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## SHORT CUTS TO DEVELOPMENT: METHODS TO CONTROL THE TRANSMISSION OF CYSTICERCOSIS IN DEVELOPING COUNTRIES

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### MAGNITUDE OF THE PROBLEM

*T. solium* infection and the resulting disease neurocysticercosis, are highly endemic in all parts of the developing world where pigs are raised as a food source. Neurocysticercosis is present throughout Latin America, Indonesia, Africa, and parts of India. In rural areas of Latin America, between five and twenty percent of the population is infected with *T. solium*. In Mexico, Ecuador, and Brazil, the prevalence of neurocysticercosis found at autopsy exceeds 1%.<sup>1,2</sup> and both Mexico<sup>3</sup> and Peru,<sup>4</sup> 12% of acute neurological beds are occupied by patients with NCC. Neurocysticercosis was the fourth most common condition found at autopsy (ranking above tuberculosis) at the Santo Toribio Neurological Hospital of Lima, Peru. Over a 37 year period from 1950 to 1987, 136/2,200 (6%) of the autopsies performed at this hospital showed cysticercosis (L. Palomino, personal communication) reflecting the considerable mortality associated with this disease.

### BIOLOGICAL BASIS OF DISEASE AND TRANSMISSION

Cysticercosis is a disease of pigs and people. The pig harbors the larval stage of *T. solium* and human beings acquire the adult tapeworm by eating under-cooked pork. Upon infestation, the larvae evaginate in the small intes-

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tine, mature over a period of months and produce gravid proglottids, each containing thousands of eggs. Disease occurs when humans become infected with the cysticerci, or larval stage through accidental ingestion of tapeworm eggs. Thus, humans can serve as both the definitive and the intermediate host. If ingested by a human or pig, the eggs hatch in the small intestine, and the larva travel through the small venules to muscle and brain tissue. Once there, the larvae develop over several months into mature larval cysts.<sup>5</sup>

From the standpoint of disease transmission to humans and maintenance of the cycle, only the tapeworm is of importance. Individuals who ingest the egg of the tapeworm and develop the larval (cystic) form do not pose a public health risk. They are a health concern because of their disease; but unless also infected with the tapeworm form of the disease have no part in maintaining the cycle of the parasite.

Developed countries, by improving sanitation and hygiene practices as well as moving to commercialization of nearly all piggeries have all but eradicated cysticercosis.<sup>6</sup> The practices of indoor plumbing and modern porcine husbandry largely dictate how free a region will be from *T. solium* transmission and consequently how much burden of disease from cysticercosis will occur. In developing countries the rates of cysticercosis are also low among individuals who live for most of their life in major urban centers for the same reasons: cities often have sewage, pork comes from commercialized piggeries or is inspected appropriately, and the meat is usually eaten after having been well cooked. Pigs in these areas are rarely bred in the houses and have little access to human feces. For example, in Lima, Peru, less than one percent of individuals born in the city have serological evidence of infection.<sup>7</sup>

Essentially, the *T. solium* cycle is transmitted mainly in rural areas where the lives of pigs and people are intimately intertwined. Pigs commonly have access to raw human sewage or feces, and *T. solium* infected meat is widely available. Unfortunately, these same regions are the last to develop adequate sanitation and to install widespread, safe animal husbandry practices. Thus, rural areas in where pigs are raised are by far the mainstay of *T. solium* transmission and the majority are highly endemic for neurocysticercosis.

## CONTROL STRATEGIES

Intervention can occur by interrupting the human or pig steps of the cycle separately or both together. Human infection in endemic areas can be decreased either by detecting and treating just the tapeworm carriers or elimi-