From 'two medicines' to 'One Health' and beyond

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We first review historic and conceptual background to integrative thinking in medicine. Lacking a general theory of 'One Health', we provide an operational definition of 'One Health' and its leverage as: any added value in terms of human and animal health, financial savings or environmental benefit from closer cooperation of human and animal health sectors at all levels of organisation. Examples of such added value of 'One Health' are given from the fields of health systems, nutrition and zoonoses control in Africa and Asia.

'One Health' must become main-stream rather than a new discipline or new association; it should just become normal that practitioners and professionals in the health, animal and environment sectors work together as closely as possible. Current and future challenges in financing clean energy, migration flows, food security and global trade further warrant rethinking of human and animal health services. A conceptual outlook relates health as an outcome of human-environment systems called 'health in social-ecological systems'. The paper ends with an outlook on the operationalisation of 'One Health' and its future potential, specifically also in industrialised countries.

Introduction

The present paper is summarising and extending an invited key note, given as a video presentation to the first African 'One Health' conference, held in Johannesburg on July 14 and 15, 2011 by the first author (http://www.sacids.org/kms/frontend/?m=103). The human and animal health research unit in the department of Epidemiology and Public Health at the Swiss Tropical and Public Health Institute (http://www.swisstph.ch) entertains partnerships with countries in East–Africa, Central–Africa and West–Africa, Central Asia and Switzerland. Here we account for conceptual and practical research work on collaborative efforts between human and animal health, between developing and industrialised countries involving disciplines as diverse as epidemiology, anthropology, cultural sciences, sociology, geography, molecular biology, statistics and mathematics. Initially the focus of the research group was on the provision of health care to mobile pastoralists, who are nearly devoid of health services. However, soon questions on the control of zoonoses, diseases transmissible between animals and humans, like bovine tuberculosis, rabies, brucellosis, anthrax and avian influenza, came in the focus of attention.

The research group is part of several larger international research networks. It is the health partner in the National Centre of Competence in Research North-South (http://www.north-south.unibe.ch), together with seven Swiss research institutions and their partners on all continents except Australia. The network covers research partnerships on natural resource management, conflict transformation, governance, water and sanitation, livelihood, urban planning and health and is jointly funded by the Swiss National Science Foundation (SNSF) and the Swiss Agency for Development and Cooperation (SDC). In this network, health research is a component of a larger development research approach for which we currently work on integrated methods involving inter- and transdisciplinary approaches. The unit is also part of the European Union funded network on integrated control of neglected zoonoses in Africa (http://www.iconzafrica.org). It involves twenty European and African partner institutes. Further, the unit collaborates in Wellcome Trust funded projects on bovine tuberculosis in Africa which evolved into an African Capacity Building program 'Ecosystem and population health: bridging the frontiers in health' (http://www.afriqueone.net). The last network is the Consortium One Health Next Generation OH-NEXTGEN with a strong focus on training young fellows to change the mindset in health system considering health problem at the human, animal and environment interface in different eco-zones. Networks have proven essential for reassembling critical mass, inter- and transdisciplinary collaboration, North-South, South-South and East-West exchanges and comparisons, yielding typically a higher output of research outcomes as could be achieved if each partner worked alone.

We provide first a brief historic and conceptual background to integrative thinking in medicine. We will then provide an operational definition of 'One Health' and its leverage. Examples of the

leverage of 'One Health' are given from the fields of health systems, nutrition and zoonoses control in Africa and Asia. Prior to further conceptual extensions the unfinished 'One Health' agenda will be described. The paper ends with an outlook on how to make 'One Health' operational and its future potential, specifically also in industrialised countries.

Brief history of integrative thinking in medicine and health

We are often asked what is new about 'One Health'. Actually nothing, close interactions between human and animals are longstanding but vary by their historical intensity and cultural background. We provide here examples from a more detailed account (Zinsstag *et al.* 2011). In the ancient Egyptian culture humans and their animals were seen as belonging to one 'flock of God'. Transformation from humans to animals (metempsychosis) are known from India and Africa. Fulbe pastoralists in Africa, in their myths of creation, see cattle as being an integral part of their society (Louanges à la femme 1966). The Zhou Dynasty in China (11th century – 13th century) maintained the first integrated public health system including medical doctors and veterinarians. The Chinese Scholar Xu Dachun stated already in the 18th century, 100 years earlier than Rudolf Virchow that, 'the foundations of veterinary medicine are as comprehensive and subtle as those of human medicine and it is not possible to place one above the other' (Driesch & Peters 2003). Whilest human medicine became a faculty in the medieval European universities (Rüegg 2004), veterinary medicine remained in the hand of equerries, the persons in charge of the horses for warfare, until Claude Bourgelat, founded the first veterinary school in Lyon (1761). The end of 19th century with the advent of cellular pathology and microbiology was a period of very close interaction of human and animal health as comparative medicine. One of its protagonists, Rudolf Virchow, stated in an address to the Prussian government on bovine tuberculosis, 'between animal and human medicine there is no dividing line – nor should there be'. The object is different, but the experience obtained constitutes the basis of all medicine. 'In the twentieth century veterinary and human medicine evolved in a way as to specialise into more and more sub-disciplines and the influence of comparative medicine decreased. The American epidemiologist Calvin Schwabe, influenced by his work with Dinka pastoralists in Sudan coined the term 'One Medicine' in the 1960s. It means that, there is no difference of paradigm between human and veterinary medicine. Both sciences share a common body of knowledge in anatomy, physiology, pathology, on the origines of diseases in all species. We can thus conclude that the modern formulation of 'One Medicine' has African roots. In the past decades, 'One Medicine', addressing more and more public and environmental health issues became 'One Health'(Zinsstag *et al.* 2005) and has seen unprecedented revival at the level of international organisations, national governments and academia (Zinsstag *et al.* 2009b) after the outbreaks of major diseases (SARS, Avian Flu, Swine fever …).

Operational definition of 'One Health' and its leverage

The scholarly statements on 'One Medicine' mentioned above have been replaced by an ongoing debate on contemporary definitions and delimitation of what has become 'One Health'. In the past conferences, in particular at the first 'One Health' conference in Melbourne in February 2011, many presenters limited themselves to recognising the interdependence of humans and animals and their environment. In our view, this is a necessary component of 'One Health', but only part of it. We lack a modern and internationally acknowledged theory of 'One Health', which may require an in-depth epistemological assessment of all involved disciplines. We propose here a pragmatic operational definition of 'One Health' as any added value in terms of human and animal health, financial savings or social and environmental benefits from closer cooperation of professionals in the health, animal and environment sectors at all levels of organisation. Claiming a 'One Health', in our view, requires the demonstration of added value to what human and animal health working alone can achieve. Specifically a 'One Health' approach is capable of identifying points of leverage of health of humans and animals from a systemic analysis.

Examples of the leverage of 'One Health'

The presented examples are published as case studies on zoonoses epidemiology, nutrition and public health services. Most often zoonoses are investigated either in humans or animals. In the case of zoonotic diseases that are transmissible between humans and animals, integrated study designs investigating health status in humans and animals simultaneously allow an instantaneous identification of the source of a zoonotic disease. For example, in Chadian pastoralist human Q-fever to camels (Schelling *et al*. 2003).

Human brucellosis can be eliminated by interventions in animals. From a public health point of view, mass vaccination of livestock to prevent human brucellosis is not profitable in Mongolia. But if societal benefits are summed up, including benefits for private households and the livestock sector, the intervention is largely profitable. If costs of brucellosis mass vaccination are shared between the health and livestock sector proportional to their benefits, brucellosis control becomes highly cost-effective (Roth *et al.* 2003). Similarly, the cumulative cost of dog rabies mass vaccination and human post-exposure treatment (PET) in N'Djaména, Chad reaches break-even with the cumulative cost of PET alone after six years (Zinsstag *et al.* 2009a). Such comparative assessments can only be made if human and animal health is investigated as a single social-ecological disease system. A shared veterinary laboratory to diagnose brucellosis in febrile patients has brought the collaborating physician in Mali to include brucellosis testing as a differential diagnosis to malaria and typhoid fever in an area where raw milk consumption is still prevalent (Steinmann *et al.* 2005).

Pastoralists in Africa depend highly on milk from their animals for their nutrition and the vitamin A status of mobile pastoralist women and children in Chad depends directly on the vitamin A levels in the milk of their cows. In the same way a study on the vaccination status of mobile pastoralist children, women and their animals showed that the vaccination coverage of livestock was much higher than that of children and women. Joining the vaccination campaigns between the veterinary and public health services reduced the logistic cost by 15% and improved vaccination coverage of children and women, who have otherwise no access to health care (Bechir *et al*. 2004; Schelling *et al.* 2005). Work with pastoral communities heavily relayed on collaboration with cultural scientists, who lived for example with Kel Tamacheq communities in North Mali. Fluency in local languages and coranic literacy were critical for creating a trustful relationship. Informations and data on mother and child health seem to be more accurate from participant observation than from clinical surveys by a medical doctor (Münch *et al*. 2007). In this way a 'One Health' approach recognises the need for collaboration between medical and cultural sciences.

The unfinished 'One Health' agenda

The above examples clearly show an added value of closer cooperation between human an animal health for the understanding of the human animal linkage by taking more a societal perspective rather than a public health point of view only. It shows how interventions become profitable or public and animal health status can be improved. Much of this dynamic has been taken up but there remain still a huge unfinished agenda (Zinsstag *et al.* 2009b).

A recent outbreak of Q-fever in the Netherlands (Enserink 2010a & 2010b) has shown the current limitations of communication between the animal and public health surveillance system. There are obvious reasons why surveillance systems of communicable diseases for humans and animals should be coupled in a single cooperative surveillance system, which informs on outbreaks in all different species simultaneously to the whole system. This would, as the Dutch Q-fever example shows, reduce time to detection and time to intervention significantly. The control of Rift Valley Fever, another epidemically occurring zoonosis, would largely benefit from joint contingency planning where roles of each sector, how information flows and cost-sharing schemes are jointly decided on based on evidence before an outbreak. Similarly there are great public health opportunities in merging human and animal cancer registries (O'Brien *et al.* 2000). Geo-referenced detection of cancer incidence in one species could reveal environmental exposure for the other species. Canada is spearheading such approaches by its joint surveillance of antimicrobial resistance (CIPARS, http://www.phacaspcgc.ca/cipars-picra/index-eng.php) or the integrated surveillance of enterobacteriacea (C-enternet). The human-animal bond has far reaching consequences in the case of non-communicable disease like depression or obesity (O'Haire 2010). Systemic approaches, well known from pastoral counseling (Van Katwyk 2005) or family therapy could be extended to health care for humans and their pets or pets and their holders (the human-animal bond as an entity). Respiratory problems of a dog may be associated to smoking behavior of the dog holder (Reif *et al.* 1992). Obesity of a pet may be associated to a health problem of its owner, and hence the owner's care determines the pet animal's health. New ways of communication between clinical veterinarians and family doctors require a dialogue and negotiation as to when an interaction makes sense and may lead to improved health of animals and their humans.

To prevent fears of institutes being absorbed by larger ones, public and animal health systems should cooperate as equal rights partners respecting each others technical field of competence.

'One Health' as a mindset, must become mains-stream, rather than a new discipline or institution, it must become normal that professionals throughout all relevant disciplines (e.g. physicians, veterinarians, social scientists and ecologists) work together as closely as possible. Current and future challenges in financing, clean energy, increasing migration flows, food insecurity and global trade further warrant rethinking of human and animal health services (see below). The above 'unfinished' agenda is also incomplete and warrants each actor's imagination as to how interactions between the two medicines can yield better health for all.

Conceptual extensions of 'One Health' towards systemic approaches

The closer cooperation between human and animal health has been extended since over a decade by including ecological and eco-systemic aspects, known as eco-system health (http://www.ecohealth.net), recognising inter-dependency of health of humans and animals and the integrity of eco-systems (Forget & Lebel 2001; Lebel 2002). Systems biology, previously concerned mainly with complex processes at cellular and sub-cellular level recognise extensions at higher scales up to populations, for example for explaining the development of persistent infections and phylo-geographic lineages in tuberculosis (Gagneux & Small 2007; Young, Stark & Kirschner 2008). Environmental sciences and work on natural resource management use conceptual approaches called Social-Ecological Systems (Ostrom 2007) or Human-environment systems, which can easily be applied to a systemic approach to health e.g. in the management of Bovine Spongiform Encephalitis (BSE) in Switzerland (Scholz 2011). Studying Health in Social-Ecological Systems (HSES) opens new ways addressing complex, multivariable, nonlinear, cross-scale and dynamic factors determining the health of humans and animals (Zinsstag *et al.* 2011). HSES formally include social sciences and humanities in health research but require further work on epistemological bridges between humanities, economics and natural sciences.

As an example on health in a social-ecological system, we can mention the interactions of the socio-political and ecological

changes from a planned economy to a market economy in Mongolia in 1990, causing the breakdown of public health and veterinary disease control systems. In the same time the privatised livestock production led to a sharp increase of livestock numbers, pasture degradation and animal disease like foot-and-mouth disease (FMD) and brucellosis, which is transmissible to humans. Effective reduction of brucellosis incidence in humans requires interventions in livestock. Understanding livestock demographic dynamics becomes a key for the planning of sustainable pasture management and the planning of animal health interventions. Seeking a stabilisation of the Mongolian livestock population in Mongolia will be an important element to preserving pastures. Potential freedom of important zoonotic and transboundary diseases will provide market access and help stabilising livestock population by increasing offtake. All these complex social-ecological processes determine the health of humans and animals but depend on political and societal forces engaging their respective interests. Further work aims at demonstrating added value of a systemic approach on overall societal burden and cost of disease and its control, while preserving ecosystem services and social stability using transdisciplinary approaches.

Operationalisation of 'One Health'

We have shown that 'One Health' is well integrated into broader conceptual thinking like 'Ecosystem health' or 'Health in Social-Ecological Systems'. Whilst research can disentangle the complex interactions between health, society and ecosystems, demonstrating central points of leverage for future interventions, governments and international agencies aim primarily at making 'One Health' work in practice.

There is not a blueprint for making 'One Health' operational and there are multiple actors involved and require stakeholders' involvement, long term partnerships, capacity-building, but also local champions. Most of the activities in industrialised countries are mirrored by the 'One Health' initiative website (http://www.onehealthinitiative.org). The World Bank for example engages in the study of structural savings from institutional planning by joining surveillance or laboratory capacity. Academic curricula teaching 'One Health' are developed by several universities, for example the University of Calgary in Canada and imply the development of methods for 'One Health' research (Zinsstag *et al.* 2009b). Research for development shows that operational models of 'One Health' require transdisciplinary processes (Schelling *et al*. 2007). Academic research extends processes to improved understanding of the interactions by involving stakeholders like communities, authorities and experts for the identification of locally acceptable and adapted health interventions. All processes need to be negotiated between actors since each context is different (Meisser, Schelling & Zinsstag 2011; Schelling *et al.* 2005; Schelling *et al.* 2007). Contextual solutions will address the importance of cultural determinants of the human animal relationship. As an example we can mention the dog, which in some cultures has mainly an emotional value with strong human-dog bonds and in others a commodity with commercial value as food supply. Researchers and planners aiming at making 'One Health' operational require high level self reflexive capacity in recognising inter-cultural aspects of the human-animal relationship. Key outcomes of a closer cooperation of human and animal health will remain economic savings, health benefits for humans and animals and ecological benefits. Not all outcomes such as improved communication and information flows between sectors with subsequent e.g. earlier detection of a disease or appropriate measure can be easily quantified, but can still be captured with qualitative attributes.

The potential is endless and potential savings go in the billions, if doctors and veterinarians communicate and interact in a closer way. But we are also very much aware that those in charge of national planning would want to be re-assured by examples of cost saving potential, if not from their own country, at least from a country in their region.

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