Measures for the prevention and control of Taenia solium taeniosis and cysticercosis

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Abstract

Taeniosis and cysticercosis due to Taenia solium are public health problems in many developing countries. Many studies of this parasitic zoonosis have focused on clinical features, diagnosis, treatment, surveillance, epidemiology and risk factors analysis. More recently projects on community and mass intervention strategies had been conducted in several rural areas worldwide focused on pig vaccination, pig cysticercosis treatment, human mass treatment, infrastructure development, as well as health education campaigns. Their advantages, disadvantages and public health impact have been published. This document discusses the feasibility and limitations of these interventions in order to assist countries in selection the best strategy for the prevention and control of this disease; we emphasized the specific strategies that might be recommended in different demographical situations.

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1. Introduction

Taeniosis and cysticercosis caused by Taenia solium are public health problems in many endemic countries where the persistence of this zoonosis is promoted by certain cultural, socioeconomic and sanitary conditions. Human activities impact on almost every one of the stages of the life cycle of this parasite. Since taeniosis is exclusively a human disease, man is responsible for dispersion of the parasite’s eggs through outdoor defecation and indiscriminate disposal of feces.

The other factors promoting transmission of the disease include contact between pigs and human feces, lack of inspection of pork, consumption of uncooked or undercooked pork, consumption of unclean vegetables and water contaminated with infected human feces and, finally, poor personal hygiene (e.g. inadequate washing of hands before eating and after defecating) (Sarti et al., 1988, 1997; Flisser et al., 1994; Garcia et al., 1991).

Several risk factors of this disease have been clarified from epidemiological studies done in many endemic countries (Sarti et al., 1988, 1992, 1994, 1997; Diaz et al., 1990; Allan et al., 1996; Keilbach et al., 1989; Cruz et al., 1989; Garcia et al., 1991; Garcia et al., 1995; Garcia-Noval et al., 1996; Sanchez et al., 1997, 1998, 1999; Schantz et
al., 1991, 1992, 1994). From these studies, several characteristics that make *T. solium* vulnerable to control and potential eradication have been summarized (Schantz et al., 1993). These characteristics are: (1) the life cycle of *T. solium* requires human beings as the definitive host; (2) taeniosis is the only source of infection for the intermediate host; (3) pigs can be monitored, considering the short life span of the animal; (4) there are no wild reservoirs; and (5) safe and efficacious antiparasitic drugs against taeniosis are available.

This document will discuss the feasibility and limitations of the various control and preventive measures that have been proposed. This analysis is based on publications on the subject or the personal experiences of the authors and their colleagues. It is our hope that this analysis will help public health authorities in deciding on the most appropriate and relevant strategy for the specific conditions in their countries. Although, there are several possible intervention strategies that could be used to control taeniosis/cysticercosis, we only discuss those that can be utilized as a single intervention strategy.

2. Pig vaccination

The value of vaccine campaigns in the control of infectious diseases is well established. Since pigs are the only intermediate host in the taeniosis/cysticercosis zoonosis, vaccination could be an effective preventive measure. Several studies have been carried out searching for the best recombinant antigens to be included in the vaccine (Sciutto et al., 1995; Molinari et al., 1993; Manoutcharian et al., 1996; Flisser and Lightowlers, 2000; Lightowlers, 1996; Lightowlers et al., 2000; Maravilla et al., 1998; Plancarte et al., 1999). However, none to date have shown total efficacy.

Even with an efficient vaccine, we must consider several aspects before including pig vaccination in a control strategy. The vaccine must be cheap, with long-term protection, and it should be easy to administer in a mass intervention campaign. Governments will have to subsidize, either completely or partially, the cost of the vaccine, since the pigs that need vaccination are usually owned by too poor families to pay for it. Other factors to consider include the logistics of distribution of the vaccine and the trained personnel needed to run a mass intervention campaign. One must also decide if such an intervention should be implemented over the entire country or only in places and communities where transmission of the disease has been demonstrated (‘hot spots’).

It is important to analyze the lessons learned from similar control strategies for other zoonotic diseases. In countries where rabies vaccination campaigns, focused on dogs, have been established and implemented once a year, rabies rates have decreased. But when rabies vaccination of dogs is offered the year round as part of an established public health program and intensified during two or three periods in a year, eradication of rabies is faster. In the case of pigs, the mean life is shorter than dogs, and this means that vaccination as a control strategy will be more complicated and expensive because the interval between the vaccination campaigns must be shorter and the vaccine should also be continuously available to the pig rearers.

If governments take up the challenge of such a vaccination campaign for pigs, then theoretically, this intervention strategy could be one of the best to prevent the transmission of this zoonosis. But the cost of an effective vaccine, if and when it becomes available, will probably be a major deterrent to this strategy being used as a control measure for taeniosis/cysticercosis.

3. Pig cysticercosis treatment

Another approach for prevention and control this parasitic disease is the treatment of swine cysticercosis with antiparasitic drugs (Gonzalez et al., 1996, 1998, 2001; Kaur et al., 1995; Flisser et al., 1990); one of the best being oxfendazole. Many authors have reported excellent results and shown that this chemotherapy is also effective as a preventive measure similar to that of a vaccine, because pigs were refractory to re-infection even in the event of ongoing exposure to the source of *T. solium* eggs, in accordance with the authors report (Gonzalez et al., 2001). Oxfenda-
zole has been shown to have 100% efficacy in curing porcine cysticercosis 3 months after its administration. During this interval of time, the pigs should not be killed for consumption.

This alternative has some advantages over a vaccine because oxfendazole is cheap and it acts both as a treatment and a vaccine. Furthermore, pig rearing families and commercial swine producers do not lose their pigs if they are infected and their herds are protected for 2 years after administration of the drug. This intervention measure could be efficiently used in swine production farms and in communities where pigs are concentrated because the local population can take charge of the responsibility of treating the pigs.

Other factors that should be taken into account are similar to those considered for mass vaccination of pigs. The subsidy for the treatment will be a major concern if this strategy is to be implemented. Since the cysts die during boiling or freezing without any additional cost, it may be difficult to convince communities the need to pay more for the same result using even a cheap drug such as oxfendazole. An educational campaign may have to be initiated before introducing the drug as a mass therapy, to illustrate the benefits of the treatment to the target population. But this will add to the cost of using cysticidal drugs in pigs as a control measure. Finally, families with infected pigs cannot eat or sell the meat from such pigs for at least 3 months after treatment. This will necessitate close supervision and monitoring of such pigs, leading to additional costs for this control measure.

4. Human mass treatment

With the introduction of praziquantel and niclosamide, both of which are safe and efficient in the treatment of taeniosis, mass chemotherapy of humans has become a feasible strategy for the control of this zoonosis. However, the initial trials with mass therapy of humans have not been shown to be consistently effective, probably because of the particular population that was targeted, the taeniacidal drug used, and the evaluation criteria that were used (Pawlowski, 1991; Flisser et al., 1994; Cruz et al., 1989; Kobayashi, 1984; Diaz et al., 1991; Keilbach et al., 1989; Sarti, 1997; Sarti et al., 2000; Bundy, 1990; Garattini et al., 1982; Lara, 1984). One of these studies included long term evaluations (6 and 42 months) after the intervention strategy was applied and recorded clinical, immunological and epidemiological observations from either the entire treated population and/or randomly selected persons from the population (Sarti et al., 2000). The study revealed the public health benefit of mass chemotherapy (5 mg/kg of praziquantel) against taeniosis, at least for short-term control. But praziquantel is not the ideal drug for the treatment of tapeworm as its efficacy, in doses lower than 10 mg/kg, declines to 67% (Sarti et al., 2000). In doses higher than 10 mg/kg, its efficacy approaches 100% but there is a risk of inducing seizures in asymptomatic individuals harboring a live cysticercus cyst (Flisser et al., 1994; Pawlowski, 1991). This is because praziquantel is both a taenicial and is cysticidal because it crosses the blood brain barrier. This event has happened in a mass treatment campaign in Mexico (Flisser et al., 1994; Sarti et al., 2000). The adverse publicity for the mass treatment campaign in such an event is not difficult to imagine and can lead to calls for suspension of the campaign, both by the people and the press. For this reason, niclosamide should be the drug of choice for mass chemotherapy.

Niclosamide mass treatment can be combined with other mass health campaigns such as children vaccination against preventable vaccination diseases, could have high compliance and impact. Its effect on the disease can be checked by monitoring the pig cysticercosis rates in the target community. In the short-term, these rates have been shown to decline after mass taenicial treatment (Garattini et al., 1982). The positive outcome of such an intervention can be used to convince the health authorities to follow up with further cycles of taenicial treatment. However, the cost and the logistics of drug distribution for such an intervention strategy must be considered. The cost of the drug has to be borne entirely by governmental or non-governmental organizations. Nevertheless the distribution of drug should not pose a major challenge in most countries. As a result of previous
mass immunization and therapy campaigns for other diseases (e.g. poliomyelitis and lymphatic filariasis) supply chains do exist for delivery of drugs and vaccines of public health importance to even the remotest areas of most countries. The other major advantages of niclosamide are its long shelf life and it does not require cold storage, unlike some vaccines. It is recommended that mass therapy with niclosamide be administered twice a year, country-wide in endemic countries, in order to have a major impact on the parasite load in the community. It should be expected that several rounds of such mass therapy intervention will be needed over 5 years or more before the disease is controlled. People must also be educated about disposal of their feces after the mass therapy. If pigs are allowed contact with human feces after such treatment, it could lead to an increase in the porcine cysticercosis rates. Hence, alongside mass therapy, mass communication and education campaign towards safe disposal of human feces, has to be implemented. We believe that the positive impact of such an intervention can be demonstrated in a short time.

5. Development as a control measure

The disappearance of T. solium in most European countries is important evidence of the potential eradication of this species in the long term. The eradication of this zoonosis in those countries is attributed to their economic development. Development in the spheres of environmental sanitation, pig husbandry and strict meat inspection are responsible for the control of taeniosis/cysticercosis. (Schantz et al., 1993; Grove, 1990; OPS, 1994). Unfortunately, these measures are not yet feasible in all developing countries. Without any doubt, overall economic development is the best strategy for control of the disease but this is likely to require several decades if not longer in some developing countries. Therefore, the other control approaches discussed must be relied upon.

6. Health education campaigns

Health education campaigns have been shown to be effective in the prevention and control of many infectious diseases. Participation of the community and schools in maintaining hygienic and sanitary conditions has been emphasized in several studies (Albonico et al., 1996; Udonsi and Ogan, 1993; Rousham, 1994; Nakamura and Siregar 1996; Sarti, 1997). In Mexico, a comprehensive study was undertaken in a rural community to evaluate the effect of health education, in both the short and the long term (6 and 42 months), as an intervention measure against T. solium (Sarti, 1997). It was a successful intervention strategy because almost 4 years after the health education was implemented, no infected pigs could be identified in this communities (swine cysticercosis rate before intervention was 2.6%). Changes in knowledge, attitudes and practices with regard to the disease, as well as, reduction in human taeniosis rates and rates of exposure to cysticercosis in humans (as determined by serological studies) were also outcome of his intervention.

Although health education can be an effective intervention strategy with permanent effects, it requires multidisciplinary input and active participation of the community. Effective, committed and enthusiastic community leaders are essential for this strategy to succeed. Due to the number of personnel required, this strategy can be expensive. It also needs infrastructure improvements such as the construction of latrines, pigpens and slaughterhouses to facilitate changes in the people’s practices; these will also contribute to the cost of this intervention.

7. Conclusions and recommendations

WHO/PAHO, have proposed two basic strategies for the control of taeniosis/cysticercosis for the short and long term. The short term strategy is based on mass treatment against taeniosis against taeniosis in endemic areas where risk of transmission is high. The long term strategy involves health education, modernization of pig farming, rigorous inspection
of pork in official slaughterhouses, creation of hygienic and sanitary conditions in the community and active epidemiological surveillance systems to identify tapeworm carriers (Gemmel et al., 1983; OPS, 1994).

We endorse these, and describe below on specific recommendations for implementing these approaches.

7.1. Control strategy 1

One combination on intervention strategies described above, depending upon conditions in different countries, should be used to control the disease. For example, in countries where there are several rural communities with many informal (clandestine) slaughterhouses, but where pigs are kept restrained, a health education campaign could be an effective strategy. But in a situation where pigs have free access to human faeces, a combination of pig and human treatment might be the best option.

7.2. Control strategy 2

Since epidemiological studies indicate that the main risk factor for acquiring cysticercosis is living with a tapeworm carrier (Sarti et al., 1988; García et al., 1995; Schantz et al., 1991, 1992), targeted treatment of the tapeworm carrier might be an alternative strategy to control the disease. However, a strong primary health care network is essential for this strategy to succeed. The identification of the taenia carrier by laboratory confirmation or questioning of individuals (Have you (or members of your family?) ever passed parts of a tapeworm (showing proglottids) in your faeces?) along with identification of human and swine cysticercosis in and around the family is essential for this strategy to succeed (Sarti et al., 1988, 1994, 1997; Schantz et al., 1991, 1994; Sanchez et al., 1997, 1998). The health personnel will then offer to treat the taenia carrier and all members of the family and the pigs. This strategy can be effective only in countries that have an efficient surveillance system with health units covering more than 70% of the population.

7.2.1. Control strategy 3

Mass treatment with niclosamide can be used initially as a short-term measure. The drug administration could be done through schools and combined with other public health intervention measures that target children and their families (e.g. niclosamide can be offered with other anti-parasitic drug (albendazole) against common and endemic intestinal worms) to obtain population approval and to have a short-term public health impact. The treatment of taeniosis could also be linked to other mass treatment campaigns such Vitamin A therapy, poliomyelitis vaccination and lymphatic filariasis prophylaxis to make it economical to the governments and acceptable to the people. But as discussed above, multiple cycles of niclosamide therapy will be needed to provide lasting benefit to the community.

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References


