

# CYSTINET

EUROPEAN NETWORK ON TAENIOSIS/CYSTICERCOSIS



## Conference

**May 28 2021**

Online  
University Ghent - Belgium



# PROGRAMME

## SESSION 1: 13h00

**WELCOME:** S. Gabriël

**KEYNOTE:** Dr. Meritxell Donadeu, consultant to WHO NTD, representing Dr. B. Abela Ridder: the WHO 2030 roadmap, implications for *Taenia solium*.

### ABSTRACT PRESENTATIONS:

1. **Validated non-local parametrization of an agent-based model to represent local-scale *Taenia solium* transmission in rural villages of an endemic area in northwest Peru.** Pizzitutti F., Bonnet G., Gonsales-Gustavson E., Gabriël S., Pan W.K., Pray I.W., Gonzalez A.E., Garcia H.H., O'Neal S.E., for the Cysticercosis Working Group in Peru.
2. **Amplification of cestode DNA in naturally infected foxes from peri-anal swabs by PCR and LAMP: Proof of concept for the potential diagnosis of human taeniosis.** Muchaamba G., Alvarez Rojas C.A, Deplazes P.
3. **Cross-sectional Study of Population Screening for Urinary Antigens to Detect Subarachnoid Neurocysticercosis in a Community Setting.** Fernandez L., Allen S.E., Vilchez P., Gamboa P., Muro C., Castillo Y., Dorny P., Bustos J., Garcia H.H., O'Neal S.E., for the Cysticercosis Working Group in Peru.

### PANEL Q&A

#### ABSTRACT PRESENTATIONS CONT.:

4. **A qualitative assessment of the context and enabling environment for the control of *Taenia solium* infections in endemic settings.** Ngwili N.M., Johnson N., Wahome R., Githigia S., Roesel K. and Thomas L.

#### SHORT ABSTRACT PRESENTATIONS:

- 1) **Exploring sources of false-positive urine cystAg screening results in a region endemic to *T. solium*.** Zagal E., Kramarz J., Beam M., Fernandez L., Vilchez P., Gamboa R., Muro C., Castillo Y., Garcia H.H., O'Neal S.E., for the Cysticercosis Working Group in Peru.
- 2) **Knowledge, attitude and practices of the of the community and meat workers towards *Taenia saginata* taeniosis and cysticercosis in Jimma and Ambo towns of Ethiopia.** Jorga E., Van Damme I., Mideksa B., Gabriël S.
- 3) **Evaluating One Health - the CYSTISTOP case study.** Cosaert M., Trevisan C., Mwape K.E., Dorny P., Gabriël S.
- 4) **CystiOne: A Prospective One Health Mixed-Methods Protocol to Identify Factors Related to *Taenia solium* in Northern Peru.** Wardle M., Atto R., Beam M., Beltran B., Bonnet G., Dumet L.M., Fernandez L., Gamboa R., Gonzales-Gustavson E., Kramarz J., Muro C., Pizzitutti F., Spencer A.G., Vilchez P., Zagal E., Gonzalez A.E., Garcia H.H., O'Neal S.E., for the Cysticercosis Working Group in Peru.

### PANEL Q&A

#### SHORT BREAK

## SESSION 2: 14h35

**KEYNOTE:** Dr. Lian Thomas (ILRI, Kenya): One Health Research, Outreach & Education Centre in Africa

### ABSTRACT PRESENTATIONS:

5. **Evaluation of an antibody detecting point of care test for diagnosis of *Taenia solium* cysticercosis in a Zambian rural community: A prospective diagnostic accuracy study.** Mubanga C., Van Damme I., Trevisan C., Schmidt V., Phiri I.K., Zulu G., Noh J., Handali S., Mambo R., Mwelwansofu C., Masuku M., Reynders D., Jansen F., Bottieau E., Magnussen P., Winkler A. S., Dorny P., Mwape K.E and Gabriel S. on behalf of the SOLID consortium
6. ***Taenia solium* infection in the Russian Federation in the last twenty years.** Bobić B., Ćirković V., Klun I., Štajner T., Sribljanović J., Bauman N., Lijeskić O., Djurković-Djaković O.
7. **Evaluation of an Antibody-Detecting Lateral-Flow-Assay for the Diagnosis of *Taenia solium* Neurocysticercosis in Rural Southern Tanzania — a diagnostic accuracy study.** Stelzle D., Schmidt V., Makasi C., Trevisan C., Van Damme I., Ruether C., Fleury A., Dorny P., Magnussen P., Zulu G., Mwape E., Bottieau E., Noh J., Handali S., Gabriel S., Ngowi B. J., Winkler A. S. on behalf of the SOLID consortium
8. **Evaluating the role of corrals and insects in the transmission of porcine cysticercosis: a cohort study.** Gonzales-Gustavson E., Pray I.W., Gamboa R., Muro C., Vilchez P., Flecker R.H., Garcia H. H., Gonzalez A.E., O'Neal S.E., for the Cysticercosis Working Group in Peru

### PANEL Q&A

#### ABSTRACT PRESENTATIONS CONT.:

9. **Preliminary assessment of the 'Game of the Worm' on knowledge uptake regarding *Taenia solium* in school going children in Belgium.** De Bock S., Gabriël S., Van Damme I., Mwape E., Dorny P., Trevisan C.

#### SHORT ABSTRACT PRESENTATIONS:

- 5) **Dose Response Model for Porcine Cysticercosis.** Andrade D., Gonzales-Gustavson E., Ho-Palma A., Prada J., Gomez L., Arroyo G., Garcia H.H., O'Neal S., Gonzalez A.
- 6) **Oral immunization with a Salmonella Enteritidis vaccine vector expressing Tsol18 peptide against porcine cysticercosis by *Taenia solium*.** Rimac R., Roller S., Gómez L., Vargas A., Fernández M., Gonzalez A.
- 7) **The epidemiology of bovine cysticercosis: preliminary findings of studies in Jimma and Ambo abattoirs of Ethiopia.** Jorga E., Van Damme I., Mideksa B., Gabriël S.
- 8) **Incidence of cysticercosis antigen excretion in the urine in a population endemic to *T. solium* in Northern Peru.** Kramarz J., Zagal E., Beam M., Fernandez L., Vilchez P., Gamboa R., Muro C., Castillo Y., Garcia H. H., O'Neal S.E., for the Cysticercosis Working Group in Peru.

### PANEL Q&A

#### SHORT BREAK

## SESSION 3: 16h15

### ABSTRACT PRESENTATIONS:

10. **CystiHuman: A Model of Human Neurocysticercosis.** Bonnet G., Pizzitutti F., Gonzales-Gustavson E., Gabriël S., Pan W. K., Bustos J. A., Garcia H. H., O'Neal S.E., for the Cysticercosis Working Group in Peru.
11. **Epidemiology of porcine and human cysticercosis (*Taenia solium*) in three states of north central Nigeria.** Weka R. P., Kamani J., Oche D., Eugene I., Cogan T., Eisler E., Morgan E.
12. **Implementing ring strategy, a cysticercosis control intervention, in Northern Peru. Phase 1: Formative Evaluation.** Spencer A., Dumet Poma L., Atto R., Cruz V., Vilchez P., Beltran B., Bustos J., Garcia H.H., Gimbel S., Garcia P.J., O'Neal S.E., for the Cysticercosis Working Group in Peru.
13. **Evaluation and validation of a field coproantigen enzyme-linked immunosorbent assay for *Taenia solium* taeniasis diagnosis in Northern Peru.** Wardle M., Castillo Y., Gamboa R., Rodriguez S., Gilman R.H., Gonzalez A.E., O'Neal S.E., Garcia H.H. for the Cysticercosis Working Group in Peru.

### PANEL Q&A

#### ABSTRACT PRESENTATIONS CONT.:

14. **GPS tracking of free-range pigs in rural communities in Zambia: an explorative study towards future ring treatment strategies for *Taenia solium*.** Van Damme I., Pray I., Mwape K.E., Trevisan C., F. Coudenys, V. Vaernewyck, Dorny P., O'Neal S.E. (2,5) and Gabriël S.

#### SHORT ABSTRACT PRESENTATIONS:

- 9) **Characteristics of People with Epilepsy and Neurocysticercosis in Three Eastern African Countries – a Pooled Analysis.** Stelzle D., Schmidt V., Keller L., Ngowi B.J., Matuja W., Escheu G., Hauke P., Ovuga E., Schmutzhard E., Amos A., Harrison W., Kaducu J., Winkler A.S.
- 10) **Development of Community-Based Health Education Package for the Control of *T. solium* taeniasis/cysticercosis in Tanzania.** Nyangi C., Mkupasi E.M., Mahonge C., Churi A.J., Schmidt V., Winkler A.S., Ngowi H.A.
- 11) **Efficacy evaluation of Newcastle disease virus as vaccine vectors for TSOL18 against porcine cysticercosis by *Taenia solium*.** Roller S., Rimaq R., Gómez L., Vargas A., Fernández M., Gonzalez A.
- 12) **Gaming 4 health – Serious games to control *Taenia solium* in endemic areas.** Trevisan C., Mwape K.E., Nöstlinger C., Dorny P., Valcke M., Gabriël S.
- 13) **The prevalence of *Taenia solium* taeniasis/cysticercosis in Chipata district of the Eastern province of Zambia.** Zulu G., Mwape K.E., Schmidt V., Stelzle D., Mubanga C., Sikasunge C.M., Phiri I. K., Winkler A.S.
- 14) **Application of Process Mapping to Understand the Steps Required to Implement a Control Program for Cysticercosis in Rural Peru.** Dumet L.M., Spencer A. G., Atto R., Vilchez P., Cruz V., Beltran B., Bustos J., Garcia H. H., Garcia P., O'Neal S.E., Gimbel S., for the Cysticercosis Working Group in Peru

### CLOSURE: 17h30-18h00

Voting for best abstract and best short abstract

Voting for best/funniest picture/selfie



# ABSTRACTS

## Keynote

### The WHO 2030 roadmap, implications for *Taenia solium*.

Dr. Meritxell Donadeu, consultant to WHO NTD, representing Dr. B. Abela Ridder (1)

- (1) Team leader for neglected zoonotic diseases, Department of Control of Neglected Tropical Diseases (NTDs), World Health Organization, 1211, Geneva, Switzerland.

## Validated non-local parametrization of an agent-based model to represent local-scale *Taenia solium* transmission in rural villages of an endemic area in northwest Peru.

**Pizzitutti F.** (1), Bonnet G. (1), Gonsales-Gustavson E. (2), Gabriël S. (3), Pan W.K. (4), Pray I.W. (5), Gonzalez A.E. (6), Garcia H.H. (7,8), O’Neal S. (5,7), for the Cysticercosis Working Group in Peru.

- (1) Independent consultant with OHSU university
- (2) Tropical and Highlands Veterinary Research Institute, Universidad Nacional Mayor de San Marcos, Peru
- (3) Department of Veterinary Public Health and Food Safety, Ghent University, Belgium
- (4) Nicholas School of Environment and Duke Global Health Institute, Duke University, USA
- (5) School of Public Health, Oregon Health & Science University and Portland State University, USA
- (6) School of Veterinary Medicine, Universidad Nacional Mayor de San Marcos, Peru
- (7) Center for Global Health Tumbes, Universidad Peruana Cayetano Heredia, Peru
- (8) Cysticercosis Unit, National Institute of Neurological Sciences, Peru

**Background:** *Taenia solium* is an important cause of epilepsy and economic loss in many rural areas of the world. Although there has been some progress in developing and testing interventions to control and eliminate transmission, optimal strategies are yet to be defined. Validated models that simulate transmission and interventions within regions may guide design and evaluation of the most effective strategies to control or eliminate *T. solium*. **Objective:** Our objective was to develop a new version of CystiAgents, an Agent Based Model of local-scale *T. solium* transmission, that does not rely on local calibration of every modeled village.

**Methods:** Based in MASON with in-house Java coding, the model covers relevant aspects of *T. solium* transmission, including processes of pig and human infection, spatial distribution of human and pig populations in several endemic villages in northwest Peru, pork production within villages for human consumption, and movement of humans and pigs in an out of simulated villages. We applied a new approach to model calibration, based on approximate Bayesian computation, in which model outputs are fit simultaneously to observed prevalences of human taeniasis and pig cysticercosis for several endemic villages.

**Results:** Despite large underlying variance associated with empirical measurement of *T. solium* epidemiological data, the calibrated model reproduces observed prevalences with acceptable precision, not only for empirical data of villages used to calibrate the model, but also for empirical data from villages not included in the calibration process.

**Conclusions:** The calibrated model can be successfully transferred to accurately simulate transmission in other villages within the same region. We plan to use CystiAgents with non-local calibrated model parametrization, as a universal tool to conduct in silico experiments to guide design and optimization of *T. solium* control and elimination interventions for northwest Peru.



## Amplification of cestode DNA in naturally infected foxes from peri-anal swabs by PCR and LAMP: Proof of concept for the potential diagnosis of human taeniosis.

Muchaamba G. (1), Alvarez Rojas C.A. (1), Deplazes P. (1)

(1) Institute of Parasitology, Vetsuisse and Medical Faculty, University of Zürich, 8057 Zürich, Switzerland

Diagnosis of taeniosis in humans is performed by coproscopy, PCR or copro-ELISA. The inherent limitation of these methods is the high turnaround time for stool sample collection during field surveys. Due to the large size and high reproductive potential of *Taenia* we hypothesise that parasite DNA/cells/eggs in the peri-anal region can be exploited as starting material for molecular diagnosis. We, therefore, evaluated the feasibility of recovering cestode DNA from the peri-anal region using cotton swabs in foxes naturally infected with *Taenia* species as a proof of concept for its use in the diagnosis of human taeniosis. A cotton swab was rubbed around the peri-anal region of foxes at necropsy, before performing sediment and counting technique (gold-standard) for parasite identification. DNA was isolated from the cotton swabs using either alkaline lysis+commercial kit (method A) or alkaline lysis with NaOH only (method B). DNA amplification was performed with multiplex PCR and LAMP detecting *Taenia* spp. and other large cestodes and *Echinococcus multilocularis*. Sensitivity for multiplex PCR for *Taenia* was 89.9% (95% CI: 77.8-96.7) and 89.5% (66.8-98.7) using methods A and B respectively. The specificity was 85.7% (57.2-98.2) and 100% (39.7-100) with methods A and B respectively. For LAMP the sensitivity was 83.7% (70.3-95.7) using method A and 89.5% (66.8-98.7) using method B; whilst the specificity was 78.6% (49.2- 95.3) and 100% (39.7-100) for methods A and B respectively. The results of this study show that DNA from large cestodes can be detected in the peri-anal region of foxes with high sensitivity. DNA extraction based on method A, which includes spin columns from commercial kits, produced similar results (in multiplex PCR and LAMP) to the cost-effective method B based only on NaOH treatment. We postulate that peri-anal swabs offer an alternative non-invasive sampling method for molecular surveillance of human taeniosis studies in resource-limited settings.

## Cross-sectional Study of Population Screening for Urinary Antigens to Detect Subarachnoid Neurocysticercosis in a Community Setting.

**Fernandez L.** (1), Allen S.E. (2), Vilchez P. (3), Gamboa P. (3), Muro C. (3), Castillo Y. (3), Dorny P. (4), Bustos J. (3), Garcia H.H. (3,5), O'Neal S.E. (1,3), for the Cysticercosis Working Group in Peru.

- (1) School of Public Health, Oregon Health & Science University and Portland State University, USA
- (2) School of Medicine, Oregon Health & Science University, USA
- (3) Center for Global Health Tumbes, Universidad Peruana Cayetano Heredia, Peru
- (4) Department of Biomedical Sciences, Institute of Tropical Medicine, Belgium
- (5) Cysticercosis Unit, National Institute of Neurological Sciences, Peru

**Background:** Subarachnoid neurocysticercosis (SANCC) is the most morbid form of *Taenia solium* infection. SANCC is diagnosed usually at late stages when treatment options are limited, and patients experience frequent adverse treatment complications due to advanced disease. We validated population screening to detect cysticercosis antigens (cyst-Ag) in urine to identify SANCC in earlier asymptomatic stages.

**Objective:** Our objective was to identify cases of SANCC in a population-based setting using a two-step screening process of urine based antigen tests followed by neuroimaging. **Methods:** We conducted a cross-sectional study in 2018 to screen for SANCC in residents of Tumbes, Peru, (n=8115). We collected first morning urine from participants at their homes and calculated optical density ratios (ODR) for cyst-Ag in these samples using ELISA and monoclonal antibody set B158/B60. We offered all participants with an ODR $\geq$ 3 a non-contrast MRI of the brain to identify intracranial *T. solium* cysts, and a clinical evaluation for neurologic symptoms consistent with neurocysticercosis (NCC).

**Results:** Of 8315 individuals screened, 81 (0.97%) had an ODR $\geq$ 3 and were offered MRI. Seventy-four obtained MRI and 17 had SANCC; 13 (76.4%) reported no symptoms. Another 7 had non-subarachnoid forms of viable NCC. Globally, the prevalence of SANCC was 2 per 1000 persons, but there were significant regional differences with higher prevalence of urinary cyst-Ag and SANCC in regions with greater immigration. In these regions, the positive predictive value (PPV) of the urine screen was 32.5% for SANCC and 42.0% for all NCC. **Conclusions:** Population urine screening in a *T. solium* endemic region identified cases of asymptomatic SANCC with an acceptable PPV. An ongoing observational cohort and planned clinical trial will help determine whether early medical intervention of asymptomatic SANCC is safe, and whether this approach merits further evaluation of efficacy to improve clinical prognosis.

## A qualitative assessment of the context and enabling environment for the control of *Taenia solium* infections in endemic settings.

Ngwili N.M. (1,2), Johnson N. (4), Wahome R. (2), Githigia S. (2), Roesel K. (1) and Thomas L.(1 and 3)

- (1) Animal and Human Health Program, International Livestock Research Institute, Nairobi, Kenya
- (2) College of Agriculture and Veterinary Sciences, University of Nairobi, Nairobi, Kenya
- (3) Institute of Infection, Veterinary and Ecological Sciences, University of Liverpool, Lea Hurst Campus, Neston, CH64 7TE, UK
- (4) CGIAR Research program on Agriculture for Nutrition and Health, IFPRI, Washington, DC

Background: *Taenia solium* (*T. solium*), is a zoonotic helminth causing three diseases namely: taeniasis (in humans), neurocysticercosis (NCC, in humans) and porcine cysticercosis (PCC, in pigs) and is one of the major foodborne diseases by burden. The success or failure of control options against this parasite in terms of reduced prevalence or incidence of the diseases may be attributed to the contextual factors which underpin the design, implementation, and evaluation of control programmes.

Methodology: The study used a mixed method approach combining systematic literature review (SLR) and key informant interviews (KII). The SLR focused on studies which implemented *T. solium* control programmes and was used to identify the contextual factors and enabling environment relevant to successful inception, planning and implementation of the interventions. KII were conducted with researchers/implementers of the studies included in the SLR.

Results: The SLR identified 41 publications that had considerations of the contextual factors. They were grouped into efficacy (10), effectiveness (28) and scale up or implementation (3) research studies. The identified contextual factors included epidemiological, socioeconomic, cultural, geographical and environmental, service and organizational, historical and financial factors.

Conclusions: Failure to consider the contextual factors operating in target study sites was shown to later present challenges in project implementation and evaluation that negatively affected expected outcomes. This study highlights the importance of fully considering the various domains of the context and integrating these explicitly into the plan for implementation and evaluation of control programmes. The contextual factors highlighted in this study may be useful to guide future research and scale up of disease control programmes and demonstrates the importance of close multi-sectoral collaboration in a One Health approach.

## Exploring sources of false-positive urine cystAg screening results in a region endemic to *T. solium*.

Zagal E. (1), Kramarz J. (1), Beam M. (2), Fernandez L. (1), Vilchez P. (3), Gamboa R. (3), Muro C. (3), Castillo Y. (3), Garcia H.H. (3,4), E. O'Neal S. (1,3), for the Cysticercosis Working Group in Peru.

- (1) Oregon Health & Science University / Portland State University School of Public Health, Portland, OR, United States
- (2) Oregon Health & Science University School of Medicine, Portland, OR, United States
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- (4) Cysticercosis Unit, National Institute of Neurological Sciences, Lima, Peru

**Introduction:** Cysticercosis is an infection by the metacestode stage of *Taenia solium*. When infection involves the central nervous system, the disease is called neurocysticercosis (NCC), and when cysts or cyst membranes invade subarachnoid spaces, it is called subarachnoid neurocysticercosis (SANCC), an aggressive form of the disease with poor prognosis. We are evaluating early detection and medical intervention for SANCC in a population screening approach by testing for high levels of cysticercosis antigen (cystAg) excreted in urine, using an ELISA with Peruvian monoclonal antibodies (TsW8/ TsW5). A positive urine screen result, however, requires magnetic resonance imaging (MRI) of the brain for definitive diagnosis of NCC, including SANCC. Approximately 75% of individuals with high levels of urinary cystAg do not have intracranial cysts detectable by MRI.

**Objective:** The objective of this study is to evaluate potential sources of high cystAg levels in absence of NCC. **Methods** In this descriptive cross-sectional study, we will enroll consecutively 30 individuals with high urine cystAg (optical density ratio $\geq$ 3) and no evidence of NCC on brain MRI, to investigate other potential sources of urine cystAg. Procedures include computed tomography (CT) without contrast of the head, chest, abdomen, and proximal limbs to evaluate for presence of *T. solium* cysticercosis of skeletal muscles, as well as other cestode infection (e.g. *Echinococcus* sp.) of lungs, liver, and abdomen. We will also examine the skin for subcutaneous cysts, and use Western Blot to evaluate for the presence of antibodies against other larval *Taenia* cestodes known to infect humans including *Echinococcus* sp. and *T. multiceps*.

**Results:** Recruitment is ongoing. We will report preliminary results including frequencies and proportions of relevant findings.

**Conclusions:** Characterizing reasons for false positive results is important for improving the performance of the assay and interpretation of its results.

## Knowledge, attitude and practices of the of the community and meat workers towards *Taenia saginata* taeniosis and cysticercosis in Jimma and Ambo towns of Ethiopia.

Jorga E. (1), Van Damme I. (2), Mideksa B. (1), Gabriël S. (2)

(1) Department of Veterinary Science, Ambo University, P.O. Box 19, Ambo, Ethiopia.

(2) Department of Veterinary Public Health, Laboratory of foodborne parasitic zoonoses, Ghent University, Salisburylaan 133, 9820 Merelbeke, Belgium

Background: *Taenia saginata* taeniosis and cysticercosis are prevalent in Ethiopia. Knowledge, attitude and practice (KAP) studies regarding taeniosis and cysticercosis are scarce in the country. Understanding the KAP to taeniosis/cysticercosis is an essential element for its control.

Method: A cross sectional KAP survey was performed on 293 randomly selected urban dwellers and 97 meat industry workers from Ambo and Jimma towns. Questionnaire evaluated the knowledge and attitudes to taeniosis/cysticercosis, plus raw meat eating, backyard slaughtering and latrine usage practices. Twenty-two KAP questions were scored. Result: The proportion of self-reported taeniosis was 49% for the community (52% Jimma and 46% Ambo) and 70% for meat workers (76% Jimma and 65% Ambo). The variables associated with community's self-reported taeniosis were age and gender, hence, for each one year increase in age the odds of self-reported taeniosis increased by 5% (OR=1.05, 95%CI, 1.03-1.07,  $p < 0.001$ ) and higher odds was observed in men (OR=1.81, 95%CI, 1.02-3.19,  $p = 0.041$ ) than women. For meat workers, age was the only related variable (OR=1.12, 95%CI, 1.03-1.22,  $p = 0.008$ ). The mean (+ SD) knowledge and attitude scores in the community were 8.5+2.1 (Jimma) and 7.2+2.8 (Ambo), and for meat workers 9.4+1.6 and 9.1+1.9, respectively. The mean good practice scores were 4.8+1.1 (Jimma) and 4.9+1.8 (Ambo) for community, and 5.3+0.9 respectively 5.4+1.5 for meat workers. Study area and ethnic group were variables associated with knowledge and attitude of community and meat worker, whereas gender, marital status, education level and self-reported taeniosis of community. Religion and educational status were related to good practice scores of the community and meat workers. Conclusion: Taeniosis is a well-known in Ethiopia and risky culinary habits, open defecation and poor meat inspection could contribute to the prevalence. Strengthening meat inspection and health education are suggested.

## Evaluating One Health - the CYSTISTOP case study.

**Cosaert M.** (1), Trevisan C. (2), Mwape K.E. (3), Dorny P. (2), Gabriël S. (1)

(1) Faculty of Veterinary Medicine, Ghent University, Belgium

(2) Institute of Tropical Medicine, Belgium

(3) School of Veterinary Medicine Dept. of Clinical Studies, University of Zambia, Zambia

**Background:** CYSTISTOP is a seven-year *Taenia solium* control study conducted in the Eastern Province of Zambia. For sustainable control, an integrated and multidisciplinary One Health (OH) approach that takes human, animal and environmental health into account should be implemented to reduce the risk of infection and transmission. The objective of the study was to evaluate the OH-ness of CYSTISTOP using the evaluation framework developed by the Network for Evaluation of One Health (NEOH).

**Materials and methods:** The NEOH framework consists of 4 elements, (1) The definition of the OH initiative and its context; (2) the description of its theory of change with an assessment of expected and unexpected outcomes; (3) the process evaluation of operational and supporting infrastructures; and (4) an assessment of the association(s) between the process evaluation and the outcomes produced. Data was collected through the analysis of the available literature on the CYSTISTOP project for elements 1 and 2. To assess element 2, the initiative's theory of change was used, where the initiative's building blocks, outcomes and long-term goals were identified. For element 3, a literature review and questionnaire targeting essential stakeholders were carried out according to the evaluation spreadsheet developed by the NEOH. Element 4 was assessed as a descriptive analysis through the comparison of the degree of OH-ness of the initiative obtained in element 3 and the achieved outcomes by the initiative itself.

**Results:** Results obtained for elements 1 and 2 indicate a high integration of disciplines within the theory of change. Analyses of elements 3 and 4 are ongoing and preliminary results will be presented. This evaluation will reveal the strengths and weaknesses of this project which can lead to improvement of future projects.

## CystiOne: A Prospective One Health Mixed-Methods Protocol to Identify Factors Related to *Taenia solium* in Northern Peru.

**Wardle M.** (1), Atto R. (2), Beam M. (1), Beltran B. (1), Bonnet G. (3), Dumet L.M. (1), Fernandez L. (1), Gamboa R. (2), Gonzales-Gustavson E. (4), Kramarz J. (1), Muro C. (2), Pizzitutti F. (3), Spencer A.G. (1), Vilchez P. (3), Zagal E. (1), Gonzalez A.E. (2,5), Garcia H.H. (3, 6, 7), O'Neal S.E. (1, 2) for the Cysticercosis Working Group in Peru (8)

- (1) Oregon Health & Science University - Portland State University School of Public Health, Portland, OR, United States
- (2) Center for Global Health Tumbes, Universidad Peruana Cayetano Heredia, Lima, Perú
- (3) Independent consultant, Oregon Health & Science University, Portland, OR, United States
- (4) Tropical and Highlands Veterinary Research Institute, Universidad Nacional Mayor de San Marcos, Lima, Perú
- (5) School of Veterinary Medicine, Universidad Nacional Mayor de San Marcos, Lima, Perú
- (6) Department of Microbiology, Universidad Peruana Cayetano Heredia, Lima, Perú
- (7) Cysticercosis Unit, National Institute of Neurosciences, Lima, Perú
- (8) Universidad Peruana Cayetano Heredia, Lima, Perú

**Background:** *Taenia solium*, a parasite with a two-host life cycle in humans and pigs, presents as a major public health, agricultural, and economic problem. Currently, there is limited community-level data collected comprehensively over the same time and place to assess disease transmission across human, animal, and environmental sectors, thus raising a need to use a One Health approach in study design.

**Objectives:** The CystiOne protocol is designed to assess spatiotemporal trends and social-behavioral factors of *T. solium* transmission across humans, pigs, and the environment. Protocol development is in its initial stages and we seek feedback to improve our theoretical framework and accompanying study designs.

**Materials and Methods:** Working as an interdisciplinary team, we will use a mixed-methods design over a 12-month period within a community of approximately 1,000 residents located in northern Peru. We will conduct a landscape analysis to map community resources, infrastructure, services, regulations, and policies relevant to *T. solium* transmission. We will also collect baseline household census data on demographic information and longitudinal data on human biomarkers (blood, stool, and urine samples) and neuroimaging (CT and MRI), pig biomarkers (blood samples) and necropsy, trade networks, and water and soil samples. In tandem, we will use interactive workshops followed by cross-sectional surveys, focus group discussions, key informant, and ethnographic interviews to capture historical movement, social norms, incentives, and practices related to pig raising, cooking, and consumption.

**Results:** We will present our current theoretical framework along with an overview of study designs.

**Conclusions:** CystiOne will provide insights into the complex systems of *T. solium* transmission within a community. Furthermore, these data will contribute towards validating the accuracy of agent-based models and informing future control strategies and implementation.

Keynote

## One Health Research, Outreach & Education Centre in Africa

Dr. Lian Thomas (1)

(1) University of Liverpool & International Livestock Research Institute Nairobi, Kenya



## Evaluation of an antibody detecting point of care test for diagnosis of *Taenia solium* cysticercosis in a Zambian rural community: A prospective diagnostic accuracy study.

**Mubanga C.** (1,2), Van Damme I. (2), Trevisan C. (3), Schmidt V. (4,5), Phiri I.K. (1), Zulu G. (1,6) Noh J. (7), Handali S. (7), Mambo R. (1,6), Mwelwansofu C. (1), Masuku M. (1), Reynders D. (8), Jansen F. (3), Bottieau E. (9), Magnussen P. (10), Winkler A.S. (4,5), Dorny P. (3), Mwape K.E. (1) and Gabriel S. (2)

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Human cysticercosis is *Taenia solium* infections of public health and economic importance. Neurocysticercosis, is associated with nearly a third of epileptic patients in endemic areas. Diagnosis and case management of *T. solium* infections is challenging because current tests cannot be used in endemic communities. They are expensive and require sophisticated equipment, infrastructure and trained manpower. Recently, a *T. solium* point of care (TS POC) test for simultaneous detection of the tapeworm (TS POC T) and cysticercosis (TS POC CC) in humans was developed at the Centre for Disease Control, Atlanta, USA. The objective of this study was to evaluate the diagnostic performance of the TS POC CC in a community set up. The study area was Mtandaza, Sinda district, Eastern Zambia. A sample of 1254 randomly selected participants were tested with the TS POC CC in a prospective community-based study. One hundred and seventy-seven participants (14%) tested positive with the TS POC CC and 1072 were negative. All positive and 20% negative participants were sampled for serum and stool. Samples were subjected to three reference tests each. Diagnostic accuracy was estimated by Bayesian analysis. Fourteen and 36 out of 255, and 43 out of 263 serum samples tested positive by the LLGP EITB, rT24H EITB and serum Ag ELISA, respectively. Sensitivity estimates were 35% (14-63%), 94% (91-98%) and 36% (15-67%) and specificity was 87% (83-90), 95% (91-98), and 87% (81-92%) for the TS POC CC, the rT24H EITB and the serum Ag ELISA, respectively (LLGP EITB was excluded from the main analysis due to faint test and control lines). Further refinement would be required with the test purpose being cysticercosis diagnosis. Diagnostic performance needs to be improved potentially by benchmarking antigen concentration in the strip against existing cysticercosis tests such as the LLGP and rT24H EITB rather than neurocysticercosis.

## **Taenia solium infection in the Russian Federation in the last twenty years.**

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**Background:** The Russian Federation (RF) is traditionally considered as endemic for this zoonosis. However, the epidemiological data on *T. solium* infection have not been reviewed in the past 20 years, when dynamic economical and societal changes occurred in the RF. **Objectives:** The aim of this systematic review was to analyse the status of *T. solium* infection in Russia in the 2000-2019 period.

**Materials and methods:** A literature search was conducted, which collected published articles, grey literature and official data on the epidemiology of *T. solium* taeniosis and cysticercosis in the RF published after 2000.

**Results:** From a total of 2021 articles and 24 official reports originally returned by the search, data were extracted from 13 full text articles and 11 official reports. *T. solium* taeniosis was continuously reported in the RF between 2000 and 2019, with a 10-fold decrease in the incidence, from 0.2 per 100,000 population in 2000 to 0.023 / 100,000 in 2019. Also, the number of administrative units where taeniosis was detected continuously decreased. Distribution of teniosis in time and space negatively correlated with the GDP per capita. Human cysticercosis is infrequent. Cysticercosis in pigs had a declining trend after 2006. **Conclusion:** In conclusion, although decreasing, *T. solium* infection is still endemic in several regions and suspected to be endemic in most of the RF.

## Evaluation of an Antibody-Detecting Lateral-Flow-Assay for the Diagnosis of *Taenia solium* Neurocysticercosis in Rural Southern Tanzania — a diagnostic accuracy study.

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**Background:** Neurocysticercosis (NCC) is a common cause of epilepsy in sub-Saharan Africa, yet often not diagnosed because of lack of affordable point-of-care tests.

**Objectives:** The aim of this study was to evaluate the diagnostic accuracy of *T. solium* taeniasis and cysticercosis antibody-detecting lateral flow assay (rES33/rT24H-LFA) to support the diagnosis of NCC in resource-poor areas in rural southern Tanzania. Accuracy was evaluated for patients with symptoms associated with NCC and for patients with other symptoms. **Methods:** Patients were recruited from mental health clinics (patient with epilepsy or severe progressive headache) and outpatient departments in three district hospitals in southern Tanzania (Ifisi, Tukuyu, Vwawa). All patients were tested with a double-stripe rES33/rT24H-LFA test. If the rT24H-LFA strip was positive, the patients received a cerebral CT scan. Every 10th negative patient recruited from mental health clinics underwent CT scanning, too. **Results:** Overall, 146 patients received a CT scan of which 107 were recruited through mental health clinics and 39 through the outpatient department. From mental health clinics, 44/63 (70%) rT24H-LFA strip positive patients had NCC-typical findings in their CT scan of which 28 were in active or mixed stage. Among the 44 rT24H-LFA strip negative patients, 8 (18%) had NCC-typical findings of which all were in inactive stage. Negative predictive value for the rule out of active/mixed stage NCC-typical lesions was 100% (95%CI: 94 to 100%). Positive predictive value was highest for patients with epilepsy and any type of NCC-typical lesion (77%, 95%CI 64 to 87%).

**Conclusions:** The *T. solium* cysticercosis antibody-detecting rT24H-LFA strip showed excellent performance for the rule-out of NCC lesions that may require anthelmintic therapy but also showed weaknesses in the accuracy of NCC diagnosis. Therefore, further optimization steps of this prototype are needed.

## Evaluating the role of corrals and insects in the transmission of porcine cysticercosis: a cohort study.

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**Background:** The widespread dispersion across endemic villages of pigs infected with cysticercosis, the low average cyst burden among infected pigs, and the low prevalence of taeniasis, all suggest that direct pig ingestion of human feces is not the only mode of transmission for *Taenia solium*. Alternate mechanisms of egg dispersal away human fecal depositions are likely to play an important role in transmission. Insects are known to transmit many cestode parasites.

**Objective:** Our objective was to evaluate the risk of porcine cysticercosis associated with exposure to human feces and to insects in an endemic community setting.

**Materials and Methods:** We used a cluster-randomized cohort design to compare the risk of developing antibodies and infection among 120 seronegative piglets raised in either free-roaming (FR; exposed to human feces and insects), standard corral (SC; protected from human feces, exposed to insects), or netted corral environments (NC; protected from human feces and flying insects). We processed monthly blood samples by LLGP-EITB to detect antibodies and necropsied all pigs after 10 months to identify cysts.

**Results:** 64 piglets developed antibodies for a seroincidence (95% CI) of 0.07 (0.04–0.11), 0.08 (0.05–0.13) and 0.15 (0.11–0.22) cases per pig-month in NC, SC, and FR groups, respectively. The relative risk of seropositivity in FR vs. corralled pigs was similar in the first 2 months, then increased to 5.3x (3-6 months) and 8.7x (6+ months). Of 108 pigs necropsied, 15 had *T. solium* cysts (range 1-2387 cysts), all belonging to the FR group.

**Conclusions:** Corrals were protective against infection but less so against seropositivity. Netted corrals, which did not completely exclude insects, did not provide added protection against seropositivity versus standard corrals. Results suggest that flying insects do not play an important role in infection. Alternate routes, such as egg persistence in soil, water, or feed should be explored.

## Preliminary assessment of the ‘Game of the Worm’ on knowledge uptake regarding *Taenia solium* in school going children in Belgium.

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Background: *Taenia solium* is a foodborne parasite associated with significant socio-economic and public health impacts, thereby affecting millions of impoverished people in endemic areas. Since lack of knowledge is a recognized risk factor for the transmission of *T. solium*, health education is a crucial element in prevention and control.

Objectives: This study aimed at developing specific measurement instruments for knowledge uptake, and at providing preliminary results on the acceptability and efficacy of the life-size board game ‘Game of the Worm’ to educate children on prevention strategies related to *T. solium* infections.

Methods: An outlay game was developed to measure knowledge levels pre- and post-gameplay. ‘Game of the Worm’ workshops were conducted in two primary schools and one youth movement in Belgium. In total, 74 children aged eight to ten years were included in the study. Each workshop consisted of a brief introductory session, a pre-assessment test, the gameplay and a post-assessment test. Finally, questionnaires and focus group discussions were administered to assess the children’s attitude towards the game.

Results: Overall, the game was perceived positively by the children, who suggested an expansion of the game by the inclusion of more tasks. While no significant improvement in knowledge regarding disease prevention was observed in the short-term after gameplay using the outlay game, the focus group discussions did highlight a good uptake of the preventive measures by the pupils. This indicates that the outlay game was ineffective at assessing knowledge uptake.

Conclusion: This study demonstrates that the ‘Game of the Worm’ could be a promising educational tool for primary school pupils, although improvements of the game and knowledge assessment tool are necessary, as well as short-term and long-term impact assessments of the modified materials in an endemic school setting.

## Dose Response Model for Porcine Cysticercosis.

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**Background:** Several experimental infections have been developed in recent years to understand the transmission of *Taenia solium*. However, some transmission parameters such as the probability of human-to-pig infection had not yet been described; therefore, mathematical models must evaluate the dynamics of transmission with great uncertainty. **Objective:** In this study, data from experimental infections with *T. solium* eggs developed in pigs through different methods were evaluated to determine the relationship with the probability to develop cysts.

**Materials and methods:** Pigs were infected, in different doses; with proglottids, eggs, beetles that ingested eggs and activated oncospheres inoculated to the carotid artery. The numbers of viable and degenerated cysts in the body and in the brain were registered for each pig. With this data, five kinds of dose-response models (exponential, logistic, log-logistic, exact, and approximate beta-Poisson) were evaluated to describe the probability of cyst as a function of the inoculated dose of eggs. Also, dose-response models were elaborated separately for the development of three types of cyst (any, viable, and brain's cysts) including the routes of inoculation used (Proglottids, Eggs, Beetles and Carotid).

**Results:** The exact beta-Poisson was the model that best fitted the data for the three types of cyst and for the four routes of inoculation evaluated. Additionally, the Proglottids, Eggs, and Beetles pathways presented similar dose-response relationship at the three types of cyst development; and were merged into a unique route of exposure named Oral which could represents the wild-type infection. Finally, the exact beta-Poisson model also shows a good fit with Carotid pathway demonstrating that is the best route to get viable cysts on the pig brains.

**Conclusion:** The parameters described in this manuscript would help further experimental infections and mathematical models to evaluate the dynamics of transmission for *T. solium*.

## Oral immunization with a *Salmonella* Enteritidis vaccine vector expressing Tsol18 peptide against porcine cysticercosis by *Taenia solium*.

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**Background:** Cysticercosis by *Taenia solium* has a negative impact in human health and economy in non-developed countries. As pigs are the intermediate host, their vaccination is an alternative for interrupting the parasite's life cycle. For this reason, the use of bacterial vector like *Salmonella* is an attractive idea for developing vaccines due to its capability of stimulating the mucosal and systemic immune system, as well as the route of entry of *T. solium* into the pigs.

**Objectives:** The aim was to evaluate the efficacy of *Salmonella* Enteritidis vaccine vector expressing Tsol18 peptide against porcine cysticercosis in experimentally challenged pigs.

**Materials and**

**Methods:** Sixteen pigs were equally divided into 2 groups. Pigs of the experimental group were orally immunized three times with 1ml of  $3 \times 10^8$  ufc/ml, whilst the control group received physiological serum. The animals were orally inoculated with two *T. solium* gravid proglottids fifteen days after the last immunization. After three months, pigs were euthanized and necropsied in order to evaluate the presence of viable cysts in muscle.

**Results:** Necropsies revealed that viable cysts were present in four pigs (4/8) of the experimental group and six pigs (6/8) of the control group. However, no significant difference was found in the median number of viable cysts in the experimental group (median=2.5, range=0-1219) and the control group (median=19, range=0-901) ( $p=0.58$ ).

**Conclusion:** *Salmonella* Enteritidis strain as a vector for delivering the Tsol18 peptide is not effective against porcine cysticercosis.

## The epidemiology of bovine cysticercosis: preliminary findings of studies in Jimma and Ambo abattoirs of Ethiopia.

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**Background:** Bovine cysticercosis, an infection of bovine musculature with cysticerci of *Taenia saginata*, is responsible for considerable economic losses in the meat sector worldwide. The meat inspection-based prevalence reports in Ethiopia might be an underestimation, since routine meat inspection has <15% sensitivity. The use of alternative diagnostic methods such as detailed meat inspection and molecular confirmation could improve estimation of the prevalence.

**Methods:** Complete dissection of predilection sites (heart, tongue, masseter muscles, esophagus and diaphragm) was performed on 808 cattle carcasses slaughtered at Jimma and Ambo Abattoirs of Ethiopia. The available routine meat inspection records were collected from the inspectors in charge. Cysticerci suspected lesions were confirmed using multiplex PCR.

**Result:** The complete dissection of predilection sites identified cysticerci suspected lesions in 158 (19.6%) carcasses. Routine meat inspection based on incision of triceps muscle only identified 10 cases out of 599 carcasses with available routine meat inspection results. Cysticerci suspected lesions were found in 11.6% of tongues, 8.8% hearts, 2.9% masseter muscles, 1.3% diaphragms and 0.8% esophagus. Out of 318 detected lesions during the complete dissection of the predilection sites, 169 (53.2%) were degenerated, 81 (25.5%) were viable, and 67 (21.1%) were calcified. Multiplex PCR confirmed cysts from 121 out of 151 carcasses with available PCR results as *T. saginata* cysticerci.

**Conclusion:** Complete dissection of predilection sites has improved the detection rate of cysticerci as compared to routine meat inspection. Multiplex PCR confirmed most of the suspected lesions. Therefore, future studies covering abattoirs in the different areas of the country using more sensitive diagnostic methods are suggested to increase the knowledge about the epidemiology of bovine cysticercosis infections in Ethiopia.



## Incidence of cysticercosis antigen excretion in the urine in a population endemic to *T. solium* in Northern Peru.

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**Introduction:** *Taenia solium* is a zoonotic cestode with a transmission cycle involving pigs as an intermediate host and humans as a definitive host. Infection of the human brain, neurocysticercosis (NCC), is a leading cause of epilepsy and other neurologic disease across many regions of Latin America, Africa, and Asia. NCC occurs when people ingest *T. solium* eggs passed in the feces of a human with an intestinal tapeworm. Although there have been many cross-sectional studies describing the prevalence of exposure and infection in human and pigs, few studies have described the incidence of exposure to *T. solium* eggs among humans in an endemic community setting.

**Objective:** The objective of this study is to evaluate the cumulative incidence of cysticercosis antigen (cystAg) excretion in urine, a marker for prior exposure to *T. solium* eggs, and one indicator of the overall level of transmission in the community.

**Materials and Methods:** As part of a large cross-sectional study to validate population urine screening for NCC, we collected 4017 urine samples in several rural villages in Piura, Peru, in March 2020. Days later, Peru entered national lockdown due to COVID-19 restrictions, forcing us to return 9 months later to recollect these samples for their original screening purposes. Both sample sets were stored frozen at -20C, including paired sets from 3759 participants sampled at both time points. We are currently processing these paired urine sets by ELISA, using Peruvian monoclonal antibodies (TsW8/TsW5), to evaluate for the presence of cystAg. Results are characterized as strong positive (Optical density ratio (ODR)  $\geq 3$ ), weak positive (ODR  $\geq 1$  &  $< 3$ ), and negative (ODR  $< 1$ ). **Results:** We will report the cumulative incidence of conversion of results between categories, as well as risk factors for both conversion and persistence of positive results.

**Conclusions:** We will discuss the implications of our results for public health control and prevention.

## CystiHuman: A Model of Human Neurocysticercosis.

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**Background:** Cysticercosis is a neglected tropical disease that was deemed “eradicable” by the World Health Organization. Neurocysticercosis (NCC) is a major cause of epilepsy in developing countries, also causes intracranial hypertension and hydrocephalus, and can lead to death. Simulation models can help identify interventions likely to bring higher benefit to cost ratios before they are implemented at a large scale and high cost.

**Objectives:** CystiHuman, the first human NCC model, was developed to allow for cost-effectiveness analyses that focus on the actual impact of the disease rather than using proxies as is the case with transmission models. It also allows the comparison of a broader range of interventions (e.g., treatment of NCC symptoms) than usual models. **Materials and methods:** CystiHuman is an agent-based model that projects NCC and associated pathologies. It uses the output of another model, CystiAgent, which projects the evolution of pig cysticercosis and human taeniasis. It includes a model of human cyst stage and location, and of symptom and treatment likelihood. CystiHuman accounts for delays in the appearance of human symptoms to help make time-dependent predictions of changes in the human disease.

**Results:** CystiHuman was used so far to model the situation at baseline in three endemic villages in Peru. It gives reasonable results for the disease and its clinical presentation, and reproduces patterns of increase in NCC prevalence with age. Initial simulations suggest that NCC prevalence increases rapidly after a peak in taeniasis but decreases very slowly after this peak has passed.

**Conclusion:** It is possible to develop and calibrate a model of human NCC and obtain reasonable results. Initial outcomes suggest that short-term interventions may not be well suited to achieve significant changes in human NCC. Further work is needed to validate the model and develop projections of the economic and health benefits/costs of different interventions.

## Epidemiology of porcine and human cysticercosis (*Taenia solium*) in three states of north central Nigeria.

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*Taenia solium* is a pig tapeworm that causes cysticercosis in pigs and neuro-cysticercosis in humans; it is a parasitic zoonosis that is becoming increasingly important globally and is typically associated with poor marginalized people in low-income countries. The study aimed to determine the epidemiology of *T. solium* cysticercosis in pigs and humans with commercial antibody-detecting enzyme-linked immune-assays (ELISAs) using crude antigen and electro-immuno-transfer blot (EITB) in order to elucidate significant risk factors associated with infection. A cross sectional survey was carried out in three pig producing states of north central Nigeria, from March 2012 to November 2013. Blood samples from 556 pigs and 1266 humans were serologically screened for evidence of *T. solium* infection. Questionnaires on pig management, human behavior and socio-demographic factors were completed to provide information on risk factors for infection. Of the 556 serum samples screened by crude antigen, 51 (9.2 %) of pigs were seropositive to porcine cysticercosis. The result showed a significant relationship between seroprevalence of porcine cysticercosis and month of sampling (April and October) and age group of pigs (5-8 months). Serum from 47 of the ELISA-positive pigs was tested by EITB, of which 4 (8.5%) showed the presence of a band of 6 kDa, indicating active cysticercosis. However, none of the 1266 human serum samples screened for *T. solium* antibodies using crude antigen was seropositive for cysticercosis; similarly, none of the 24 borderline samples screened by EITB was positive, therefore no case of active cysticercosis was identified in the sampled humans. The results of this study indicate that active transmission of porcine cysticercosis is present in the study area; however, human infection was not observed. Larger studies should be carried out to underpin holistic control strategies to reduce economic loss to the farmers and the risk of zoonotic disease.

## Implementing ring strategy, a cysticercosis control intervention, in Northern Peru. Phase 1: Formative Evaluation.

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**Background:** Ring strategy is an evidence-based intervention to control cysticercosis that targets taeniasis treatment to people living within 100 meters of an infected pig. In a randomized controlled trial, ring strategy achieved comparable reduction in cysticercosis incidence as mass drug administration, while requiring only a fraction of the drug. However, substantial questions remain about how ring strategy can be adopted as a public health program.

**Objectives:** We are working with the health system in rural Northern Peru to implement ring strategy as a government-run program. Successful implementation requires ongoing community surveillance for pig infections and an efficient health system response to deliver niclosamide to community members. This five-year study has three phases: formative evaluation with the health system, pilot study of a government-run and community-engaged ring intervention, and a district-level implementation trial.

**Methods:** We are currently in phase one, conducting interviews with health system staff to develop the optimal processes and protocols for implementation. Using a social network analysis approach, we are mapping organizational networks to identify the key stakeholders responsible for implementing ring strategy and new linkages that need to be created among animal and human health departments. We are creating network visualizations and calculating network centrality and cohesion. We are conducting semi-structured interviews, based on the Consolidated Framework for Implementation Research, and conducting qualitative content analysis to understand participants’ views of organizational barriers and facilitators to implement ring strategy.

**Results:** This presentation will report on phase one preliminary findings and describe the overall implementation strategy.

**Conclusion:** This work contributes to the development of the necessary tools and evidence base required to establish guidelines and promote adoption and scaling of control programs.

## Evaluation and validation of a field coproantigen enzyme-linked immunosorbent assay for *Taenia solium* taeniasis diagnosis in Northern Peru.

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**Background:** Neurocysticercosis (NCC), a major cause of epilepsy, is acquired by ingesting *Taenia solium* eggs passed in the feces of people infected with the adult intestinal tapeworm (taeniasis). The standard coproantigen (coAg)-ELISA has high sensitivity and specificity for diagnosis of taeniasis, which is frequently asymptomatic. However, access is limited by the need for expensive laboratory equipment and reagents.

**Objectives:** To address this barrier, we compared the performance of a novel field coAg-ELISA to the standard and validated it during fieldwork.

**Materials and Methods:** From a repository in Peru, we selected known positive and negative stool samples to verify consistency of optical density ratios (ODR) of the field coAg-ELISA and to calibrate a color chart. Reliability of the color chart was assessed by agreement between two independent readers and a spectrophotometer. During fieldwork, we collected stool samples prospectively to measure agreement between tests. Our analysis included Pearson's correlation test, Kappa statistic, sensitivity, specificity, positive predictive value, and negative predictive value.

**Results:** Among the repository stool samples, there was a high correlation between the ODR values of the field coAg-ELISA and standard ( $r = 0.97$ ), the color chart categorization between two readers ( $r = 0.99$ ) and between each reader and the spectrophotometer ( $r = 0.99$  and  $r = 0.99$ ). Among stool samples collected during fieldwork, the agreement between tests was 97% ( $\kappa = 0.69$ ). When examining performance at a diagnostic threshold of  $ODR \geq 40$ , the field test demonstrated 100% sensitivity, 98% specificity, 51% positive predictive value, 100% negative predictive value, and 98% agreement ( $\kappa = 0.67$ ,  $p < 0.001$ ).

**Conclusions:** The field coAg-ELISA is an excellent option for diagnosis of taeniasis in regions without advanced laboratory infrastructure. Further validation of the test in other endemic regions is necessary.

## GPS tracking of free-range pigs in rural communities in Zambia: an explorative study towards future ring treatment strategies for *Taenia solium*.

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**Background:** Although elimination of *T. solium* is achievable using mass drug administration programmes, more sustainable strategies to control the disease are urgently needed. As such, 100-m ring treatments have been shown effective in Peru, though results might not be directly generalizable to sub-Saharan settings. Pig movements play a vital role in the transmission and consequently the success of ring treatment programmes towards *T. solium*. **Objectives:** Our study aimed to explore roaming patterns of pigs in *T. solium* endemic communities in Zambia, particularly focusing on the time spent and the number of recurrences outside different circles around the pigs' household.

**Material and methods:** Global Positioning System (GPS) technology was used to track 48 free roaming pigs in two rural neighbourhoods in Eastern Province of Zambia. Tracking of pigs took place during April 2019 (end of the rainy season) and October 2019 (end of the dry season). The number of revisitations and the time spent outside a ring around the household of the pig were calculated for circles of different radii (50m, 100m, and 250m) around the coordinate of the pigs' household.

**Results:** The tracking time of 43 pigs in the final analysis set ranged between 44 and 95 hours. Pigs spent a median of 13% of the tracked time outside the 100-m radius, ranging between pigs from 0% to 91%. The median number of visits per day outside this ring was 6. Overall, 25 pigs (58%) went at least once outside the 250-m ring. The odds of traveling outside the 250-m radius was estimated to be 4 (95% CI 1-16) times higher in the dry season compared to the rainy season.

**Conclusion:** The vast majority of pigs spent most of their time within a 100-m circle around their household, supporting the use of 100-m ring treatments. Nevertheless, further studies are required to investigate the importance of the time spent outside the 100-m ring, as well as the open defecation behaviour of people.

## Characteristics of People with Epilepsy and Neurocysticercosis in Three Eastern African Countries – a Pooled Analysis.

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**Background:** Epilepsy is a common neurological disorder, especially in sub-Saharan Africa, yet its treatment gap is large in some areas. Neurocysticercosis (NCC) represents one of the most common causes of secondary epilepsy but remains often undiagnosed due to lack of awareness and diagnostic facilities.

**Objectives:** The aim of this analysis was to report NCC prevalence and clinical characteristics among people with epilepsy (PWE).

**Methodology:** We pooled data from four cross-sectional studies on epilepsy and NCC in eastern Africa. Study sites were in Uganda, Malawi and Tanzania (Dar-es-Salaam and Haydom). The study in Uganda and Malawi were community-based, the two studies in Tanzania were hospital-based. The same questionnaire was used for assessment of clinical characteristics of patients with epilepsy. Computed tomography (CT) scans and serological testing were performed in order to diagnose NCC.

**Results:** Overall, 1005 patients with epilepsy were included in our analysis. Of those, 941 PWE underwent CT scanning and hence were pooled for NCC analysis. Seventy patients were diagnosed with NCC, but NCC prevalence differed considerably between sites ranging from 2.0% (95%CI 0.4% to 3.6%) in Dar es Salaam to 17.5% (95%CI 12.4 to 22.6%) in Haydom. NCC prevalence was higher among males, increased with age, and was higher in rural than urban settings. PWE with NCC more commonly had focal signs at neurological examination (16.7% versus 7.1%) and experienced the first epileptic seizure around 4 years later in life compared to PWE without NCC.

**Conclusions:** NCC is common among PWE in eastern Africa, although it may not be as common as previously stated. Clinical characteristics of PWE with NCC differ from those without NCC and may be used as supportive indicators for a diagnosis of NCC in the absence of neuroimaging.

## Development of Community-Based Health Education Package for the Control of *T. solium* taeniasis/cysticercosis in Tanzania.

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**Background:** Current *Taenia solium* cysticercosis/taeniasis (TSCT) control relies, among others, on proper pig management, sanitation/hygiene, and meat inspection. However, these control methods so far failed to eliminate the parasite. Health education package developed and implemented with full community participation could contribute to effective control of TSCT. The present study, therefore, was conducted to develop a community-based health education package aimed at control of TSCT in endemic areas in Tanzania.

**Methods:** To identify potential TSCT infection risks and formulate key messages for the health education package development, a formative research method was used. Data were collected using a questionnaire and household infrastructure observation. For triangulation purposes, 12 focus group discussions and 38 key informant interviews were conducted and analysed using ATLAS.ti 8. Data from the questionnaire survey were analysed using SPSS.

**Results:** The general knowledge of transmission, health effects, prevention, and treatment of TSCT was poor across the study areas. Significant risk practices for TSCT transmission included drinking untreated water, free-range pig management, not washing hands with water and soap after visiting toilets and before eating, and undercooking of pork. A community-based education package was developed that comprised of the following four components, a training manual for training of trainers, leaflet, poster, and handbook containing illustrations.

**Conclusions:** This study aimed at developing a community-driven ready to use HEP for control of TSCT using key messages formulated from the potential infection risks as assessed through community engagement. The approach used in this study can be adapted in other countries where TSCT is endemic for and with similar health challenges.



## Efficacy evaluation of Newcastle disease virus as vaccine vectors for TSOL18 against porcine cysticercosis by *Taenia solium*.

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**Background:** Cysticercosis is caused by larval stage of *Taenia solium*. The consumption of poorly cooked pork causes taeniasis in human and accidental ingestion of eggs by fecal-oral route produce neurocysticercosis. Thus, vaccination of pigs is an alternative to prevent the transmission of *T. solium*. Viral-vector vaccines like Newcastle disease virus had employed for delivering Tsol18 peptide resulting in antibody production in pig immunized, however, there is not information about their efficacy in animal challenge studies.

**Objectives:** The objective was to evaluate the efficacy of Newcastle disease virus as vaccine vectors for TSOL18 peptide in experimentally challenged pigs.

**Materials and Methods:** For this, pigs (n=16) two months-old were divided in two groups. Animals were vaccinated with  $1.6 \times 10^9$  pfu/ml at the same time by intranasal and intramuscular routes and then twice only by intranasal route each two weeks interval between doses. Each animal was challenged orally two weeks after the last vaccination with one *T. solium* gravid proglottid.

**Results:** One animal of the experimental group died from unknown reasons. In addition, five animals of each group developed viable cysts. No significant difference between the experimental (median=24, range=0-5383) and control (median=3, range=0-3568) groups was found.

**Conclusion:** Our results not found statistical difference between the experimental and control groups, which means that the vaccine did not provide protection against the disease.

## Gaming 4 health – Serious games to control *Taenia solium* in endemic areas.

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**Background:** Lack of knowledge and awareness are recognised risk factors for *Taenia solium* infection and transmission. Health education should thus form a core component of control efforts, to sustain externally imposed control strategies such as human and pig treatments.

**Objectives:** In the project 'Gaming4Health', the overall objective is to test the use of serious games – a board game and a digital game - to prevent and control foodborne diseases and assess the potential of children being active agents of change.

**Materials and Methods:** The pork tapeworm will be used as a model to evaluate game play in view of knowledge uptake and behaviour change in school going children and their households in a highly endemic area in Zambia. Within the project two serious games are developed and evaluated to educate school going children within their surrounding communities about *T. solium* cysticercosis and how to prevent it. Building on the theory of gamified learning, the digital and board game currently under development through a multidisciplinary team, will be assessed for knowledge uptake and behaviour change in children. Gaming impact will be measured and evaluated via a mixed methods approach in primary school children in Zambia, where the parasite is highly endemic. Knowledge transfer and behaviour change will also be assessed at household level linking the children to their families and surrounding community and correlated to parasite presence in pigs.

**Results:** The project officially started in November 2020. Currently, the digital game is under development and the boardgame is being optimized based on a preliminary study conducted in Belgium and a preliminary assessment in Zambia.

**Conclusions:** Based on the study results, recommendations will be formulated and disseminated at national and international levels to advance the control of the pork tapeworm as part of the WHO 2030 goals for priority Neglected Tropical Diseases.

## The prevalence of *Taenia solium* taeniasis/cysticercosis in Chipata district of the Eastern province of Zambia.

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**Background:** *Taenia solium* taeniasis/cysticercosis is a neglected zoonotic parasitic disease complex occurring in many developing countries with significant economic and public health impacts. Neurocysticercosis (NCC) is estimated to be responsible for 30% of acquired epilepsy cases in endemic areas. An accurate estimate of the prevalence of NCC among people with cysticercosis in Zambia is not well known. A recent pilot study reported the prevalence of NCC among people with epilepsy to be over 50%. The primary objective is to determine the prevalence of cysticercosis and taeniasis in the study area and characterize the clinical signs and symptoms of NCC among cysticercosis positive individuals. This abstract report preliminary findings of the study.

**Methods:** A community based, cross sectional study with a sample size of 6668 participants is currently being conducted in Chipata and Gwembe districts of Eastern and Southern provinces of Zambia respectively. Proportional household sampling was conducted to include participants aged 10 years and above living in a free-range pig rearing community. Blood samples were obtained for serological tests; stool samples for coproantigen ELISA as well as microscopy to examine the presence of *T. solium* eggs. Cysticercosis positive participants will be followed up for neurological examinations and CT scanning to ascertain their neurocysticercosis status.

**Results:** Preliminary results from Chipata district have shown a taeniasis prevalence of 10.1% from 2389 stool samples examined by coproantigen ELISA and 0.4% from the 2865 stool samples examined by microscopy. Serology results for 2873 samples examined showed that 3.7% and 5.9% of the participants were positive for cysticercosis based on serum antigen ELISA and EITB respectively.

**Conclusion:** The findings indicate that taeniasis and cysticercosis are prevalent in Chipata district and therefore urgent interventions by policymakers are required to ensure control programs are in place.

## Application of Process Mapping to Understand the Steps Required to Implement a Control Program for Cysticercosis in Rural Peru.

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**Background:** Ring treatment is a strategy to control cysticercosis that is efficacious when delivered by research teams. We are using implementation science tools to transfer ring treatment to the public health system in Northern Peru. Process mapping is a system engineering and quality improvement tool used in health care settings to break down complex processes into sequenced steps, identify efficiencies, and streamline work.

**Objective:** Our objective was to develop process maps to facilitate the early stages of ring treatment implementation.

**Materials and Methods:** The Systems Analysis and Improvement Approach guided our process mapping activities. We collected examples of existing protocols and procedures documents that have been applied in other infectious diseases in Peru and designed a prototype for community control of cysticercosis. We are conducting interviews and walk-through exercises with health system staff to detail each step of ring treatment, from community case identification and verification of *T. solium* infection to the presumptive treatment of community members with niclosamide in 100-meter ‘rings’, and follow-up. We use Visio software to display our final process maps.

**Results:** We will present the steps to develop a process map in collaboration with stakeholders from the health system and provide recommendations for training staff and conducting fieldwork to build the process map flow chart. We will include examples of completed process maps in the poster. It will serve as a guide for applying process mapping when the processes are not well standardized but need to be established in low-resource settings.

**Conclusions:** Quality improvement tools, such as process mapping, can be applied in health care and community health settings with low resources to implement and scale up evidence-based interventions, conserve resources, and establish sustainable control strategies.