

## Porcine Cysticercosis Summary

### Introduction

1. This note provides a brief summary of an analysis undertaken by a DISCONTTOOLS group of experts on Porcine Cysticercosis. They reviewed the current knowledge on the disease, considered the existing disease control tools, identified current gaps in the availability and quality of the control tools and finally determined the research necessary to develop new or improved tools. Full details can be downloaded from the web site at <http://www.discontools.eu/>.

### Disease profile

2. Porcine cysticercosis is an infection of pigs with the metacestode larval stages of the parasitic cestode, *Taenia solium*. Humans are the definitive host of the adult tapeworm. Segments containing eggs are shed in the faeces. If eggs from infected humans are ingested by pigs, the oncospheres penetrate the intestine and migrate primarily to muscle tissue and develop into cysticerci. The parasite life cycle is completed when humans ingest undercooked pork containing viable cysticerci. Adult tapeworms which develop in humans can reside in the small intestine for year(s).

3. Humans can also become infected with the larval stages. Infection occurs when the tapeworm oncospheres enter the body and form cysticerci. The most serious form is neurocysticercosis when cysticerci are found in the central nervous system (CNS). Symptoms of neurocysticercosis depend upon where, the stage and how many cysticerci are found in the CNS. Epileptic seizures and headaches are the most common symptoms. Death can occur suddenly with heavy infections or, in low infections, when hydrocephalus is created.

4. Cysticercosis in pigs causes economic loss through value loss or condemnation of infected meat.

### Risk

5. *Taenia solium* taeniasis and cysticercosis are common in LMICS in the global south, infection is rare in the U.S. and most parts of Europe. Cysticercosis is classified as a neglected zoonosis. Neurocysticercosis requires imaging for diagnosis which leads to an underestimation of incidence in areas where such facilities are lacking. Infection is found most often in rural, resource poor areas within LMICs where poor sanitation coverage co-exists with free-ranging pigs, facilitating the transmission through the ingestion of human faeces/contaminated feed/water.

6. *T. solium* eggs can spread from human to human through contaminated food and drinking water or by direct contact. Human cysticercosis can occur in local populations even if pork is not eaten and the environment is not shared with pigs if there is a human excreting *T. solium* eggs in the locality. *T. solium* eggs can survive in the environment for months. The eggs may be disseminated by rain, wind and invertebrates and can contaminate vegetation and water.

### Diagnostics

7. Diagnosis in animals is usually based on the detection of the cysticerci at meat inspection or necropsy. Tests for antibodies or antigens in serum are not used currently for the diagnosis of cysticercosis in animals except for research purposes.

8. Improved diagnostic tools are needed in pigs, for ante- and/or post-mortem use. A serum bank is needed with well documented serum to study sensitivity, specificity, reproducibility of serological tests. Further improved diagnostics are needed to study environmental contamination and for the diagnosis of adult tapeworm infections.

### **Vaccines**

9. Recently, a commercial vaccine has been registered against porcine cysticercosis. Further studies are now required to investigate its uptake in local veterinary systems, market studies including willingness to pay, combination with other vaccines, duration of immunity, vaccination schedules, storage conditions, formulation (development of an oral vaccine) and cost-effectiveness assessments.

### **Pharmaceuticals**

10. Oxfendazole kills muscle cysts in pigs within 4 weeks of dosing. Drug residues in meat of treated pigs require the animals to be withheld from slaughter for 21 days. Use of oxfendazole in pigs to prevent human infections requires further studies similar as those for the vaccine: uptake in local veterinary systems, market studies, cost-effectiveness, formulation (feed-based vs. oral).

### **Knowledge**

11. Underdiagnosis and underreporting is a major gap. The real prevalence and incidence of taeniosis, cysticercosis (in particular neurocysticercosis) need to be assessed in different areas.

12. More needs to be known about transmission of infection and the relative importance of different routes of transmission: foodborne vs waterborne vs human autoinfection and the role of mechanical vectors (birds, dogs, coprophagic insects, ...). The role of environmental conditions on the distribution and infectivity of eggs needs also to be better quantified.

13. The pig can be more used as a model to better understand neurocysticercosis in humans in particular by studying the pathogenesis and immunological responses.

### **Conclusions**

14. Cysticercosis is of major importance in LMIC where it is a neglected zoonosis and where the neural form is grossly underdiagnosed. Control of the tapeworm in humans is important, but treatment is challenging due to the difficulty in finding the very few cases that exist. Improvements in sanitation, education and pig rearing practices in wealthy countries have seen cysticercosis disappear indicating that similar measures would be effective if they could be implemented in current endemic areas. However, these improvements have not been achieved sustainably to-date in any *T. solium* endemic region without simultaneous improvements in general living standards. Condemnation or thorough cooking of infected meat is important but in poor areas the presence of meat inspection is unlikely and the discarding of infected meat is very hard to achieve. Control of infection in pigs either by vaccination or pre slaughter treatment with a compound which kills the cysticerci is possible although their costs and application may be too high to enable implementation in developing countries. Increasing knowledge and awareness creation are essential for uptake and sustained control. Elimination of the disease is theoretically possible but requires an integrated One Health approach and utilizing two or more control options in both hosts of the parasite at a high frequency. Additional close monitoring and surveillance will be essential for maintenance of control/elimination.