A Global Veterinary Medical Perspective on the Concept of One Health: Focus on Livestock

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Abstract

While globalization has yielded many benefits for society, it has also created many new challenges, particularly with regard to animal, human, and environmental health. Livestock contribute significantly to the livelihoods of hundreds of millions of people worldwide and global demand for foods of animal origin has been steadily increasing for decades. It is therefore critical to recognize and understand the global dimension of livestock production and its impacts. Despite the clear benefits of livestock for humans, some livestock production practices are associated with certain forms of environmental degradation, and trade in livestock and livestock products can contribute to the emergence and spread of new animal and zoonotic diseases. This article provides a review of the major global trends affecting livestock production and trade, related implications for human, animal, and environmental health, and reasons why veterinarians should embrace a One Health approach in dealing with disease problems in this era of globalization.

Key Words: animal health; emerging diseases; environmental health; globalization; livestock; One Health; public health; zoonosis

Introduction

Livestock contribute significantly to the livelihoods of hundreds of millions of people worldwide. Many countries count receipts from trade in livestock and animal products as significant contributions to their gross national product. Moreover, global demand for foods of animal origin is steadily growing and it is apparent that the livestock sector will continue to expand accordingly (FAO 2009b).

In recent years, there have been notable increases in the occurrence of emerging and reemerging infectious diseases, many of them diseases of livestock with zoonotic potential. These diseases have negatively affected animal and human health around the world and caused considerable social disruption and economic loss. In addition, livestock production practices in both developed and developing countries are increasingly associated with various forms of environmental degradation, including global warming, deforestation, and loss of biodiversity. As such, livestock must be a focus of attention for health professionals who embrace the holistic concept of One Health, which strives to integrate human, animal, and environmental health management to achieve global health and well-being.

Numerous global trends facilitate the development and dissemination of zoonotic disease around the world and contribute to environmental degradation. The next section provides a brief review of these trends, followed by a discussion of why the One Health approach is an appropriate response to the emergence of animal and zoonotic disease and should be embraced by the veterinary medical profession.

Major Trends Shaping Global Society and Their Effects on Human and Animal Health

In simple economic terms, globalization can be defined as the process of increasing the connectivity and interdependence of the world’s markets and business. This is not a new idea or process. About 750 years ago, Marco Polo set out along the Silk Road to the court of Kublai Khan near present-day Beijing with the intention of expanding markets and business opportunities in Asia for merchants in Venice.

How is it, then, that the current period in history has come to be known as the “era of globalization”? The answer lies mainly in the enormous technological advances since the Industrial Revolution, and particularly in the last 50 years. The jet airplane, the computer, the Internet, and the cellular phone have made the planet a smaller, more accessible, more interconnected and interdependent place for people to visit, relocate, conduct business, expand trade, exchange culture and ideas, share information, and mobilize in support of common interests. Thus globalization is now generally considered to extend beyond the sphere of business and markets to encompass technological, sociocultural, political, and biological aspects of life as well.

While globalization has yielded many benefits for society, it also has created many new challenges, a number of which affect animal, human, and environmental health. For the
veterinary medical profession to optimize its usefulness in these times, veterinarians must understand the important global trends affecting health and disease and develop the knowledge, tools, and skills to respond effectively to these challenges.

Emerging Animal Diseases and Zoonoses

By the mid-20th century, with the development of effective antibiotics and vaccines well advanced, there was a prevailing attitude among health professionals that the scourge of infectious disease had largely been conquered and the focus of medicine could be shifted to neoplastic, cardiovascular, and other noninfectious categories of disease. Quite the contrary, however, the current period is characterized by not only the emergence of new infectious diseases of animals and humans but also the reemergence of diseases previously thought to be under control, such as tuberculosis.

Studies report that 64% of 1,400 known human pathogens (Heeney 2006) and 73% of emerging human pathogens are zoonotic (Woolhouse and Gowtage-Sequeria 2005). These include many infections with global reach such as human immunodeficiency virus (HIV), severe acute respiratory syndrome (SARS), West Nile virus, highly pathogenic avian influenza H5N1, and the more recently identified influenza virus, H1N1. There are multiple, complex reasons for this emergence (Brown 2004; Morse 2004), including the movement of pathogens through modern jet travel, landscape transformations that result in closer contact between wildlife and humans, the intensification of livestock production, the raising of livestock and poultry in close association with people, inadequate biosecurity in livestock management, and the development of antibiotic resistance in some bacterial diseases. Some of these are described in the following sections; recent reports provide further information (FAO 2009a, 75-93; Jones et al. 2008; Patz et al. 2004; PCIFAP 2008, 10-29; Snowden 2008; Weiss and McMichael 2004; Wolfe et al. 2007).

High-Speed Transportation and Communication

Modern jet travel now allows passengers to move from virtually any place in the world to any other place within 36 hours—less than the incubation period of many viral and bacterial diseases. This means that infections can become globally disseminated before clinical disease is recognized. The SARS outbreak of 2003, which quickly spread to 29 countries, and the ongoing, novel H1N1 influenza pandemic (see Pappaioanou and Gramer 2010 in this issue) dramatically underscore this point. As such, the notion of “foreign” or “exotic” diseases has become less meaningful. A wide range of diseases now have the potential to crop up unexpectedly anywhere in the world and some may quickly become endemic; for example, West Nile virus infection was unknown in North America before 1999 but is now firmly established on much of the continent.

As these examples indicate, health professionals, including veterinarians, must be familiar with the epidemiology and clinical signs of a broad range of infectious diseases that may not be—for the moment—present in their countries. This of course includes the highly contagious diseases of livestock and poultry such as foot and mouth disease, peste des petits ruminants, African swine fever, Newcastle disease, and highly pathogenic avian influenza, to name but a few.

Modern communication has facilitated the rapid dissemination of information, both scientific and journalistic, about disease occurrence: the World Animal Health Information System (OIE 2010) and the International Society for Infectious Diseases’ ProMED-mail service (ISID 2010) are two examples of such sources. This information allows regulatory veterinarians to better understand emerging disease patterns and act more quickly to initiate disease investigation and control efforts. It also raises public expectations that officials will move quickly to initiate control efforts. Intense media coverage and high public expectations mean that regulatory veterinarians must have effective disease control plans in place that are adequately resourced and that they can communicate risk to the public clearly and effectively. But such communications can also have serious adverse effects on consumer perceptions of the wholesomeness of animal source foods, with disastrous economic consequences for producers. Such extensive media coverage increases the need for proper, responsible, effective risk communication by respected authorities (also see Decker et al. 2010 in this issue).

Growth in International Trade

International trade has grown dramatically since World War II. That growth has been facilitated by international efforts to break down trade barriers and to create a level playing field for all trading partners through free market initiatives formalized through the World Trade Organization (WTO) in the 1990s. Growth in the trade of livestock and foods of animal origin has been particularly robust as a result of several factors: the elimination or reduction of tariffs associated with free-market reforms; technological advances in containerized and refrigerated shipping; and a steadily increasing global consumer demand for foods of animal origin, associated with economic growth and increasing prosperity, particularly in developing countries. Since 1960, global meat production has more than tripled, milk production has nearly doubled, and egg production has increased almost fourfold. Global production and consumption of meat will likely continue to rise, from 233 million metric tons (Mt) in 2000 to 300 million in 2020, as will that of milk, from 568 to 700 million Mt over the same period. Egg production will also increase by 30% (Speedy 2003).

The increased movement of live animals and animal products corresponds to an increased risk in the spread of transboundary diseases of animals as well as zoonotic diseases, particularly foodborne diseases. As such, the WTO has actively promoted the development of regulations and policies to ensure that animal health and food safety are considered and
protected as core elements in international trade. The World Organization for Animal Health (OIE) provides scientific expertise to WTO for regulating trade in livestock while the Food and Agricultural Organization of the United Nations (FAO) and World Health Organization (WHO), through the Codex Alimentarius (www.codexalimentarius.net), provide guidelines for the regulation of food products, including foods of animal origin.

War and Terrorism

In the past 30 years, the dominant form of armed conflict has shifted from wars between nations to conflicts within nations, or civil wars. At the beginning of 2008, for example, there were 26 active armed conflicts worldwide, all of them civil conflicts between the government of a state, on the one hand, and at least one internal group on the other (Hewitt et al. 2010, 19).

War is a disruptive force on animal health. It can lead to the breakdown of specific disease control programs, as has been documented in Zimbabwe (Lawrence et al. 1980), or the collapse of the veterinary medical infrastructure itself, as in Afghanistan (Sherman 2005). Conflict also produces refugee populations, and in agricultural societies refugees often flee with their animals, bringing livestock diseases to new areas of their own countries or into neighboring countries.

Attempts to maintain disease control efforts in times of war or insecurity can be daunting and may require novel approaches. It is noteworthy that rinderpest was successfully eliminated from areas of conflict in the Horn of Africa in part through the recruitment and training of community-based animal health workers who were trusted by local populations and who used novel, heat-stable rinderpest vaccine to carry out effective vaccination campaigns under dangerous and difficult conditions (Mariner et al. 2002).

The specter of bioterrorism adds a new and troubling dimension to the challenge of controlling animal and human disease because of its unpredictability and malevolent intent. Bioterrorist events may not necessarily evolve as naturally occurring disease outbreaks might evolve. For example, terrorist operatives may use multiple pathogens and multiple sites of introduction, confusing the clinical picture and severely taxing the resources of disease control authorities. Furthermore, the majority of potential bioterrorist agents are zoonotic disease agents (Davis 2004a, b), meaning that animals and humans may be affected concurrently during outbreaks. In fact, animal populations may well serve as important sentinels for early detection of bioterrorist threats (Rabinowitz et al. 2006).

Climate Change and Other Environmental Perturbations

There is a two-way relationship between livestock production and environmental health. On the one hand, livestock contribute to climate change and other environmental problems, and at the same time livestock health and productivity can be adversely affected by these same environmental perturbations (Sherman 2002, 170-244; Steinfeld et al. 2006). Ruminant animals contribute to greenhouse gas emissions and global warming by eructation of methane. The clearing of forests for cattle ranching is a major cause of deforestation and associated loss of biodiversity, particularly in Latin America. Intensive livestock production often produces manure in excess of what the surrounding land can accommodate and runoff of manure into waterways results in pollution and alterations in the balance of aquatic life. Overgrazing contributes to range-degradation, particularly in semiarid regions.

At the same time, patterns of disease in animals and humans are influenced by environmental and climatic change. Global warming is associated with the northward spread of bluetongue disease in Europe (Purse et al. 2005). Outbreaks of Rift Valley fever in East Africa are linked to El Niño Southern Oscillation events (Linthicum et al. 1999) as are hantavirus infections in North America (Yates et al. 2002), malaria outbreaks in Africa and South America, dengue fever in Asia, and cholera in South Asia (Anyamba et al. 2006; WHO 2002).

Landscape transformation is another environmental factor contributing to disease. The fragmentation of forests in North America into segments of less than 2 hectares has changed the ecology of the forest fauna and led to increased transmission of Lyme disease to companion animals and humans (Allan et al. 2003). Increased settlement with a high density of domestic dog populations adjacent to Serengeti National Park is likely to have led to the emergence of new human infections derived from butchering and eating primates, including T-lymphotropic virus (Wolfe et al. 2005b), Ebola virus, and HIV (Wolfe et al. 2005a).

Loss of Biodiversity

The International Union for Conservation of Nature (IUCN 2006) has reported that 1 in 3 amphibian species, 1 in 8 bird species, and 1 in 4 mammalian species globally are threatened with extinction and that the rate of extinctions is increasing, not slowing. The current situation represents a mass extinction that is unparalleled in Earth’s history. Paleontologists believe that this is the sixth mass extinction since the first was identified as occurring 440 million years ago. It differs from previous extinctions in its magnitude and velocity and in the fact that it is primarily the result of human impacts rather than from physical events unrelated to human activity. The current rate of species extinctions is estimated to be 100 to 1,000 times greater than prehuman levels and could reach a rate that is on average 10,000 times greater (Pimm et al. 2008, 18).

The importance of biodiversity for human health has been well described (Chivian and Bernstein 2008). There are numerous reasons—esthetic, spiritual, philosophical, scientific,
impacts of poverty and prosperity on veterinary care and training

poverty remains widespread around the world. based on 2005 world bank figures, up to 1.37 billion people live on less than $1.25 per day and an additional 2.56 billion on less than $2 per day (world bank 2008). a large proportion of the world’s poor still live in rural areas. many rural people, including the landless and pastoralists in particular, depend on livestock for their livelihoods. because poor livestock owners often have little or no access to preventive and curative veterinary medical services (ifad 2004), their animals suffer considerable morbidity, mortality, and reduced productivity. these livestock may also serve as a source of transmissible diseases for livestock populations at large and for the spread of zoonotic diseases such as tuberculosis and brucellosis (who 2006).

regrettably, in many developing countries veterinary medical professionals, for economic or other reasons, are not willing or able to provide services to the poor, yet oppose efforts to sanction paraprofessionals who could provide such services. following the lead of the oie (vallat 2004), the veterinary medical profession needs to recognize those situations in which paraprofessionals can and indeed must participate in the delivery of effective veterinary medical services (such as the control of rinderpest in the horn of africa, as discussed above) and find ways to benefit from their participation rather than viewing them as usurpers or competitors.

in developed countries, and increasingly in many developing countries, a growing, prosperous middle class has embraced the ownership of companion animals as a social norm and has come to expect a high level of veterinary medical service for dogs, cats, and other animals kept as pets. the veterinary medical profession has responded enthusiastically, with increasing numbers of graduates entering companion animal practice and pursuing medical specializations in support of individual animal care. the veterinary medical curriculum has evolved accordingly, with less time available for subjects aimed at food supply veterinary medicine and public health. one example is the diminished time spent on teaching veterinary students in the united states about foreign animal diseases that potentially threaten the health of us livestock (thurmond et al. 2003). at the same time, the demographic of veterinary medical school entrants has become increasingly urban and suburban and less rural. these factors, along with shifting market forces and changing patterns of livestock production, are resulting in shortages of veterinary medical graduates willing or able to engage in clinical food animal practice in rural areas of the united states (prince et al. 2006) and elsewhere, as well as veterinarians ready to work in public health and food supply veterinary medicine (hird et al. 2002; hoblet et al. 2002). in response to this situation, many schools of veterinary medicine are now developing innovative incentive programs to recruit and train students committed to food animal practice and/or public health (aavmc 2008).

the need for a one health approach

in the 1960s, scientist james lovelock developed and articulated the controversial gaia hypothesis, which suggests that the earth’s biosphere, atmosphere, oceans, and soil act together in a feedback system that seeks an optimal physical and chemical environment for life on the planet (lovelock 1995). in other words, he proposed that the living and nonliving parts of the earth form a complex, interacting system that functions as a single, living, self-regulating superorganism.

viewing photographs of earth taken from space, one can at least emotionally, if not scientifically, accept the underlying concept of the gaia theory. floating in the universe, surrounded by its atmospheric cell wall, with its oceanic cytoplasm and terrestrial organelles, the image of earth as a unified organism seems real enough and it is easy to imagine how serious insults to its functional integrity can disrupt planetary life. this view underscores the interdependency of the physical environment of earth and the living things that reside on and in it. scientists are now beginning to see and understand how disruptions such as global warming, widespread deforestation, and chemical pollution of marine environments can adversely affect the health and well-being of the earth’s flora and fauna, including humans and domestic animals.

gai theory aside, numerous examples (some presented in this article) make it increasingly clear that many new diseases are emerging as a result of environmental perturbation and increased contact between humans and domestic and wild animals in disturbed environments. full understanding of the natural history of emerging diseases and effective strategies for their control therefore require collaborative, interdisciplinary efforts of human, animal, and environmental health specialists. in other words, a proper response to the current situation of emerging disease is the one health approach.

veterinarians at the wildlife conservation society (cook et al. 2004) articulated this concept quite perceptively in the manhattan principles on one world, one health:

it is clear that no one discipline or sector of society has enough knowledge and resources to prevent the emergence or resurgence of diseases in today’s globalized world. no one nation can reverse the patterns of habitat loss and extinction that can and do undermine the health
of people and animals. Only by breaking down the barriers among agencies, individuals, specialties and sectors can we unleash the innovation and expertise needed to meet the many serious challenges to the health of people, domestic animals, and wildlife and to the integrity of ecosystems. Solving today’s threats and tomorrow’s problems cannot be accomplished with yesterday’s approaches. We are in an era of “One World, One Health” and we must devise adaptive, forward-looking and multidisciplinary solutions to the challenges that undoubtedly lie ahead.

The Role of Veterinarians in One Health

In the context of the Manhattan Principles statement, a reasonable case can be made that veterinarians are particularly well prepared by virtue of their training and professional experience to embrace and work effectively in the One Health paradigm, and indeed to take a leadership role in moving it forward from concept to practice.

Veterinarians are the only health professionals whose formal training is based in comparative medicine, with in-depth studies of the health and diseases of multiple species across a wide taxonomic range. Veterinarians are also trained in population health as it pertains to livestock production and they routinely incorporate environmental assessments in their workups of animal health problems on farms and feedlots, assessing such elements as water, feed, and air quality to arrive at a proper diagnosis. While admittedly more challenging in the execution, the same approach, already familiar to veterinarians, applies to assessments of ecosystems as well as farming systems.

Furthermore, veterinarians are already active in public health, working closely with physicians, other health professionals, and disaster response specialists on disease investigation, disease surveillance, and effective outbreak response. Veterinarians in the zoo and wildlife sectors are gaining valuable experience in the evolution of disease in wild animal species and populations and are developing productive, interdisciplinary relationships with wildlife biologists, ecologists, and other relevant specialists. Companion animal veterinarians can also play an important role in detecting newly emerging zoonotic diseases since companion animals, including exotic pets, can serve as sentinels for such diseases. The monkeypox outbreak in the United States in 2003, in which staff at a veterinary medical clinic were affected by contact with infected pet prairie dogs, is a case in point (Croft et al. 2007).

Support for One Health in Organized Veterinary Medicine

For the reasons outlined above, the veterinary medical profession is poised to become actively engaged in the One Health approach to human, animal, and environmental well-being. Recognizing the value and importance of such an approach, the American Veterinary Medical Association in 2007 established a One Health Initiative and created a One Health Initiative Task Force to “study the feasibility of an initiative that would facilitate collaboration and cooperation among health science professions, academic institutions, governmental agencies, and industries to help with the assessment, treatment, and prevention of cross-species disease transmission and mutually prevalent, but non-transmitted, human and animal diseases and medical conditions” (AVMA 2008).

The task force concluded that the One Health approach had become a critical, strategic need for addressing the emerging disease problems associated with the globalization of contemporary society, but that there were many barriers to its implementation. Among these were the needs for key leadership to embrace the concept; buy-in from human medical, veterinary medical, industrial, and environmental partners; and implementation of a program of change on a global basis. Other perceived barriers included the difficulty of changing the mindset of healthcare providers from one of “disease care” to one of preventive medicine, the increased specialization and fragmentation of the veterinary field, and the difficulty of getting busy practitioners on board. While recognizing barriers, the task force also proposed concrete recommendations and actions for moving a One Health agenda forward. The full task force report is available online (www.avma.org/onehealth/).

A further notable barrier, for veterinarians and veterinary medical students, is the identification of career pathways and employment opportunities for working on One Health issues in a global context. In addition to technical competence, other important attributes are strong leadership abilities, teamwork, foreign language proficiency, improved communication skills, cross-cultural experience, adaptability and flexibility, and even advanced training in other medical specialty areas such as epidemiology, toxicology, or virology, or in nonmedical fields such as agricultural economics or business administration. A wide range of potential employers does exist, including government agencies, academic institutions, private industry, international or intergovernmental institutions, nongovernmental organizations, and private consulting or contracting firms. Information on preparation for international work in veterinary medicine and potential employers is available (Sherman 2002, 417-462).

A Different Supporting Perspective

According to the biblical story of Noah, God became frustrated with the wickedness of humans and decided to obliterate all life on Earth by causing 40 days of rain and global flooding. But then God recognized Noah as a righteous man and offered him the chance to survive the deluge by building an ark and taking aboard his family and breeding pairs of all the world’s animals, thus creating the opportunity to reestablish life on Earth after the flood. Noah was given the responsibility of stewardship of all the living things on Earth and he performed his task admirably. There is no mention in the story of Noah having lost any animals to coccidiosis, kennel cough, shipping fever, or any of the other myriad diseases
one might expect to develop when thousands of animals are crowded together in a small ship and subjected to over a month of rain and dampness. Rather, all disembarked in good health at Mount Ararat when the flood subsided. Noah, it seems, was a pretty good veterinarian.

Today, humankind, through the awesome power of technology and the ever-expanding use of the Earth’s resources, is capable of threatening the existence of life on Earth without divine retribution. Indeed, global warming may produce the contemporary equivalent of the biblical floods without the 40 days of rain!

With the world facing such global challenges to health and well-being, veterinarians must see themselves as the new Noahs, embracing stewardship for all the world’s creatures and working with other scientists and citizens across disciplines to promote global health and well-being through the One Health approach.

Conclusion

Through modern technology, the world has become a smaller place and local events increasingly have global ramifications. This is particularly true in the area of health and disease. The current era of globalization is associated with an unexpected increase in infectious diseases, many of which are zoonoses that spread rapidly among human and animal populations around the world through increased travel and trade. The origin of many emerging zoonoses can be traced to increased contact between human beings, wildlife, and domestic animals as human populations and their livestock increasingly penetrate areas inhabited by wild animals and transform landscapes in ways that disrupt natural ecosystems.

Because emerging infectious diseases represent a complex interaction of human, domestic, and wild animal populations in conjunction with ecosystem perturbation, it is clear that the effective understanding and prevention of disease evolution require a multidisciplinary or One Health approach involving veterinarians, physicians, wildlife biologists, ecologists, and environmental scientists, among others. Veterinarians, by virtue of their formal training in comparative medicine and population medicine, are well positioned to embrace the concept of One Health and take a leadership role in moving it forward as a rational approach to addressing issues of health and disease in today’s complex, global society.

References


