SCIENCE COMMUNICATION AS A MEANS OF PREVENTING INFECTIOUS DISEASES: COMMUNITY SELECTION AND DEVELOPMENT OF THE COMMUNICATION PROGRAM

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Abstract

Can we use science communication as a tool for preventing infectious diseases? Our aim is to develop a communicative programme that promotes critical thinking in the participants, using team work to encourage them to think, propose and implement action and intervention plans that help improve community's health and well being. Moreover, through a process of knowledge appropriation, we seek that the program promotes risk behaviour modification. The programme will take into account ethnological, sociological and marketing aspects in order to make learning more appealing. It is directed to young people between 12 to 25 years old, although the participation of the community as a whole is fundamental in order for the programme to have success. As a working model we are using taeniosis-cysticercosis caused by the parasite worm *Taenia solium*. Here we present results of the initial community selection process and the progress in the development of the communicative programme.

Keywords: Science communication, critical thinking, community's health, *Taenia solium*, taeniosis-cysticercosis

1. Introduction

"¿How can great discoveries be useful if there are no means of making them accessible to all?"
Alexander von Humboldt

In more than a decade that I've been working with infectious diseases from a basic science perspective, I have come to the conclusion that many of these diseases could be prevented if a person were given the chance to *understand* which human activities increases the risk to acquire a certain disease and the advantage of avoiding infection. Teaching people how diseases are transmitted, how to improve their sanitary behaviour, how to avoid vector bites, etc., have been shown to have an impact in disease prevention. However, some of the educational programs tested so far, had as a main problem that once the program concludes, people return to their original behaviour. Moreover, although health education interventions increase the level of *knowledge* of the population, modification of *risk practices* are less apparent, suggesting that changes in knowledge does not necessarily modify behaviour [1].

My hypothesis is that educative interventions do not have an impact in modifying risk practices because they use a non-feedback unidirectional (only informative) model of communication [2], which prevents the participants from forming their own ideas and conclusions. People are never allowed to draw evidence-based conclusions in order to understand and make decisions about the natural world and the conditions, where a specific disease is transmitted. What is more, they are never allowed to develop scientific thinking, which would promote the capacity to use the recently learned scientific knowledge. It is at this point where science communication becomes important. In order to be able to appropriate knowledge, people needs to place the information they receive in a context in which it makes sense with their own everyday experience. Our aim, as a multidisciplinary group, is to develop a communicative programme that allows the participants to "*discover*" facts about health and hygiene in their community through the systematic use of the scientific method. This bidirectional model of communication would promote knowledge acquisition and appropriation by means of observation, argumentation and deduction (scientific method and inquiry). Then, through in-depth analysis, it is expected that the participants will be able to identify, analyze and propose solutions to solve community's health problems, including modifying personal risk behaviours.

As a working model we are using taeniosis-cysticercosis (TC) caused by the parasite worm *Taenia solium*. *T. solium* life cycle alternates between man as a definitive host and pigs as intermediate hosts (Figure 1). The adult worm inhabits human small intestine causing taeniosis, a mild disease that usually produce no symptoms. The adult worm, which is hermaphrodite, produces thousands of eggs that are excreted during defecation. Pigs get infected when they ingest human faeces containing segments of the adult parasite or eggs. Each egg has the potential to become a cysticercus, the larval stage of the parasite, causing swine cysticercosis. The cycle ends when man eats improperly cooked pork meat that contains cysticerci. Cysticerci adhere to the wall of the intestine where they mature into the adult worm. Inadequate hygienic measures associated to the worm carrier may cause accidental ingestion of eggs by man, causing human cysticercosis. Infection of the nervous system is called neurocysticercosis and may cause death [3, 4].

T. solium is endemic in México, being neurocysticercosis a major cause of epilepsy [5]. Frequencies of neurocysticercosis have been obtained from clinical and pathological studies during the 1990s when field epidemiological studies were initiated. One of the most important findings relates to a marked clustering of cases of human and swine cysticercosis with those of individuals harbouring the adult intestinal tapeworm [6-10]. Performance of field studies aimed to identify risk factors associated to human cysticercosis has advanced to such a degree that intervention measures can be adequately tested. It has been shown that mass treatment against taeniosis is a proper measure to control cysticercosis [1, 10, 11] and that pigs are adequate sentinels to detect environmental contamination with *T. solium* eggs [12, 13]. Alternatives like the development of a vaccine are on their way [14]. Nevertheless, neither of them are long term solutions as the factors involved in disease transmission remain, favouring people reinfection. TC as many other parasitic diseases, are closely related to poverty (lack of running water and drainage, adequate housing, etc) and a low level of education of the population, which results in poor hygienic and pig husbandry practices. There is nearly a complete ignorance of the relationship between the parasite's life cycle stages in pigs (cysticercosis) and the adult stage (taeniosis) and invasive disease (neurocysticercosis) in humans [1]. Three behavioural changes would stop the transmission cycle: not defecating outdoors, avoiding pigs to eat human faeces and washing hands after going to the WC and before cooking and eating. Finding a way to provide people with the necessary tools to comprehend the factors involved in disease transmission, allowing them to draw conclusions and propose their own solutions by applying the scientific method to develop their own knowledge, may be the long lasting solution we have been looking for.

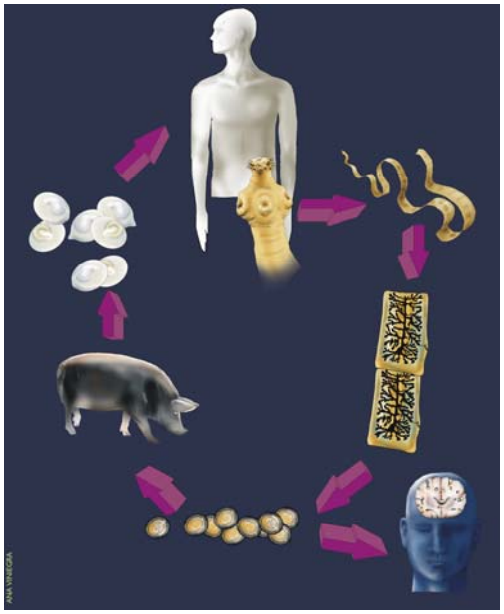

Figure 1. *Taenia solium* life cycle

The research project is divided in four phases: (i) selection of the community, (ii) design of the communicative programme, (iii) implementation of the programme in the community and, (iv) assessment of the programme (Figure 2). The programme will be assessed through field research. A questionnaire will evaluate the knowledge, attitudes and practices regarding *T. solium* life cycle, transmission, and risk factors. This questionnaire will be applied to the participants and to a sample of people in the community before the intervention and 6 months later (blue arrows, Figure 2). The sample in the community will allow us to evaluate if the information provided to the participants is ultimately transmitted to the rest of the population. The instrument is based on other questionnaires previously proven in field work [1, 6-8, 15, 16], and based on known methodologies for evaluating knowledge, attitudes and practices (KAPs) [17-20]. Swine cysticercosis prevalence is established by in vivo tongue palpation and by immunologic test for detecting serum anti-cysticercus antibodies. Pigs have a short life span (they are slaughtered usually before one year of age) acting as sentinels of environmental contamination; prevalence is determined before the start of the project in the community and six moths after intervention (pink arrows, Figure 2). Finally, a qualitative and quantitative assessment on the impact of the programme in the scientific competences (critical thinking skills) of the participants will be performed before, during and 6 months after the intervention (green arrows, Figure 2).

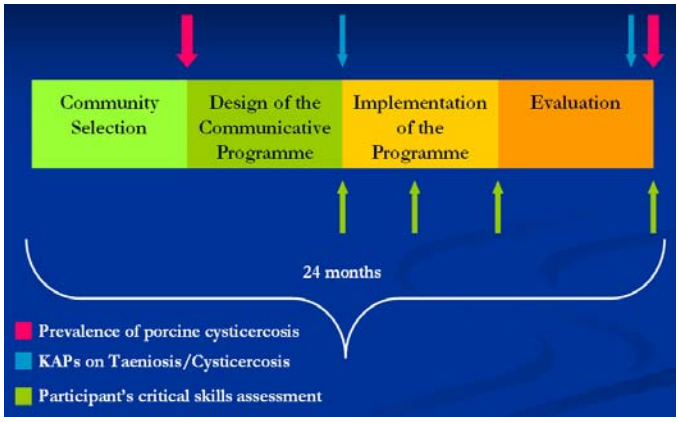

Figure 2. Structure of the research project

2. Community Selection

We selected a rural community where the risk factors associated to the prevalence of TC are present (deficient sanitary infrastructure and pig-raising practices that results in pigs access to human excrement, ineffective inspection of pig meat, etc). The community is located in the state of Michoacan, in the western part of the Mexican territory, and is inhabited mainly by native Indians: the Purepecha (Figure 3).

Figure 3. Arantepacua, Michoacan

In order for the research project to succeed, it is fundamental to involve key members of the community in the organization and coordination of the project. Key decisions should come from local authorities in order to have an impact in modifying some conditions promoting TC. Their participation is also important to receive feedback on how they see the problem and to take some actions. Local authorities are elected in accordance to "uses and practices of the indigenous people". Every community has a Government Board where there is a representative of common assets, a representative of the people (*jefe de tenencia*) and a local judge. All the authority representatives are male and every one of them has a deputy.

We invited the authority representatives to become part of a committee to coordinate the programme inside the community. Both, representative of the people and its deputy accepted to participate, as well as the physician and nurse of the local health centre. After receiving the approval from the authorities to carry out the research project we determined the prevalence of porcine cysticercosis by tongue examination and assessed hygienic practices and sanitary conditions by direct observation. Also a preliminary ethnographic study was done with in-depth interviews with key members of the community. Interviews lasted about 40 minutes and were audiotaped with the consent of the informant. Interviews were completed with non participative observation. This helped us understand how they perceive health and disease, how they represent disease and general health practices. For the interviews we used quantitative and qualitative methods (Chambers 1985, Jick 1975, Manderson 1992, Bauman 1992).

3. Prevalence of porcine cysticercosis

Pigs are adequate sentinels to detect environmental contamination with *T. solium* eggs [12, 13]. They are usually kept in the backyard, with precarious shelter, and fed agricultural by-products. Some pigs wander freely through the village. Most pigs are raised to the age of about 12 months and then slaughtered and sold informally, with little or no sanitary inspection. A census was made of all pigs in the community, identifying in a map the households where pigs were raised. Each head of household was interviewed, using a basic 10 question questionnaire investigating pig breeding and husbandry practices. The owners were asked whether each pig was usually tied, corralled or allowed to roam freely. Type of roof or floor of the corral was noted. Other household factors such as type of house, presence of toilet or latrine were also noted. With the owner consent pigs aged > 3 months were marked, blood samples were taken for specific antibody detection by immunoblot assay and examined by tongue palpation [12, 21] (Figure 4). Tongue palpation allowed the identification of superficial cysts while serology will allow us to confirm the presence of anti-cysticerci antibodies [15]. Positive pigs were treated with praziquantel [22]. Samples from 107 pigs from 408 households were taken. Only 1 person refused to participate. The overall prevalence of cysticercosis by tongue examination was 1.86%.

Figure 4. Determination of the prevalence of porcine cysticercosis

4. Development of the Communicative Programme

3.1 Programme Branding and Selection of Participants

Branding for the project was developed. With the information gathered from the ethnographic study and with the advice from the anthropologist's colleagues, we selected a name for the project that would reflect its nature and allow members of the community to recognize it. The idea was to give to the community a sense of ownership of the project. We selected the purepecha term ***JORHÉNKUARHIKUA*** meaning to learn by doing. For the Purepecha a person won't learn by mere observation at someone performing but by performing oneself, that is, by training on the job. We liked the term because the central idea of the communicative programme is exactly the same. Participants will learn the scientific method by performing science, that is, to become researches and do community research, and through the process learn all the skills needed to use the scientific method to solve problems.

Using photographs and materials from the ethnographic study, at the science communication office, a team of graphic designers developed a logo and other materials as part of the communicative strategy to impact the community and to make it more attainable. For the design they took in account elements of quotidian use to the purepecha culture, like symbols and colours. A poster was made to raise interest of the community in the project. A second poster was developed to summon the community to a general meeting. Also a brochure was made for young people interested in registering for participating in the programme. We also used broadcasting with loudspeakers, a local practice used in the community for mass-communication, to address people to come to the meeting. There was a good response to the marketing strategy, although it is important to note that for the general meeting it was only women who attended. This may be explained as women in charge of promoting health in the community also helped us to summon for the general meeting. Traditionally, women are in charge of health promotion in the community and are coordinated by government programmes. To approach men, we have to make individual visits.

Forty young people inscribed for the informative workshops. Again, most of the first to come candidates were women. This time, it was the strategic work of the ethnologist who is living at the community, that we were able to recruit male participants. Based on interest, participation and performance during the informative workshops we selected 18 youngsters. A formal letter of invitation to participate in the project as "young researchers" was made and presented to the youngsters and their parents. A signature of acceptance was required from parents of minors. From the initial 18 youngsters selected, three decided not to participate and were substituted for other candidates. The final 18 participants receive an official identification as participants in the project.

3.2 Assumptions for developing the Communicative Programme

Using as a starting point the information gathered at the in-depth interviews and non participative observations, we started the design of the contents and formats of the communicative programme.

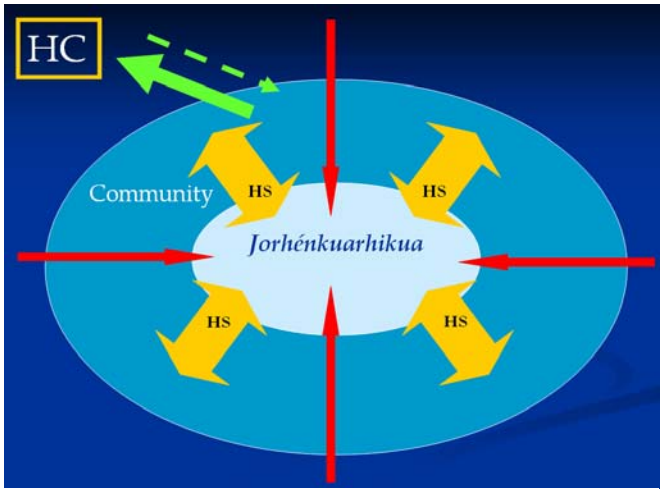

Figure 5. Communication model for the project

A basic model was developed to represent the relevant points of the process of communication (Figure 5). We selected a small sample of the community: 18 young people between 12 to 25 years (represented by the light blue circle). They will participate in our communicative programme, named *Jorhénkuarhikua*. All the information will come from outside the community, that is, from the designers of the project, though a series of activities designed to promote their critical thinking skills (red arrows). The programme will promote the interaction between the participants and the rest of the community, (represented in the figure as a medium blue circle). The interaction is represented by a solid yellow arrow that goes in both directions, from the participants to the community and from the community to the participants, time and again. Finally, as a result of the activity we expect new information to rise from the community as a whole after a process of socialization (green solid line). This information will be evaluated between the researchers of the project and the community's health centre. A question arises as how the local health centre will respond to the new information generated with the project. Traditionally all health programmes are imposed from an institutional central view. But what will happen now that we will be able to learn what do people of the community think of their health and their health problems? Is there a chance to develop

integrated programmes where interests of the community are also taken into account? Could this type of join-programmes be more effective in prevention than current ones? This is represented by the green dotted line.

3.3 The programme

Scientific hypothesis and knowledge acquisition generally have their roots in observations and insights about the natural world. Critical thinking is judging in a reflective way what to do or what to believe. A thoughtful, purposeful process of forming judgements using reasons and evidence [23] And at the heart of critical thinking are the cognitive skills of analysis, interpretation, inference, explanation, evaluation, and of monitoring and correcting one's own reasoning [24]. The scientific method lies at the centre of analysis, inference, evaluation, deductive and inductive reasoning. That is why we chose this method as a way of promoting critical skills in the participants, each skill related to one of the steps on the method. In order to develop the tools to achieve this goal we decided to design a series of workshops. The aim is that with the workshops the participants will acquire some basic research tools needed for the second part of the programme: conduct a field research project. By doing a research, participants will be able to put into action their recently learned skills through a hands-on activity. With the research they will be able to complete their training on basic critical skills by means of data interpretation, analysis and hypothesis evaluation. Their scientific knowledge will be developed through a process of scientific inquiry.

With inquiry, we do not necessarily lead students to discover information unknown to anyone before; it simply allows participants to discover information new to them, by employing deductive reasoning in developing their own reasonable definition [25]. Through a series of step by step developments, participants incorporate new information and eliminate alternative ideas as they define concepts. Three main steps are comprised in each activity: what is the question, answering the question, and arguing the answer.

The main structure of the programme is shown in Figure 6. The programme is being developed as a box that contains two separate compartments: one with all the materials needed for implementing the workshops and the other, with all the materials needed to accomplish the research project (a community's health diagnosis). Table 1 describes the content of each box.

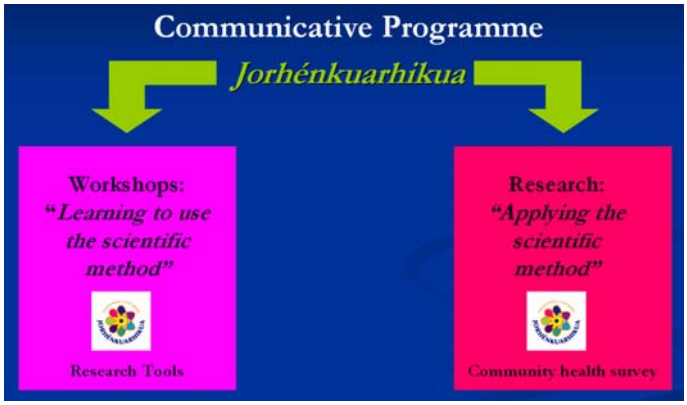

Figure 6. Structure of the communicative programme

Table 1. Contents of the communicative programme box.

Workshops: Learning to use the scientific method	Research: Applying the scientific method
The Workshop Book: A booklet explaining *What is the basic structure of the workshops? How will we work? How long will they take?* as well as information on the procedures for implementation, suggestions and dynamics	The Research Project Book: A booklet explaining *What is the purpose of the project?, What we will look at?, How the research will be performed?, How long will it take?,* as well as information on the structure of the project and the procedures to its implementation.
Disease Detectives Booklet. Explains the basic concepts of health and disease as well as the importance of epidemiological research.	The Research Booklets. Six booklets one for each question to be addressed in the survey. It will help each team with the systematization and analysis of the compiled information.
The Method of the Scientists: steps to do a research. Booklet explaining what is the scientific method, its uses, steps, etc.	The Results Booklet. A booklet where the results of each team will be annotated and will serve to report the final results of the research.
Workshop booklets. Nine booklets one for each step	The Survey. A package containing the questions for the

of the scientific method: Observation, Hypothesis, Predictions and Arguments, Method Interview, Method Survey, Method Experiment, Compiling Data, Analysis 1, Analysis 2, Presenting the Results	survey. Enough quantity to survey a member from each household in the community.
A chronogram of the workshops schedule	Colour labels for marking the surveyed houses.
	A chronogram of the research phases

3.3.1 Workshops

All the activities on the workshops are designed for participants to discover and understand concepts for themselves, the moderator acting only as a catalyst. Each workshop provides the participants with an introduction to a concept and enough background information so they can work out the rest of the idea. By means of questions, discussion is encouraged and team work is the main framework for working in the workshops. Each workshop has a booklet guide explaining how to implement the workshop, all the materials needed for the workshop, a series of dynamics to relax during the workshop and a section with suggestions for adapting the workshop to different conditions. As the programme is directed to young persons between 12 to 25 years all, all the material use a simple and direct language but without any trace of condescendence. This allows the material to be used also with adults.

3.3.2 Research

For the research project, the participants will develop a community's health diagnosis. This diagnosis will be achieved by means of a survey composed of six questions aimed to understand some perceptions, ideas, concepts and experiences on health and disease of members of the community.

For deciding which questions to include in the survey we constructed six modules based in aspects of relevance for the community's health: Concepts of Health and Disease, Customs and Hygiene at Home, Health in the Community, Animals and Disease, Pigs and Disease and, Taeniosis-Cysticercosis in the Community. The modules were constructed with the information gathered by means of the ethnographic study. For preparing the health survey (HS) we chose the first module, which addresses the following concepts:

i) Social construction and representation of disease
ii) What are the diseases that predominate in the community and which are the causes of death
iii) What do people know of these diseases
iv) Sources of health information
v) To whom they refer to in search of treatment

Participants will work on teams for raising the survey and for the analysis of the compiled information. The questions addressed in the survey will be:

i) How do you know you are sick?
ii) What was the last disease you have?
iii) Why do you think you got sick?
iv) How did you get cured?
v) Which are the three most important diseases in the community in your opinion?
vi) Who do you look for when you are sick?

All are open-ended questions that allow the respondents to elaborate in their answers. From a previous pilot study some categories have been identified in order to help the participants in the analysis of the information. After analysing the information, the participants will prepare a report that will be presented to the local authorities and the community in general. The idea is to socialize the results in order to construct all together possible strategies for solving health concerns.

4. Conclusion

Development of reasoning and critical thinking is a long time goal of education [26]. It has been shown that under certain learning conditions, transfer of thinking skills can take place [27]. Among these conditions are exposure to multiple examples in different content areas and supplementing the examples by rules and generalizations, particularly when the latter are formulated by learners themselves [28, 29]. Examination of the list of thinking skills that constitute critical thinking [23] reveals a partial overlap with scientific inquiry skills [30, 31, 32], such as testing hypothesis, planning experiments, and drawing valid conclusions.

With this project we intend to use strategies as inquiry and critical thinking as part of a communication process of scientific information related to health, disease and prevention. Modifying the way information is presented is essential for an effective understanding. If an individual is involved in the process of discovering and understanding health related information, then s/he might be able to find a context that gives sense to prevention. Hopefully this project will not only help participants develop the skills needed to understand themselves and the world around them, but encourage them to modify their risky behaviours as a result of scientific knowledge appropriation.

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