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Veterinary Medicine and Human Public Health in Africa*

by

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KEYWORDS. — One Health; Africa; Zoonosis; Perception; Antimicrobial Resistance.

SUMMARY. — The "One Health" concept refers to the fact that animals and humans share many biological, physiological, medical and epidemiological features and advocates for increased collaboration between the medical and veterinary sectors to improve both human and animal health. In Africa, intersectoral collaboration is particularly relevant in the surveillance of emerging diseases and zoonoses, in the control of diseases and zoonoses in humans and animals and in the use of antimicrobials and anthelmintics. This paper reports on the importance of brucellosis and zoonotic tuberculosis in sub-Saharan Africa, on the people's perception of hydatidosis and hydatidosis control in Morocco and on antibiotic resistance in *Klebsiella* isolated in surface water in South Africa as illustrations of the "One Health" concept.

MOTS-CLES. — *One Health*; Afrique; Zoonose; Perception; Antibiorésistance.

RESUME. — *Médecine vétérinaire et santé publique humaine en Afrique*. — Le concept de *One Health* dérive du fait que l'animal et l'homme partagent de nombreuses caractéristiques biologiques, physiologiques, médicales et épidémiologiques. Ce concept préconise une plus grande collaboration entre les secteurs médicaux et vétérinaires afin d'améliorer la santé humaine et animale. En Afrique, la collaboration intersectorielle se justifie en particulier pour la surveillance des maladies et des zoonoses émergentes, pour le contrôle des maladies et des zoonoses chez l'homme et l'animal et pour l'utilisation d'antibiotiques et d'anthelminthiques. Afin d'illustrer le concept *One Health*, cet article aborde l'impact de la brucellose et de la tuberculose zoonotique en Afrique subsaharienne, la perception de l'hydatidose et de son contrôle au Maroc, et enfin la résistance aux antibiotiques de *Klebsiella* isolés dans l'eau de surface en Afrique du Sud.

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TREFWOORDEN. — *One Health*; Afrika; Zoönose; Perceptie; Antibioticaresistentie.

SAMENVATTING. — *Diergeneeskunde en menselijke volksgezondheid in Afrika.* — Het *One Health* concept verwijst naar het feit dat mens en dier een aantal biologische, fysiologische, medische en epidemiologische processen delen en streeft naar een nauwere samenwerking tussen de medische en diergeneeskundige sectoren ter bevordering van de menselijke en dierlijke gezondheid. In Afrika is zulk een samenwerking van belang bij het toezicht op het uitbreken van ziekten, de controle van ziekten bij mens en dier en voor het stimuleren van een rationeler gebruik van antibiotica en anthelmintica. In deze publicatie wordt het belang van de *One Health* benadering geïllustreerd a.h.v. de impact van brucellose en zoötische tuberculose in Afrika ten zuiden van de Sahara, de invloed van percepties in hydatidosebestrijding in Marokko en de ontwikkeling van antibioticaresistentie in *Klebsiella* in Zuid-Afrika.

Introduction

The "One Medicine" concept was initially proposed by Calvin Schwabbe, a veterinary epidemiologist, in his book "Veterinary Medicine and Human Health" (1984). His idea referred to the fact that humans and animals share a number of pathogens, known as zoonotic, as well as many physiological, immunological, pathological, surgical, medical and epidemiological principles. Though Calvin Schwabbe initially restricted the concept to medicine (the art to control and cure diseases), the "One Health" concept was, at a later stage, extended to all health issues (KING *et al.* 2008). For instance, experimental animals have been extensively used in biomedical and pharmacological research, and improved understanding of immunological and pharmacological mechanisms have greatly contributed to the development of new drugs and vaccines for use in animals and humans. Finally, some epidemiological concepts, such as endemic stability, were first developed in animals (COLEMAN *et al.* 2001) before being applied in human epidemiology (SARGEANT 2008).

The "One Health" concept becomes useful when the collaboration between the medical and the veterinary sectors generates more benefit than a mere sum of their respective outcomes. This is the case if, for instance, the knowledge gained in animal science can be applied to human medicine or when disease surveillance or control in animals does not only improve animal health but also positively affects human health (ZINSSTAG *et al.* 2007). In Africa, the field of neglected zoonoses is probably the area in which collaboration between the veterinary and the medical professions would be the most profitable, mainly in terms of public health (WHO 2006). Neglected zoonoses were listed by WHO and include anthrax, brucellosis, bovine tuberculosis, leishmaniasis, African trypanosomiasis, hydatidosis, cysticercosis and rabies. Control tools do exist for most of them and were successfully used in many industrialized countries. The reasons why low-resource countries still fail to control endemic zoonoses might not be technical or economic. It is suspected that people's perception of animals, zoonoses and control of animal diseases and zoonoses play a major role in the success of disease control programmes. Evaluating the communities' needs and demand for disease control and the acceptability and transferability of the different control tools should be a prerequisite to the development and implementation of zoonosis control strategies (Marcotty *et al.* 2009).

The emergence of drug resistance among animal and human pathogens is, on the other hand, a serious threat to public health (WHO 2005). The medical sector could benefit from the lessons learned in animals with the emergence of resistance against a large number of anthelmintics when drugs were extensively used in the field (Geerts *et al.* 1997). A more rational use of drugs employed in human and animal medicine could also benefit human health. Enterobacteriaceae causing diarrhoea in humans are known to acquire resistance in animals before being transmitted to people through the consumption of contaminated food (Angulo *et al.* 2004, Molbak 2004). This is particularly a problem in elderly and immunologically compromised populations. In Africa, the development of antibiotic resistance in *Klebsiella* species is a serious concern, especially in infants and children (Lautenbach *et al.* 2005). *Klebsiella* being a commensal bacterium widely found in animals and in the environment, the development of antibiotic resistance in animals could be very detrimental to human health.

The aim of this paper is therefore to illustrate the impact of endemic zoonotic diseases in low-resource communities in Africa, to describe the communities' perception of zoonotic diseases and control strategies and to evaluate the risk of antibiotic resistance transmission from animals to humans in some African settings.

Zoonotic Diseases in Africa: The Example of Brucellosis and Bovine Tuberculosis

Zoonoses are diseases that are transmissible from animals to humans. They should be distinguished from emerging diseases of animal origin. In fact, it is estimated that 62 % of human pathogens, including the viruses causing AIDS, Ebola, SARS and Chikungunya, originate from animals and have crossed the species barrier (Taylor *et al.* 2001). Emerging diseases often break out in developing countries, where people live in close contact with domestic and wild animals carrying wide and unknown collections of potential pathogens. Unlike endemic zoonoses, emerging infectious diseases usually attract major international interest, given their potential threat to the whole world.

Brucellosis and bovine tuberculosis are two zoonoses for which animals are the only reservoir (Acha & Szyfres 2003a). They are transmitted through direct contact with infected animals or animal products. Zoonotic *Brucella* species are mainly found in cattle, sheep and pigs where they cause abortion and reduced fertility. In humans, brucellosis causes a flu-like syndrome called undulant fever.

Brucellae were described in numerous domestic and wild species throughout the world (Godfroid *et al.* 2005). Vaccinating the young female stock reduces significantly the risk of abortion in animals and the chance of *Brucella* transmission to human beings (Moriyon *et al.* 2004). In Africa, vaccination is erratic and it is assumed that most of the domestic animals in Africa are unvaccinated (Marcotty *et al.* 2009). Though brucellosis is considered a notifiable disease in most countries (making its declaration compulsory), very few African governments have their animals tested and the positives slaughtered. In spite of the absence of control in animals, human cases are rarely reported. This could be due to low prevalence in livestock, low transmission from livestock to people, low pathogenicity in people or lack of diagnostic ability (Marcotty *et al.* 2009).

Mycobacterium bovis causes tuberculosis in many mammal species, including man (Acha & Szyfres 2003a). In animals, tuberculosis mostly affects cattle and a number of wild mammalian species resulting in a chronic and debilitating disease which may ultimately lead to death. Infection in cattle occurs predominantly via the aerial route as evidenced by the formation of granulomas in the lungs and associated lymph nodes. Dissemination of the bacterium from these sites will result in tuberculous mastitis in about 10 % of cows. In humans, *M. bovis* tuberculosis cannot be differentiated clinically and on sputum cytology from the human tuberculosis caused by *Mycobacterium tuberculosis* (Grange 2001). *Mycobacterium bovis* is mostly transmitted to humans from cattle through the consumption of dairy products causing extra-pulmonary tuberculosis, unlike *M. tuberculosis* which is mostly transmitted among humans through the aerial route. Yet, human beings could also be infected by *M. bovis* through the aerial route following close contact with infected cattle.

Much information is available on the prevalence of tuberculosis and brucellosis in livestock in Africa (Cosivi *et al.* 1998, McDermott & Arimi 2002), but very little is known on their impact on human health as zoonoses. International experts have recommended that modern diagnostic tools are made available in low-resource countries, even if they are not particularly cheap, to ensure accurate diagnosis in humans (Marcotty *et al.* 2009). So as to reduce the cost, the collaboration between medical and veterinary laboratories and the development of regional laboratories have been encouraged. As far as control is concerned, it has been admitted that eradication of brucellosis and tuberculosis from livestock in low-resource countries might not be possible in the near future. Instead, living with the diseases and mitigating their effects is viewed as a better approach. In such a case, the burden of diseases on animal and human health should be better quantified and control strategies suiting the communities' habits and perceptions should be developed accordingly.

The prevalence of animal brucellosis in low-resource communities varies greatly. In a recent study in Kenya, values ranging between 20 and 30 % were recorded in Turkana and Maasai cattle, indicating a state of endemicity (Marcotty *et al.*, in preparation). These pastoral communities usually have little contact with medical services and the incidence of brucellosis in humans, particularly in infants and children, is unknown. Other areas in Kenya and Zambia presented with a lower prevalence but were also considered as endemic. Arid areas in Kenya and Ethiopia were found free of brucellosis in cattle (Marcotty *et al.*, in preparation; Amenu *et al.* 2010). This could be explained by the reduced survival of the bacterium in the environment and, consequently, the reduced transmission from one animal to another. Brucellosis in small ruminants seems to be rare in sub-Saharan Africa. *Brucella melitensis*, the main causative agent of brucellosis in sheep and goats, relies on large populations of small ruminants and probably fails to survive in areas where animals are scattered, like in most parts of sub-Saharan Africa. Pigs might be an important source of *Brucella* in low-resource settings. Village pigs showed a seroprevalence of 16 % in eastern Zambia (Marcotty *et al.*, in preparation). There is need to confirm the role of pigs as reservoir in this area since all *Brucellae* of pig origin are not pathogenic to humans (Acha & Szyfres 2003a).

In spite of the absence of tuberculosis control in cattle, tuberculosis seems to be absent or to present a low prevalence in traditional cattle in several sub-Saharan areas. We have observed that in central Ethiopia (Amenu *et al.* 2010) and in Kwazulu-Natal in South Africa (Geoghegan *et al.*, recent data). The situation in South Africa is particularly striking since cattle raised next to highly infected buffalo populations (Michel *et al.* 2009) were found free of tuberculosis. The risk of zoonotic tuberculosis might, however, be substantially higher in commercial settings or in periurban areas since exotic cattle and cross-breeds were reported to be more sensitive to tuberculosis (Ameni *et al.* 2007).

Perception of Zoonotic Diseases: The Example of Hydatidosis in Morocco

Hydatidosis is endemic in several African countries, mainly where sheep are raised (Acha & Szyfres 2003b). This parasitic zoonosis is caused by a taeniid worm (*Echinococcus granulosus*). The adult form is short and found in large numbers in the intestine of canines. Eggs shed in the environment are infective to sheep and other species, including man. The larval stage develops mostly in the liver and lungs of their host, where they cause large-size hydatid cysts. These cysts are infective to dogs when they feed on infected dead animals or offal. Animals do not seem to suffer much from the infection but livers are usually discarded from human consumption due to their unpleasant appearance. In humans, hydatidosis is a chronic but severe disease. Depending on their locations, cysts may be painful and cause organ failures. Human hydatidosis is usually treated surgically. Operations are difficult to implement in low-resource countries and often prove to be painful and prone to complications (Shaw *et al.* 2006, Ali *et al.* 2005, Cooney *et al.* 2004).

In Morocco, human hydatidosis remains particularly frequent in the Berber community in Atlas (Macpherson *et al.* 2004, Azlaf & Dakkak 2006) despite numerous control attempts. In order to address this public health issue, people's perceptions of the disease and of the way it is transmitted or controlled should be studied using socio-anthropological and behavioural theories (Ellis-Iversen *et al.* 2010). Focus-group meetings were therefore organized to identify the importance the communities were giving to human and animal hydatidosis and to identify possible control strategies (Chomel 2008). Focus-group meetings consist of eight to ten persons brought together and asked to express their views on specific issues (Patton 2002, Dawson *et al.* 1993). These meetings are animated by trained facilitators and recorded for analysis purpose. In Morocco, focus groups were carried out among male and female villagers separately and among butchers. Discussions mainly focused on the severity of hydatidosis in people, people's knowledge of sheep hydatidosis and transmission to man, the role of dogs in society, the control of stray dogs and how to restrain dogs from feeding on sheep offal.

Preliminary results indicate that the communities consider human hydatidosis as a serious and relatively frequent disease but poorly understand the cycle of the parasite (Thys *et al.*, in preparation). Actually, the cycle is rather complicated and people tend to believe that humans are infected through contact or consumption of infected sheep. Very few of them are aware that dogs and dog faeces are the only source of infection for other species. The communities are aware that stray dogs may be harmful and that feeding dogs with offal is not a good practice. However, dogs play an important role in the communities in terms of herding and security. Dogs are usually not fed and have to find food on their own, often on markets, abattoirs and butcheries. People fear stray dogs, mostly for attacks, bites and rabies, but have no means to control them. Butchers claim to have no alternative to dispose of offal though, by law, they should be appropriately dealt with. Finally, living without dogs does not seem to prevent people from hydatidosis. Contamination of the water system by dog faeces might explain why hydatidosis cases remain so frequent in the area even in the absence of dogs in villages.

***Klebsiella* Resistance against Antibiotics**

Klebsiella, a commensal bacterium widely found in the environment and in animals, is a frequent cause of human infection and septicaemia in Africa (Simeunovic *et al.* 2009, Okesola & Kehinde 2008, Iregbu *et al.* 2006). Resistant *Klebsiella*, especially those that are resistant to sulphonamides, aminoglycosides and the broad-spectrum beta-lactam drugs, are getting commonplace in human infections (Lautenbach *et al.* 2005). The emergence of antibiotic resistance in a number of human enterobacteria (*E. coli, Salmonella* and *Campylobacter*) was attributed to the use of antibiotics in animals, especially as food additives for pigs and chickens (Angulo *et al.* 2004, Molbak 2004). In a recent study, we therefore tried to confirm whether industrial animal production settings contaminated surface water with antibiotic resistant *Klebsiella*. *Klebsiella* bacteria were isolated from two polluted rivers in Johannesburg (South Africa), in the vicinity of human settlements or industrial animal production units, and tested for their resistance to antibiotics used in veterinary and human medicine. Resistant *Klebsiella* were mainly isolated in surface water in high human activity areas (Picard *et al.*, in preparation). Furthermore, resistance was mainly observed against drugs that are not used in animals. Therefore, this study tends to demonstrate that the emergence of antibiotic resistance in *Klebsiella* in Johannesburg is most likely caused by the use of antibiotics in human patients and that the role played by animal husbandry in the emergence of *Klebsiella* resistance against antibiotics is marginal. Interestingly, this study and a small pilot study done in poultry workers and broilers indicate that tetracycline resistance is more common in *Klebsiella* of animal origin. Thus, resistance to this class of antibiotic may act as a marker for animal to human transfer of resistance. Yet, the use of critically important antibiotics should be reserved to humans and not be allowed in animals, as suggested by WHO (2005), to reduce by all means the risk of resistance emergence against these drugs.

Conclusion

The “One Health” concept advocates for increased collaboration between the veterinary and the medical sectors, in particular in the field where collaboration generates added value. In Africa, intersectoral collaboration would be most needed for surveillance of endemic zoonoses, diseases emerging from animals and antibiotic resistance development. As far as the control of neglected zoonoses is concerned, it is crucial to better quantify the burden of these zoonoses on human and animal health before control strategies are developed. Control strategies should meet the needs and expectancies of the medical and veterinary sectors, be acceptable by and transferable to the target populations, and be cost-effective. The occurrence and transmission of zoonotic diseases are sometimes difficult to understand by local communities. It would be important, if justified by the burden on human health, to improve people’s education on zoonoses so that the communities could contribute to the development of more adapted control strategies, taking into account, for instance, the role that animals play in society and the relationship between humans and animals. The cost of zoonoses control strategies should ideally be equitably borne by the medical and the veterinary sectors. This is often the problem in developing countries, where the veterinary services are expected to control zoonoses in animals for the benefit of human health. Veterinary services often fail to meet their responsibilities due to lack of funding. More coordinated actions will hopefully result in more cost-effective surveillance and control of diseases transmissible from animals to man in Africa.

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