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The Future of One Health

RONALD M. ATLAS[1] and STANLEY MALOY[2]
[1]Department of Biology, University of Louisville, Louisville, KY 40292; [2]Center for Microbial Sciences, San Diego State University, San Diego, CA 92182

ABSTRACT There are significant opportunities for improving human, animal, and environmental health by adopting a One Health approach. One Health approaches are likely to have a major impact on public health, with a focus on surveillance and upstream interventions that are likely to reap obvious and rapid benefits for the health of human populations. However, despite the obvious benefits, the barriers to achieving a comprehensive One Health approach are formidable given that education, research, diagnostics, surveillance, and funding for human medicine, veterinary medicine, and environmental health often exist as separate silos with limited exchange. These barriers must be overcome if the benefits of One Health are to be realized.

The recognition that human, animal, and ecological health are integrally interconnected has given rise to a growing recognition of the importance of crossing boundaries that have arisen in education, research, and practice. The value of the One Health approach is obvious to microbiologists who confront the frequent emergence of zoonotic diseases and the ecological factors that bring about changes in the distribution and activities of microorganisms across the globe. Microbes readily cross the boundaries of ecosystems—they have evolved to jump environmental barriers, including those that differentiate humans from other animal species (1).

This is not a new idea: the pioneering microbiologists Louis Pasteur and Robert Koch carried out research on both animal and human diseases and recognized the interconnection between animal and human health (2). Medical and veterinary educators of that era, including Rudolph Virchow and Sir William Osler, also freely crossed the boundaries of human and animal health (3, 4). Virchow is quoted as saying: "Between animal and human medicine there are no dividing lines—nor should there be" (5). Calvin Schwabe, who helped establish the modern One Health movement, shared this perspective when he said: "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 origins of diseases in all species" (6). Although a major thrust for One Health has emerged from the veterinary community, the value of One Health goes well beyond cooperation between veterinarians and physicians. Importantly, "in the past decade, the concept of One Health has expanded beyond an examination of the human-animal health interface to encompass the health and sustainability of the world's ecosystems" (7).

Although it is an old concept, the need for One Health approaches is more important than ever. The risks of not adopting a One Health approach were clearly evident in 1999 when a lack of coordination between veterinary and human diagnostic labs delayed recognition of the outbreak of West Nile fever in New York City (8). Subsequently this disease has spread across the United States and around the world.

Given that more than 60% of emerging infectious disease events are caused by the transmission of an infectious agent from animals (zoonoses), with 75% of these originating from wildlife, employing a systematic One Health approach has great potential for reducing threats to global health from infectious diseases. In other countries, particularly in the developing world, there is less of a division between the veterinary and human

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Correspondence: Ronald M. Atlas, ronald.atlas@louisville.edu

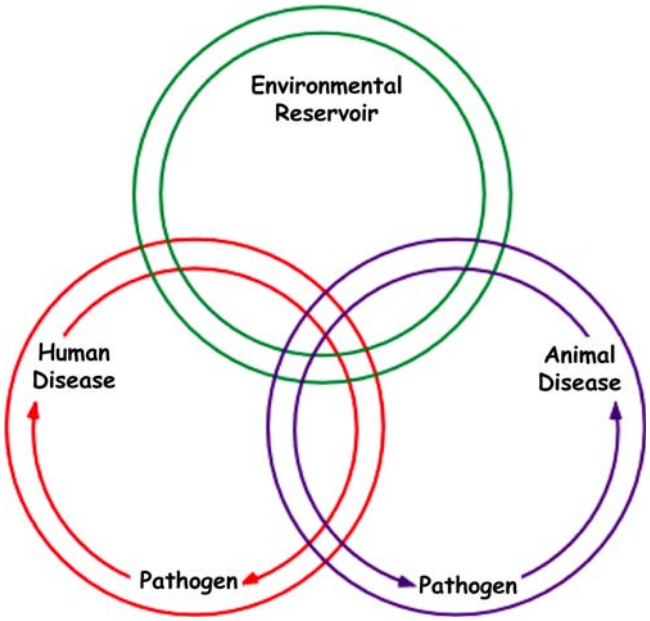


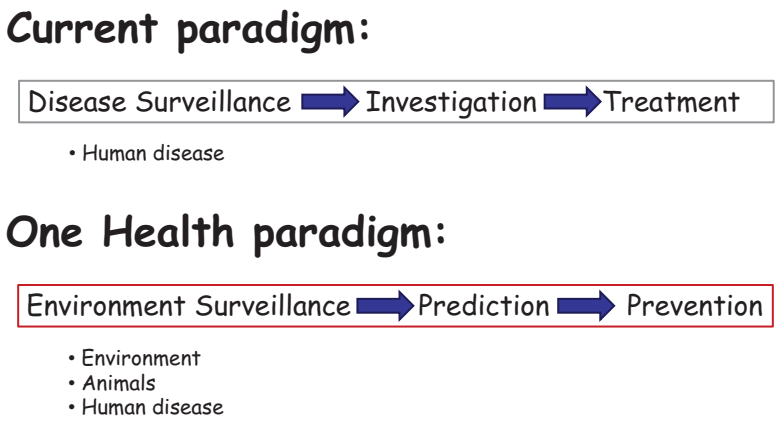
FIGURE 1 The interrelationship among human disease, animal disease, and the environment. One Health is represented by the region of overlap. doi:10.1128/microbiolspec.OH-0018-2012.f1

health communities. In fact, many countries now are seeking better ways to ensure early detection of zoonotic diseases. Canadian ministries and major international organizations have initiated consultations entitled "One World, One Health: from Ideas to Action." There also now is a One Health office within the Centers for Disease Control and Prevention (CDC) and increased cooperation between the CDC and the U.S. Department of Agriculture. The One Health approach should advance health care for the 21st century and beyond by accelerating biomedical research, enhancing public health efficacy, expeditiously expanding the scientific knowledge base, and improving medical education and clinical care (6).

Despite the obvious benefits, the barriers to achieving a comprehensive One Health approach are formidable. Education, research, diagnostics, surveillance, and funding for human medicine, veterinary medicine, and environmental health often exist as separate silos with limited exchange. Medical students often are trained only in human diseases. Similarly, veterinarians concentrate on nonhuman animals. Environment is often not even considered in introductory microbiology courses. These barriers must be overcome if the benefits of One Health are to be realized. One critical aspect involves reforming the fundamental system of education in the way Virchow, Osler, and Schwabe envisaged. Fortunately, some academic medical centers are beginning to rise to this challenge, providing the interdisciplinary educational opportunities needed to form the foundation of a One Health approach, including consideration of environment and its health implications (7).

This challenge is both regional and global. Changing demographics, the resulting environmental disruption, and international travel have a major impact on animal and human health (7). Expansion of farms and cities into wilderness areas and ecological disruption of animal habitats have led to new niches for pathogenic microbes and promoted the transmission of new diseases from animals to humans (Fig. 1). Human developments have resulted in global climate change that influences the distribution of animal habitats and disease vectors. Furthermore, the expansion of global travel and food distribution networks has facilitated the rapid transmission of disease between urban and rural regions of the entire world. Hence, it is clear that international

FIGURE 2 The current human health versus the One Health paradigm. doi:10.1128/microbiolspec.OH-0018-2012.f2



cooperation in many areas will be required to thwart these threats.

In addition, solving these problems will demand new tools for rapid identification and response. A variety of new tools such as environmental metagenomics, geospacial modeling, and mobile communication technologies have made it possible to rapidly detect many diseases in the environment, and provide a window of opportunity to develop upstream barriers to transmission before the diseases become a major health risk. This changes the way we deal with infectious disease from responding to an outbreak by treating patients to detecting and intervening in the process upstream (Fig. 2). When this One Health approach is most successful, it prevents disease outbreaks before they are recognized as a problem by the public and funding agencies; thus it will demand constant effort to inform policymakers about the need to support these efforts.

In addition, to foster the necessary research there will need to be cross-agency funding opportunities. Traditionally, funding for human, animal, and environmental health has been supported by different agencies in the United States, limiting the potential for supporting interdisciplinary One Health approaches. One step in the right direction is the interagency program by the U.S. National Institutes of Health (NIH) and the National Science Foundation to support research on the evolution and ecology of infectious diseases. The NIH has also supported work on the emergence of potential human infectious agents in wildlife populations. The work on viral chatter by Nathan Wolfe and his efforts at viral forecasting (9) (http://www.globalviral.org/) as well as work by Peter Daszak are nice examples of the need for such cross-disciplinary research. Recent concerns about the potential jump of H5N1 influenza viruses into a human-transmittable form highlight the extreme need for such molecular surveillance programs in nonhuman animal populations and the environment. Nevertheless, there is tremendous need for more cross-agency support for interdisciplinary research on One Health approaches.

One Health approaches are likely to have a major impact on public health, with a focus on surveillance and upstream interventions that are likely to reap obvious and rapid benefits for the health of human populations. For that reason public health agencies such as the CDC and the World Health Organization are joining with veterinary organizations and agricultural departments in advancing the One Health agenda. The chapters in the book *One Health: People, Animals, and the Environment* (10) provide compelling examples of the imperatives and opportunities for One Health and the impact of this approach on our future.

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