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Review Article

One health and echinococcoses: something missing?

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ABSTRACT

According to WHO, One Health is an approach to designing and implementing programs, policies, legislation and research in which multiple sectors communicate and work together to achieve better health outcomes such as public health, animal health, plant health and environmental health. However, the concept of “One Health” is too often reduced to a (desirable) dialogue between physicians and veterinarians, with little or no involvement of specialists dealing with other fields such as wildlife ecology, ecosystem health and anthropological processes of pathogen transmission. Here, we explain why research on echinococcoses critically requires the expansion of the current collaborations, and to release significant funding in each field. If not, “One Health” will still stay as an aspiration, and will not hit its promised targets.

Keywords: One Health, ecohealth, echinococcosis, sustained development

INTRODUCTION

Are Humanity and Nations learning enough from the health crises they face? This is doubtful when one considers that the concept of “One Health” is too often reduced to a (desirable) dialogue between physicians and veterinarians. According to WHO definition, recalled at every plenary of the World Congress of Echinococcosis and others since more than a decade, One Health is “an approach to designing and implementing programs, policies, legislation and research in which multiple sectors

communicate and work together to achieve better public health outcomes”. It underlines that “many professionals with a range of expertise who are active in different sectors, such as public health, animal health, plant health and the environment, should join forces to support One Health approaches” (1).

Most of the major pandemics of the 21st century have still not found their precise zoonotic origins. Budgets are massively directed towards research into diagnostic kits, treatments and vaccines (2). The focus is on care, most

often late when the house is on fire and only if victims are solvent (these happy few will not complain). In comparison, research on the ecology of emergence and prevention is rare, because it is poorly or not at all funded although it is one of the three pillars of a "One Health" approach (Figure 1). Therefore, without a sufficient knowledge of the socio-ecosystems they explore, virus hunters for instance, technologically armed but overwhelmed by the virus number and variations (3), are likely to become anglers of useless barcodes. The spatial and temporal dynamics of populations of both animal and human host organisms, at multiple scales, determined by all the physicochemical, ecological (predators, other parasites, competitors, etc.)

and anthropological forces, with many idiosyncrasies, are the driving forces behind sustained transmission and emergence (4). Condemned to costly repair, after a few million deaths, health actors nowadays cannot act early, so they rely on biosecurity, and humanity is perpetually surprised and overwhelmed.

This applies to a degree also to echinococcoses, a group of chronic zoonotic diseases. They are categorized as "neglected" diseases, and some of them such Alveolar echinococcosis (AE) and those caused by neotropical species of the genus *Echinococcus* are considered "rare" on a continental scale. However, for AE, the global annual human burden was estimated to up to 1.3 million DALYs in 2010 (6). For Cystic echinococcosis (CE), more widespread, it reaches several hundred thousand DALYs, with an annual livestock production loss of up to more than 2 billion US\$ in 2006 (5). In countries like China where the estimate is available, the human burden of echinococcoses (CE and AE) in some local communities is 4.5 times higher than that of all other communicable and non-communicable ailments combined in the general population (7).

Successful elimination or reasonable control of CE has been obtained from the combined action of medical and veterinary people alone, in the past and nowadays (8). Successes of this restricted tandem are explained by the fact that the parasite concerned, *Echinococcus granulosus* mostly, is massively transmitted through a domestic life-cycle involving dogs and a small number of domestic ruminant species. In specific contexts, such as in islands where reinfection from outside is more easily prevented, controlling dog infection and improving inspections at abattoirs on a long term of several decades can be enough. On a continental scale, CE as well as AE elimination becomes much more complicated because the movements of parasite definitive and intermediate hosts are much more difficult to limit, community perceptions, traditions and governance are more spatially varied, and the species richness of wildlife, with more hosts that can act as a reservoir for the parasite, is greater (9). For

those reasons, echinococcosis endemicity is spatially heterogeneous on several space-time scales and it may be affected by global environmental changes. This means that successful sustainable control must be grounded on sound science and a deep understanding of transmission processes that take place in complex sets of socio-ecological interactions.

For instance, among the species for which research faces similar lack of specialists, *Echinococcus multilocularis*, is a good example of a parasite transmitted primarily via wildlife life-cycles including a large range of species of (small mammal) intermediate hosts. Over large areas like Eurasia, however, their taxonomy and their geographical distribution is still incompletely known. The taxonomy of a species as common as *Arvicola amphibius* (formerly *A. terrestris*), one of the species historically known to be one of the natural host of *E. multilocularis* (and a grassland pest in some areas) has only been revised as late as in 2020 (10), and a new species of mole discovered in southwest France as recently as in 2016 (11). DNA barcoding has proved to provide efficient tools for non-specialists in order to identify species, but it can still make problem where the taxonomy of species is still not well established (which is the case for many of them in Central and Eastern Asia) or reference specimen on sequence database wrongly identified. Moreover, the large range of species of intermediate hosts makes *E. multilocularis* transmission a community process (12,9). To sample populations in order to address those issues soundly, needs sampling designs taking the full range of habitats and the differences in trapability between species into account (e.g. rodent traps are usually designed for species feeding on the surface and are unsuited for underground). If seasonal variations of population densities of each species are generally easily evidenced, long-term interannual variations patterns, their geographical extent and their drivers are most often virtually unknown. The subsequent dietary variations (prey switching, etc.) and population dynamics of their predator definitive host (fox, dog, coyotes, jackal, etc.) are most often ignored. However parasite transmission intensity depends on all of those variables. Few studies are based on the long-term monitoring of such systems for lack of long-term funding of specialists able to carry them out. Good mammal and parasite taxonomists are not necessarily good wildlife ecologists and conversely, and wildlife ecologists desperately need good taxonomists. The inflation of cheap models thought to be affordable surrogate of costly data acquisition unfortunately cannot replace the lack of relevant validating data of good quality.

In ecosystems of similar parasite transmission intensity (e.g. as measured by fox and dog infection), human exposure and infection can vary according to human behavior (general hygiene, type of contact with

domestic and wild animals, access to safe water, etc.) (13). Furthermore, the success of control programs is dependent on their understanding and acceptance by target populations. If epidemiological studies about risk factors for echinococcoses are plenty, references of anthropologists or sociologists embedded in research teams about transmission and control are rare exceptions in the scientific and medical literature (14). Unfortunately, this does not prevent (possibly wrong) interpretations from scratch, given orally hence unpublished, about why prevention and education campaigns often (but not always) fail to hit the target, and why some successful prevention measure in one place reveals unsuccessful in another. This field of research on socio-ecosystems is still open, while integral to One Health, but will not develop if appropriate funding to relevant people and research fields is not released on a long-term basis.

Last but not least, public health concerns are meeting more and more other global concerns in which they are intricately. Global warming and the erosion of biodiversity (the 6th extinction) are weakening the world's ecosystems and pose an acute threat to the earth's habitability for humanity. This means that health issues nowadays must urgently be considered in connection with resource sparing, species and ecosystem protection and the transition to environmentally friendly agriculture (termed "agroecology"). For instance, in the Jura mountains in France, solutions for AE prevention and control are sought in connection with farmer organizations for small mammal

pest control, conservationists and hunter societies. This led to the idea, endorsed by local regulations, that foxes, although definitive host for *E. multilocularis*, should be protected in some areas as part of a rich community of an auxiliary fauna of predators of small mammal pests, and AE prevention oriented towards targeted praziquantel bait distribution and public education. To our knowledge, no integrated approach of such kind has been undertaken yet in other places or for other *Echinococcus* species. In countries where small mammal pests are also targeted for control, and sustain a large biodiversity of predators and commensals, like in China, a One Health approach balancing between the three healths (human, animal and ecosystems) should certainly be an important concern. Furthermore, the impact of the massive deforestation of the Amazon basin on the neotropical *E. vogeli* and *E. oligarthra* whose life-cycles also include primarily a wildlife component, has never been evaluated. Moreover, the effect of global and regional changes on CE incidence through the interactions between domestic ruminants, dogs, wildlife and societies has received little attention if any, however it might be important on all continents.

It might be that the now classical tryptic of the Brundtland's report about sustainable development from which the "One Health" component is derived is already out-of-date: humanity is playing games with the biosphere limitations (Figure 1). To deal with world complexity is an additional challenge of research and prevention of echinococcoses. One Health (sometimes termed also

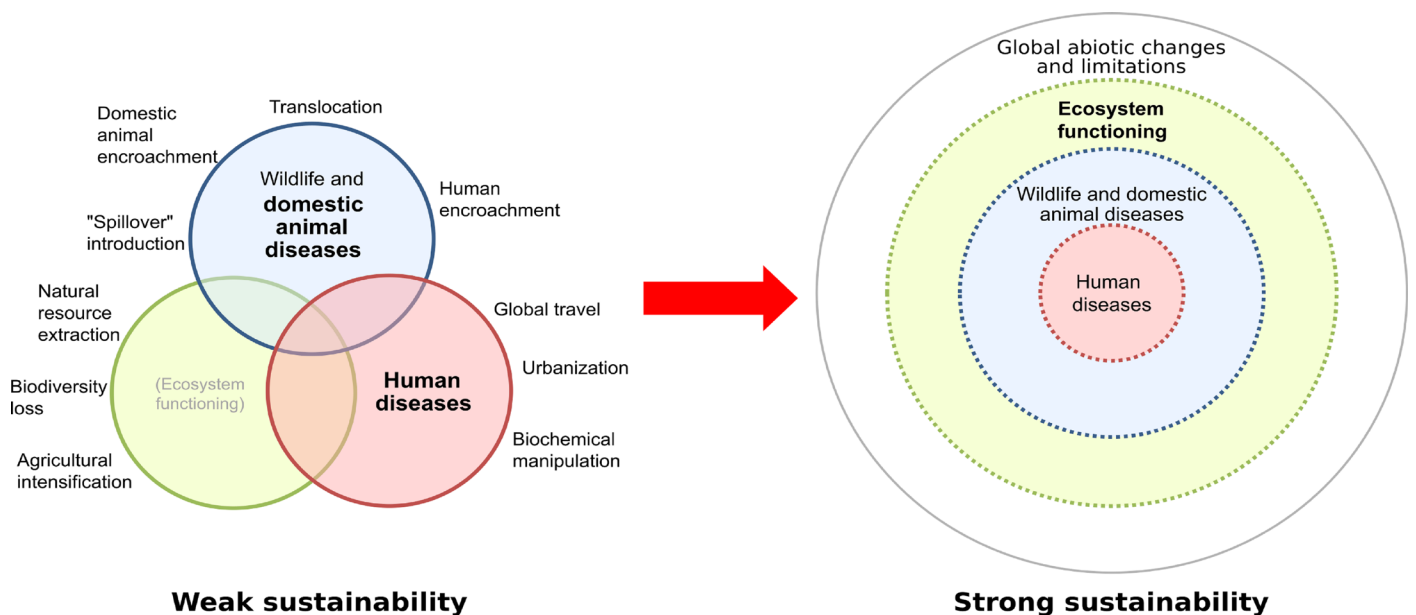


Figure 1. Left: "classical" One Health tryptic, after (4): only the overlap is important, as neither circle seems to constrain the other; human diseases are in no way limited by the non-human (the environmental), the emphasis here is on balanced governance between three virtually independent poles. Ecosystem functioning is between parenthesis and wildlife not bolded, as it is most often the case in "One Health" claimed studies. Right: here we underline a functional hierarchy between health issues

Ecohealth) is a relevant concept to take this challenge and move to better health outcomes, public, animal as well as ecological (15,16). It requires necessarily the expansion of current collaborations between physicians and veterinarians to additional relevant expertise, wildlife ecologists, taxonomists, anthropologists, geographers, etc. concerned with human, animal, and ecosystem health, and to release significant funding in each field for long-term monitoring and research. If not, business as usual, "One Health" will still stay in midstream as an aspiration, and will not hit its promised targets.

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