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Intersectoral collaboration between the medical and veterinary professions in low-resource societies: The role of research and training institutions[☆]

Tanguy Marcotty^{a,b,*}, Eric Thys^a, Patricia Conrad^c, Jacques Godfroid^{b,d}, Philip Craig^e, Jakob Zinsstag^f, Filip Meheus^g, Abdou Razac Boukary^{a,h}, Mallam Abdou Badé^h, Hamid Sahibiⁱ, Hind Filali^j, Saskia Hendrickx^k, Cyrille Pissang^l, Michel Van Herp^m, Dirk van der Roostⁿ, Séverine Thys^g, David Hendrickx^{g,o}, Marleen Claes^a, Tine Demeulenaere^p, Joep van Mierlo^q, Jean-Paul Dehoux^r, Marleen Boelaert^g

^a Department of Biomedical Sciences, Institute of Tropical Medicine, Nationalestraat 155, 2000 Antwerpen, Belgium

^b Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, P/Bag X04, Onderstepoort 0110, South Africa

^c Department of Pathology, Microbiology and Immunology, School of Veterinary Medicine, 1 Shields Avenue, University of California, Davis, CA 95616, USA

^d Section Arctic Veterinary Medicine, Department of Food Safety and Infection Biology, Norwegian School of Veterinary Science, Stakkevollveien 23, 9010 Tromsø, Norway

^e Cestode Zoonoses Research Group, School of Environment and Life Sciences, University of Salford, Greater Manchester M54 WT, UK

^f Human and Animal Health Unit, Department of Epidemiology and Public Health, Swiss Tropical and Public Health Institute, PO Box 4002, Basel, Switzerland

^g Department of Public Health, Institute of Tropical Medicine, Nationalestraat 155, 2000 Antwerpen, Belgium

^h University of Niamey, BP 10895 Niamey, Niger

ⁱ Department of Pathology and Veterinary Public Health, Hassan II Agro-Veterinary Institute, PB 6202, Rabat, Morocco

^j National Institute of Sanitary Administration, PB 6329, Rabat, Morocco

^k International Livestock Research Institute (ILRI), c/o IILAM: Av. das FPLM 2698, Caixa Postal 2100, Maputo, Mozambique

^l Vétérinaires Sans Frontières – Belgium, 3rd Floor, Titan Complex, Chaka Road, PO Box 13986-00800, Nairobi, Kenya

^m Médecins Sans Frontières – Belgium, Rue Dupré 94, 1090 Brussels, Belgium

ⁿ Institute of Tropical Medicine, Nationalestraat 155, 2000 Antwerpen, Belgium

^o Telethon Institute for Child Health Research, Centre for Child Health Research, The University of Western Australia, PO Box 855, West Perth, WA 6872, Australia

^p Damien Foundation, Léopold II Boulevard 263, 1081 Brussels, Belgium

^q Dierenartsen Zonder Grenzen – Vétérinaires Sans Frontières, Avenue Paul Deschanel 36-38, 1030 Brussels, Belgium

^r Faculty of Medicine, Catholic University of Louvain, Avenue Hippocrate, 56, 1200 Brussels, Belgium

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ABSTRACT

Background: Neglected zoonoses continue to significantly affect human health in low-resource countries. A symposium was organised in Antwerp, Belgium, on 5 November 2010 to evaluate how intersectoral collaboration among educational and research institutions could improve the situation.

Results: Brucellosis and echinococcosis were presented as models for intersectoral collaboration. Low-resource societies face evident knowledge gaps on disease distribution, transmission within and across species and impact on human and animal health, precluding the development of integrated control strategies.

[☆] Report of an international symposium organised in Antwerp, Belgium on 5 November 2010.

* Corresponding author at: Institute of Tropical Medicine, Nationalestraat 155, 2000 Antwerpen, Belgium. Tel.: +32 3 247 62 63; fax: +32 3 247 62 68.
E-mail address: tmarcotty@itg.be (T. Marcotty).

Recommendations: While veterinarians have been the main driver of the One Health initiative, the medical profession does not seem to be fully aware of how veterinary science can contribute to human public health. It was postulated that transdisciplinarity could help fill knowledge gaps and that encouraging such transdisciplinarity should start with undergraduate students. Furthermore, intersectoral collaboration on zoonoses should not ignore the social sciences (e.g. assessment of indigenous knowledge and perception; participatory surveillance), which can contribute to a better understanding of the transmission of diseases and improve communities' participation in disease control activities.

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1. Introduction

In low-resource societies, neglected zoonoses (i.e. anthrax, bovine tuberculosis, brucellosis, leptospirosis, echinococcosis, cysticercosis, fasciolosis, leishmaniasis, trypanosomiasis, Rift Valley fever and rabies) continue to significantly affect human health [1]. This is often due to the close contact with animals, the lack of recognition when zoonoses occur in humans and the lack of resources to control them. In fact, domestic and wild animals harbour a huge pool of micro-organisms that are potentially pathogenic to humans. Some authors estimated that more than 60% of human pathogens originate from animals [2]. As such, most human emerging diseases, including haemorrhagic fevers, H5N1 influenza, SARS and HIV/AIDS, have a zoonotic origin. Furthermore, the emotional value of pets in Northern societies and the impact of the culling of infected herds on their owners' psychological health have been increasingly recognised [3].

The strong case for intersectoral collaboration between the veterinary and medical professions, particularly in developing countries, that Calvin Schwabe clearly made in his book "Veterinary Medicine and Human Health" in 1984 [4,5] is even more relevant in today's world which is characterised by major ecological changes [5–7]. Human population development, growth and movement have a tremendous impact on the likelihood of inter- and intra-species transmission of diseases, including wildlife. In such a context, transdisciplinarity initiatives, defined as epistemological perspectives unique to the collaborative effort and distinct from those of any of the cooperating disciplines [8], could prove useful to address infectious disease surveillance and control more efficiently. The focus should therefore not be on debating whether and why one discipline should be considered more important than the other, but on collaboration and on finding ways to combine each discipline's strengths in order to improve the surveillance and the control of diseases.

A symposium was organised in Antwerp on 5 November 2010 to evaluate the needs and relevance of intersectoral collaboration between the medical and the veterinary disciplines in low-resource societies. While it is acknowledged that One Health also encompasses wildlife and environmental health, the aim of this symposium was to present the One Health approach as an opportunity to improve human health and well-being through an integrated management of pathogens in humans and domestic animals. The issue of disease prioritisation and impact quantification, the challenge of reconciling disease impact on human and animal health and the need to provide decision

makers with disease impact evidence were discussed. Finally, examples of intersectoral collaboration successes and failures were presented and discussed, and ways to improve intersectoral collaboration at research and educational levels were suggested. A total of 224 participants from 41 different countries and with various backgrounds attended the meeting.

2. The role of animals as reservoirs for human diseases

Brucellosis (a bacterial zoonosis) and echinococcosis (a helminthic zoonosis) were used as models to illustrate the need for improved intersectoral collaborations in low-income societies. Both zoonoses are known to have a severe impact on human health, most particularly in pastoral and livestock breeding communities, and are both characterised by the role of animals as the only source of human infections [9,10].

Not all species of the *Brucella* genus and their respective biovars are zoonotic. *Brucella abortus* (all biovars), *Brucella melitensis* (all biovars) and *Brucella suis* (biovars 1, 3 and 4) are the most important human pathogens [11]. These *Brucella* species are mainly found in cattle, sheep and pigs respectively, where they cause abortion and reduced fertility. Brucellosis is transmitted through direct contact with infected animals (especially during abortion or delivery) or animal products (raw milk). In humans, brucellosis causes a flu-like syndrome called undulant fever. Brucellosis has been controlled in most industrialised countries through vaccination, testing and culling of infected animals. In developing countries, this eradication method has often proved too expensive and too difficult to implement [12]. Vaccination is used in some countries, but usually too erratically to have any significant impact. Most developing countries are therefore assumed to be endemic for brucellosis, which has been confirmed by numerous serological surveys. Yet, brucellosis serology presents serious deficiencies in terms of diagnostic sensitivity and specificity [13,14]. In addition, serology does not permit any *Brucella* species identification, which might be necessary when, for example, *B. abortus* and *B. melitensis* occur in species other than cattle and small ruminants, respectively (Table 1). The isolation, identification and characterisation of circulating *Brucella* species is thus of paramount importance to define a given host species as a reservoir or spill-over host.

Despite its high burden on human health, cystic echinococcosis has remained a neglected zoonotic disease mostly associated with sheep breeding and nomadic

Table 1

Domestic reservoir and spill-over hosts of the main zoonotic *Brucella* species.

Host species	Significant reservoir role	Spill-over
Human		<i>B. abortus</i> [9] <i>B. melitensis</i> [9] <i>B. suis</i> biovars 1 and 3 [9,37] <i>B. melitensis</i> [38–40] <i>B. suis</i> biovars 1 and 2 [41,42] <i>B. abortus</i> [43,44] <i>B. abortus</i> [45]
Cattle	<i>B. abortus</i>	
Goat	<i>B. melitensis</i>	
Sheep	<i>B. melitensis</i> (<i>B. ovis</i>)	
Camel	<i>B. melitensis</i> and <i>B. abortus</i> ? [46]	
Horse		<i>B. melitensis</i> and <i>B. abortus</i> [46] <i>B. abortus</i> [42,47] <i>B. suis</i> [42,47] <i>B. melitensis</i> [48] <i>B. melitensis</i> (rare) [42,50] <i>B. abortus</i> [49] <i>B. abortus</i> [42,51] <i>B. melitensis</i> [48] <i>B. suis</i> [42,52]
Pig	<i>B. suis</i> <i>B. abortus</i> ? [49]	
Dog	(<i>B. canis</i>)	

communities, in which the prevalence may reach up to 10% among older persons [15]. This parasitic zoonosis is caused by a cestode parasite, *Echinococcus granulosus*, which lives in the intestine of canines. Cystic echinococcosis is caused by the parasite in its larval stage, which occurs in numerous species (mostly herbivores), including humans. These species are infected through the accidental ingestion of

eggs that are disseminated in the environment (see life-cycle in Fig. 1A). Hydatid cysts are mostly found in the liver and lungs but may be found in any organ. They are often pathogenic in humans where they can reach very large sizes (several kilograms). Given the rather low host-specificity, several wildlife species are expected to be susceptible to either the adult or the larval stage of *E. granulosus*. Yet, their reservoir role is unknown. In endemic areas, domestic animals play the most important epidemiological role. Control in humans does not affect the transmission cycle at all since humans are considered as a dead-end for the parasite. Thus, intersectoral collaboration is particularly appropriate to the control of this zoonosis. Apart from hygienic measures including the destruction of infected carcasses and organs, control of dogs (especially in slaughterhouses) and reduced contacts with infected dogs or egg-contaminated material, interventions could be operated at various levels. For instance, dogs could be regularly treated with anthelmintic drugs and this could be combined with rabies vaccination campaigns. Livestock could be vaccinated against the larval stage [16] and this could be synchronised with other vaccination programmes such as for brucellosis. Finally, detection, diagnosis and control in humans could be organised by the health services.

These two models highlighted different aspects of neglected zoonoses. While other neglected zoonoses might also present very specific features, the need for improved diagnosis in the reservoir species, improved understanding of the epidemiology of endemic zoonoses, improved burden assessment in human beings and enhanced intersectoral collaboration in low-resource societies has been demonstrated.

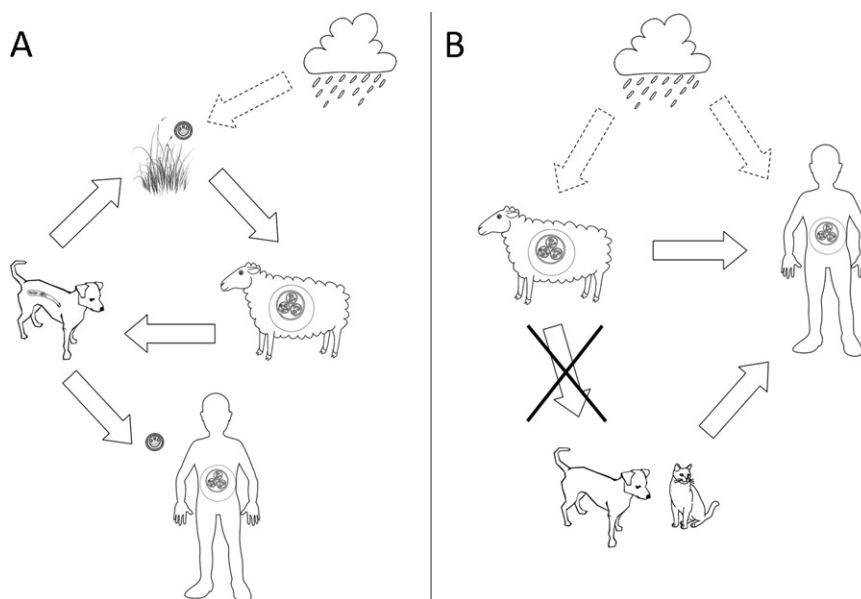


Fig. 1. (A) Lifecycle of *Echinococcus granulosus*. Adult *E. granulosus* live in the intestine of dogs and disseminate their eggs in the environment with the dogs' faeces. Rains contribute to the egg dissemination whereas cold and humid climate benefits their survival. Ruminants and humans develop echinococcosis through direct or indirect contacts with dogs. Dogs get infected when feeding on organs infected with hydatid cysts (larval stage). (B) Transmission routes as perceived by the Moroccan communities in High Atlas (focus group discussions). Sheep and mutton meat are seen as the main source of human echinococcosis. Sheep and, to a lesser extent, humans get infected in humid or cold climatic conditions. Dogs, as well as cats, are thought to contribute to echinococcosis and other diseases in humans through saliva, hairs and bites. Infection of dogs through feeding on infected organs is not perceived as a risk.

3. Burden assessment

Quantifying the burden of diseases is essential for informing decision-making processes and advocating for interventions, whether in humans or animals. Disease burden can be defined in terms of both economic (impact on livelihood) and health burden. Today, health burden is mostly quantified using the disability adjusted life years (DALY) measure [17]. This single metric accounts for the mortality and the morbidity of diseases in humans. The merit of this metric is that it proposes a relatively objective ranking for prioritising public health interventions.

However, DALY applied on neglected tropical diseases (these include the neglected zoonosis plus Buruli ulcer, Chagas disease, dengue, leprosy, trachoma, yaws and helminthiasis) present a number of drawbacks. First, the disability weight used to calculate the burden due to morbidity is difficult to establish objectively and might vary across different cultural communities, depending on the perception people have of a disease and its health consequences. Second, the DALY measure has a reputation for underestimating the burden of neglected tropical diseases [18]. Finally, while neglected tropical diseases might show rather limited impacts on a global level, they can have very severe impacts on a more local scale. This is certainly the case with focal vector-borne diseases such as leishmaniasis and trypanosomiasis [19]. Lack of data on disease morbidity, severity and mortality seems to be another common cause of inaccurate burden estimations of neglected tropical diseases.

As far as zoonoses are concerned, it would be important to consider the overall societal benefit of disease control. Deterministic mathematical models were very instrumental for making such estimations. For instance, Zinsstag et al. [20] showed that dog rabies vaccination in N'Djamena would, in the long term, be cheaper than the treatment of exposed patients. In Mongolia, vaccinating livestock against brucellosis appears to be economically profitable both for the health sector and the livestock sector. If the vaccination costs were shared proportionally to the benefits, each DALY averted would cost only \$19 [21]. Unfortunately, the exact impacts of zoonotic pathogens on human health and animal productivity are often poorly estimated in low-resource societies. Depending on the value systems prevailing in various societies, animals may merely be considered as commodities on the one end of the spectrum (e.g. livestock in industrialised production settings) or as individuals with rights on the other. Therefore, quantifying animal health in economic terms might not be sufficient. In the future, developing a new indicator similar to the DALY might offer a way of quantifying, for each cultural system, the impact of diseases on animal health and human psychological wellbeing.

4. Voices from the field

This session addressed the three following themes: intersectoral collaboration on the epidemiology of zoonotic tuberculosis and brucellosis in Niger, communities' knowledge and perception of echinococcosis in the High Atlas

in Morocco and participatory epidemiology and disease surveillance in Africa. The need to integrate social science in One Health research was emphasised.

Although the prevalence of brucellosis and zoonotic tuberculosis in Niger is poorly documented due to the absence of relevant control initiatives for livestock, both diseases are suspected to be endemic in livestock as well as humans [22,23]. A study was set up to better describe the occurrence of these two infections, both in livestock and in humans, through an intersectoral collaboration between veterinary and medical scientists. Selected herds were tested and *Brucella* spp. and *Mycobacterium bovis* bacteria were isolated from infected animals for bacteriological and molecular characterisation, whereas humans with a high-risk of exposure (i.e. farmers, butchers) were tested serologically. Human tuberculosis cases were also investigated for species identification (*M. bovis* or *M. tuberculosis*). This collaboration highlighted the fact that common interests are shared between the two professions and that close collaboration allows for a better understanding of the transmission of zoonotic diseases to humans and, possibly, improved diagnosis in exposed humans. However, the study only received limited support from the political authorities, possibly because of low awareness of the benefits of such collaboration and other major priorities at the time of the study such as drought, floods and food insecurity.

In Morocco, echinococcosis caused by *E. granulosus* remains a serious zoonotic issue, particularly in the High and Middle Atlas [24]. In spite of decades of efforts by the government, the disease continues to be prevalent among humans, often requiring them to undergo surgery to remove the hydatid cysts. In these sheep-breeding societies, dogs play important roles for herding and security. However, dogs usually must secure their food themselves, as they are not fed. They are therefore often found roaming around abattoirs and slaughter slabs where they are left to feed on infected organs. In theory, controlling *E. granulosus* should be relatively simple: dogs, which play the major role in disease transmission, should not be allowed to feed on the organs and tissues of infected animals, such as sheep and goats. Owned dogs should be treated with appropriate anthelmintics on a regular basis while stray and feral dogs should be controlled by culling [10]. Yet, this strategy has not worked and it was suggested that a better understanding of people's perception and knowledge of the disease, coupled with a better collaboration between the human health and the veterinary sectors could improve the situation. Preliminary results indicate that the communities have a very poor understanding of the transmission of the parasite and fail to identify the main risk factors (Fig. 1B). However, they are aware of the risks presented by dogs (bites, rabies, etc.) but reject the possibility of living without them and fail to understand that dogs become infected by feeding on infested offal. The role of water in transmission of the disease and the lack of diagnostic capability of medical workers were also highlighted. The authors therefore suggest encouraging intersectoral collaboration, involving communities working with medical and veterinary experts, to identify the most appropriate way to break the parasite's cycle.

This could be promoted by organising local interdisciplinary meetings or workshops to allow each party to express their understanding of the problem, whilst also coming to a better comprehension of the views of other parties.

Participatory epidemiology relies on participatory rural appraisal (PRA) techniques to collect epidemiological knowledge and intelligence [25]. It is based on the fact that people usually have a certain understanding of the most prevailing diseases in their community and their livestock [26]. PRA techniques are qualitative methods used to collect information from key informants amongst community members. Due to their semi-structured characteristics, participatory epidemiology techniques are flexible and adaptable to changing situations and data from multiple sources are normally rapidly analysed for quick feedback and response (Participatory Epidemiology Network for Animal and Public Health: www.penaph.net). However, collected data are often subjective and require triangulation with other sources of information and where possible laboratory confirmation. Such methods allow for a good estimation of the local epidemiology and impact of diseases, as well as people's perceptions of the diseases, especially in remote areas where disease surveillance by governments is difficult to ensure [27]. This approach has contributed to the successful eradication of Rinderpest [25] as well as to a better understanding of other animal diseases e.g. foot and mouth disease [28]. As far as zoonotic diseases are concerned, participatory epidemiology methods have been successfully used to evaluate the spread of highly pathogenic avian influenza in Egypt [29] and Indonesia [30] in 2006–2008 and Rift Valley fever in Kenya in 2006–2007 [31]. Participatory epidemiology as used by the livestock sector may also be exploited by the medical sector for collecting data on neglected or emerging diseases particularly in remote areas [32].

The latter two examples show how important it is to integrate social science in One Health efforts in low-resource societies. Medical and veterinary scientists usually understand the need to work with social sciences to achieve better outcomes, but often overlook the need for prior and complementary qualitative research. Although well designed quantitative surveys may be useful for population-level generalisations, prior qualitative work is essential to develop an understanding of local knowledge as the underpinning context on which health interventions must build [33]. Anthropological, ethnoveterinary and ethnomedical studies address the interface between local and western scientific knowledge, underpin formulation of pertinent research questions and representative sampling frames, and permit greater accuracy in interpretation and analysis of data. Good qualitative data are necessary to enable an accurate understanding of the ways local communities construct categories, processes, relationships and perceptions, while also informing researchers about the way communities will understand research questions and interpret interventions. Qualitative work is particularly critical in a cross-cultural context, and is essential to the internal validity of subsequent research [34].

5. The road ahead

Thus far, the One Health initiative has been driven primarily by veterinarians, with limited involvement by the medical profession. Physicians might not be convinced that emerging and zoonotic diseases have a huge impact on human health, compared to the “Big Three” infectious diseases (HIV/AIDS, tuberculosis and malaria) [35]. Clear evidence of the added value for collaboration with veterinarians might also persuade the medical sector to become more readily involved in a One Health approach to preventing and controlling neglected zoonotic diseases. Therefore, what is probably most critical at this stage is a good understanding of how the different disciplines, including veterinary medicine, can actually benefit human health. Ideally, medical students should be exposed to these issues during their studies. They should also be given the opportunity to gain a broader understanding of disease ecology. On the other hand, veterinary students and researchers need to be more exposed to social sciences and should understand the importance of human behaviour in the surveillance and the control of animal diseases and zoonoses. Consequently, joint lectures could be organised by medical, veterinary and biology faculties as attempted in South Africa where undergraduate medical and veterinary students participated in a joint One Health training programme in a remote rural area [36].

Intersectoral collaboration often seems easier to implement in less developed countries because of lower administrative barriers. However, collaboration needs to be institutionalised for long term sustainability [7]. Today, most international organisations (WHO, OIE, FAO, World Bank, etc.) are aware of the need to view human and animal health in a global system, taking into consideration the numerous factors that favour the transmission of pests, vectors and pathogens. Since pathogens are able to cross species and geographic barriers, scientists should make an effort to cross their discipline barriers.

Conflicts of interest

There is no conflict of interest for any of the co-authors in relation to this article.

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