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ABSTRACT

Echinococcosis: costs, losses and social consequences of a neglected zoonosis

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Abstract The socio-economic impact of echinococcosis, with special reference to cystic echinococcosis (CE) caused by *Echinococcus granulosus*, is reviewed. The following items are discussed: socio-economic consequences in humans; economic consequences in livestock; costs and benefits of control programmes; economic evaluation of control programmes; social reasons favouring the life cycle of CE; social, political and economic situations hindering the control of echinococcosis. Many consequences are difficult to evaluate from an economic point of view. However, many evaluations have shown that CE is an important (often neglected) public health and economic problem, especially in endemic areas, and that the socio-economic evaluation of its consequences and of control actions proves indispensable to best use available resources and possibly tailor control strategies.

Keywords Echinococcosis · Echinococcus granulosus · Socio-economic impact

Abbreviations

AE	alveolar echinococcosis
CE	cystic echinococcosis
DALY	disability adjusted life year
PAIR	puncture-aspiration-injection-reaspiration technique.

Introduction

Echinococcosis, with special reference to cystic echinococcosis (CE) caused by *Echinococcus granulosus*, is a significant public health and economic problem in many parts of the world, especially in the Mediterranean Region, Latin America, Africa south of

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the Sahara, and in other areas where the parasite is endemic. CE is emerging or re-emerging in some countries of eastern Europe, such as Bulgaria, and in Asia, such as in Kazakhstan and the People's Republic of China. Socio-economic consequences of CE are related to both human and livestock infections and to the costs of control programmes. In spite of its socio-economic significance, CE is a scarcely considered ("neglected") zoonosis, owing to several reasons, for instance: occurrence (generally endemic) and risk of infection in poor areas and populations; little interest shown by the media, decision makers and health services; lack of information and official reports. The data presented, unless otherwise stated, have been taken from Battelli et al. 2002, and Battelli 2004.

Socio-economic consequences in humans

In humans, CE may have various consequences, including direct monetary costs (diagnosis, hospitalisation, surgical or percutaneous treatments, therapy, post-treatment care, travel for both patient and family members) as well as indirect costs (mortality, suffering and social consequences of disability, loss of working days or "production", abandonment of farming or agricultural activities by affected or at-risk persons). It should be noted that some of the above-mentioned consequences are difficult to evaluate from an economic point of view and others can be mainly or exclusively evaluated in social terms. The disease may negatively affect the "quality" of life. For example, some studies conducted in the United Kingdom (Torgerson and Dowling 2001) and Jordan (Torgerson et al. 2001) suggested that patients surgically treated for CE had a significant decrease in their quality of life, and that patients presenting for treatment of CE had twice the unemployment rate of the general population in Kyrgyzstan (Torgerson et al. 2003).

"Disability adjusted life years" (DALYs) are the preferred measure of the World Health Organisation for quantifying the burden of a disease on a population. In the simplest terms, a single DALY lost can be thought of as a healthy year of life lost. The parameters for the computation of DALYs include the degree of disability, the age at time of diagnosis, and the time lost for disability or premature mortality. In a highly endemic County of the Tibetan plateu in the People's Republic of China, it was demonstrated that the impact of the DALYs lost due to both CE and alveolar echinococcosis (AE), in terms of medical treatment costs, lost income, and physical and social suffering, is likely to be substantial (Budke et al. 2004). Averages of 0.81 and 5.8 DALYs lost per person were estimated, due to echinococcosis over the entire population and due to CE in affected individuals, respectively. These estimates suggest that in these areas echinococcosis can be considered very important. Recently, a preliminary global evaluation of the socio-economic impact of CE was performed based on data from the literature and the World Organisation for Animal Health databases (Budke et al. 2006). When underreporting is accounted for, the human burden of the disease was estimated at nearly 1 million DALYs (or US$ 764 million). This value indicates that CE produces disability on a similar scale to some important tropical diseases, such as Dengue, Chagas disease and African trypanosomiasis.

Among the costs associated with the identification and treatment of CE in humans, those related to the duration of hospitalisation and convalescence represent the most important components. Where efficient services and modern techniques and interventions have been applied, the hospitalisation period has decreased by about 50% within a few years. Such an implementation also leads to a better control of the convalescent period and to a decrease in the working days lost. In Italy, at the main hospital of Bologna, an evaluation of hospitalisation costs was carried out using an analytical method of assessment. The 1995

mean specific cost of a surgical case (hepatic infection) was about US$ 14,000. The mean number of days spent in hospital was 28 (73.4% of total costs). The average costs (US$) of a surgical case were about 13,600 in Wales (UK) (2000), 1,480 in Tunisia (2000), and 700 in Jordan (2002) (Budke et al. 2006). In Argentina, in the Rio Negro Province, the 1997 mean cost per CE infected patient in two hospitals amounted to approximately US$ 4,500; the latter costs were about 31% lower than in 1980, mainly due to the introduction of chemotherapy with albendazole and of the Puncture-Aspiration-Injection-Reaspiration technique (PAIR). In Italy, a first attempt of comparing the costs of PAIR and of conservative surgery for uncomplicated echinococcal cysts have been recently made (Brunetti et al. 2007). The 2006 mean specific cost of a PAIR treatment for a 3 day hospital stay and 1 year follow-up was EUR 2,072 and that of conservative surgery for a 4 day hospital stay and 1 year follow-up was EUR 3,267.

Economic consequences in livestock

In livestock, the following consequences of CE must be considered: reduced yield and quality of meat, milk and wool; decreased hide value; reduced birth rate and fecundity; delayed performance and growth; condemnation of organs, especially liver and lungs; costs for destruction of infected viscera and dead animals. There are also other possible indirect detrimental consequences, such as bans on export of animals and their products if these are required to be free of CE. In livestock, the importance of the above-mentioned economic consequences will depend, to a large extent, on the typology and general health status of the animals and on the characteristics of the farming or livestock industry. Quantification, standardised evaluation of such losses and exclusion of biassing factors in animal production are very difficult; therefore the available data should be interpreted with caution.

Losses in sheep with CE have been reported to approximate 7–10% of milk yield, 5–20% of meat or total carcass weight, and 10–40% of wool production. In Sardinia, with a population of three million dairy sheep, the loss in milk production was estimated to about US$ 13.7 million in 1982. This evaluation was based on a presumed decrease in milk production of 7% in infected sheep and on an 80% prevalence of CE in the sheep population. The quantification of losses caused by infected viscera is influenced by both the legislative rules of each country (e.g. compulsory condemnation and destruction) and the number of animals slaughtered under veterinary supervision. Depending on the utilisation of viscera and on the total or partial condemnation of infected organs, the order of magnitude of losses can vary. For instance, in South America, it was estimated that the viscera of 2 million cattle and 3.5 million sheep are condemned every year, and that the cost of such condemnation (1999) amounts to US$ 6.3 million in Argentina and US$ 2.5 million in Chile. In Italy, in 1980, an estimate of 10% was proposed for the reduction in commercial value per sheep infected with CE; this percentage included the value of the condemned viscera. An annual worldwide livestock production loss for CE has recently been estimated as being at least equal to US$ 142 million and possibly up to US$ 2,2 billion (Budke et al. 2006).

Costs and benefits of control programmes

The awareness of the socio-economic impact of the disease has stimulated the implementation of control campaigns against CE in certain areas or countries. The main costs for control programmes are the following: education; dog control; dog treatment; detection

and destruction of infected viscera; diagnosis (e.g. mass screening) and therapy in humans; epidemiological surveillance and monitoring; and administration and evaluation of the programme. It should be noted that some of the expenses sustained for echinococcosis control may simultaneously be beneficial to control programmes against other diseases or animal-correlated problems (e.g. rabies, tapeworm infections, dog straying, food hygiene). If the control includes vaccination, costs of vaccine and stock vaccination must also be considered. The benefits of control programmes may be financial and non-financial (the latter category is difficult to evaluate). The most relevant financial benefits are the following: increase in farm animal production; increase in the quantity and quality of organs suitable for consumption by humans and carnivorous animals; decreased medical costs. The non-financial benefits (in some cases these may be evaluated from an economic point of view) include the following: increase in the average number of healthy years of life; improvement of the physical, psychological and social status of the population, mainly of the poor; improvement of veterinary and public health services, hygiene and primary health care; reduction in other health or zoo-economic problems such as rabies, food-borne infections, diseases by cestode larvae in farm animals, etc.

Economic evaluation of control programmes

For many years, some methods have been applied to the evaluation of control programmes. Among the economic procedures, mention should be made of cost-effectiveness analysis and cost-benefit analysis.

Until now, few examples are available of economic analyses of CE control programmes. With regard to the Mediterranean Region, a prospective analysis was performed of a ten-year project involving Sardinia. Assuming a reduction in the disease prevalence in sheep from 80 down to 10%, in 1982 the net present value of the gained milk production was evaluated at US$ 18.3 million. With a reduction in human cases per year from 235 down to 15, a gain of 669 years of human life was reckoned. The total cost of the programme was estimated equal to US$ 8.8 million and the internal rate of return at 53.6%. In the Community of La Rioja, Spain, a programme of prevention and control of CE was initiated in 1987. In 2000, this programme led to a reduction of 97.2% in the CE occurrence in dogs, of 74.4% in sheep, and of 78.9% in humans. These reductions were estimated to yield an increasing cumulative cost/benefit balance that was already positive on year 8 of the programme, and that reached 1.96 in 2000.

Recently, the use of mathematical models has been introduced to compare different intervention strategies aiming at controlling echinococcosis (Torgerson 2001). Cost per DALY averted has been estimated for a higly endemic County in People's Republic of China (Budke et al. 2005). In this study, a control programme, based on dog treatment and sheep and goat vaccination, was projected to prevent 65–95% and 9–50% of annual losses due to CE and AE, respectively. Cost per DALY averted, for both CE and AE combined, was evaluated to be as little as US$ 89. This cost would be less than 25 US$ for the human health sector if cost sharing was implemented between the public health and agricultural sectors based on the proportional benefit from control. It should be noted that in 1993 the World Bank proposed the cut-off for a higly cost-effective programme for low income countries as equal to US$ 150/DALY averted.

Social reasons favouring the life cycle of CE

Many social reasons favour the life cycle of *E.granulosus* and the persistence of CE in many parts of the world. The following are of particular significance: many rural families

have small lots of lands and/or live in close proximity with their flocks and dogs (this is especially true for pastoralists, nomadic people and their families); the practice of gathering together groups of animals belonging to different owners and leading them to common pastures is an occasion for the circulation of infections, including CE; home slaughter is largely practised, and dogs are fed on offals; uncontrolled trade and exchange of animals and of animal products are frequent; numerous small abattoirs exist which are insufficiently equipped or lack facilities and are built in the vicinity of human settlements; professional training of farm and animal industry workers, health education of the public, and information by mass-media are often inadequate or neglected; stray (often numerous) and feral dogs (including wolves) may feed on dead animals and garbage, and hunt intermediate hosts; in some areas, also in the urban environment, where dogs and farm animals often live together with man, the circulation of zoonotic infection, including CE, is favoured. Moreover, the high cost and difficulties of slaughtering single animals consequent to legislative rules may create situations of uncontrolled slaughtering.

Social, political and economic situations hindering the control of echinococcosis

The control of echinococcosis is directly linked to social, political and economic situations, and sometimes to religious practices, in the affected areas. A situation of social and political instability and poverty favours the spread of the disease owing to uncontrolled animal slaughtering and viscera disposal, uncontrolled animal trade, presence of roaming dogs, absence or scarcity of veterinary services. Lack of knowledge and of health education and information of the people are barriers facing the effectiveness of control programmes and interventions. For instance, control of CE is less effective without the support of dog-owners, and this support can only be obtained if the people have a clear understanding of the life cycle of *E. granulosus* and of risk factors for human infections (Heath et al. 2006). Another important point to be underlined is that the factors facilitating the occurrence of CE may become much more crucial in the event of emergencies (e.g. earthquakes, floods, famine, wars and institutional upsets). Moreover, CE is re-emerging in some countries where drastic changes in the typology of animal husbandry (from intensive to familiar management) have occurred as a consequence of policy changes, as observed, for example, in the former Soviet Republics in Central Asia and Bulgaria.

Where the public administration lacks funds for social services, resources become unavailable for the control of CE and related activities: other priorities may be promoted which demand shorter action times. Besides the problem of funding, other hindrances exist which must be overcome. Indeed, many countries, especially in the Mediterranean region and in Latin America, are developing long-term control programmes. However, sometimes public administrators are reluctant to invest resources in programmes lasting longer than their mandates. Another factor which affects the effectiveness of control plans is the presence of geo-political borders which make it difficult to prevent the infection from entering from outside territories.

Final considerations

When evaluating the social and economic impact of echinococcosis and of its control programmes, many parameters should be considered, the majority of which are difficult to quantify in economic terms. Due to the uncertainity of many costs, recent studies have

evaluated the economic effects of echinococcosis using analytical techniques (such as Monte-Carlo analysis) that can give a range of cost estimates (Torgerson 2003). The evaluation of the "economic weight" of the disease varies in different countries. For example, it may be much higher in a developing country than in an industrialized one. The validity of the estimates strongly depends on an efficient information system (not only sanitary) capable of providing reliable and real data. For instance, in many endemic areas, due to the poor level of reporting, evaluating the number of human and animal infections is the first difficulty encountered. Despite extant restraints and because of finite resources, estimates of the financial burden and social consequences of the disease prove indispensable to best use available resources and possibly tailor control strategies.

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