td>Temperate</td>
</tr>
<tr>
<td><em>T. pseudospiralis</em></td>
<td>Wildlife, birds, (pigs)</td>
<td>Worldwide NoCapsule</td>
</tr>
<tr>
<td><em>T. murrelli</em></td>
<td>Wildlife</td>
<td>North America</td>
</tr>
<tr>
<td><strong>Tropics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>T. nelsoni</em></td>
<td>Wildlife</td>
<td>Africa</td>
</tr>
<tr>
<td><em>T. papuae</em></td>
<td>Pigs, crocs</td>
<td>Papua New Guinea No Capsule</td>
</tr>
<tr>
<td><em>T. zimbabwensis</em></td>
<td>Crocs, lizards</td>
<td>East Africa No Capsule</td>
</tr>
</tbody>
</table>
Confirmed *T. spiralis* Infections in Sylvatic Mammals in North America

Masuoka et al., 2009, J. Parasitol 95: 829.
Infected Meat Sources in North American Outbreaks (T spiralis, T nativa)
Relative importance of domestic pork as a source of human infections

- Of 40 countries with outbreak source data, 23 (58%) reported pork as the only or chief source of infection (1986-2009).

- Remaining 17 countries (42%) reported wild game or non-pork domestic animal meat (e.g., horse, dog) as major sources.

(Murrell and Pozio 2011)
- Of particular concern is an increase in the association of wild animal with domestic pigs (e.g., free-range).
- The increase in outbreaks from the consumption of pork from wild boars in Europe are believed to be related to the great increase in wild boar populations.
Association of Trichinella with farm types

1. Backyard/Free-range
2. Confined

(Murrell and Pozio 2011)
INSPECTION AND DIAGNOSIS:

Traditional First Line of Defense
Postmortem detection of trichinae in pork, etc.

• Direct methods:
  Trichinoscopy
  Digestion

• Indirect methods:
  Immunodiagnosis
  PCR
Meat inspection for *Trichinella*
⇒ artificial digestion (magnetic stirrer method)

The magnetic stirrer method is the widely preferred method in the EU Member states.

advantages compared to trichinoscopy:
- saving of time
- examination of pooled samples
- higher sensitivity
- detection of non-encapsulated species (*T. pseudospiralis*)
TRICHINELLA SPIRALIS ANTIBODY TEST KIT
Catalog #8008
Enzyme Immunoassay for Detection of *Trichinella spiralis* Antibody in Swine

ELISA
Larval ES Antigen
Issue with ELISA

Quality of ES antigen variable:
commercially available, but needs international standardization
SURVEILLANCE, PREVENTION AND CONTROL
Continuing Cost of Trichinellosis to the Pork Industry

• Consumers negative image of fresh product is based on a history of “worms in pork” and is still the #1 pork safety question

• Lack of any inspection program hinder access to international markets

• Processed product regulations must be met for all ready-to-eat products

• In countries with mandatory inspection, cost is high (more than 500 million euros/year in EU).
Association of Trichinella with farm types

1. Backyard/Free-range
2. Confined

(Murrell and Pozio 2011)
#1: Low infection Intensity.

Slaughterhouse Digestion data

![Bar chart showing pigs distribution across LPG categories]
Germany

- German legislation: meat inspection for domestic pigs, horses and wild boars

- results of meat inspection (Federal Office for Statistics):

<table>
<thead>
<tr>
<th>animal species</th>
<th>no. animals (1995-1998)</th>
<th>animals / year</th>
<th>no. positive (prevalence)</th>
<th>Trichinella sp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>pig</td>
<td>151.9 Mio</td>
<td>38 Mio</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>horse</td>
<td>70.100</td>
<td>17.500</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>wild boars</td>
<td>839.700</td>
<td>209.900</td>
<td>49 (0.06%)</td>
<td>T. spiralis</td>
</tr>
</tbody>
</table>

no evidence for *Trichinella* prevalence in the domestic cycle; but *T. spiralis* in wild boars

*Noeckler, 2003*
#2 Declining human cases
THE NEW APPROACH:

TRICINELLA-FREE FARMS,
COMPARTMENTS
or COUNTRIES
CRITICAL Interventions to Reduce or Eliminate Risk of Pig Exposure to *Trichinella*

**Risk**

- Exposure to meat waste containing infective larvae
- Exposure to infected rodents
- Exposure to infected wildlife
- Cannibalism

**Intervention**

- Proper cooking of all meat containing waste
- Rodent control program
- Bio-security to eliminate exposure to wildlife
- Prompt removal of dead pigs
Actions Underway to Mitigate Impact

◆ EC Regulation 2075/2005 permits a region of country to declare “negligible risk” based on risk-based surveillance. (e.g., Denmark, Netherlands)

◆ OIE developing pre-slaughter guidelines for *Trichinella*-free farms where pigs are kept under controlled management conditions. Negligible risk-compartments may comprise a number of pig herds (Draft Chapter 8.13.).
◆ Codex Alimentarius Commission developing guidelines for post-slaughter guidelines. (Codex Working Group CX/FH/43/6)

◆ The OIE Ad Hoc Group on Zoonotic Parasites recommended a cross-reference between the revised Codex Guidelines and articles in the OIE Chapter 8.13, particularly those relating to international trade
USA Program

Pre-Harvest Certification

• Based on production of pigs under management practices which **minimize the risk** of exposure to *Trichinella*

• Uses third party **auditing** to document the good management practices

• Is supported by **regular testing** of certified animals to verify the absence of infection
TRADE

Recommendations for the importation of meat or meat products of domestic pigs

Veterinary Authorities of importing countries should require the presentation of an international veterinary certificate attesting that the entire consignment of meat or meat products:

- comes from domestic pigs slaughtered in an approved abattoir; AND

- comes from domestic pigs that tested negative by the digestion method for *Trichinella*, as described in the OIE Terrestrial Manual; OR

- was processed to ensure the inactivation of *Trichinella* larvae in accordance with the recommendations in the [Codex working document CX/FH/11/43/6].
Conditions for destroying *Trichinella spiralis* in pork by freezing

<table>
<thead>
<tr>
<th>Meat size (cm)</th>
<th>Temperature (°C)</th>
<th>Duration (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 15</td>
<td>-15</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>-23</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>-29</td>
<td>6</td>
</tr>
<tr>
<td>15 to 50</td>
<td>-15</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>-25</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>-29</td>
<td>12</td>
</tr>
</tbody>
</table>

Other methods to kill trichinae

- Heating to 63° C (145° F)
- Salt Curing
- Low Dose Irradiation (FDA/FSIS 9CFR Part 318)
And as proposed in Draft OIE Chapter 8.13 on *Trichinella*

- comes from domestic pigs from a negligible risk country or zone in accordance with Article 8.13.5., OR
- comes from domestic pigs originating from a *Trichinella*-free herd in accordance Article 8.13.6.
The number of horse meat related outbreaks reported has regularly increased in the past 3 decades.
Recommendations for the importation of meat or meat products of domestic equids

Veterinary Authorities of importing countries should require the presentation of an international veterinary certificate attesting that the entire consignment of meat or meat products comes from domestic equids:

1. that were slaughtered in an approved abattoir; AND

2. that tested negative by the digestion method for Trichinella as described in the Terrestrial Manual.