Assembling a framework for intensified control of taeniasis and neurocysticercosis caused by *Taenia solium*

Report of an informal consultation

WHO Headquarters, Geneva, 17-18 July 2014

World Health Organization

In collaboration with

Food and Agriculture Organization of the United Nations

World Organisation for Animal Health

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This report is available in electronic format on http://www.who.int/taeniasis/en/

Acronyms and abbreviations

Ag-ELISA	Antigen ELISA
CC/NCC	cysticercosis and neurocysticercosis
CSF	cerebrospinal fluid
CT	computerised tomography scan
DALY	disability-adjusted life year
ELISA	enzyme-linked immunosorbent assay
GSO	General Statistics Office of Viet Nam
FAO	Food and Agriculture Organization of the United Nations
IBE	International Bureau for Epilepsy
ILAE	International League against Epilepsy
ILRI	International Livestock Research Institute
ITM	Institute of Tropical Medicine, Belgium
LAMP	loop mediated isothermal amplification
LMIC	low- and middle-income countries
MDA	mass drug administration
mhGAP	Mental Health Gap Action Programme
MRI	magnetic resonance imaging
NCC	neurocysticercosis
NIMPE	National Institute of Malariology, Parasitology and Entomology (Viet Nam)
NTD	neglected tropical disease
OFZ	Oxfendazole
OIE	World Organisation for Animal Health
PCR	polymerase chain reaction
PCD	point of care diagnostics
RFLP	restriction fragment length polymorphism
SIVAC	Supporting National Independent Immunization and Vaccine Advisory Committees
SLMEN	Endemics and Neglected Diseases Service of the Ministry of Public Health
STAG-NTD	Strategic and Technical Advisory Group for Neglected Tropical Diseases
STH	soil-transmitted-helminthiasis
TDR	tropical disease research
TS/CC	taeniasis and cysticercosis
TS/NCC	taeniasis and neurocysticercosis
WHO	World Health Organization

Executive summary

The World Health Organization (WHO), in close collaboration with the Food and Agriculture Organization, the World Organisation for Animal Health (OIE) and International Livestock Research Institute (ILRI), convened an informal consultation in Geneva, from 17-18 July 2014.

The aim of the consultation was to build a framework for the intensified control of *Taenia solium* taeniasis and cysticercosis (TS/CC) and management of neurocysticercosis (NCC) cases in resource-constrained endemic countries. Further the consultation sought to initiate the development of control strategies in selected countries and identify any barriers to implementation due to gaps in knowledge or availability of tools. The meeting was a first step in achieving the milestone defined by the WHO Neglected Topical Disease Roadmap and endorsed by Member States at the 66th World Health Assembly in 2013 of having a "*validated strategy for control and elimination of T. solium taeniasis/cysticercosis available".*

The two-day meeting was attended by delegates from countries with endemic *T. solium*, experts covering various disciplines and representatives of the pharmaceutical industry. Situation analyses presented by Brazil, China, Côte d'Ivoire, Madagascar and Viet Nam provided the foundation for discussions regarding the design and operationalization of strategies for control. Two detailed landscape reviews of the literature on 1) control options and 2) management of neurocysticercosis in low resource settings and an updated transmission dynamics model provided the available evidence for control. The group agreed that current tools, technologies and knowledge of the disease are sufficient to begin the implementation of control programmes in countries, starting on a small scale, and integrating, where appropriate, with other neglected tropical diseases (NTDs) and animal health interventions. Further research remains important to improve tools and permit easy application and standardisation of intervention measures to effect control of cysticercosis particularly in resource-poor regions.

Situation analyses of the different presenting countries demonstrated the disparity in levels of capacity to implement large-scale control activities for *T. solium.* Support to countries would include:

1) Collecting relevant base line as well as monitoring and evaluation data as interventions unfold
2) Integrating with other NTDs and animal health interventions or programmes
3) Provision of existing diagnostic tools
4) Providing access to drugs for treating humans and pigs, and vaccine for porcine use
5) Choosing the best algorithms for control
6) Implementing inter-sectoral control
7) Facilitating international advice and support for implementation of control

Based on the requests from the countries, the WHO accepted to constitute and manage in close collaboration with OIE and FAO an informal practical network aiming to provide support to countries in their efforts to control *T. solium* cysticercosis. More specifically the role of this network would be to create a centralised data repository to summarise country situations, provide an inventory of evidence-based control options including diagnostic and evaluation tools, provide guidance for training and educational material, facilitate leverage for funding and other support for country control programmes, and facilitate inter-sectoral collaboration. The network would include country representatives and as needed, researchers, human and animal health experts, international agencies, and other stakeholders. The WHO suggested hosting a second informal consultation in 2015, where the specific country control strategies for *T. solium* TS/CC designed over the course of the year will be presented, needs and progress assessed and a plan for implementation agreed upon.

1 Introduction

1.1 Background and rationale for the meeting

In 2011, the WHO's Strategic and Technical Advisory Group for Neglected Tropical Diseases (STAG-NTD) and partners adopted a roadmap for control of 17 neglected tropical diseases, including infection with the zoonotic parasite *T. solium*. The roadmap was published in 2012 **(1)** and set targets for a validated strategy for control of *T. solium* by 2015, with interventions scaled up in selected countries by 2020. The roadmap was endorsed by Member States at the 66th World Health Assembly in 2013 (WHA66.12) **(2)**.Options for control of *T. solium* were discussed in 2009 during the WHO expert consultation on foodborne trematodiasis and taeniasis/cysticercosis held in Vientiane, Lao People's Democratic Republic. The meeting issued guidance that single interventions are insufficient to control TS/CC and that successful control strategies must be built on interdisciplinary and integrated approaches that target both taeniasis and cysticercosis and include large-scale preventive chemotherapy in humans, and treatment and vaccination of pigs **(3)**. The meeting further acknowledged that community-led total sanitation, that is, the provision of adequate water and sanitation organized by the community itself, had the potential to significantly reduce infection with *T. solium* with minimal investment **(3)**. Since 2009, advances in tools, technologies and knowledge have set the scene for reconsidering building a framework for intensified control of TS/CC while working closely with countries to meet their needs in the context of operationalizing a strategy for control.

In order to meet the targets of the 2012 NTD roadmap, and in recognition of the importance of interdisciplinary control strategies for the control of *T. solium*, the WHO, in collaboration with FAO, OIE and ILRI, convened the 2014 informal consultation for intensified control of taeniasis and neurocysticercosis caused by *T. solium*. This informal consultation brought together representatives from endemic countries, public health and agricultural experts, researchers and other key stakeholders. Presenting countries at the meeting included Brazil, China, Côte d'Ivoire, Madagascar and Viet Nam.

1.2 Objectives and expected outcomes

The objectives of the 2014 Informal Consultation were:

- To build a framework for intensified control of taeniasis and management of NCC caused by *T. solium* in resource-constrained endemic countries
- To initiate the development of control strategies for identified countries
- To identify gaps and future steps to be taken

1.3 Declarations of interest

Country representatives and advisors invited to the WHO informal consultation completed the WHO standard form for declaration of interests prior to the meeting. At the start of the meeting, the secretariat reported that no conflicts of interest were identified.

1.4 Landscape analysis for prevention/control of *T. solium*

A WHO landscape analysis on control strategies for *T. solium* was prepared in advance of the consultation, in order to guide discussion and to provide guidance for countries in the selection of control strategies. The landscape analysis constituted a detailed review of all the current evidence for *T. solium* control identified in the literature published in English **(see Annex 3)**. Eight key intervention components were identified, namely:

- Preventative chemotherapy (PCT) through Mass Drug Administration (MDA), focus-orientated chemotherapy or identification and treatment of taeniasis cases
- Health education
- Improved pig husbandry
- Anthelmintic treatment of pigs
- Vaccination of pigs
- Improved meat inspection
- Processing of meat products
- Improved sanitation

Empirical data were available only for preventative chemotherapy, health education, anthelmintic treatment of pigs and vaccination of pigs and some combinations thereof.

Valid comparison between control strategies were difficult due to variable durations of follow-up and differing methods of monitoring between studies. Over the short term, however, there is an indication that disruption of transmission has been achieved through administration of niclosamide or praziquantel to humans in combination with either health education or anthelmintic treatment/vaccination of pigs. Some reduction in transmission has been reported through the use of health education although it has been difficult to attribute this directly to the interventions used. Oxfendazole administration and vaccination of pigs have both shown efficacy in the treatment and prevention of porcine cysticercosis, although the impact of these strategies on the prevalence of human TS/CC infections has yet to be quantified.

Due to the paucity of data available it is difficult to make evidence based recommendations on control strategies to be used for this parasite. Extrapolation from the evidence available along with modelled projections and the various recommendations by experts that are available in the literature, however indicates that a combined approach utilising the treatment of human taeniasis cases (through MDA or selective chemotherapy) combined with the vaccination (TSOL18) and treatment of the porcine host (oxfendazole 30mg/kg) would be the ‘best-bet’ for rapid reduction of infection pressure. This is the strategy currently being undertaken in Peru (see page 7) and the results of this trial are eagerly awaited. It is strongly suggested that this core approach be supplemented by supporting measures such as health education and followed by those measures requiring fundamental social changes including improved meat inspection, improved husbandry and improved sanitation. Any control programme must also involve long term (>5years) standardised monitoring & evaluation in order to ensure programmes can be compared across countries.

The claims of being '*tool ready*' for the control of *T. solium*, in 2007 and again in 2011 may have been premature. Since then the first formulation of oxfendazole specifically registered for use in pigs (Paranthic 10% produced by M.C.I. Santé Animale in Morocco) has become commercially available in Africa, the vaccine TSOL18 for pigs is currently undergoing registration in India and the B60/158 Ag-ELISA by ApDia has become commercially available, providing real tools for programme use.

Niclosamide (2g) is recommended as the anthelmintic of choice for PCT programmes, having shown good efficacy and safety. Praziquantel (5-10mg/kg), however, has also shown efficacy against taeniasis and at a dose of 40mg/kg is used extensively in Africa as the drug of choice for schistosomiasis. In areas of co-endemicity for *T. solium* and schistosomiasis, PCT with praziquantel should enable control of both infections within one control initiative. There are, however, ongoing

concerns regarding the safety of praziquantel in NCC endemic areas, due to systemic absorption of the drug, which can cross the blood-brain-barrier, potentially resulting in seizures in people harbouring cerebral cysticerci. There are differing opinions of the extent of this problem and results from a study in Malawi investigating mass praziquantel administration in NCC endemic areas will assist in making treatment recommendations in taeniasis-schistosomiasis co-endemic areas.

1.5 Transmission model

A new transmission model for cysticercosis is currently under development and a demonstration of the power and scope of this model was presented at the meeting. The model currently under development builds on a previous model published in 2007 **(4)** and contains a number of refinements including: a) the ability to explicitly model dynamic cysticercosis prevalence in the human populations, b) modelling the presence of eggs in the environment, c) the use of frequency dependent transmission terms and d) the ability to model differing human and pig population sizes. These improvements increase the resolution of the model, allow specific targeted interventions to be tested and make the model more applicable to a wider range of scenarios.

The new model was designed to accommodate a wide range of single interventions identified by the WHO landscape analysis **(see page 2)** including human MDA with praziquantel, improved human testing and treatment, MDA of pigs with oxfendazole and vaccination of pigs with TSOL18. The model also accommodates behavioural interventions including meat inspection, cooking of meat and hygiene improvements. The landscape analyses and literature searches have produced point estimates and plausible bounds on key control parameters, although considerable uncertainty still remains surrounding key transmission parameters.

Currently, there are a number of assumptions and biological simplifications associated with this model. These include: homogeneity of infection intensity in pigs, homogeneity of risk amongst susceptible people, no natural recovery from porcine cysticercosis, pigs treated and recovered from cysticercosis are assumed to have acquired natural immunity to reinfection, humans infected with Taeniasis are assumed infective immediately with no pre-patent period and consumption of *T. solium* eggs by humans and pigs has a negligible effect upon the total number of eggs present in the environment. The uncertainty inherent in this model and the assumptions included within it were discussed by the modellers and highlighted by participants of the meeting, though it is envisaged that these assumptions could be refined as the model is further developed.

Although all outputs of the new model should be considered preliminary, it is hoped that consultation with experts in the field and additional research will reduce the uncertainty associated with individual parameters of the model and improve accuracy of predictions. Once completed, and made publicly available, the new model will be used to analyse different combinations of interventions to identify those that have pronounced effect on *T. solium* prevalence in humans and those where synergy is lacking.

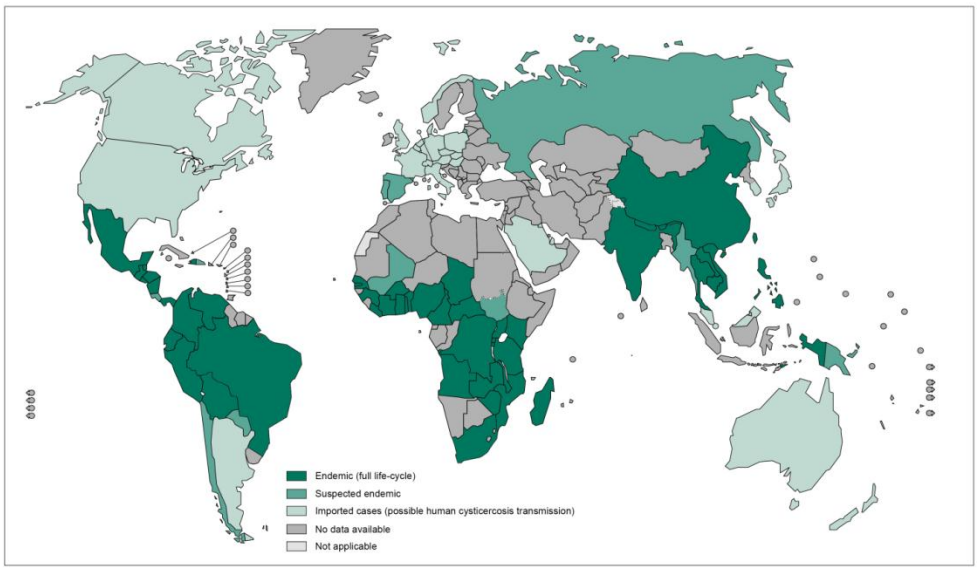
1.6 Epilepsy burden and neurocysticercosis

Worldwide, it is estimated that more than 50 million people suffer from epilepsy, 85% of whom are poor, under-privileged and vulnerable. The incidence of epilepsy in the developed nations is approximately 50/100,000/year compared to approximately 80-100/100,000/year in the developing world **(5, 6)**. Parasitic diseases such as NCC are likely to contribute considerably to this increase in incidence. In endemic countries **(Figure 1),** it is estimated that 30% of epilepsy cases may be due to NCC **(7).** Epilepsy is a truly chronic condition and is often referred to as a hidden burden as sufferers may be socially stigmatised due to superstition, misunderstanding and fear. The impact of epilepsy is far reaching, with children unable to attend school and adults being unable to obtain or retain employment. Epilepsy also has a high economic burden and is estimated to cost the European Union 17.8 billion USD annually.

The burden of NCC is imposed primarily through its association with epilepsy. The 2010 Global Burden of Disease Study (GBDS) estimated that 0.07 Disability Adjusted Life Years (DALYs) are lost per 1000 people globally through NCC, although this is likely to be an under estimation **(8)**. Two studies have illustrated the extent of this under estimation in endemic countries. In Mexico and Cameroon 0.25 and 9 DALYs per 1,000 people were estimated respectively **(9, 10)**. The monetary burden of NCC appears to be substantial and mainly arises from direct or indirect epilepsy-associated costs, predominately diagnoses and drug therapy **(11).**

Despite the fact that more than 70% of epileptics could live a normal life if adequately treated; there is a large treatment gap for epilepsy in the developing world. Over 75% of patients are not properly treated due to poverty, inadequate healthcare infrastructure or lack of access to medication. Addressing this large treatment gap will require raising the priority of epilepsy in national healthcare agendas, integrating epilepsy management into primary healthcare systems and promoting public awareness and education about epilepsy. Out of the Shadows: a global campaign against epilepsy, organized by the WHO, the International League Against Epilepsy (ILAE) and the International Bureau for Epilepsy (IBE), recently set up a demonstration project in China to diagnose and treat epilepsy at the primary healthcare level. The result was a reduction of 13% in the treatment gap. The mental health gap action programme (mhGAP) is also working to address the treatment gap for epilepsy and is currently active in Ghana, Mozambique, Myanmar and Viet Nam aiming to improve the life of patients suffering from this condition. Until *T. solium* is controlled there is a pressing need to reduce the treatment gap and improve case management for all epileptics and to integrate NCC with other epilepsy programmes.

Figure 1. Countries and areas at risk from cysticercosis (WHO NTD, 2013)



1.7 Landscape analysis for case detection and management of neurocysticercosis in low resource settings

A WHO landscape analysis on case management for NCC was prepared in advance of the consultation. This document constituted a detailed review of all current evidence identified in the literature and published in English **(see Annex 4)** with an emphasis on low- and middle-income countries. The main findings of the landscape analysis are summarised below. The full document can be found at xxx

Adequate prevalence data from Asia and sub-Saharan Africa are scarce, but figures point to an emerging public health problem with projected numbers of around three million people with cysticercosis in China (**12)** and it is likely that 0.95-3.08million people suffer from symptomatic NCC in sub-Saharan Africa (**13**). In Latin America it is estimated that approximately 400,000 people suffer from symptomatic NCC (**14)**

The pathology of NCC can be classified into intra- and extra-parenchymal disease, the latter including subarachnoid and ventricular NCC with multiple lesions in the same individual being a common occurrence. A subgroup of intra-parenchymal NCC, termed solitary cerebral cysticercus granuloma, has been reported mainly from India **(12)**. The importance of spinal NCC has been emphasized recently. Symptoms can vary depending on the location, number, size and stage of cysts, as well as on the hosts immune response to the parasite (**13)**. The most common presenting signs of NCC are epileptic seizures, which may be simple or complex, partial or generalised. Other symptoms include: chronic or acute headache, meningitis, hydrocephalus, psychological problems, dementia or impaired vision/loss of vision. In extreme cases encephalitis may occur with severe consequences. NCC can occur in children but is not included in the list of differential diagnoses for childhood epilepsy in many countries. There are significant clinical, radiological and inflammatory differences between NCC in children and adults which are important for the development of management guidelines. Treatment with anthelmintic medication in the paediatric population is controversial and anti-epileptic drug management does not seem straight forward **(15)**.

Many regions endemic for *T. solium* are also endemic for HIV/AIDS and co-infection may influence progression of both diseases. Data on prevalence and clinical presentation of NCC in this population are not uniform and range from reduced to increased prevalence of NCC in people with HIV/AIDS and from a benign course with good response to treatment to a relatively malignant course with increased frequency of ventricular NCC , the latter carrying a rather bleak prognosis. Sensitivity and specificity of serological tests during immunosuppression may be altered and initiation of medical treatment according to the CD4 T-cell level has been suggested **(15)**. The requirement for separate guidelines specific to paediatric and HIV/AIDS co-infections was acknowledged.

Neuroimaging is the tool of choice for the establishment of a diagnosis of NCC and ideally is combined with serological tests for detection of *T. solium* antigens and/or antibodies **(see figure 2)**. In addition, affordable, reliable and easy-to-perform diagnostic tests of either an immunological or molecular biological nature may also play a role in case detection and confirmation of NCC in patients without access to neuroimaging, although therapeutic consequences in these settings are still undetermined **(15)**.

To date there are no standardized treatment guidelines for NCC. The choice of anthelmintic, anti-inflammatory and anti-epileptic medication as well as neurosurgical approaches must be tailored to the individual patient. In the presence of neuroimaging the combination of medication depends on the various stages of NCC (active, transitional and inactive) and on its location (intra-parenchymal versus extra-parenchymal) **(15)**. In the absence of neuroimaging, symptomatic treatment with anti-epileptic medication is recommended, but “blind” treatment with anti-inflammatory medication in suspected NCC cases is debatable. However, there is clear consensus that anthelmintic treatment must not be started in the absence of neuroimaging in presumed NCC cases.

Praziquantel and albendazole are both effective in treating intra-parenchymal live cysts, although there seem to be clear advantages of albendazole both in terms of cysticidal activity and side effects profile compared to praziquantel. A combination of anthelmintic and anti-inflammatory drugs improves outcome in multicystic disease. Evidence for treatment of extra-parenchymal NCC using higher doses, repeated cycles and combinations of anthelmintic drugs has recently emerged **(15)**.

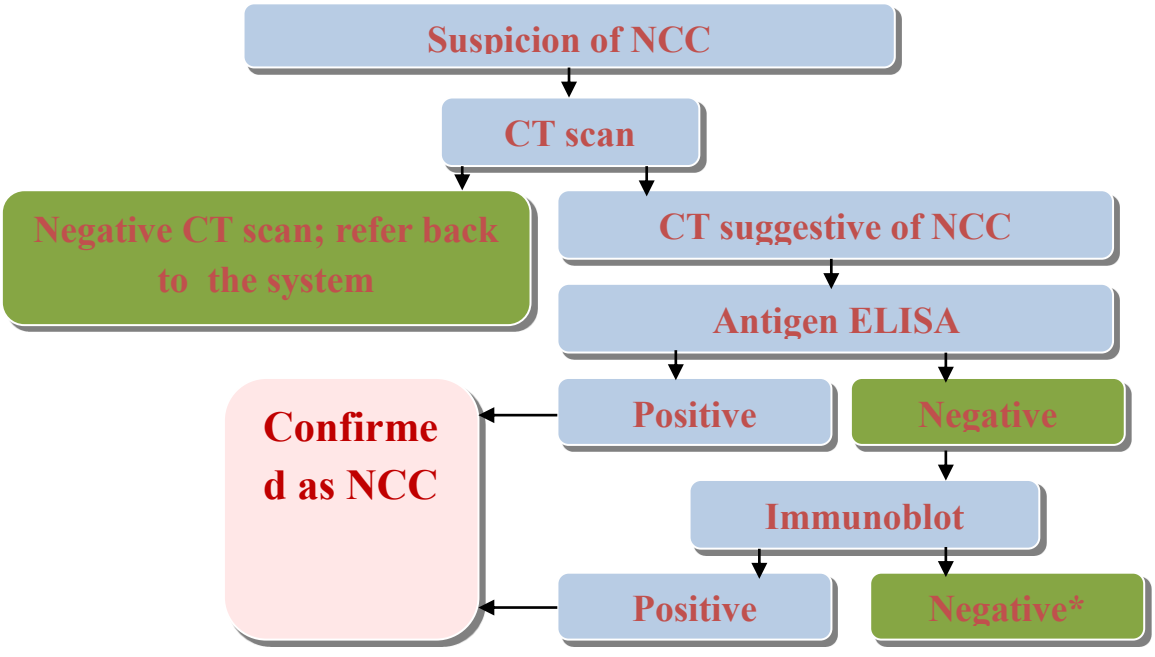
The usefulness of corticosteroids has been documented well in subarachnoid, ventricular and encephalitic NCC - either alone or in combination with anthelmintic medication. There is also evidence from randomized controlled trials in patients with solitary cerebral cysticercus granuloma that prednisolone 1mg/kg per day in different regimes attenuates epileptic seizures and contributes to early resolution of cysts. In contrast, evidence based data on the use of anti-inflammatory drugs (type of drug, dosage, route of administration and length of treatment) in intra- and extra-parenchymal multicystic disease, alone or in combination with anthelmintic medication, is still missing **(15)**.

In case of an underlying lesion, treatment with anti-epileptic medication needs to be started after the first seizure. Suggestions for withdrawal of anti-epileptic medication are less clear and range from the patients being seizure-free for a couple of months to two years. This does not necessarily depend on the availability of neuroimaging. Most patients can be maintained on anti-epileptic monotherapy. Carbamazepine and phenobarbitone are available drugs in most LMIC and seem to offer adequate seizure control. The efficacy, safety and cost-effectiveness of phenobarbitone have been confirmed in various observational studies from resource-poor settings **(15)**.

Surgical management is the first-line choice in people with ventricular NCC, mainly through endoscopic removal of the cyst and/or cerebrospinal fluid (CSF) shunting. The latter has also its place in subarachnoid NCC complicated by hydrocephalus. Treatment with anti-inflammatory drugs may be beneficial and prolong shunt viability **(15)**.

Successful community-based prevention programmes for *T. solium* infection in terms of reduction of NCC from Mexico **(16)**, Peru **(17)** and Honduras **(18)** may serve as role models for programmes on the Asian or African continents.

Figure 2. Diagnostic algorithm for neurocysticercosis * negative serology does not exclude diagnoses of NCC: disease course and treatment response may give further clues as to the right diagnosis.



2 An example of research into elimination of *T. solium*

Over the past 10 years a demonstration project aiming to eliminate the transmission of *T. solium* was carried out in the Tumbes region of Peru, which included more than 100 villages. The project was funded under the auspices of the Bill and Melinda Gates Foundation and the leadership comprised researchers from the Centers for Disease Control and Prevention, Johns Hopkins University, the Peruvian Ministry of Health, Cayetano Heredia University, and the National University of San Marcos. It is hoped that this research will serve to develop a model by which the disease may be eliminated in other parts of the world. An overview of this project was presented at the meeting by Dr Hector Garcia.

The results of this intervention are not yet available but preliminary findings suggest the feasibility of small-scale focal elimination of *T. solium* under intensive research conditions (elimination is probably not feasible at large programmatic scale and under such circumstances intensified control may be more realistic). The programme is currently examining the persistence of the effect and potential re-introduction pathways. The applied intervention involved an intensive combination of mass human tapeworm deworming with niclosamide, pig anthelmintic treatment with oxfendazole and pig immunization with the TSOL18 vaccine, in several rounds for approximately one year. The baseline infection level of pigs was determined by mass buying and culling of pigs from villages followed by necropsy. Necropsy of pigs was also used as a standard monitoring method. The initiative was developed and performed as a vertical programme of applied research in close coordination with the local ministries of health and agriculture, and resulted in the absence of cyst-infected pigs in almost all intervened villages by the end of the intervention and one year after, in the absence of further control interventions. The initial control area is now being expanded to a neighbouring province to test its reproducibility.

Next steps should include making control tools available and accessible, and in this regard a local formulation of oxfendazole has been prepared and tested, and a new simplified version of the coproantigen assay has also been tested in the field. Work lead by other institutions is complementing these efforts by making the TSOL18 vaccine and other commercial formulations of oxfendazole available. Across endemic regions control programmes require tailoring to local scenarios and monitoring strategies must be harmonised to allow valid comparison of strategies. The experience of Peru suggests that control of *T. solium* is feasible

A pig is weighed during fieldwork in the Tumbes region (© Cysticercosis Working Group in Peru)

3 Situation analyses and proposed control plans by presenting countries

3.1 The Federative Republic of Brazil

Control of NTDs in Brazil is based on an integrative strategy comprising the active search for cases combined with timely treatment and the implementation of preventive chemoprophylaxis interventions although there is as yet no active and specific programme for the control of *T. solium.*

Epidemiology of T. solium in Brazil As there is no active surveillance for *T. solium* epidemiological data are only available from two sources, namely: the information systems of the schistosomiasis elimination programme (SIS-PCE), which undertakes stool examination within schistosomiasis endemic areas providing information on the presence of *T. solium* eggs, and mortality data from the Ministry of Health collected in hospitals from most states. The prevalence of taeniasis according to stool samples collected through the SIS-PCE is as high as 4% in some communities and there are reports of NCC cases from all regions.

In Brazil, the Ministry of Agriculture and Livestock is responsible for regulation of all animal products, from the perspectives of industrial production and health/safety. Data for the prevalence of cysticercosis in pigs are available from the Management Information System of the Federal Inspection Service and the Ministry of Agriculture and Livestock. These data includes meat inspection records and refers to regular and systematic inspections of registered/legalized slaughterhouses. The existence of illegal slaughterhouses cannot, however, be ignored. Clandestine slaughter supplies meat to a considerable part of the population, especially the poorest and those who live in high-risk areas with insufficient sanitation services and supply of safe drinking water including rural communities, indigenous communities, small towns and pockets of poverty in the largest cities. Despite its limitations, the available data suggest that NCC is a public health problem and that action needs to be taken to improve the situational awareness and reduce the burden of disease.

Proposed control strategy

Considering the severity of morbidity associated with NCC and the availability of suitable tools and scientific knowledge necessary to commence effective interventions, Brazil is committed to establishing systematic prevention and control activities for *T. solium* at the community level.

Proposals from Brazil include the integration of *T. solium* specific health education into other NTD programmes and the instigation of appropriate active surveillance mechanisms to facilitate the identification and treatment of tapeworm carriers and the people who are in close contact with them. It is proposed that the General Coordination of Leprosy & Diseases in Elimination (CGHDE) may be the most suitable body to lead the *T. solium* control efforts in Brazil as it already heads the schistosomiasis and STH control programmes. Activities are also to be integrated with the Ministry of Agriculture and Livestock, with the consolidation of data collection across ministries. Collaboration between ministries has already begun, with a successful first meeting.

Addressing informal slaughter is a key priority for Brazil, although progress is expected to be slow. It is hoped that veterinary solutions such as the TSOL18 vaccine may be included in the strategy in the long-term. Based upon the information currently available it is proposed that the initial control activities should be prioritised in the regions of Paraíba, Sergipe and Minas Gerais which have the highest prevalence of *T. solium* in Brazil.

3.2 The Republic of Madagascar

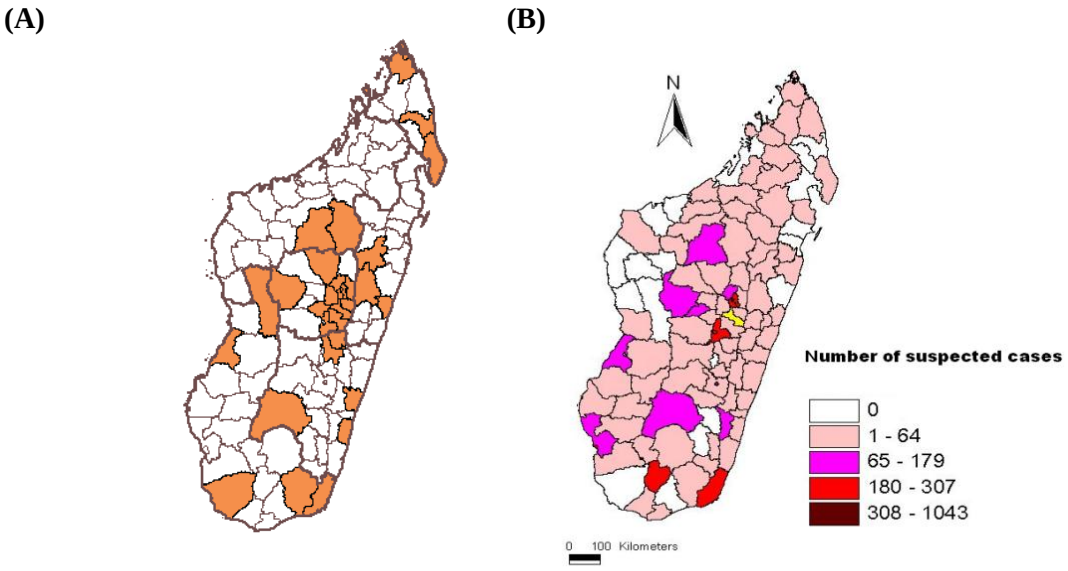
Cysticercosis is emerging as a serious public health issue in Madagascar and is endemic largely due to the persistence of traditional pig husbandry practices and the lack of knowledge about the disease and general poor hygiene.

Epidemiology of human TS/CC in Madagascar

Suspected cases of NCC in Madagascar are included in the monthly report of disease priorities of the Ministry of Health. This report includes data from all 112 districts of the country; 5,891 suspected cases of NCC were registered in 2013. Upon clinical suspicion, a serological test is required and diagnosis must be confirmed by performance of a CT scan. These diagnostic tools, however, are only available in large cities and even in the capital, only 10% of people requiring imaging can access it due to the expense. Consequently, clinical symptoms of NCC confirmed by serological testing are, in most cases, treated like neurological cases.

Studies carried out by the Ministry of Public Health and the Institute Pasteur of Madagascar (IPM) have reported a prevalence of human cysticercosis ranging from 7% to 21% **(19)**. National prevalence is estimated at 16%. These data are unlikely to reflect the true situation because studies did not cover the whole country.

Figure 3. Mapping of *T. solium* and cysticercosis in Madagascar



(A): The 33 districts officially assumed to be endemic for *T. solium* (in orange and based on the origin of patients treated in hospital in Antananarivo).
(B): Reported suspected cases of cysticercosis from district and municipality hospitals in 2013 (5,891 total)

Thirty-three districts are officially assumed to be endemic with *T. solium* **(see Figure 3)** but it is likely that more districts are at risk based on an epidemiological survey conducted for schistosomiasis using the Kato-Katz method. In 2013 and 2014, of the 18 districts targeted, co-endemicity of schistosomiasis with *Taenia spp.* was identified in 10 districts. According to the origin of NCC cases, 17 others districts without schistosomiasis are at risk and need intensification of specific preventive strategies against *T. solium* because they do not benefit from MDA against schistosomiasis.

The pig industry and porcine cysticercosis in Madagascar

Madagascar has an estimated pig population of 1.3 million animals, with the majority of these being raised in the central highlands by smallholder farmers with an average herd size of 2.4 animals. The free-range or scavenging system is the most widely used, where pigs are enclosed during the night but roam freely around the village during the day seeking food and the majority of animals are slaughtered in the village or at home to be sold to butchers for local markets or for family consumption. Although health officers are responsible for inspecting pigs at live-pig markets, slaughterhouses and retail markets most of the time, both inspected and non-inspected pork can be found for sale. In remote areas, numerous butchers provide meat at markets and these carcasses are mainly purchased from illegal slaughterhouses.

The total economic impact of cysticercosis in Madagascar has been estimated at 360 million euro per year with 96% related to the impact on public health **(20)**. Losses are incurred by pig farmers through either condemnation of infected carcasses at formal slaughter houses or through a reduced sale value (20-50% loss) for infected carcases sold on the 'black' market

Prevalence studies have been carried out at farm-level and a prevalence of 22.9 % has been found in the rural areas and 15% in peri-urban areas. These figures are significantly higher than the 'official' prevalence of cysticercosis reported in 2008-2012 as being 0.5% to 1% in pork carcasses inspected at formal slaughter houses. The disparity between these prevalence figures brings into question the reliability of the surveillance system in Madagascar as it is currently implemented.

In Madagascar porcine cysticercosis is not yet among the list of priority diseases of veterinary services although since 2010 a multidisciplinary network involving the National Centre of Applied Research in Rural Development (FOFIFA), the IPM, the French Agricultural Research Centre for International Development (CIRAD) and the Veterinary Department of the Faculty of Medicine, University of Antananarivo has been set up. This network has undertaken several epidemiological studies, investigated new diagnostics and is investigating strategies to reduce free-roaming pig production. Support has been obtained from the French Mission (Parrur Project), Swiss Mission, the Qualireg network, the Wellcome Trust and the Institut Pasteur.

Capacity of the Institut Pasteur of Madagascar to develop diagnostic tools

The Institut Pasteur of Madagascar (IPM) is performing ongoing research to improve diagnostic tools for *T. solium*, mainly in collaboration with ministries. Much work has been done over the past 15 years to establish and validate serological diagnostic tools (ELISA and EITB) for cysticercosis. The IPM has also developed an RT-PCR test for the detection of the *T. solium* cytochrome c oxidase (*cox1*) gene in CSF for NCC.

One of the challenges for diagnosing CC/NCC in rural areas is that currently available diagnostic tools require costly equipment and/or are technically sophisticated and require specialised training. In order to address this issue the IPM is developing tools suitable from laboratory use to patients bed-side ("Point-of-care" diagnostics tools), and pen-side diagnostic tools for use by farmers on pigs in rural areas. Development of a loop-mediated isothermal amplification (LAMP) test for diagnosis of NCC has already been completed and shows promising preliminary results. A Rapid diagnostic test (RTD) using recombinant protein(s) is also under development and is designed for use in humans and pigs.

Current & proposed control measures

Since 2005, a national control programme for cysticercosis has been defined and implemented in the 33 districts assumed to be endemic. The goal of the programme is to reduce the high risk of contracting human infection in order to reduce human cysticercosis prevalence from 16% to less than 10% and to eliminate human taeniasis. The strategy is based upon prevention, specifically preventative chemotherapy and sanitation programmes alongside training, social mobilisation, collaboration and partnership.

Since the implementation of the programme and its integration with the NTD national plan, 121,678 children have been treated with anthelmintics, training of 375 health workers and 741 local 'decision makers' has been undertaken and a large health education programme is underway comprising posters, books, radio and TV programmes. As a result of the ongoing sanitation programmes, the rate of toilet usage by the population increased from 42% in 2012 to 48.5% in 2014. Promoting the importance of hygiene and "washing hands with soap" is also included in health educational programmes in schools and villages.

Despite the ongoing success of this programme Madagascar is experiencing several barriers to scaling-up the programme to the whole country. These barriers include a lack of financial support for the activities, lack of diagnostic capacity outside of the capital city, poor availability of anthelmintics in many areas, insufficient meat inspection in rural areas and poor managerial and coordination capacity of the programme.

In addition to all the action already undertaken, Madagascar proposes that the following activities to be included within a future framework of action supported by the WHO/FAO/OIE:

- A baseline survey to be conducted to determine national prevalence, variability among regions and associated risk factors
- Preventative chemotherapy to be extended to those districts currently not covered through schistosomiasis control
- Improve the performance and availability of diagnostic tools
- Undertake operational research to determine cost-effectiveness of intervention options
- Include treatment (oxfendazole) and vaccination (TSOL18) of pigs within pilot programmes
- Education of farmers on the value of a cyst-free meat chain
- Promotion of alternatives to the scavenging system by promoting the utilisation of locally available feed-stuffs for pigs
- Preparation of a standardised monitoring and evaluation protocol for control programmes
- Improve the in-country capacity for diagnosis and treatment of CC/NCC and improve decentralized treatment of epilepsy at primary healthcare level.

3.3 The Republic of Côte d'Ivoire

As yet, cysticercosis has received little attention from the health authorities in Côte d'Ivoire and there is no specific surveillance and control programme for *T. solium* in place. Although the full disease burden of cysticercosis in Côte d'Ivoire remains largely unstudied, *T. solium* is anticipated to be present in most of the pig-raising regions. There are still many regions where pigs are raised traditionally and where all conditions (poor sanitation in particular) are fulfilled for transmission from pigs to humans and vice versa.

Epidemiology of human TS/CC in Côte d'Ivoire

The routine national health surveillance programme requires that cases of human cysticercosis are reported to national authorities. Under-reporting routinely occurs due to lack of access of the population to health care, misdiagnoses of aetiological factors or poorly established data reporting systems. Studies conducted in schoolchildren and in the general population by Institute Pasteur have reported human taeniasis prevalence, without determining or reporting the species causing infection, ranging from 0.3% to 11.1%, with a high degree of spatial variation. High prevalence was observed in the Toumodi (11.1%), Divo and Lakota (5.4%) and Abidjan (2.5%) departments. Human cysticercosis has been reported in a small number of studies, with several cases of NCC and cutaneous cysticercosis reported between 1972 and 1980 **(21-24)**. Taeniasis, schistosomiasis and STH infections are endemic throughout Côte d'Ivoire and individuals are commonly co-infected with combinations of helminths (Institut Pasteur Côte d'Ivoire, unpublished data).

Pig industry and porcine cysticercosis in Côte d'Ivoire

Pork comprises approximately 22% of total meat consumption in Côte d'Ivoire, where 1341 farmers in 2011 produced 8,447 tons of meat, representing a turnover of 10.9 billion CFA francs. The modern pig production sector is based around the SIVAC (Société Ivoirienne d'Abattage et de Charcuterie) which produces 21% of pork in the country and is the only place at which routine inspection for *T. solium* is carried out. 79% of pork is produced in the traditional way, providing around 40% of the meat consumed in the city of Abidjan and over 98% of the pork consumed in other towns and villages.

The true prevalence of porcine cysticercosis in Côte d'Ivoire remains to be assessed with few available reports. In 1978 the prevalence of porcine cysticercosis was reported to be 2.5% with high prevalence in Korhogo (3.9%) and Bouaké (5.7%) **(25).** In 1991 Danho *et al.* reported a national prevalence of 3.6% **(26)**. A recent surveillance system report by the Direction des Services Vétérinaires of the Ministère des Ressources Animales et Halieutiques (DSV/MIRAH) in 2013, identified 72 cases of porcine cysticercosis by meat inspection with 23 cases from Abidjan in the south and 38 cases from Yamoussoukro in the centre of the country.

Control strategies & proposal

Control strategies in Côte d'Ivoire include health education campaigns focusing on the biology of the disease, safe meat preparation, the importance of hygiene and the need for adequate sanitation and are targeted at the general population and health workers. The provision of adequate and appropriate sanitation and ensuring that these facilities are utilised by the community are crucial to discourage people from openly defecating and to prevent pigs from coming into contact with human faeces. These programmes have been conducted by the Ministry for the Environment, Urban Safety and Sustainable Development in collaboration with the Ministry of National and Technical Education, and the Ministry of Animal Resources and Fisheries.

Farmers are currently being educated in order to encourage the confinement of pigs to prevent them coming into contact with human faeces and to utilise anthelmintic drugs. The improvement of meat inspection and education of meat workers to prevent the consumption of infected pork is also being

attempted. Unfortunately the presence of black markets, combined with poor staffing levels within the meat inspectorate present barriers to effective implementation.

Côte d'Ivoire proposes a number of improvements to existing systems in order to achieve intensified control of *T. solium:*

- Establishment of person(s) responsible for implementation and evaluation of control measures
- Training of medical and veterinary laboratory staff in a standardised serological method for human and porcine diagnoses Undertaking of epidemiological survey on farms and slaughterhouses for porcine cysticercosis
- Undertaking human taeniasis surveys and provision of anthelmintic treatment to carriers
- Registration of epilepsy cases for use in the identification of high transmission areas
- Production and distribution of a protocol for active surveillance with establishment of a robust reporting system at all levels of existing medical and veterinary services
- Ensuring regular analysis of the incoming data for use in further decision-making at the national and/or local levels.
- Promotion of regional and international cooperation and collaboration among medical, veterinary and non-medical institutions in the implementation of control measures.
- Distribution of available educational materials to educate all members of the community about the public health impact of *T. solium* infections and its prevention and control
- Improvement in sanitation through provision of effective fresh water supplies, safe toilets, composting of human excreta, and training in elementary hygiene
- Improvement of pig production through enforcement of existing legislation against free-range pig rearing, illegal slaughter and clandestine marketing of pigs along with improved meat inspection
- Implementaion of systematic treatment of pigs with anthelmintics and vaccination with TSOL18

3.4 The Socialist Republic of Viet Nam

In Viet Nam infection with *T. solium* has been associated with the consumption of raw pork dishes such as "*Nem chua, nem thinh"* and "*thit lon chua*", which is common among men and most prevalent in the Northern and Central regions of the country. Other risk factors associated with infection include eating unwashed vegetables, allowing pigs to roam, poor sanitation, lack of hygienic latrines, the use of human faeces as fertilizer, and absent or inadequate meat inspection, especially in rural areas **(27)**.

Epidemiology of human TS/CC

Taeniasis has been recorded in humans across 50 of the 63 provinces in Viet Nam. Three *Taenia spp.* have been reported in the country, namely: *T. solium, T. saginata* and *T. asiatica* of which the latter is thought to be the most common **(27-29)**. Prevalence estimates across the country vary, but have been reported to range between 0.2 and 12% **(30)**. Studies have reported human cysticercosis in two provinces, Ban Ninh and Ban Kan with an estimated prevalence of approximately 5% in both provinces according to Antigen ELISA **(31, 32).** From 2008 to 2010 Trung *et al*. conducted a questionnaire survey in 7 northern provinces and found many people with history of seizures, chronic headache and subcutaneous cysts. Antigen-ELISA confirmed cysticercosis in the epileptic, headache and subcutaneous cyst patient populations at levels of 0.09%, 0.08% and 0.06% respectively **(33)**. Hospital records confirmed the presence of NCC in Viet Nam, with an average of 332 cases per year between 2006 and 2013 (NIMPE).

Pig industry and cysticercosis in Viet Nam

In Viet Nam the per capita consumption of pork per capita is very high, with a total pork consumption of 3,217,920 tonnes in 2003 (GSO, 2013). Porcine cysticercosis has been reported across the country, with prevalence estimates as high as 9.9% in Bac Ninh and Bac Kan provinces according to antigen ELISA **(34).** Prevalence levels detected at formal slaughter facilities are, unsurprisingly, lower than those detected in the communities, with a reported prevalence of 0.04% in Hanoi and 0.03 and 0.09% in the northern and southern provinces **(27)**. In Viet Nam, the Ministry of Agriculture (MOARD) has issued regulations regarding veterinary hygiene inspection measures for slaughterhouses. Veterinary inspection of pigs prior to sale at market as well as meat inspection to monitor food safety normally take place in urban areas but are rarely carried out in rural areas.

Treatment guidelines and control measures

In 2004, the Ministry of Health of Viet Nam issued guidelines for the diagnosis, treatment and prevention of TS/CC. For treatment of taeniasis the Ministry of Health recommends a single 2g dose of niclosamide or a single dose of praziquantel at 15-20 mg/kg bodyweight (Guidelines of the Ministry of Health, 2004). According to the guidelines of the Ministry of Health, human cysticercosis should be treated with albendazole at 15 mg/kg/day × 20 consecutive days, with the inclusion of a single dose of praziquantel 15mg at 20mg/kg body for taeniasis on the first day of treatment.

Between 2012 and 2013 an MDA study for the control of *T. solium* was initiated in a mountain commune in Phú Thọ province, an area with a population of 5,675 inhabitants. The target population for the MDA was approximately 4,103 people aged 15 years or older, and the drug used was praziquantel, administered as a 10mg/kg single dose. The first round of treatment, in October 2012, achieved 52.4% coverage, with the second round the following year achieving 69% coverage. No side effects were recorded and the prevalence of taeniasis dropped to 0% from an estimated 4% determined by Kato-Katz examination prior to the intervention (research collaboration between NIMPE and ITM, Antwerp, Belgium).

Gaps and proposed control strategy

The Ministry of Health of Viet Nam is currently developing a national plan for NTD control, including TS/CC, for 2015-2020, and is working towards the development and distribution of information, education and communication materials for TS/CC prevention and control in communities.

A number of challenges exist for control of *T. solium* in Viet Nam, including: the persistence of traditional, free-roaming production systems, poor waste management, cultural norms for the consumption of raw pork, lack of interest from the health system in TS/CC and poor capacity of the veterinary system to enable adequate meat inspection in the rural communities. The current staffing levels are insufficient for the monitoring of all slaughterhouses, especially the small-scale ones. Therefore, not all meat destined for market is adequately inspected, especially in rural areas, and infected pigs in the community are not diagnosed and treated.

Viet Nam proposes that in order to intensify control of *T. solium*, a four pronged approach is required, consisting of assessment, prevention, control and clinical management. The aspect of assessment focuses on providing improved epidemiological data, including burden of disease data, economic impact, and spatial mapping. In order to prevent infection, education is proposed on appropriate food processing, improved pig husbandry practices, and awareness of the importance of safe waste management. The key control measure Viet Nam wishes to undertake involves MDA with praziquantel to eliminate the source of infection (*Taenia* carriers), combined with improved point of care diagnostics (PCD). It is hoped that a national guideline for NCC management, including diagnoses, treatment and follow-up will be developed in order to improve case management.

3.5 The People's Republic of China

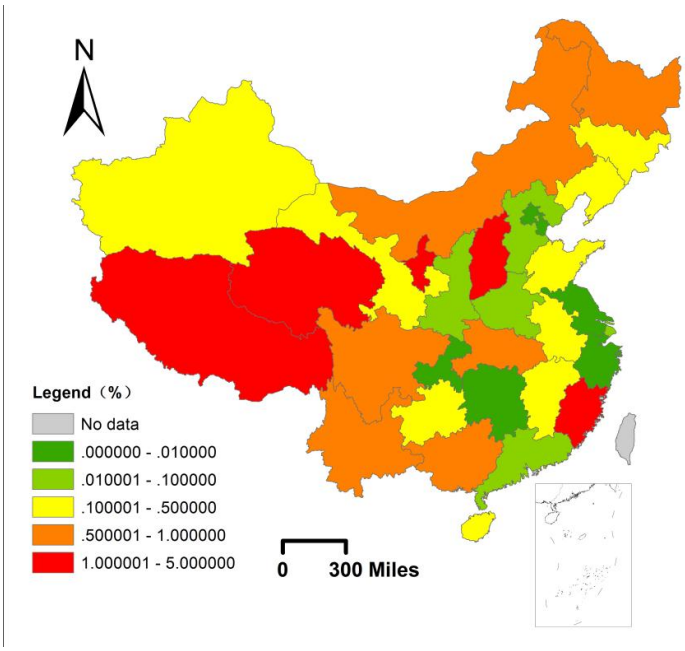
Taeniasis is thought to have been endemic in China for more than 2000 years as evidenced by the discovery of an ancient body in Hubei province found to show signs of *Taenia* infection and dated to 167 BC **(35)**. The high endemicity of TS/CC in China is attributed to a number of factors. The habit of eating raw or undercooked meat is prevalent in the population, poor sanitation is widespread, many pigs are kept under free-ranging conditions and slaughtering in rural areas is usually poorly managed.

Epidemiology of Human TS/CC in China

Two national surveys on parasitic diseases have been carried out in China; the first in 1988-1992 and the second in 2001-2004. In the 1st national survey, out of 1,477,742 participants in 30 provinces, 2,449 from 28 provinces were found to be infected with *Taenia spp.* **(36)**. It was then estimated that about 1.3 million people nationwide were infected with *Taenia spp*. In the 2nd national survey, out of 356,629 participants from 31 provinces, 983 in 12 provinces were found to be infected with *Taenia spp*. **(37)**. Thus, a total population of 550,000 people nationwide were estimated to be infected with taeniasis. In the 2nd national survey a serological survey was also carried out for cysticercosis. Out of 96,008 samples from 31 provinces, 553 in 25 provinces were found positive with cysticercosis, with a national prevalence estimate of 0.58% **(36)**. Cysticercosis is thought to be one of the leading causes of hospitalization due to parasitic diseases in China and in areas endemic with *T. solium*, cysticercosis is the predominant cause of epilepsy and psychosis. The prevalence of cysticercosis reached 67% in those with secondary epilepsy in Dali, Yunnan province, which makes this one of the most highly endemic foci of taeniasis and cysticercosis in China **(38)**.

Many provinces in China are co-endemic with other important parasitic diseases, raising both the potential for an increased burden upon the population, but also possibilities for integrated control strategies. Four provinces are thought to be co-endemic with schistosomiasis, 7 with echinococcosis, 13 with high prevalence of STH and 3 with clonorchiasis.

Figure 4. Mapping of cysticercosis in the most recent (2001-2004) national serological survey in China *Current control measures & proposed strategy*



Due to the great burden of cysticercosis, national action against taeniasis and cysticercosis was carried out during the 1970s-1990s in Northern China **(39)**. 'Offices for taeniasis control and cysticercosis elimination' were established in highly endemic provinces which involved the Departments of Commerce, Agriculture and Health. Four major measures have been applied to block transmission: a)human chemotherapy, whereby those with a history of expelling proglottids were screened and treated with the Chinese traditional medicine "*Shataoling*", b) improved sanitation with the establishment of closed toilets, c) thermophilic fermentation of human faeces and d) confinement of pigs in pigpens, inspection of pigs destined for market and treatment of pigs infected with cysticercosis with praziquantel or albendazole.

"*Shataoling*" is a drug made from the Chinese traditional medicinal plant*Gemma agrimoniae* (agrimony bud) and was widely used to treat taeniasis in the 1970s-1990s **(40)**. To this day, two Chinese traditional medicines, namely pumpkin seed extract and areca nut extract, are often used simultaneously for the treatment of taeniasis **(41)**. Praziquantel and albendazole are administrated in combination over 3 or more courses to increase the efficacy and lower the potential side effects **(42)**. Anti-parasitic therapy for cerebral cysticercosis in China is always undertaken in hospitals under a close observation.

Overall, great efforts have been made to tackle TS/CC in China, especially in the 1970s-1990s. Some gaps, however, still exist and must be filled in order to achieve the stated goal of elimination in China. Firstly, no accurate disease burden map (including economic burden) is available, especially for cysticercosis. Neither the retrospective survey on hospital cases nor the national serological survey, provide an adequate map of cysticercosis. Although a National Reporting System for Infectious Diseases has been established, TS/CC is not yet included and there is currently a paucity of valid, up to date, data on prevalence available. A national treatment guideline should now be formulated, which must take into consideration the different locations, treatment times and objective evaluation of treatment efficacy. A new national control strategy is also requested by China.

Three pilot interventions are proposed to be carried out in China

1. A pilot elimination programme integrated with malaria elimination in a county in Henan province
2. An integrated control programme with soil-transmitted helminthiasis in Yunnan province
3. An integrated control programme with the national echinococcosis control programme in Tibetan areas of Sichuan province where there is co-endemicity of *T. solium* with *T. saginata*

4 Reports of working groups

With the aim to initiate the development of control strategies for identified countries, three working groups were assigned on day two of the meeting. The first two groups addressed requirements for development and successful implementation of pilot control programmes for *T. solium* and the third group addressed improvement of NCC treatment. Discussions of the first two groups were formed around epidemiological data requirements, the needs and options for cross-sectoral collaboration, standardization of assessment tools including tools for monitoring and evaluating the outcome of the programmes, research gaps and the role of and possible support from the WHO, FAO and OIE. The third group concentrated on needs for assessing the burden of NCC, challenges related to diagnosis and development of an algorithm for NCC treatment. After two hours of discussion, each group prepared and presented a report of their views to the meeting participants.

4.1 Recommendations for implementation of pilot control programmes

1. Collaboration between health, agriculture, education, and other relevant sectors would be vital for successful control of *T. solium* infections. A central cross-sectoral coordination body should be established from the beginning (the avian influenza model could be explored). The body should coordinate data collection and control initiatives to ensure they are undertaken simultaneously for both humans and pigs as single interventions have proven ineffective. The aim of the pilot programmes should be control rather than elimination at this time.

2. Baseline data on pig populations should be collected and country wide mapping and assessments of the burden of human TS/NCC, and porcine cysticercosis undertaken. Co-endemicity mapping with schistosomiasis, foodborne zoonotic trematodiasis and STH should be made to explore options for integrated control programmes. Low, medium and high TS/CC prevalence areas should be properly defined so that strategies may be developed according to endemicity. Key points of identification should be targeted, the disease in both humans and pigs made notifiable, and a surveillance system with a central coordination body set up with the help from the WHO, FAO and OIE.

3. Standardization of toolsets for control activities will be essential to compare between programmes and fully assess the outcome of interventions. Toolsets should include assessment tools, standards for epidemiological data, control tools, costing protocols and monitoring and evaluation guidelines. Furthermore, the toolsets should include possible algorithms for control (e.g. MDA + Health education + pig treatment) and provide country options depending on cultural and economic challenges. New “point of care” bed-side and pen-side tools should be properly assessed. For porcine cysticercosis, standardisation of a measure of efficiency for treatment and vaccination is needed (dead cysts, cyst-free carcasses). Guidance should also be established for water and sanitation to reduce transmission of *T. solium*.

   A network of excellence, supported by the WHO, FAO and OIE should be established to provide the guidelines.

4. Research to assess existing tools and control principles under various scenarios including cost-effectiveness and integration with other control programmes should be undertaken. Along with research to assess the survival of *Taenia* eggs in the environment (soil, insectsand water) and the impact of African swine fever on porcine cysticercosis. The efficiency of a using a single dose of niclosamide against taeniasis should also be assessed.

5. Mobilization, sensitization, training and transfer of technologies for assessment of disease status and control monitoring should be given high priority as *T. solium* is not visible in most of the affected societies

6. International inter-agency support and national prioritisation of TS/CC should be promoted because *T. solium* lags behind other NTDs

4.2 Recommendations for improvement of NCC treatment

1. Assessment of the burden of NCC in the selected countries would be a prerequisite for proper management of NCC cases. Risk factors for human *T. solium* infections should be identified, information on index cases from hospital records collected and supported by seroprevalence data where possible. The prevalence of epilepsy should be assessed in communities and in areas with high prevalence of HIV co-infections should also be assessed.

2. Diagnosis of NCC should be standardised, with serological diagnosis needing agreement on cut-off values used to determine seropositivity. Development and distribution of simple bed-side "point of care" tests are a top priority. Options for human NCC diagnosis should be included in the toolset.

3. The algorithm for treatment of different types of NCC (and treatment regimes for children) should be established and included in the toolset. An international definition of the end points of NCC should also be established. The side effects of using praziquantel (40mg/kg) to treat NCC should be assessed

4. Monitoring of epilepsy and NCC in the countries should include quantifying incidence of epilepsy in hospitals, seroprevalence in epilepsy patients, NCC prevalence in CT referred patients and seroprevalence in asymptomatic subjects in the community.

4.3 Development of a targeted research agenda

Although control of TS/CC is within reach using currently available tools and technology, the need for labour intensive control measures combined with minimal infrastructure, scare technical expertise and inadequate surveillance in many resource-poor highly endemic regions makes effective control difficult or impossible. New control strategies should be developed for low-resource endemic regions. Research will be crucial to develop toolsets for control of *T. solium* and to enable countries to design interventions that suit their available resources and infrastructure, and that could form part of pilot interventions. The elimination project in the Tumbes region of Peru (although undertaken under research conditions with extensive and repeated treatments), demonstrated that control is possible within a year using existing tools and may help to form a basis for future research to determine whether less treatments could be used to attain a similar effect in low-resource endemic areas.

A targeted research agenda is absolutely necessary to effect control of *T. solium*, particularly in resource poor regions, and will be essential to direct funding to where it is most needed. Development of an agreed upon, comprehensive and prioritised list of research needs will be an important task for the research arm of the new network and should address, and perhaps expand upon, the research needs that were identified in the working groups.

5 Comments from private sector and other organizations

The consultation was attended by observers from the companies Bayer, GlaxoSmithKline, Merck Serono, Sanofi, and UCB Pharma, and the international non-governmental organizations GALVmed and World Vision International. On the first day of the consultation the observers were given the opportunity to give a short statement to the participants. Sanofi and Bayer both looked forward to the outcomes of the meeting and the possibility that they may be able to consider contributing to efforts to improve patient care on the ground in the future. Merck Serono, although at present more engaged in supporting work on schistosomiasis, echoed these sentiments and suggested the possibility of integrating future efforts with the schistosomiasis alliance. GALVmed expressed their support and offered to help with facilitation of access to distribution channels that will be important for future programmes. Finally GlaxoSmithKline expressed their commitment to NTDs and the desire to maximise synergy to control *T. solium* with other NTDs.

Overall the message from the observers was one of strong support and all looked forward to the outcomes of the meeting and the possibility of working with the WHO in future to support efforts against *T. solium.*

6 Informal Consultation Outcome & Conclusion

6.1 Establishment of a WHO-led network

Participants of the 2014 Informal Consultation unanimously expressed a common commitment towards the implementation of larger scale control activities against *T. solium* and requested that the WHO, with the support of the FAO and the OIE, establish and manage a network to support countries in their efforts for intensified control of *T. solium* and NCC management. This network will be open to Member States and include country representatives and as necessary researchers, human and animal health experts, and other stakeholders.

This network should provide technical and operational support to countries for the initiation of large-scale control programmes and make available an inventory of evidence-based control options including diagnostic and evaluation tools. The network should also provide a central data repository summarising country situations and trends and address the issue of harmonization of diagnostic tools to allow the effectiveness of interventions to be more accurately monitored. Other important roles for this network will be to provide guidance to training (including preparation of educational materials), helping countries to leverage funding for control programmes and to facilitate inter-sectoral collaboration and coordination of control activities against other NTDs.

It is hoped in the long term that the network will help to improve disease management for people with TS/NCC, and decrease disease transmission by addressing all aspects of the disease life cycle (preventive measures in humans and animals, food safety and improved sanitation).

The network will consist of two arms: Operational, with control of *T. solium* led by the Department for Control of Neglected Tropical Diseases and management of neurocysticercosis led by the Department of Mental Health and Substance Abuse and a research arm.

The WHO will support human interventions, while providing overall leadership, and will work with OIE and FAO for animal and food safety based interventions. An important consideration for the network will be the different levels of capacity and support needs of participating countries. Outcomes of the network must therefore be flexible and allow countries to tailor intervention strategies to best suit their available resources, infrastructure and specific needs.

6.2 Milestones before the first meeting of the network (anticipated to take place in late 2015)

Work groups within the network will be established and tasked with meeting the following objectives:

1. Preparation of complete assessments for all participating countries including NCC surveillance data from hospitals/health care centres and animal health data
2. Establishment of a set of detailed control recommendations with disease indicators
3. Preparation of a forecast of country needs including medication, vaccine, diagnostics etc.
4. Identification of outstanding research needs and improvements needed for diagnostics tools

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8 Annex 1. List of participants

Country representatives:

The Federative Republic of Brazil-

Dr Rosa Castália França Ribeiro Soares, Secretariat for Health Surveillance, Department of Epidemiological Surveillance, Ministry of Health, Brazil

The People's Republic of China-

Dr Men-Bao Qian, Assistant Professor, National Institute of Parasitic Diseases, Chinese Centre for Disease Control and Prevention, Shanghai, China (by teleconference)

Dr Ning Xiao, Deputy Director, National Institute of Parasitic Diseases, Chinese Centre for Disease Control and Prevention, Shanghai, China (by teleconference)

The Republic of Côte d'Ivoire-

Dr Diarra Cissé-Aman, Veterinary Inspector and Director, Veterinary Services, Ministry of Animal Resources and Fisheries, Côte d'Ivoire

Dr Aboulaye Meité, Director and Coordinator of the National Programme against Schistosomiasis, Soil-Transmitted Helminth Infections and Lymphatic Filariasis, Institut Pasteur of Côte d'Ivoire

Dr André Offianan Toure, Head of Parasitology and Mycology Department and Head of Malariology Department, Institut Pasteur of Côte d'Ivoire

The Republic of Madagascar-

Dr Anjanirina Rahantamalala, Institut Pasteur of Madagascar

Dr Sylvia Ramiandrasoa, Responsible for the fight against cysticercosis, SLMEN/DULMT, Ministry of Public Health of Madagascar

Dr Harentsoaniaina Rasamoelina-Andriamanivo, National Centre for Agricultural Researches/ Department of Livestock and Animal health, Faculty of Medicine, Antananarivo, Madagascar

The Socialist Republic of Viet Nam-

Dr Do Trung Dung, Head of Parasitology Department, National Institute of Malariology, Parasitology and Entomology (NIMPE), Ministry of Health, Hanoi, Viet Nam

Dr Thai Thi Thuy Phuong, Vice Director, Regional Animal Health Office No.6, Department Of Animal Health, Ho Chi Minh City, Viet Nam

Advisors:

Dr Helen Cross, International League against Epilepsy, Institute of Child Health, Great Ormond Street Hospital, London, UK

Professor Dr Pierre Dorny, Veterinary Helminthology Unit, Department of Biomedical Sciences, Institute of Tropical Medicine, Antwerp, Belgium

Professor Eric Fèvre, Chair of Veterinary Infectious Diseases, Institute of Infection and Global Health, University of Liverpool, UK (Chairperson)

Dr Hector H. Garcia, Department of Microbiology, Cayetano Heredia University and Cysticercosis Unit, Institute of Neurological Sciences, Lima, Peru

Dr Wendy Harrison, Faculty of Medicine, School of Public Health, Imperial College London, UK

Professor John Horton,Tropical Projects, Hitchin, UK

Dr Bounnaloth Insyxiengmay, Chief of Parasitology Control Division, Department of Communicable Diseases Control, Lao People's Democratic Republic

Professor Maria Vang Johansen, Professor in Parasitic Zoonoses, Section for Parasitology and Aquatic Diseases, Department of Veterinary Disease Biology, Faculty of Health and Medical Sciences, University of Copenhagen, Denmark (rapporteur)

Professor Marshall Lightowlers, Faculty of Veterinary Science, University of Melbourne, Australia

Professor Samson Mukaratirwa, Dean and Head of School of Life Sciences, University of KwaZulu-Natal, Durban, South Africa

Dr Theodore E. Nash, Principal Investigator, Clinical Parasitology Section, Laboratory of Parasitic Diseases, National Institutes of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, USA

Dr Vincent Porphyre, Coordinator of the QualiREG network in the Indian Ocean, CIRAD, Saint Pierre, La Réunion - France (DOM)

Dr Vedantam Rajshekhar, Professor of Neurosurgery, President of the Neurological Society of India, President of the Indian Society of Neuro-Oncology, Department of Neurological Sciences, Christian Medical College Hospital, Vellore, India

Dr Hardy Richter, Department of Neurology, Klinikum rechts der Isar, Technical University of Munich, Germany

Dr Josemir Sander, Professor of Neurology, UCL Institute of Neurology, Department of Clinical and Experimental Epilepsy, Clinical Neurosciences Centre, London, UK

Dr Muth Sinuon, Programme Manager of Helminthiasis, National Centre for Parasitology Entomology and Malaria Control, Cambodia

Dr Philip Toye, International Livestock Research Institute, Nairobi, Kenya

Dr Arve Lee Willingham, Director, One Health Centre for Zoonoses, and Tropical Veterinary Medicine and Professor, One Health Veterinary School Faculty, Ross University School of Veterinary Medicine, Basseterre, Saint Kitts and Nevis

Dr Andrea Winkler, Department of Neurology, Klinikum rechts der Isar, Technical University of Munich, Germany

Mr Peter Winskill, Department of Infectious Disease Epidemiology, Imperial College London, UK

Observers:

Dr Mark Bradley, Director Global De-worming, Global Health Programs, GlaxoSmithKline, Brentford, UK

Dr Jane YC Chan, Associate Director Global Health Medical Strategy, UCB Pharma SA, Brussels, Belgium

Dr Daniel Gerard, Chronic diseases, Mental health and epilepsy, Department of Access to Medicines, Sanofi, Gentilly, France

Dr Beatrice Greco, External Translational Innovative Platform Global Health, Merck Serono, Coinsins, Switzerland

Dr Ulrich-Dietmar Madeja, Executive Director, Access to Medicines, Bayer AG, Berlin, Germany

Dr Tim Rowan, Scientific Consultant, GALVmed, Edinburgh, UK

Dr Mesfin Teklu Tessema, Partnership Leader, Health and Nutrition, World Vision International, Châtelaine, Switzerland

International Organizations

FAO-

Dr Sarah Cahill, Food Safety Officer, Food Safety and Quality Unit, Food and Agriculture Organization, Rome, Italy

Marisa L. Caipo, Food Safety Officer, Food Safety and Codex Unit, Food and Agriculture Organization, Rome, Italy

Dr Baldomero Molina, Veterinary Public Health, Animal Production and Health Division, Food and Agriculture Organization, Rome, Italy

OIE -

Dr Gillian Mylrea, World Organisation for Animal Health, Paris, France

WHO Secretariat:

Department of Control of Neglected Tropical Diseases-

Dr Dirk Engels, Director

Dr Bernadette Abela-Ridder, Team Leader, Neglected Zoonotic Diseases

Dr Denis Daumerie, Programme Manager

Mr William Donck, Intern, Neglected Zoonotic Diseases

Dr Jean Jannin, Coordinator, Innovative and Intensified Disease Management

Dr Zeb Andrew Youard, Volunteer, Neglected Zoonotic Diseases (co-rapporteur)

Department of Mental Health and Substance Abuse-

Dr Tarun Dua, Medical Officer, Programme for Neurological Diseases and Neuroscience Evidence, Research and Action on Mental and Brain Disorders

TDR for Research on Diseases of Poverty-

Dr Christine Halleux, Scientist, Intervention and Implementation Research

Dr Johannes Sommerfeld, Scientist, Social Science and Community Engagement, Vectors, Environment & Society

Department of Food Safety and Zoonoses-

Ms Amy Cawthorne, Epidemiologist, Foodborne and Zoonotic Diseases unit

Department of Global Capacities, Alert and Response (GCR)-

Dr Stéphane de la Rocque, Technical Adviser, Global Capacities

WHO Regions:

Dr Abate Mulugeta, WHO Regional Office for Africa (AFRO)

Dr Steven Ault, Regional Adviser, Communicable Diseases, HDM, WHO Regional Office for the Americas (AMRO) and the Pan American Health Organization (PAHO)

Dr Hilde Kruse, Programme Manager Food Safety, WHO Regional Office for Europe (EURO)

Dr Anna Fahrion, Division of Information, Evidence, Research and Innovation, WHO Regional Office for Europe (EURO)

Dr Padmasiri Eswara Aratchige, Medical Officer, WHO Regional Office for the Western Pacific (WPRO)

9 Annex 2. Agenda of the meeting

Thursday, 17 July 2014

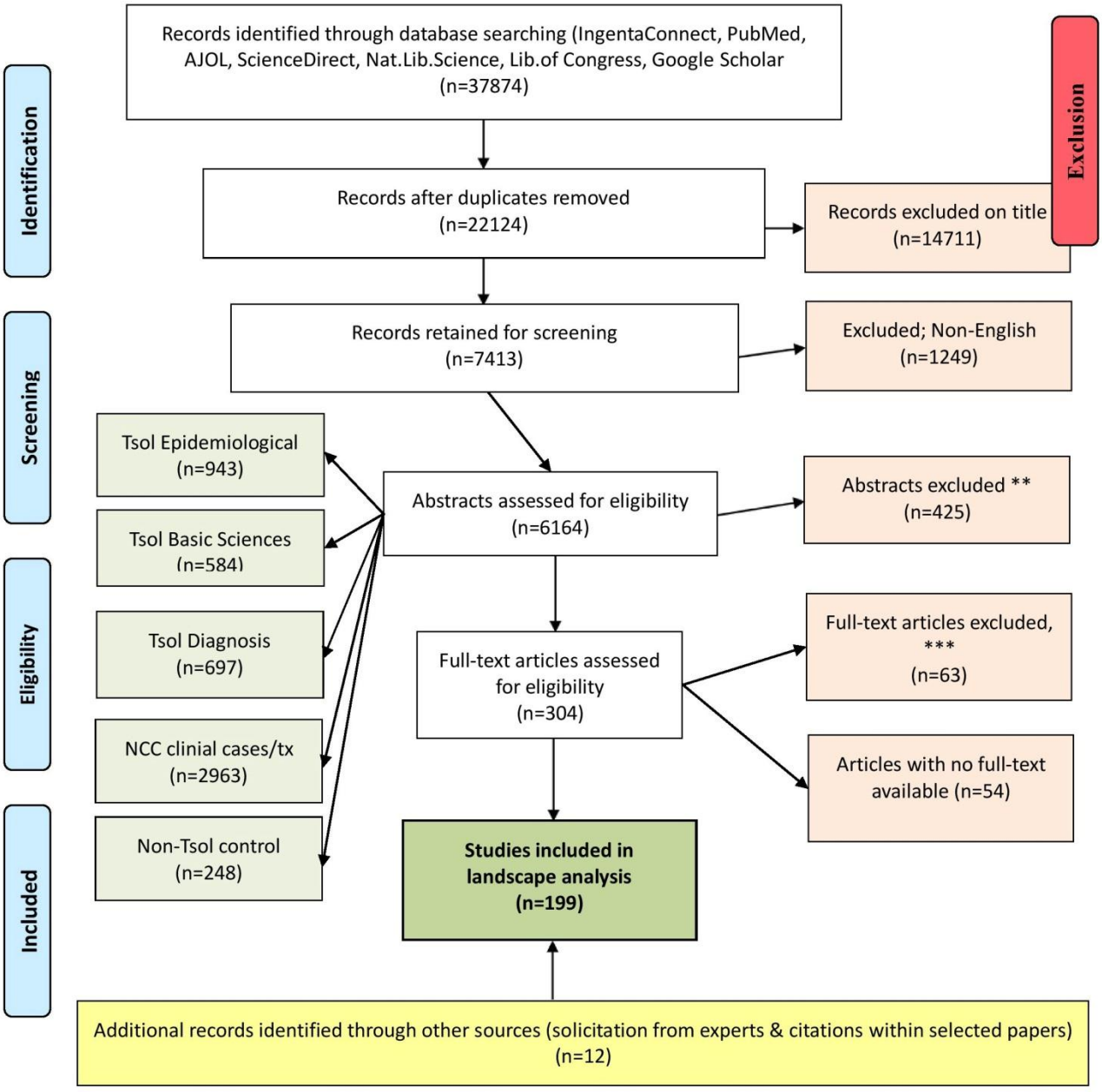
09.00-10.00	**Welcome by NTD Director, WHO Secretariat, FAO, OIE.** **Election of Chair and Rapporteur** **Objectives and Scene Setting by Bernadette Abela-Ridder**
10.00-10.30	Landscape analysis: Control of *T. solium* Eric Fèvre
10.30-11.00	*Coffee break*
11.00-11.30	Transmission Model for *T. solium* Peter Winskill
11.30-12.00	Epilepsy burden and Neurocysticercosis Tarun Dua
12.00-12.30	Landscape analysis on case detection and management of Neurocysticercosis in low resource settings Andrea Winkler/Hardy Richter
12.30-14.00	*Lunch break*
14.00-14.30	*T. solium* control programme in Peru Hector Garcia
14.30-15.00	Situation analysis Brazil
15.00-15.30	Situation analysis Madagascar
15.30-16.00	*Coffee break*
16.00-16.30	Situation analysis Côte d'Ivoire
16.30-17.00	Situation analysis Viet Nam

Friday, 18 July 2014

09.00-09.15	**Summary of Day 1 by Rapporteur and Chairperson**
09.15-09.30	NTD Perspectives NTD Director
09.30-10.00	Situation analysis China (by teleconference)
10.00-10.30	*Coffee break*
10.30-12.30	Working Groups with identified countries to define a strategy for control of *T. solium* and case management for NCC/Epilepsy
12.30-14.00	*Lunch break*
14.00-15.00	Report of Working Groups Discussion
15.00-16.00	Summary of Day 2 by Rapporteur and Chairperson Formal meeting closure by NTD Director

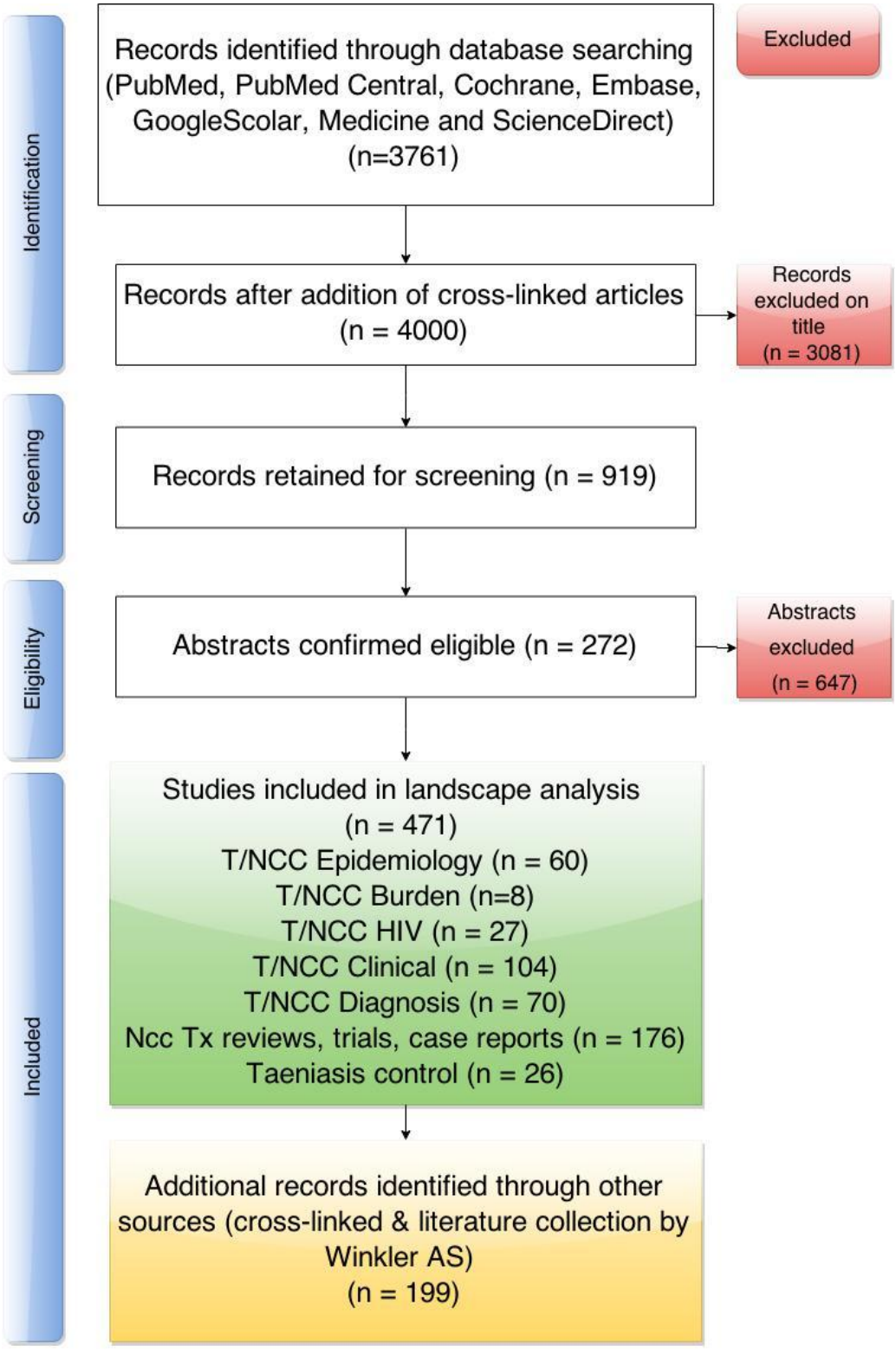
10 Annex 3. Prisma summary for *T. solium* control landscape analysis

The following Prisma summary **(43)** illustrates the search and exclusion process used to select literature for the WHO landscape analysis: *control of Taenia solium.*



11 Annex 4. Prisma summary for NCC landscape analysis

The following Prisma summary **(41)** illustrates the search and exclusion process used to select literature for the WHO landscape analysis: *management of neurocysticercosis with an emphasis on low-and-middle-income countries*.

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