

***Taenia solium* Transmission Dynamics and the Burden of Neurocysticercosis**



ECWG meeting
Institute of Tropical Medicine of Antwerp
Nicolas Praet



April 16th 2012

Presentation Plan

- Introduction
- The burden of NCC
- Why is it important to study the transmission dynamics of *Taenia solium*?

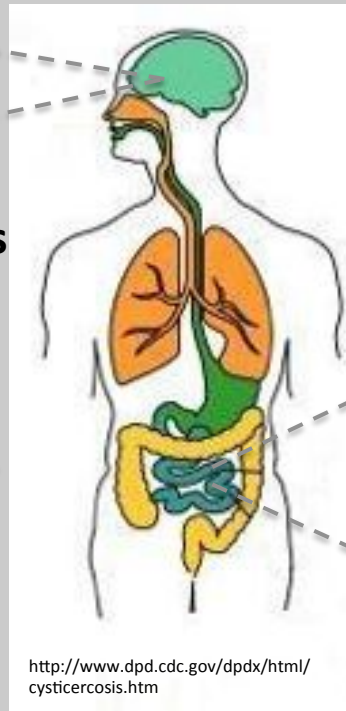
Introduction

- Life cycle
- Distribution and risk factors
- The diagnosis of cysticercosis in pigs and humans



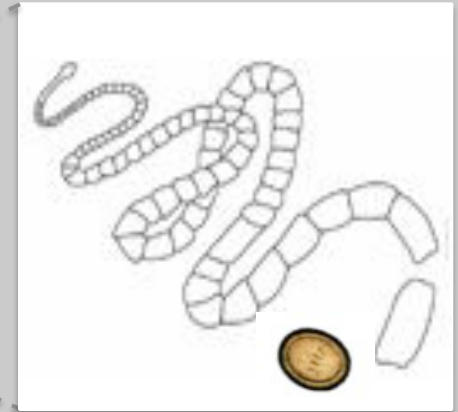
Human cysticercosis

cysts in raw or undercooked infected meat consumed by humans



eggs accidentally consumed by humans

Taeniosis



Life Cycle



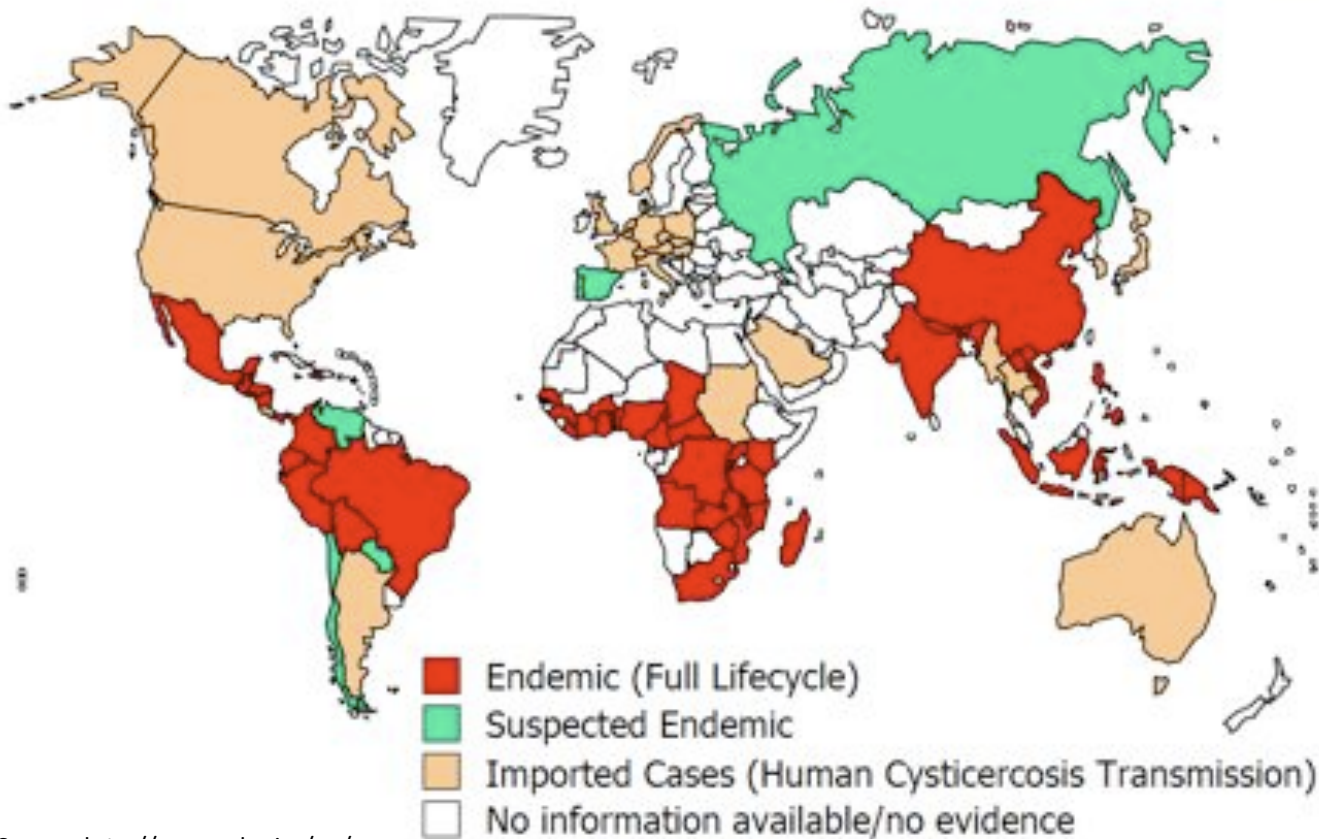
Porcine cysticercosis



eggs in human faeces consumed by pigs

Where is *Taenia solium*?

Global distribution of *Taenia solium* cysticercosis/taeniosis



Source: <http://www.who.int/en/>

Where is *Taenia solium*?

Human to pig transmission: free-roaming pigs



Where is *Taenia solium*?

Human to pig transmission: no sanitations, open-air defecation



Where is *Taenia solium*?



Human to pig transmission:
latrines inappropriately built

Where is *Taenia solium*?

Pig to human transmission: raw undercooked or pork, culinary habits



Where is *Taenia solium*?

Human to human transmission: direct contact or food or water contaminated with eggs



How to diagnose cysticercosis?

🐷 Looking for the parasite in pigs 🐷



TONGUE INSPECTION



CARCASS INSPECTION



Looking for the parasite in humans

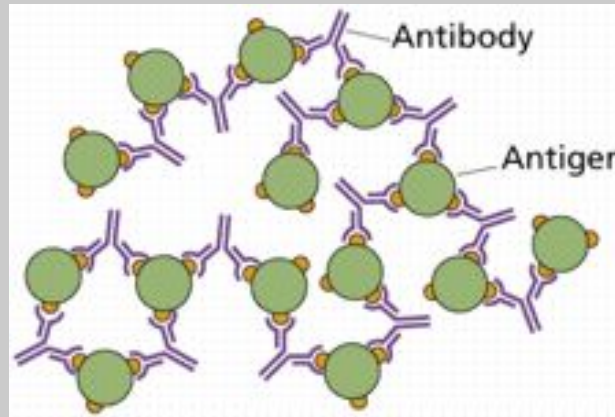
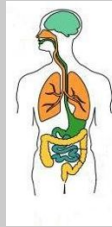
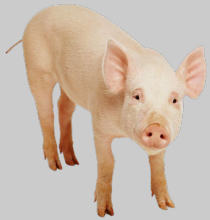


IMAGING



SUB-CUTANEOUS NODULES

Looking for antibodies raised against *T. solium* or circulating antigens of the parasite in porcine and human serum



ANTIBODY DETECTION

ELISA (Enzyme-linked immunosorbent assay)
EITB (Enzyme-linked immunoelectrotransfer blot assay)



EXPOSURE

ANTIGEN DETECTION

SANDWICH ELISA



INFECTION

The disease burden of NCC

The burden of a disease

Why is it important to estimate the burden of a disease?

1. Setting priorities for public health research, policy and services
2. Comparing the cost-effectiveness of disease control programmes
3. Comparing the importance of a disease between countries/regions of the world

How to estimate the burden of a disease?

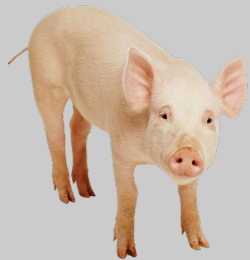
Monetary burden



- Direct costs: medical doctor, diagnostic tests and treatments



- Indirect costs: incapacity to go to work or to get a job



- Animal production: carcass condemnation at slaughterhouse and meat price decrease

Health Burden: Disability Adjusted Life Year (DALY)

DALYs = number of years of full health lost due to the disease



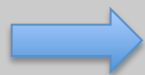
➤ = Years of Life Lost due to premature death
= YLLs



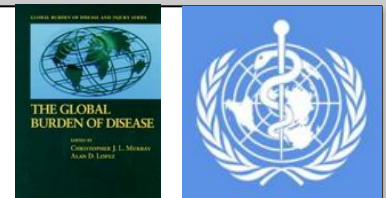
➤ = Years of Life lived with Disability
= YLDs

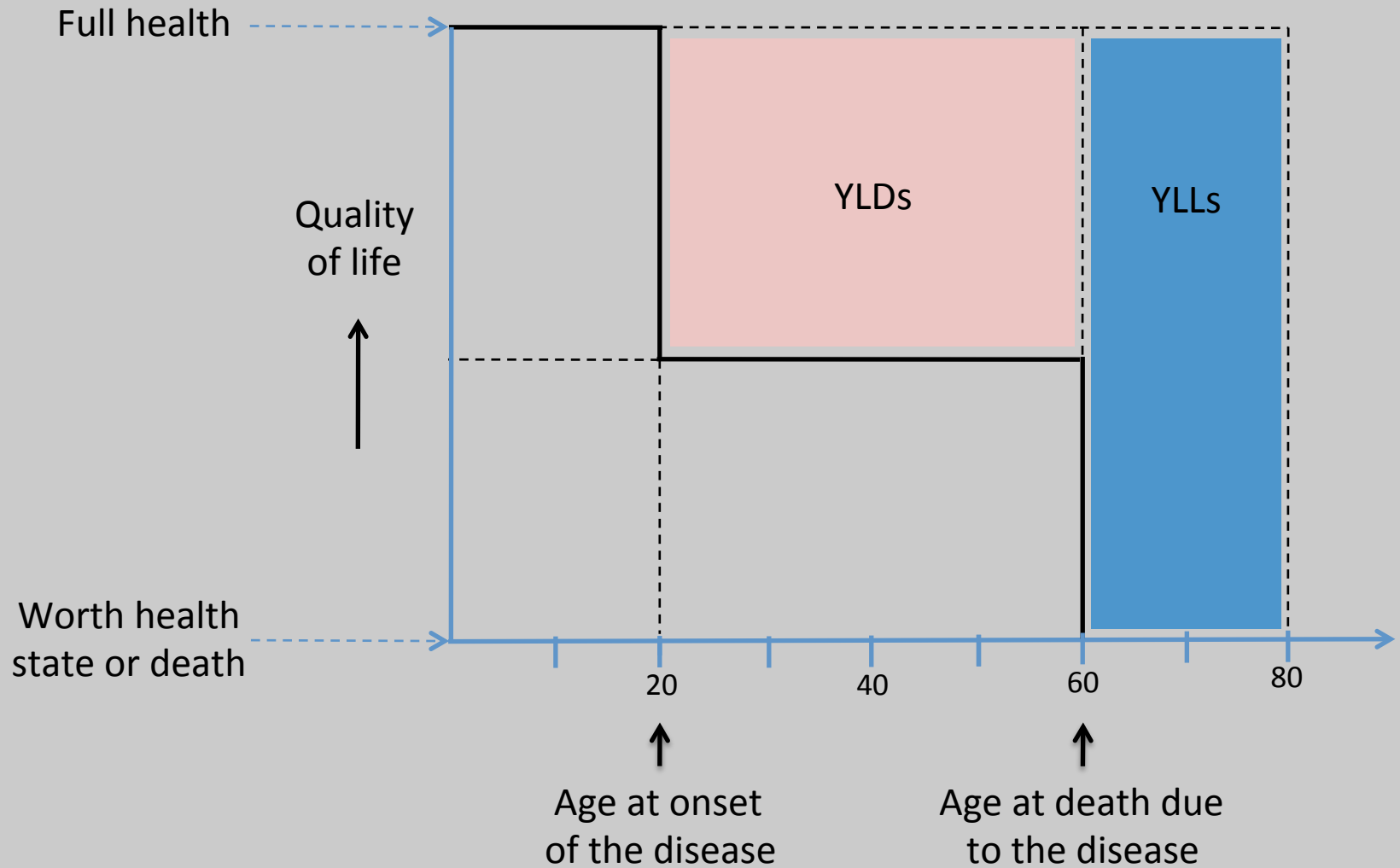


$$\text{DALYs} = \text{YLLs} + \text{YLDs}$$



Approach used by the World Health Organization to estimate the Global Burden of Diseases





DALYs = YLLs + YLDs

3 comprehensive studies available

Tropical Medicine and International Health

doi:10.1111/j.1365-3156.2006.01627.x

VOLUME 11 NO 6 PP 906–916 JUNE 2006

Estimation of the cost of *Taenia solium* cysticercosis in Eastern Cape Province, South Africa

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3 comprehensive studies available

OPEN  ACCESS Freely available online



The Disease Burden of *Taenia solium* Cysticercosis in Cameroon

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3 comprehensive studies available

OPEN ACCESS Freely available online



Estimating the Non-Monetary Burden of Neurocysticercosis in Mexico

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Burden estimation components

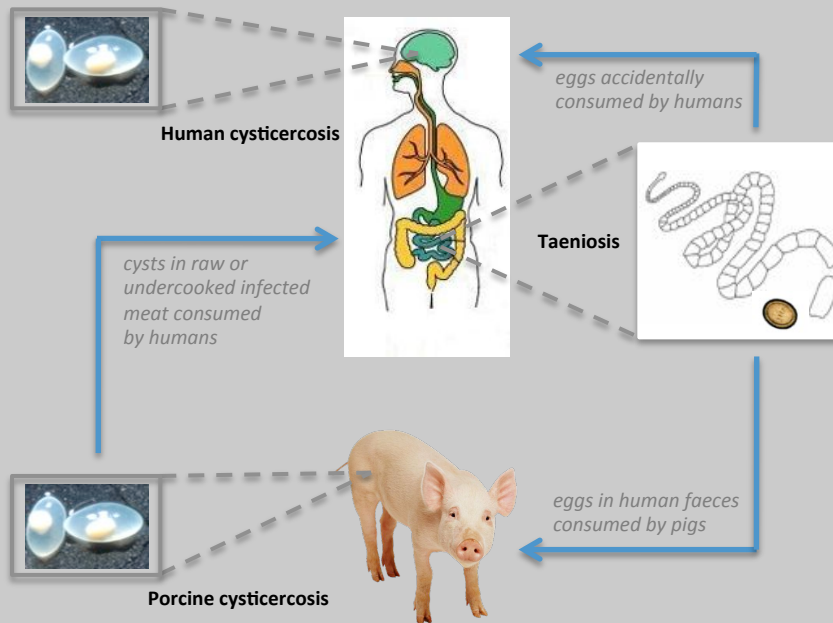
Monetary burden assessment

Health burden assessment

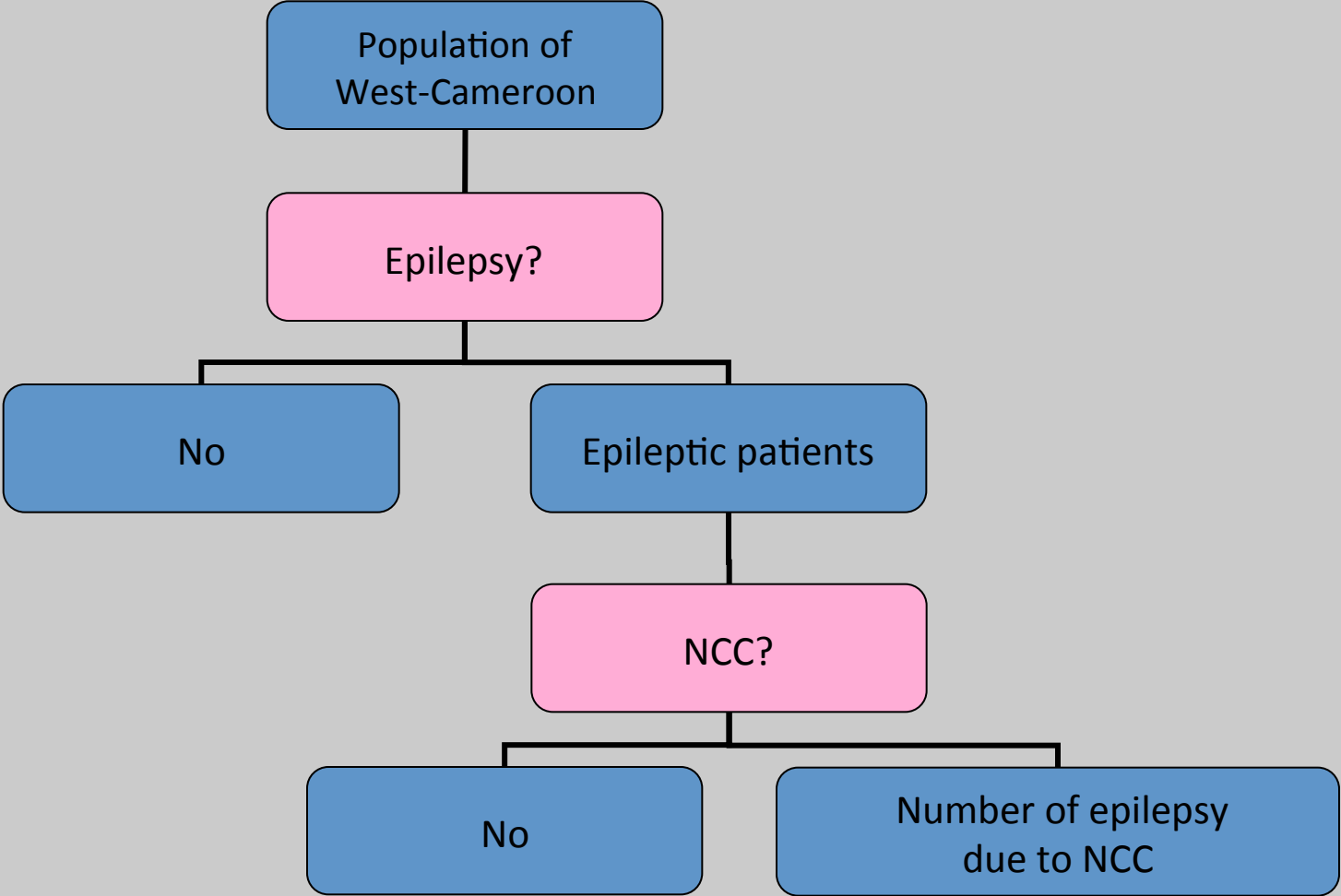
Direct & indirect costs linked to human health

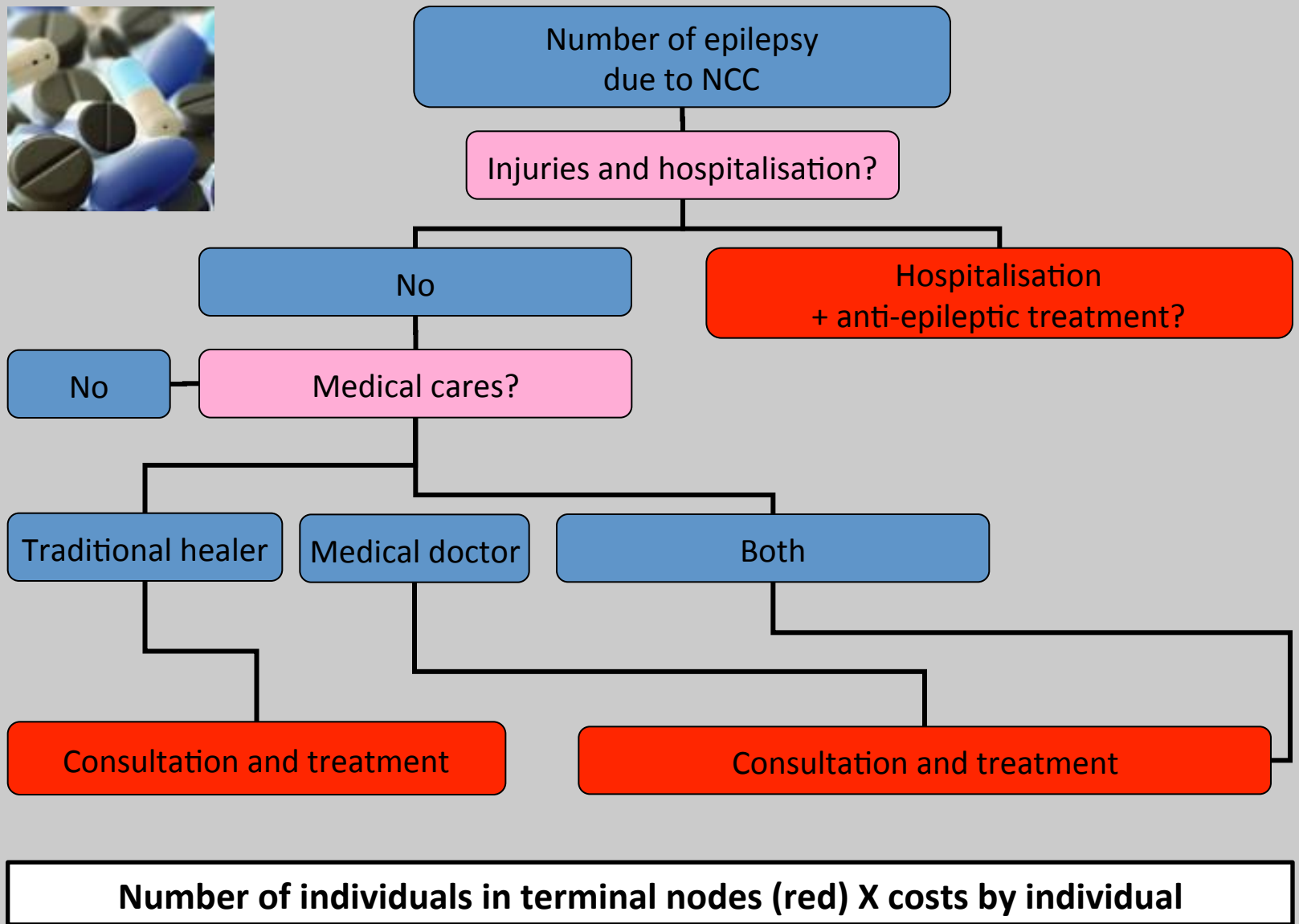
DALYs lost (YLLs + YLDs)

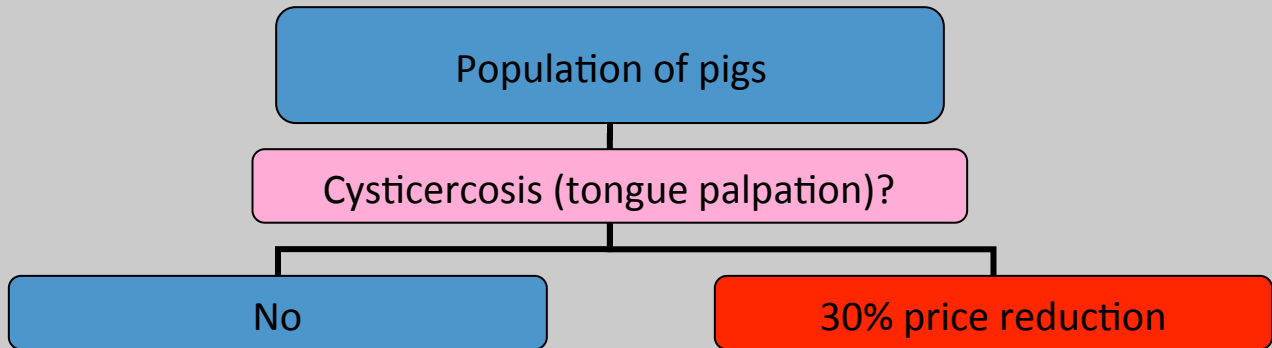
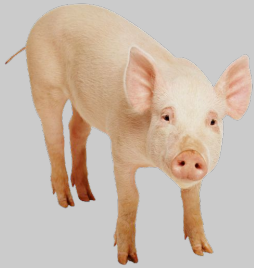
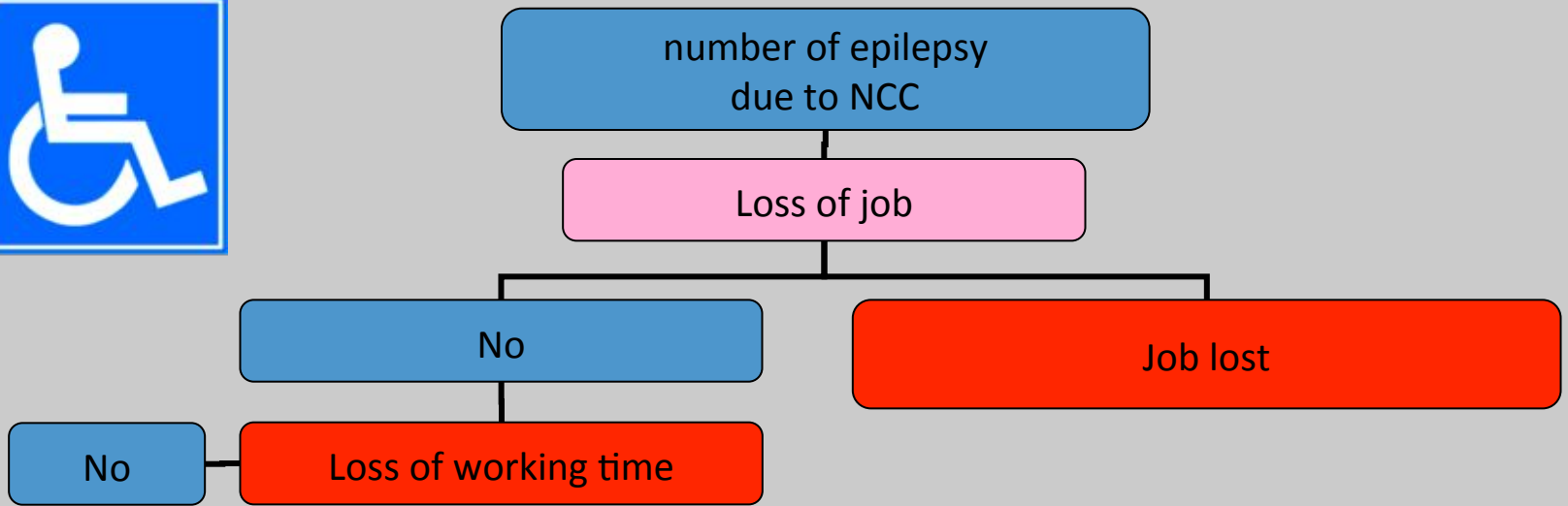
Costs linked to pig meat production (infected meat price decrease)



Decision tree







Number of individuals in terminal nodes (red) X costs by individual

Retrospective study

Collection of existing data to estimate

1. how many individuals are suffering from NCC
2. How many pigs are infected with *T. solium*



Searching for the necessary information:

1. National and international health statistics
2. Scientific publications
3. Expert opinion



Consider the uncertainty around this information by using probability distributions for almost each of above-mentioned parameters

Monetary burden comparison

More cases in Cameroon but lower monetary burden: mainly due to difference in indirect costs (lower salary)

8. Comparison of the monetary burden of *T. solium* cysticercosis in West Cameroon and Eastern Cape Province South Africa.

	West Cameroon (This study)	ECP, South Africa [3]
• Population	5,065,382	7,088,000
• No. (%) of NCC-associated cases of epilepsy	50,326* (1.0)	34,662 (0.5)
• Overall monetary burden ($\times 10^6$ Euro)	10.3	15.0–27.5 ^o
○ % due to human cysticercosis	95.3	73.1–85.4
○ % due to porcine cysticercosis	4.7	14.6–26.9
• Monetary burden per capita (Euro)	2.0	2.1–3.9

* based on a prevalence of epilepsy of 3.6%.

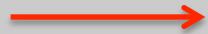
^o different calculation methods were used (based on 2004 exchange rate of 1US\$ = 0.805 Euro).

doi:10.1371/journal.pntd.0000406.t008

DALY studies comparison

Cameroon	Mexico
9 DALYs lost per 1,000 person-years*	0.25 DALYs lost per 1,000 person-years*

*years of life in perfect health yearly lost per 1000 inhabitants of the area



Higher health burden in Cameroon mainly due to higher mortality rate

Conclusions

1. Burden of human and porcine CC may be non negligible and deserves a more global assessment
2. Identification and description of disease data gaps (epidemiological and clinical)

Conclusions

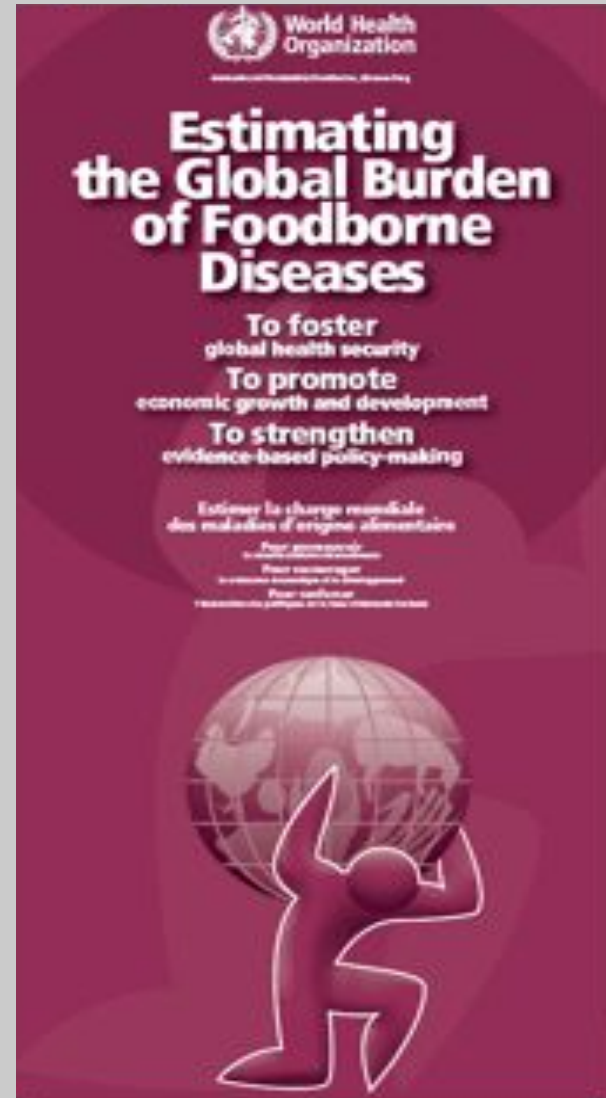
3. Comparison Monetary and Health burden approaches

	Monetary Burden	Health (DALY) Burden
Indicator	monetary costs related to morbidity	years lost due to morbidity AND mortality
Zoonotic infections	cost of animal production losses may be included	cost of animal production losses can NOT be included
Social impact	not taken into account	not taken into account
Economic impact	taken into account	not taken into account
Comparison between world regions	depends on time- and region-specific economical factors (difficulties in comparing poor and rich countries)	possible throughout the whole world
Interpretation for decision-makers	accessible	needs a certain background
Identification of decision-tree end component	sometimes difficult to identify for each cost	only mortality rate and incidence of each symptom to be identified
Disability weighting	not necessary	disability weights rather subjective and not context specific

Perspectives: towards the assessment of the Global Burden of NCC

GBD of NCC considered by WHO in the framework of the Foodborne Disease Burden Epidemiology Group (FERG) initiative:

- Systematic review conducted
- % of NCC-associated epilepsy available: 29%
- DALY calculations on going (estimates expected in 2013)



Why is it important to study the transmission dynamics of *T. solium*?

- Accurate burden estimates/filling data gaps on:
 - Age-related prevalence/incidence/mortality estimates (pigs and human)
 - Disease duration
- Cost-effective intervention programmes

Why is it important to study the transmission dynamics of *T. solium*?



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www.elsevier.com/locate/ijpara

Simulating transmission and control of *Taenia solium* infections using a Reed-Frost stochastic model

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Study of the effect of age on the proportion of infected and exposed individuals

International Journal for Parasitology 40 (2010) 85–90



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International Journal for Parasitology

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Age-related infection and transmission patterns of human cysticercosis

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Modelling as a tool

- Available data and expert opinion on the transmission dynamics and control of *T. solium* need to be objectively synthesized in order to be objectively interpreted
- Large scale and multifactorial studies are expensive and difficult to implement



Modelling allows to use available information to estimate the prevalence/incidence and effect of control strategies on an objective manner and in different settings

Modelling may include several techniques such as:

- Bayesian approach
- Rule-based modelling
- Expert elicitation
- Stochastic approach (uncertainty)

Conclusions

1. Burden of human and porcine CC may be non negligible and deserves a more global assessment
2. Identification and description of disease data gaps (epidemiological and clinical)
3. Transmission dynamics studies are essential to assess the burden of *T. solium*

Perspectives

Assessment of the global burden of cysticercosis

How to obtain these estimates when only fragmentary data are available?

2 approaches



Prospective approach

- more accurate diagnostic tools
- standardise data collection

Longitudinal age-related immuno-epidemiological and clinical data to estimate:

- the incidence of the disease
- the proportion of CC-associate symptoms



Retrospective approach

- using existing data in innovative ways

Systematic literature reviews

Meta-analyses

Simulation models

Bayesian modeling

Expert elicitation

Stochastic models

Burden estimates



Cost-effectiveness of prevention and control programs can be tested and help national and international policy- and decision- makers in setting priorities in public health and veterinary public health policies, services and research



CC burden



Intervention costs

<http://www.ecriturecreative.net/wp-content/uploads/2009/06/balance2.jpg>