Current public health problems related to pork

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Brussels, 25 October 2010
Main hazards associated with pork consumption

- *Campylobacter* spp.
- *Listeria monocytogenes*
- *Mycobacterium* spp.
- *Salmonella* spp.
- *Staphylococcus aureus*
- VTEC
- *Yersinia* spp.

- Hepatitis E virus

- *Ascaris suum*
- *Echinococcus* spp.
- *Cryptosporidium* spp.
- *Taenia solium*
- *Trichinella* spp.
- *Toxoplasma gondii*

- Antimicrobial resistance

Source: EFSA Opinion 613
What are the risks and how do they compare?

- Epidemiology
  - Incidence
  - Mortality
  - Severity
  - Attribution

- (Comparative) risk assessment
  - Risk Ranger
  - sQMRA
  - iRisk
Data on human illness at EU level

- Available data in Annual Community Summary Report on Trends and Sources of Zoonoses and Zoonotic Agents and Food-borne Outbreaks in the European Union (Annual)
Main hazards associated with pork consumption: data availability EU

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- Ascaris suum
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- Taenia solium
- Trichinella spp.
- Toxoplasma gondii

- Antimicrobial resistance
Foodborne outbreaks in 2008

Source: Community Summary Report 2008 (EFSA, 2010)
Reported incidence of human salmonellosis in the EU

Source: Community Summary Report 2008 (EFSA, 2010)
The surveillance pyramid for gastrointestinal pathogens

Methods used for calibration:

- Cohort studies
- Multiplier methods
- Travelers as sentinels
- Modelling
- Seroepidemiology

Reported fraction differs between countries and between diseases

- # reported cases
- # positive lab results
- # tested for pathogen
- # cases submitting stool sample
- # cases seeking medical care
- # cases of AGI in community, due to specific pathogen
- # asymptomatic infections with specific pathogen in community

Sero-survey of population
Salmonella sero-incidence and incidence estimates in Swedish travelers

Spearman’s rho = 0.9, p = 0.007


Source: dr. K. Mølbak, SSI, Denmark
Salmonella prevalence in layers (baseline study, all serovars) and sero-incidence

\[ \text{Spearman’s } \rho = 0.90, \ p = 0.005 \]

Source: dr. K. Mølbak, SSI, Denmark
### What are the priorities?

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Norovirus</th>
<th>Rotavirus</th>
<th>Campylobacter</th>
<th>Salmonella</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastroenteritis</td>
<td>640,000</td>
<td>300,000</td>
<td>79,000</td>
<td>43,000</td>
</tr>
<tr>
<td>GE – visit to GP</td>
<td>16,000</td>
<td>21,000</td>
<td>19,000</td>
<td>7,600</td>
</tr>
<tr>
<td>GE – hospital</td>
<td>2,000</td>
<td>4,400</td>
<td>570</td>
<td>650</td>
</tr>
<tr>
<td>GE – death</td>
<td>6</td>
<td>2</td>
<td>46</td>
<td>47</td>
</tr>
<tr>
<td>Reactive arthritis</td>
<td>-</td>
<td>-</td>
<td>1,500</td>
<td>1,700</td>
</tr>
<tr>
<td>Guillain-Barré S.</td>
<td>-</td>
<td>-</td>
<td>65</td>
<td>-</td>
</tr>
<tr>
<td>Irr. Bowel Syndrome</td>
<td>-</td>
<td>-</td>
<td>6,900</td>
<td>3,900</td>
</tr>
</tbody>
</table>
HALYs: integrated measures of disease burden

- Integrate morbidity and mortality
- Incorporate age and health status of those affected
- Address incidence, severity and duration of adverse health consequences
- One example, frequently used in public health: Disability Adjusted Life Years

\[ \text{DALY} = \text{YLL} + \text{YLD} \]

- Mortality: years of life lost
  \[ \text{YLL} = \sum_{\text{all diseases}} (D \times e) \]
  \( D \): number of deaths; \( e \): life expectancy of fatal cases

- Morbidity: years lived with disability, weighted for severity of illness
  \[ \text{YLD} = \sum_{\text{all diseases}} (N \times t \times w) \]
  \( N \): number of non-fatal cases; \( t \): duration, \( w \): severity weight
Disease burden in the Netherlands (all sources)

Campylobacter has the highest burden

Burden of Toxoplasma very uncertain, recent data suggest 4x higher burden

Strong effect of discounting (child deaths)
Disease burden per case

Diseases affecting unborn or young children have the highest burden.

Systemic infections also have a high burden.

Lowest burden for protozoa.
Attribution

● The partitioning of the human disease burden of one or more foodborne infections to specific sources (animal reservoirs and vehicles such as foods)

● Microbiological approaches
  – Microbial subtyping
  – Comparative exposure assessment

● Epidemiological approaches
  – Case-control studies of sporadic infections
  – Outbreak investigations

● Intervention studies
  – Surveillance after new legislation
  – Natural experiments

● Expert elicitation

● Currently most data available for Salmonella
Attribution of salmonellosis in the Netherlands, 1984-2009

Source: dr. Wilfrid van Pelt, RIVM, the Netherlands
10-20% of human *Salmonella* infections in EU may be attributable to the pig reservoir as a whole. 

EFSA Opinion 1547, 2010
Monophasic Salmonella (1,4,[5],12:i)

- ... are regarded as variants deriving from *S. Typhimurium*
- ... have been shown to have similar virulence and antimicrobial resistance characteristics to strains of *S. Typhimurium*
- ... the third most common serovar from human infections
- .... the second most common serovar from pigs
- .... the third serovar from bovine samples

Source: EFSA Opinion 1826
Attribution of the burden of 14 pathogens to major pathways in the Netherlands

Disease burden (DALY per year)

- Food: 50%
- Human: 22%
- Environment: 18%
- Animal: 10%

Estimates based on expert elicitation
Attribution of the foodborne burden of 14 pathogens to food groups in the Netherlands

Disease burden (DALY per year)

- Beef and mutton: 15%
- Pork: 12%
- Poultry: 19%
- Eggs: 6%
- Dairy: 9%
- Cereal products: 4%
- Other food: 11%
- Fish and shellfish: 7%
- Fruit and vegetables: 6%
- Beverages: 2%
- Human and animal: 9%
- Poultry: 19%
- Dairy: 9%
- Eggs: 6%
- Fish and shellfish: 7%
- Beverages: 2%
- Fruit and vegetables: 6%
- Cereal products: 4%
- Other food: 11%
- Human and animal: 9%

Mainly *T. gondii* and *Salmonella spp.*

Estimates based on expert elicitation
Filling the data gaps

● ECDC
  – Burden of Communicable Diseases in Europe
  – Sero-epidemiology of Salmonella and Campylobacter

● WHO
  – Foodborne Epidemiology Disease Burden Reference Group
Conclusions

- Surveillance systems for the main pathogens in pork are in place in the EU, but coverage varies between Member States.
- Reported data represent only a fraction of all cases in the population.
- The reported fraction varies strongly between Member States and between pathogens.
- Severity of acute illness, sequelae and mortality need to be taken into account when deciding about public health priorities.
- Data for attribution of human illness to animal reservoirs and foods are poorly available.
- Major international projects are on-going to fill data gaps, but Member States need to invest in more systematic surveillance.

- Based on current evidence, *Salmonella* spp., *Toxoplasma gondii* and *Trichinella* spp. appear to be the most important pathogens in pork.