Good governance in ‘One Health’ approaches

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Summary
The authors discuss ‘One Health’ approaches for controlling newly recognised and re-emerging diseases of animal origin and contributions towards pandemic preparedness based on enhanced collaboration between Veterinary Services, Human Health Services and Environmental Services. Improved veterinary governance and cooperation with public health managers, social scientists, ecologists and many other stakeholders are important for reducing the risks of potential zoonoses – including foodborne diseases – at their source. Two case studies are presented to illustrate how One Health approaches can make a difference – Hendra disease incidents in Australia and rabies management on the African continent. This article also includes an overview of collaboration at the international level between the Food and Agriculture Organization of the United Nations, the World Organisation for Animal Health, and the World Health Organization. Environmental determinants for disease emergence, anthropogenic climate change and human encroachment on shrinking wildlife habitats are considered, using highly pathogenic avian influenza A (H5N1) and Nipah virus as examples. Finally, the authors discuss the effects of livestock production on environmental change – in the light of global population growth and increasing demand for livestock and aquaculture products – with the need for future policy decisions to be based on a multidisciplinary One Health approach.

Keywords

Introduction

The emergence of newly recognised and re-emerging diseases poses a substantial and continued threat to public health, animal health and agricultural production. These risks exist within a global context in which human and livestock animal populations, globalisation, international trade and travel are increasing, the effects of climate and other environmental change are more apparent, and demand for livestock products is growing significantly.

This paper provides a brief introduction to ‘One Health’ approaches to such problems, emphasising the benefits of a team approach with complementary expertise from animal and human health professionals, ecologists and other specialists to reduce risks from emerging infectious diseases for all species. The concept of public sector governance, in which the State acquires and exercises the authority to provide and manage public goods and services, is an essential element of One Health approaches.

In our modern interconnected world – through good global governance – international organisations and groups of States can also play an active role in reducing global disease threats or the impacts of climate change.

Cooperative approaches are important between Veterinary Services, Human Health Services and other relevant government services at the interface between domestic and wild animals, ecosystems and human populations. A case study from Australia illustrates the benefits and challenges
of cooperative approaches in the response to various Hendra virus incidents in 2011. A second case study, from Africa, demonstrates the benefits of such approaches in the control of canine rabies. At the international level, this One Health approach is reflected in the commitment to cooperation between the World Health Organization (WHO), the United Nations Food and Agriculture Organization (FAO) and the World Organisation for Animal Health (OIE).

This paper also outlines the links between environmental change and the epidemiology of animal diseases, including zoonoses. Finally, it considers, from a governance perspective, the fundamentals of the debate on the effects that livestock production has on global warming as the world demand for animal protein increases.

One Health approaches: linking human, animal and environmental health

Scientists have long recognised that human health is intimately linked to the environment in which we live. This recognition is often summarised in the well-known epidemiological triad of host, agent and environment. However, the complexities of cross-species transmission of disease between wildlife and domesticated animals, between domesticated animals and humans, and between wildlife and humans continue to challenge scientists and decision-makers. Unprecedented specialisation and increasingly reductionist approaches in modern sciences have led to artificial divisions between human medicine, veterinary science and ecology. These divisions reduce the effective communication, cooperation and collaboration that are crucial to an early recognition of system changes and drivers that lead to disease outbreaks (43).

Pathogens that are transmitted between animals and humans present an increasingly significant threat to human health (14). About 60% of human pathogens and 75% of recent emerging diseases are zoonotic. The classical example is influenza virus, which causes pandemics in humans after the exchange of genes between viruses circulating in wild and domestic birds, pigs and humans. Recent examples include the emergence of severe acute respiratory syndrome (SARS), highly pathogenic avian influenza (H5N1) and pandemic influenza A (H1N1) (30). Other important zoonoses include the Ebola and Marburg viruses emerging from primary reservoirs in bats, with secondary host chains leading to human infections.

Many zoonoses are endemic and affect the poorest communities in the developing world where conditions for their maintenance and spread exist. Most of these diseases have been present for centuries and are often associated with populations living close to their animals (36). In developing countries, many poor livestock owners experience co-morbidity of several zoonoses. Q-fever, anthrax, brucellosis and many internal parasitic diseases can be transmitted through the consumption of animal products or through close contact with infected animals. Minimising the spread of such diseases to people is a primary driver for veterinary public health and changes in the livestock sector (36).

The need for sanitation is of primary importance and a major factor in prompting structural change in the livestock sector (27). Surveillance for previously unknown or newly identified pathogens in wildlife has also become an important strategy for countering emerging disease threats to domestic animals and humans (5).

One Health approaches recognise the importance of acknowledging shared disease risks between animals and humans in their shared environment, and of moving towards practical approaches that accelerate integrative efforts (31).

Cooperation at the interface between wildlife, domestic animals and humans

Given the importance of shared disease risks, many countries have adopted formal approaches for cooperation between Veterinary Services, Human Health Services and other key public services at the interface between domestic and wild animals, ecosystems and human populations.

In Australia, cross-sectoral cooperation has been essential in responding to recent outbreaks of Hendra virus, in which the disease was transmitted from free-living (wild) bats to domestic horses and then to humans. Rabies is another disease in which strong levels of cooperation across sectors are needed to reduce the spread and impact of an otherwise preventable zoonotic disease. Two case studies outline the One Health approaches adopted in Australia for managing Hendra virus and in continental Africa for managing rabies. These examples provide insights into such One Health approaches adopted for risk mitigation, improved governance, and determining research priorities for diseases at the interface between domestic and wild animals, ecosystems and human populations.
Case study one: managing Hendra virus incidents in Australia using a One Health approach

Hendra virus causes a relatively rare disease in horses and occasionally humans. Since 1994, spillover of Hendra virus from bats has occurred periodically in Queensland and New South Wales (NSW), typically between May and October (Fig. 1). To date, there have been about 70 confirmed cases in horses and seven cases in humans (of which four have been fatal) (3). In 2011, routine monitoring of bat colonies in Queensland showed a variable but significant increase in shedding of Hendra virus, but the reasons for this are unclear.

The approach to risk mitigation

Since the first identification of Hendra virus in Australia, a research programme has been undertaken into the causative virus, bats, horses and managing the risk to humans. Work on the virus has focused on understanding its method of infection and replication in host cells. Work in bats has involved bat carers, wildlife ecologists, immunologists, epidemiologists and veterinarians, and has included studies on the distribution and translocation of various species of bats, as well as more detailed studies on the immune system of bats and characterisation of their immunological response to infection. Studies of the disease in horses have involved veterinary clinicians, virologists, pathologists, epidemiologists and immunologists. Results demonstrate that, even before the onset of clinical signs, horses can shed virus and are potentially infectious. Laboratory studies with a candidate Hendra vaccine antigen have shown excellent protection, in terms of significantly reducing shedding as well as abrogating the clinical signs of infection.

Studies of how to manage the disease risk to humans have involved medical clinicians, immunologists, general hospital staff, sociologists and communication experts. Much effort has focused on how best to convey key messages about appropriate biosecurity precautions to horse owners and to veterinary clinicians treating sick horses. More recent work has focused on the production of a human monoclonal antibody against the Hendra virus to be available as a therapeutic for high-risk exposure cases.

Bat species in Queensland and northern NSW have been affected by the clearing of natural vegetation and have subsequently increased their reliance on vegetation in urban and peri-urban areas. This may have driven an increased opportunity for pathogen transmission to novel domestic animal and human hosts. Transmission of pathogens from wildlife may also be seasonally driven, and for bats this may be related to seasonally available food sources. Recent studies in Australia have demonstrated a significant occurrence of spillover events from 1994 to 2010 during the dry season (19).

Fig. 1
Incidents of spillover of Hendra virus in 2011
Source: Australian Government Department of Agriculture, Fisheries and Forestry (2)

The national intergovernmental Hendra task force

In response to a significant cluster of cases in June and July 2011, an intergovernmental Hendra task force (3) was established by the Premier of Queensland and the Premier of NSW. This comprised senior managers of the Queensland and NSW primary industry departments, the Chief Veterinary and Medical Officers from Queensland, NSW and the Australian Government, the Director of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Australian Animal Health Laboratory, the Chief Scientists from Queensland and NSW, and a wildlife (bat) ecologist. This group was charged with identifying appropriate risk management strategies in the affected states and ensuring a coordinated and effective response.

The future research programme

The task force identified two priority areas of research to assist risk mitigation and decision-making. The first was to
accelerate current research on a Hendra horse vaccine, and on the distribution of flying foxes in Australia. The second was to commission research in four areas:

- to characterise infection of dogs with Hendra virus
- to understand the risks from serologically positive animals
- to assess the effects of dispersal on stress in flying foxes and on their excretion of Hendra virus
- to conduct Phase 1 studies on a human monoclonal antibody against Hendra virus.

The final area of work involved an open grants programme for research on Hendra virus, including a Hendra Congress in Australia in December 2011.

How has a One Health approach made a difference?

Understanding the ecology and epidemiology of the disease to develop mitigation strategies required a range of specialised skills and broad collaboration across a wide range of disciplines. This was crucial in developing appropriate risk management, from farm biosecurity measures and behavioural changes (such as the use of personal protective equipment) to research into developing an effective vaccine for horses. An understanding of bat ecology was also vital to inform public debates on bat dispersal or destruction. These synergies of understanding and knowledge occurred only after some effort to break down institutional and interdisciplinary barriers and to share resources and results. None of this would have been possible without the One Health approach.

The policy and political issues addressed by using a One Health approach should not be overlooked. These incidents attracted enormous media coverage in Australia and this itself led to further community concern and an increased interest by both state governments and the Australian Federal Government. Several government departments became involved, including those managing the environment, those managing agriculture and livestock, and those managing human health. The Public Health Association of Australia established a One Health Special Interest Group to promote advocacy and awareness of emerging infectious disease issues across the relevant sectors.

**Case study two: managing rabies in Africa using a One Health approach**

Rabies occurs virtually worldwide (35) and is a neglected zoonosis, often endemic in countries with poor
infrastructure and limited resources for combating disease (Fig. 2). Between 50,000 and 100,000 human cases occur each year, mainly in Africa and Asia, with most being the result of rabies transmission by dog bites (11).

Rabies control involves multiple agencies, including those responsible for human and animal (domestic and wild) health, and requires coordinated management across these sectors (11). Animal bite victims may seek treatment at pharmacies, health centres or veterinary clinics. An improved exchange of information between sectors is needed for better patient information, planning of personal protective equipment and monitoring the success of dog vaccination campaigns. This case study illustrates rabies control efforts on the African continent and outlines the importance of intersectoral approaches for success (17).

Canine rabies elimination in Africa

Lack of effective domestic dog control is often attributed to four main factors:
- lack of political will and low priority assigned to the problem
- epidemiological constraints
- operational constraints
- lack of resources.

However, none of these constraints presents insurmountable obstacles and the elimination of rabies is a feasible objective for many countries, if agencies adopt a collaborative One Health approach (17).

Which agencies should be involved in canine rabies control?

Although there is some variation between countries in the responsibilities of different agencies, the following agencies should be involved in rabies control programmes in the following areas (22):
- the Ministry of Agriculture and national Veterinary Services: regulation of dog rabies control programmes, livestock rabies, wildlife rabies, tracing dog bites and the origin of infections, laboratory services, biosecurity and border controls for animal health
- Ministries of Health: human rabies issues (e.g. post-exposure prophylaxis and clinical care), human population surveillance and risk assessments, coordination of vaccine procurement, community awareness campaigns
- the Ministry of Natural Resources and Environment or Tourism: surveillance and control of wildlife rabies, control of dogs in protected wildlife areas
- the Ministry of Education should take part in implementing rabies awareness campaigns, especially those targeting children
- the Ministry of Finance should take part in the development of inter-ministerial financing mechanisms
- the Ministry of Police, Defence or the Interior: jurisdiction over issues related to animal protection, implementing road checks to monitor/limit animal movements
- the Ministry of Justice should take part in legal assistance and advice on laws and regulations
- the Ministry of Labour should be concerned with the health and safety issues of occupations at increased risk of rabies infection
- local authorities: implementing rabies prevention and control at the local level with advice from national authorities in collaboration with veterinary associations, the development and enforcement of legislation for dog ownership and population management
- academic and research institutions: research and the dissemination of findings (including those from economists, anthropologists and other social scientists), technical advice and training for animal and human health professionals
- non-governmental organisations (NGOs): local, national and international NGOs can contribute resources, raise public awareness, and design and implement programmes
- the private sector: veterinary practitioners can provide advice for dog handlers and bite victims, play an active role in surveillance and implementing control programmes, and help to ensure that dogs are vaccinated by their owners
- the media should be involved in disseminating information to the public (including extension material and key messages provided by official veterinary and medical authorities)
- inter-ministerial committees or task forces should coordinate across all those Ministries with responsibility for the implementation of rabies prevention and control programmes
- international organisations, such as FAO, the OIE, WHO and the Pan American Health Organization (PAHO) should develop guidelines on the provision and supply of appropriate biologicals, as well as support and provide an overview of national and regional planning of rabies control programmes.
Collaboration between the Food and Agriculture Organization of the United Nations, the World Organisation for Animal Health and the World Health Organization

Promoting cross-sectoral collaboration and good governance at the international, regional and national levels is a goal advocated by the OIE, FAO and WHO, as expressed in the Tripartite Concept Note entitled, ‘The FAO-OIE-WHO Collaboration – sharing responsibilities and coordinating global activities to address health risks at the animal-human-ecosystems interfaces’, which was distributed at the 2010 Hanoi International Ministerial Conference on Animal and Pandemic Influenza (IMCAPI) meeting (9).

The concept note outlines the need for strategic alignment between the three organisations, reviews their current collaboration, and proposes the development of future joint action plans. Some of the key principles for collaboration include partnerships (between players with different perspectives and levels of resources, according to their mandates) and coordination (at both national and international levels) to minimise duplication and streamline resources for efficiency and effectiveness.

Such collaboration also provides opportunities to share human and animal health laboratory resources and enhance quality assurance in collaboration with relevant reference laboratories. Collaboration on public health and animal surveillance can enhance the usefulness of epidemiological analysis of surveillance data, reducing the time needed to detect events and guiding targeted vaccination and other preventive actions. Sound governance, improved infrastructure and enhanced response capacities also contribute to ensuring food security and the livelihoods of vulnerable populations, especially in the case of major zoonotic diseases.

Since the 2010 IMCAPI meeting in Hanoi, several areas of work have advanced through such cooperation between the OIE, FAO and WHO, including:

- The preliminary identification of key elements for a joint action plan. This plan sets out priority activities to which each agency will contribute, over a three-to-five-year timeframe.

- The convening of a high-level technical meeting (in Mexico City, 2011) on ‘Health risks at the human-animal-ecosystems interface’, in preparation for a Joint Ministerial Meeting (JMM). Discussions among the health, agricultural and environment sectors – as well as regional organisations and representatives from industry (e.g. pharmaceutical and animal production sectors) – focused on risk analysis and risk management, using animal influenza, antimicrobial resistance and rabies as examples of cross-sectoral collaboration, coordination and communication. The process intended for the JMM and beyond is to identify key principles for intersectoral collaboration that can be implemented at the national level, to optimise disease prevention, detection and control efforts at the local, national and regional levels.

- The development and implementation of integrated risk assessment projects at the country level, using avian influenza A (H5N1) as an example. These projects are intended to identify gaps in national systems, including cross-sectoral collaboration, improve data collection and data-sharing from different sectors, and facilitate the joint assessment of risks for both animal and human health. Pilot projects are under way in Egypt and Vietnam, two countries that have been severely affected by influenza A (H5N1).

- The undertaking of pilot One Health assessment missions in Costa Rica and Kenya.

- Table-top simulation exercises to test contingency plans for avian influenza, which can be expanded to address other zoonotic diseases or diseases of unknown origin.

- Collaborative approaches in practice, including the Global Early Warning System for Major Animal Diseases including Zoonoses (GLEWS), which aids understanding of the risk factors for disease emergence, maintenance and spread through the open sharing of information (38).

- Collaboration between WHO and the OIE/FAO Network of Expertise on Animal Influenza (OFFLU) (42), to improve understanding of influenza viruses and their genetic characterisation.

- Collaboration between FAO, the OIE and WHO on antimicrobial resistance risk in animals and within the public health sector.

- Collaboration between FAO, the OIE and WHO on strengthening awareness for National Focal Points on food safety events of regional and global significance, through the WHO-FAO International Food Safety Authority Network (INFOSAN), with outreach through OIE Focal Points.

- The development of a tripartite roadmap to tackle neglected zoonotic diseases (NZDs), and a tripartite proposal for investment in a ‘priority NZDs portfolio’. This portfolio is defined as including three NZDs of global
importance (human and canine rabies, echinococcosis/hydatidosis and Taenia solium taeniosis/ cysticercosis); two NZDs of regional importance (fasciolosis and other foodborne trematodes, and zoonotic trypanosomiasis), and major bilateral NZDs (anthrax, brucellosis and leptospirosis).

Other examples of collaboration include work on global standard-setting activities: for example, the Codex Alimentarius (joint FAO–WHO food standards programme), and the OIE standards for animal health and zoonoses (contained principally in the OIE Terrestrial and Aquatic Animal Health Codes and Manuals), referred to in the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement).

Countries would benefit if capacity-building efforts to support good governance at the national level were further harmonised by undertaking activities such as:

- the OIE PVS Pathway (41), which supports international standards on the quality of animal health services, as described in the OIE Terrestrial and Aquatic Animal Health Codes
- the FAO National Medium-Term Plan Framework, which encompasses food security, marketing, governance, structure and functions (8)
- the WHO International Health Regulation (IHR) Implementation Framework (35).

Progress in these areas provides an opportunity for the three international organisations to provide effective leadership and also serves as a visible example of intersectoral collaboration and the One Health approach.

In the 2010 Tripartite Concept Note, the OIE, FAO and WHO committed themselves to working more closely to align their activities at the animal–human–ecosystems interface. The concept note does not limit itself to emerging high-impact zoonotic diseases but includes a wider scope of activities and issues, such as cooperation on the prevention, surveillance and control of NZDs. Such cooperation has included a joint commitment to rabies after the OIE Global Conference on Rabies, organised with the support of FAO and WHO, in September 2011 in Seoul. There have also been numerous joint publications on emerging issues or in areas where common guidance is needed for Member States.

The growing threat of transboundary animal and zoonotic diseases – exacerbated by globalisation and environmental change – and increasing societal demands for food availability and security, food safety, public health and animal welfare underline the crucial importance of collaboration between these international organisations, as well as among partners at the regional and national administrative levels. Preventing the emergence and spread of human and animal infectious diseases is a global public good, with benefits extending to all countries, people and generations. This highlights the importance of global governance in a highly interconnected world.

Environmental change and the epidemiology of animal diseases, including zoonoses

Environmental change is a significant determinant for the emergence of infectious diseases, including zoonoses. People, animals and the environment co-exist in a new dynamic in which the health of each group is inextricably and globally interconnected (1).

Disease emergence is closely linked to changes in the host, the agent and the environment. Pressures of human encroachment on shrinking wildlife habitat contribute to increased wildlife population densities and the emergence of diseases from wildlife (7). International movement of livestock and modern agricultural practices (and human changes to the natural environment) have also led to emerging disease, such as Rift Valley fever in Africa or bovine spongiform encephalopathy (BSE) in Europe. Changes in arable farming may lead to disease emergence, such as the reforestation of eastern areas of the United States, which provided conditions for the emergence of Lyme disease.

Understanding the emergence of new zoonotic agents also requires an understanding of deforestation and associated hunting (34). Bushmeat hunting presents an important source of risk for emerging diseases, due to the contact between humans and wild animals. The illegal trade of bushmeat is also increasingly problematic, with recent studies estimating that, for example, 270 tonnes of bushmeat could be passing through one of Europe’s busiest airports each year (15).

Anthropogenic global climate change is also likely to cause further changes in the geographical range and incidence of arthropod-borne infectious diseases, such as malaria, dengue and Japanese encephalitis. Correlations between the emergence of human diseases (such as cryptosporidiosis, haemorrhagic fevers, cholera and malaria) and weather patterns (such as flooding and the El Niño Southern Oscillation) are well known (5).

The introduction of new pathogens or vectors into new areas can have devastating results for the affected host populations, with potential for the durable colonisation of
new ecosystems and new modes and patterns of disease transmission. A major increase in disease distribution may also expose new host populations that lack immunity. The African continent may be one of the more vulnerable continents, due to its human demographic growth, shrinking natural ecosystems, water shortages and soil erosion. Climate change presents an additional stress factor for many African countries that have insufficient capacity to adapt (6).

Recent examples of the links between environmental determinants, behavioural and adaptive changes, and the epidemiology of diseases include the emergence of HPAI A (H5N1) in the Asian region, outbreaks of Nipah virus disease in Malaysia and Bangladesh, and the emergence of Hendra virus in Australia.

**Highly pathogenic avian influenza A (H5N1)**

During the past three decades, HPAI H5N1 has spread from Asia to countries in the Middle East, Europe and Africa. The disease is considered to be endemic in five countries (Bangladesh, China, Egypt, Indonesia and Vietnam) (10), disrupting poultry production, adversely affecting smallholders’ livelihoods, and increasing the risk of the emergence of a genotype adapted to human-to-human transmission (13). More than 566 laboratory-confirmed cases of human infection with avian influenza A (H5N1), 332 of them fatal, were confirmed by WHO between 2003 and October 2011 (37).

Multivariate analysis of agro-ecological niches to explore the persistence of diseases and human cases highlights a series of variables that may contribute to this persistence. The regions with the greatest number of human cases were those with the largest duck and agricultural population densities, intermediate levels of productivity and low-to-medium purchasing power per capita (e.g. Egypt; Guangdong and Anhui provinces in China). These regions are also in the midst of economic transition and form a geographical mosaic of traditional and modern systems of poultry production and marketing that offer the virus an array of micro-niches through which it can spread. The historical roots of agricultural production systems help to explain the effects of environmental change on the epidemiology of diseases. For example, in China, rice cultivation marked the transition between Mesolithic foragers and the surplus-food-producing economies of the Neolithic period. Ducks were used to help control pests in rice paddies, but the rapid expansion of chicken and duck production over the past 30 years has enabled disease persistence and spread (13).

A further aspect of the evolution and spread of HPAI A (H5N1) is the circulation of avian influenza viruses in wild bird populations. Environmental factors for disease emergence are influenced by seasonal variations in climate, as well as particular wild bird species and their migration patterns across geographical regions. Although little is known of the direct influences of environmental factors, such as climate, on the epidemiology of avian influenza, there is substantial documentation of the indirect influences. Links between the timing of rice and duck production with monsoonal patterns are well documented, as are changes in rice production based on the timing of floods or droughts. Indeed, the intensity of rice cropping is a good predictor of the disease in Thailand and Vietnam. By changing the distribution, composition and abundance of wild duck populations, climate change may indirectly modify the interface between domestic and wild waterfowl, and this may also be a factor in the epidemiology of the disease (12).

**The emergence of Nipah virus in Malaysia**

Studies in South-East Asia have documented the effects of anthropogenic environmental changes and the emergence of Nipah virus. Slash and burn techniques used in forests throughout the region cause severe smoke hazes that, each year, blanket much of the area for months. These conditions preceded the 1998 Nipah virus disease outbreak in Malaysia, and coincided with a severe drought caused by the 1997 to 1998 El Niño Southern Oscillation event. There is some evidence that this series of environmental and anthropogenic events led to a reduction in the availability of flowering and fruited forest trees. In their search for new food sources, distressed bats resettled in fruit orchards close to piggeries and human settlements. The disturbance of bats from their natural habitat led to subsequent high levels of shedding of the virus and its transmission, first to domestic pigs, as reservoir hosts, and then to humans and other animal hosts (4).

More recent studies indicate that agricultural intensification (the dual use of agricultural land and increases in production) resulted in the direct overlap of mango production and livestock rearing. This provided a pathway for a virus circulating in fruit bats to infect an intensively managed commercial pig population, driving the initial phase of emergence. Because Nipah virus had a very low probability of persisting on the index farm without reintroduction, priming for persistence was necessary to bring about enzootic circulation and the emergence of a novel zoonotic pathogen (25).

In contrast, in Bangladesh, recurrent outbreaks of Nipah disease have been recognised since 2001, caused by repeated introductions of Nipah virus from fruit bats into the human population (18). Fruit bats are attracted to specific foods available in these areas during the winter and spring. Human infections occur when people are exposed to foods (including raw date-palm sap) contaminated with
Livestock production, the environment and disease emergence

The many effects of livestock production on the environment create challenges for policy-makers, consumers and producers. The effects are complex and many are indirect, or not immediately visible to policy-makers. For example, in low- and middle-income countries, priority is given to food supply and food security over environmental concerns. Livestock production is often the only economic activity available to one billion poor people who lack access to technology or the means to counteract environmental degradation. In contrast, in wealthier countries, lobbying by livestock producers may result in well-connected, large-scale commercial producers avoiding environmental regulatory requirements (23, 26).

Policy development needs to encompass regulatory approaches and economic instruments, but it also needs to engage all stakeholders along the market chain. Consultative approaches, such as those currently aided by FAO (e.g. the Ethiopian dairy chain, Moroccan small ruminants chain, Vietnamese pork chain and Mauritian dromedaries chain), aim to foster interaction between the stakeholders in a specific livestock production chain to work collectively to identify the constraints, viable interventions and policy options for sustainable development. Discussions among farmers, processors, service providers, abattoir workers, consumers and technical experts (e.g. veterinarians, public health specialists, economists) take account of the priority animal diseases, including zoonoses, and identify the roles and responsibilities of different stakeholders (e.g. the FAO Veterinary Public Health Livestock Consultation Tool: strengthening livestock value chains through national stakeholder engagement).

The effects of livestock production on environmental change

The 2006 FAO report, ‘Livestock’s long shadow: environmental issues and options’, noted the substantial impacts of livestock production and the urgent need for mitigation measures. Livestock production is a significant contributor to the world’s environmental problems, including global warming, land degradation, air and water pollution and loss of biodiversity. Intensified food production also has significant implications for the emergence of zoonotic diseases and increased antimicrobial resistance. There are also opportunities associated with intensified production, such as controlling environmental damage and improving animal health, welfare and biosafety (20).

Human population has more than doubled in the past 50 years and the United Nations estimates that it may reach 10 billion by 2100, mainly as a result of high fertility rates in countries in Africa, Asia, Oceania and Latin America (Fig. 3) (29). Rapidly growing populations and incomes, along with changing food preferences, are increasing demand for livestock products and driving significant increases in international trade, in both livestock supplies and products (23).

Livestock populations globally are estimated at about 1.3 billion cattle, 2 billion small ruminants, more than a billion pigs and more than 50 billion poultry, reared annually for food production, and these populations are also likely to increase over coming years (28). Demand for animal products such as meat and milk is expected to double between 2001 and 2050, with most of the growth occurring in developing countries (Fig. 4). However, this growth is unequal, with higher rates in Asia than in Africa.

A dramatic increase in demand for aquaculture and aquatic products (fish, molluscs and crustaceans) has led to increasing destruction of wild fish stocks worldwide. Aquaculture is the world’s fastest-growing food production sector, with more than 90% of the 53 million tonnes of global farmed fish and shellfish production originating in the Asian and Pacific regions. The devastating effects of aquatic animal diseases have clearly demonstrated the risks of international trade and the vulnerability of aquaculture to the spread of disease (32).

Intensification leads to the concentration of livestock production, with the associated issues of nitrogen and phosphorus surpluses, discharge of toxic materials, contamination of land and water, and adverse effects on biodiversity. As intensification of livestock production increases, demand for feed crops expands, causing conversion of natural habitats into cropland (with associated issues such as water depletion, climate change, chemical residues and biodiversity loss). Without appropriate intervention (including environmentally aware policies), livestock’s contribution to anthropogenic greenhouse gas emissions will also increase and livestock-induced degradation of the world’s arid and semi-arid lands will continue, contributing to further climate change, water depletion and loss of biodiversity (26).
Changing land use also has ramifications for the development of therapeutics, since it potentially threatens the existence of plant species, fungi, algae and animals that may be the source of as-yet undiscovered therapeutic compounds (16).

Livestock are an important contributor to global greenhouse gas emissions, with varying contributions from different countries to anthropogenic emissions. Original estimates of the contributions of livestock were based on overall global contributions that attracted substantial debate (20). Later studies have demonstrated that emission intensities vary across countries, based on levels of industry development, production timeframes and rates of deforestation. Developed countries, such as the United States, may have global greenhouse gas emission levels close to 3.4%, while countries with significant livestock numbers, such as Brazil, China and India, have higher emission intensities. The overall global greenhouse gas emissions from the global livestock sector are dwarfed by those of the transport, energy and industry sectors in developed countries, such as the United States. This is due to greater efficiencies with livestock production and intensification, in areas such as waste management, improved breeding and feeding techniques, minimised land usage and the introduction of new technology (24). Recent FAO studies of species-specific emissions illustrate the variations in emission intensity by region. For milk production, the variability of global greenhouse gas emissions across regions is significant, with the highest levels of emission production per kilogram of milk coming from the Sub-Saharan African and South Asian regions (Fig. 5).

![Fig. 3](image)

**Countries and areas classified by human fertility**
*Source: United Nations, 2011 (29)*

![Fig. 4](image)

**Expansion of livestock production and supporting land**
*Source: H. Steinfeld & P. Gerber (27)*

**Employing a One Health approach to address the impact of livestock production**

Future policy decisions for the livestock–environment interface will be shaped by balancing the increased demand for animal food products to feed an expanding human population and the need to reduce environmental impacts, such as anthropogenic climate change (27). A multidisciplinary One Health approach is needed to respond to the challenges arising from livestock production. By addressing the economic, social, health and environmental
Livestock and milk production: variations by region for greenhouse gas (GHG) emissions per kilogram of milk

Source: H. Steinfeld, Food and Agriculture Organization of the United Nations, cited in Von Braun (33)

Fig 5

The challenges of livestock production simultaneously, decision-makers will be better positioned to respond to increased food demands while also reducing negative impacts. Good information, education and communication will play a significant role in achieving these results.

Conclusion

This paper highlights the importance of One Health approaches for addressing complex interdisciplinary issues associated with emerging infectious diseases (including zoonoses), as an example of good governance at both the national and international levels. Through partnerships, coordination of joint action plans, collaboration across disciplines and sectors, integrated risk assessment strategies, joint research initiatives and streamlined financing, One Health approaches provide a sound basis for good governance. Based on the evidence presented in this paper, there are several key messages from One Health approaches that are vital for good national and global governance:

- intersectoral approaches are important for success
- ownership and leadership are needed at the highest level
- long-term commitment is required for sustainable results
- success requires demonstrated efficiency in the use of public money
- success requires accountability (not only of individual Governments to their constituents but also of individual countries to other countries).

At the national level, collaboration between animal health, public health, environmental and other authorities is crucial in instigating preventive measures, setting research priorities and implementing collaborative responses to disease outbreaks.

At the international level, there is a need for improved global governance, and the OIE–FAO–WHO collaboration is an important step in that direction. The growing threat of transboundary animal and zoonotic diseases – exacerbated by factors such as globalisation and environmental change – and increasing societal demands for food availability and security, food safety, public health and animal welfare underline the crucial importance of collaboration between international organisations.

Good governance at both the national and international levels to prevent the emergence and spread of human and animal infectious diseases is a global public good with benefits extending to all countries, people and generations.
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Stratégies « Une seule santé » et bonne gouvernance

J. Landford & M. Nunn

Résumé
Les auteurs examinent les stratégies « Une seule santé », qui visent à lutter contre les maladies d'origine animale décrites récemment ou ré-émergentes et à soutenir la préparation en cas de pandémie, en se fondant sur une collaboration renforcée entre les Services vétérinaires, les services de santé publique et ceux chargés de l'environnement. La maîtrise des risques de zoonoses (y compris celles d'origine alimentaire) à leur source passe par une meilleure gouvernance vétérinaire et par une coopération accrue avec les gestionnaires de la santé publique, les spécialistes des sciences sociales, les écologistes et bien d'autres parties prenantes. Deux études de cas illustrent l'intérêt déterminant de ces stratégies « Une seule santé » : la première est consacrée aux incidents survenus en Australie suite à l'infection par le virus Hendra et la deuxième à la gestion de la rage sur le continent africain.
L'article fait également le point sur la collaboration au plan international mise en œuvre par l'Organisation des Nations unies pour l'alimentation et l'agriculture (FAO), l'Organisation mondiale de la santé animale (OIE) et l'Organisation mondiale de la santé (OMS). Les auteurs analysent les facteurs environnementaux d'émergence des maladies, le changement climatique dû aux activités humaines et l'empilement humain sur les habitats de la faune sauvage de plus en plus resserrés, à partir des exemples de l'influenza aviaire hautement pathogène due au virus H5N1 de type A, d'une part, et de l'infection par le virus Nipah, d'autre part. Enfin, ils étudient l'impact des élevages sur le changement climatique, compte tenu de la croissance démographique mondiale et de la demande en hausse de produits issus de la production animale et de l'aquaculture, et font ressortir la nécessité de fonder les futures décisions politiques sur des approches multidisciplinaires de type « Une seule santé ».

Mots-clés
Afrique – Australie – Changement climatique – Collaboration intersectorielle – Production animale – Rage canine – Santé animale – Santé publique – Une seule santé
El buen gobierno desde los planteamientos de “Una sola salud”

J. Landford & M. Nunn

Resumen
Los autores examinan la forma en que se puede aplicar el concepto de “Una sola salud” para luchar contra enfermedades recién descritas o reemergentes de origen animal y contribuir a la preparación para pandemias, partiendo para ello de una colaboración más eficaz entre los Servicios Veterinarios, los de salud pública y los ambientales. Para reducir desde su mismo origen el riesgo de eventuales zoonosis (en particular enfermedades de transmisión alimentaria) es importante contar con un sistema de gobierno veterinario más eficaz y colaborar con responsables de salud pública, científicos sociales, ecologistas y otros muchos interlocutores. A fin de ilustrar la eficacia del concepto de “Una sola salud” los autores describen dos casos reales: el primero se refiere a episodios de la enfermedad de Hendra en Australia y el segundo a la lucha contra la rabia en el continente africano.

Los autores presentan la colaboración internacional entre la Organización de las Naciones Unidas para la Alimentación y la Agricultura (FAO), la Organización Mundial de Sanidad Animal (OIE) y la Organización Mundial de la Salud (OMS). También exponen los determinantes ambientales de las emergencias sanitarias, el cambio climático antropogénico y la invasión humana de los hábitats cada vez más exiguo de la fauna salvaje, utilizando como ejemplo el caso de los virus de la influenza aviar altamente patógena A (H5N1) y Nipah. Por último, reflexionan sobre la influencia de la producción ganadera en el cambio ambiental (habida cuenta del aumento de la población mundial y de la creciente demanda de productos derivados de la ganadería o la acuicultura) y apuntan que en el futuro sería conveniente que las decisiones normativas se basaran en planteamientos multidisciplinarios inscritos en el concepto de “Una sola salud”.

Palabras clave

References

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