One Health Informatics

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ABSTRACT
Zoonoses are a class of infectious diseases causing growing concern of health authorities worldwide. Human and economic costs of zoonoses are substantial, especially in low-resource countries. New zoonoses emerge as a consequence of ecological, demographic, cultural, social and behavioral factors. Meanwhile, global antimicrobial resistance increases. This public health threat demands for a new approach to which the concept of 'One Health' is emblematical. It emphasizes the interconnectedness of human, animal and environmental health. To protect and improve public health it is imperative that transdisciplinary collaboration and communication takes place between the human and the veterinary domain. This strategy is now widely endorsed by international, regional and national health policy and academic bodies. Nonetheless the contributions of both the social sciences and the new data sciences need more appreciation. Evidence is available that the methods and concepts they provide can budge 'One Health'.

Categories ans Subject Descriptors
J.4 [**Computer Applications**]: Social and Behavioral Sciences

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Management, Measurement, Design, Human Factors

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Public Health; Public Health Informatics; Digital epidemiology; Zoonoses; One Health

1. INTRODUCTION
The human and the animal worlds have age-old correspondences that lead to a wide range of psychological, social, medical, economical and agricultural advantages. However, there are serious hazards as well, for instance, with regard to the transmission of infectious diseases from vertebrate animals to human beings (zoonoses). The pathogenic micro-organisms - such as bacteria, viruses, fungi or prions – human beings share with domesticated or wild animals, have caused some of the most significant disease outbreaks in recent years, including HIV, Ebola, avian influenza, Q-fever, H1N1 flu SARS and recently MERS-CoV. Over 200 zoonotic diseases, often species-specific, have been identified. Transmission takes place either directly from animal to humans, or indirectly via the air, food, water, soil, blood or vectors (rodents, insects et al.). Globally, the poorest people are most affected. A 2012 review of the International Livestock Research Institute concludes that the thirteen most important zoonoses together cause 2.4 billion cases of human illness and 2.2 million deaths each year, mostly in low- and middle-income nations. But 'hot-spots' for emerging zoonoses are appearing in the developed world as well [1]. The immediate costs of zoonotic diseases over the last decade have been estimated to be more than $20 billion, with over $200 billion indirect losses to affected economies as a whole [2]. It is commonly recognized that zoonoses will continue to (re)emerge because of a global increase of people and animals populations (density, cattle); more international (illicit) traffic of people, animals and products (globalization, eco-tourism); cultural changes (urbanization, migration, war, agro-industrial developments, farming new animal species, food habits, land use); and because of ecological changes (global warming, environment, biodiversity).

Many zoonoses are caused by RNA (Ribonucleic acid) viruses, which are extremely adaptive to changing circumstances. All this has raised global awareness among national, international, intergovernmental bodies and to the redirection of resources towards research, prevention and control of zoonoses [3].

2. ONE HEALTH
Over the last decade, the original concept of 'One Medicine One Health' evolved, driven by public concern after the 2003 outbreaks of SARS and Ebola hemorrhagic fever. It has been adopted and advanced by international bodies such as the United Nations, the European Union, the World Health Organization, the World Organization for Animal Health, the Food and Agriculture Organization and regional or national organizations such as the European Center for Disease Control, the U.S. Centers for Disease Control or the Dutch National Institute for Public Health and the Environment. Today, the integrative, holistic concept of 'One Health' entails a positive, global strategy for expanding interdisciplinary collaborations and communications in all aspects of health care for humans, animals and the environment [4, 5]. It inspired many initiatives to improve cooperation between often-segregated disciplines in policy, education and research. Remarkably, contributions of social sciences and public health informatics have received too

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little attention. These perspectives could be vital for One Health to become effective.

3. NEW PERSPECTIVES

3.1 Social Sciences

Though it is historically explainable that scientific attention has one-sidedly focussed on the pathogen, the One Health approach demands that we better understand what people *do*. Social behavior obviously is the essential element of R_0, the basic reproduction number of an infectious disease. People create the conditions both for the transmission of zoonoses and the reduction of their prevalence and incidence. Without the social sciences, the interactions of factors and circumstances that determine novel zoonotic disease spill-over simply cannot be understood. Knowledge on the social nature of transmission dynamics informs the design of effective public health interventions that target human behavior. Successful examples are e.g., measures to increase personal hygiene, sanitary control, 'test and slaughter' procedures or school-based health prevention and education [6]. Social scientific methodologies have been extended for use in the field of applied infectious disease research. Examples can be found in studies that model the impact of individual behavior on the spread of infectious diseases [7] or in qualitative research on the behavioral and psychological defences through which people protect themselves against diseases [8]. Where social sciences integrate information and communication technologies new and productive paradigms emerge for public health and health care. For instance, Health 2.0 or mHealth build on the participative possibilities of the internet, social media or mobile apps [9] and technology-supported Antibiotic Stewardship by the collaborative Eursafety Health-net project effectively reduces nosocomial MRSA cases [10]. It is time One Health benefits from the corresponding growing body of evidence in this domain.

3.2 Public Health informatics

The second perspective to boost One Health comes from an innovative strand of research called public health informatics, digital epidemiology, infodemiology or similar terms. Fast developments in data science theory delivered digital technologies that provide us with new ways for monitoring and research in population health. In the area of infectious diseases control these methods create opportunities for prevention strategies e.g. to communicate, to inform or to educate [11]. 'Big data' is the kind of digital information made available by improved data management, advanced mathematical measurement and increasing storage capacity. Though somewhat clouded in hype, it is already clear that analyses of massive amounts of data generated through social media or search engines have opened new ways for early-warning, detection and even predicting outbreaks of infectious diseases [12, 13]. Fundamental issues with regard to statistical inference, questions of validity and reliability, data-optimization, dealing with data-provenance and other issues are currently in need to be resolved [14]. But some optimism about the potential of 'One Health informatics' is legitimate. To scientists from all domains serious concern for ethical issues is self-evident here [15] as moral considerations naturally belong to One Health as well.

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