Neurocysticercosis
(\textit{Taenia solium} Infection)

Feasibility and Strategy of Eradication

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Atlanta, Georgia
• Imaging
• Immunoblots
• Immigration

Global Emergence of *Taenia solium*
Clinical manifestations of cysticercosis in humans
TAENIA SOLIUM LIFE CYCLE

- **Egg**
- Human consumption
- **Cysticercus**
- **Adult Worm in Small Intestine**
- Pig consumption
World Distribution of *Taenia solium*

- High or moderate prevalence
- Low or sporadic prevalence
Ecologic settings conducive to *Taenia solium* transmission
La Neurocisticercosis es "un testimonio al sub-dessarollo"
H.M. Canelas, 1962
Seropositive persons often clustered in households in association with taenia carriers
Prevalence of Human and Porcine Cysticercosis Infection and Human Taeniasis in 8 Villages in the Central Sierra of Peru.

From Garcia et al., 2002
## Calculation of Disease Burden Associated with Neurocysticercosis in Peru

<table>
<thead>
<tr>
<th>Variable</th>
<th>Calculated value (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population of Peru (1993)</td>
<td>22,704,204</td>
</tr>
<tr>
<td>Population in area of endemicity</td>
<td>10,449,649</td>
</tr>
<tr>
<td>Population aged &gt; 15 years in areas of endemicity</td>
<td>6,269,789</td>
</tr>
<tr>
<td>Estimated range of cysticercosis seroprevalence, %</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td>No. of seropositive persons aged &gt; 15 years</td>
<td>376,187</td>
</tr>
<tr>
<td>with NCC-associated seizure disorders</td>
<td>18,809</td>
</tr>
<tr>
<td>with other clinical manifestations of NCC</td>
<td>4702</td>
</tr>
<tr>
<td>Total with symptomatic NCC</td>
<td>23,512</td>
</tr>
</tbody>
</table>

Source: Bern et al., 1999
Neurocysticercosis in the U. S. A. is Primarily an Imported Disease

Current husbandry practices for pigs in the U.S. are not conducive to transmission of Taenia solium
Clinical and Epidemiologic Experiences with Neurocysticercosis in Non-Endemic Countries

- **Imported Disease** - In Los Angeles Co., epidemic of diagnoses began in the 1970s

- **Introduced infection/disease**
  - Cluster of “endemic” cases in Brooklyn community
  - Continuous isolated cases

Richards et al., 1985
Schantz et al., 1994
Driving force of continuing emergence of neurocysticercosis in North America is Hispanic immigration.

During decade 1991-2000, Hispanic population in USA increased by 58% to 35.3 million.

Factors Associated With Migrations
- scarcities of land, water, food
- overcrowding
- widening disparities of income
- poverty
- lack of employment

Source: Kane H: World Watch, 1994
Eradicability of *Taenia solium* Infection

- The International Task Force for Disease Eradication (1992) determined that *Taenia solium* was potentially eradicable based on the following considerations:
  - Life cycle requires humans as definitive hosts
  - Tapeworm infections in humans are the only source of infection for pigs, the natural intermediate host
  - Swineherds can be managed
  - No reservoirs of infection exist in wildlife.
Eradicability of *Taenia solium* Infection

- However, *T. solium* has not been eliminated from any region by a designed program and no national programs are yet in place.
Strategies for Intervention

- Cook meat
- Control slaughter
- Meat inspection
- Mass taeniacidal treatment
- Improve sanitation
- Restrain pigs
- Vaccinate pigs*
- Treat pigs*
Proposed Control Measures

- Improved living conditions
- Control of pig slaughter
- Health education
- Mass taeniacidal Rx of humans
- Mass cysticercicidal treatment of pigs
- Vaccination of pigs
Effectiveness of Intervention Combining Taeniacidal Treatment in humans and Cysticercicidal Treatment of Pigs in Hyperendemic Villages in Peruvian Highlands

• Interventions
  – Mass treatment of pigs
    – Two rounds of oxfendazole (30 mg/kg)
  – Mass treatment of humans
    – One round of praziquantel (5mg/kg)

• Effect
  • Reduced prevalence and incidence of cysticercosis in pigs, however, the magnitude of the effect was lower than expected.

Garcia H and the Cysticercosis Working Group in Peru, 2002
Cysticercosis/Taeniasis: Elimination progress

- Categorized as ‘potentially eradicable’
  - International Task Force for Disease Eradication (1993)
- Operational research to define optimal strategy
- Developing political/social constituencies
  - World Health Assembly 2002
Questions?
Prevalence and Morbidity Caused by Neurocysticercosis in Latin America

• **Seizures**
  - **Peru-24-39 thousand cases**
  - **Latin America- 400 thousand cases**

Some assumptions:

- Nearly 10% of people will be infected by the time they reach adulthood
- 1 in 200 will develop seizures

Source: Bern et al. 1999
Prevalence of Human and Porcine Cysticercosis Infection and Human Taeniasis in 8 Villages in the Central Sierra of Peru.

From Garcia et al., 2002
### Prevalence Estimates of *Taenia solium* Cysticercosis and Taeniasis in People and Pigs in Latin American Communities

<table>
<thead>
<tr>
<th>Country</th>
<th>Community</th>
<th>Sample Size</th>
<th>Prevalence Cysticercosis (Immunoblot) (%)</th>
<th>Prevalence Taeniasis (%)</th>
<th>Prevalence Cysticercosis in pigs (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexico</td>
<td>Angahuan</td>
<td>1552</td>
<td>10.8</td>
<td>0.3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Xoxocotla</td>
<td>1005</td>
<td>4.9</td>
<td>0.2</td>
<td>7</td>
</tr>
<tr>
<td>Guatemala</td>
<td>Quesada</td>
<td>862</td>
<td>11</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>El Jocote</td>
<td>955</td>
<td>20</td>
<td>2.8</td>
<td>14</td>
</tr>
<tr>
<td>Bolivia</td>
<td>“rural community”</td>
<td>159</td>
<td>22.6</td>
<td>n.d.</td>
<td>39</td>
</tr>
<tr>
<td>Ecuador</td>
<td>San Pablo del Lago</td>
<td>118</td>
<td>10.4</td>
<td>n.d.</td>
<td>8</td>
</tr>
<tr>
<td>Peru</td>
<td>Lima (urban)</td>
<td>250</td>
<td>0</td>
<td>n.d.</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Maceda</td>
<td>371</td>
<td>8</td>
<td>0.3</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Churusapa</td>
<td>134</td>
<td>7</td>
<td>n.d.</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Haparquilla</td>
<td>108</td>
<td>13</td>
<td>n.d.</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Monterredonda</td>
<td>489</td>
<td>16</td>
<td>n.d.</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Quilcas</td>
<td>18</td>
<td>n.d.</td>
<td>60-70</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Saylla</td>
<td>99</td>
<td>24</td>
<td>8.6</td>
<td>36</td>
</tr>
</tbody>
</table>

From: Schantz, Wilkins and Tsang, 1998
Cysticercosis/ Taeniasis: Elimination Strategy

- **Interrupt transmission**
  - health/sanitary education
  - modernize swine husbandry
  - mass-treat populational foci of infection

- **Surveillance**
  - identify infected populations

- **Operational research**
  - explore alternative elimination approaches
Praziquantel for taeniasis can provoke neurologic symptoms in patients with occult neurocysticercosis

12 y.o. girl developed severe headaches persisting for 10 days after receiving praziquantel (5mg/kg). MRI revealed 7 intracerebral cysticerci.
Neurocysticercosis in the U. S. A. is Primarily an Imported Disease

- Published clinical reports through 1986 totaling >900 cases documented that >90% of patients were born outside of U.S. (most frequently in Mexico)
  - only 15 cases were diagnosed in patients born in the U.S. with no foreign travel history to countries with endemic *T. solium* infection.

Current husbandry practices for pigs in the U.S. are not conducive to transmission of *Taenia solium*
Cysticercosis/Taeniasis: Elimination strategy

- **Interrupt transmission**
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**Criteria for Assessing Eradicability of Diseases**

- Political Will/Popular Support
  - Perceived burden of disease
  - Expected cost of eradication
  - Synergy of eradication efforts with other interventions
  - Necessity for eradication rather than control

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**Eradication of Taenia solium Infections in Europe**

Due to: (Pawlowski, 1987)

- Improvement in general sanitation
- Improvement in economy status
- Change into in-door husbandry
- Rigorous meat inspection

**None of these factors operative in the endemic countries now**
Symptomatic disease

Asymptomatic infection

CT + EITB -

EITB + CT +

EITB + CT -

Symptomatic disease

Bern et al., 1999
Pig Population in Eastern & Southern Africa 1961 - 2000*  

*excludes South Africa
Hispanic Population in the United States

- 1990 total population: 249 million
  - 22.4 million Hispanics
  - 9% of total population
- 2000 total population: 281 million
  - 35.3 million Hispanics
  - 12.5% of total population
- 1990 to 2000 Hispanic change:
  - 13.0 million
  - 58% increase since 1990