

Predicting the role of veterinary medicine in future health and food safety challenges

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Abstract. Animals have always been a source of food, materials, protection and wellbeing for humans; however, animal diseases, including zoonoses, have both direct and indirect negative effects on human health, economy and the society. Since its establishment, the veterinary profession has provided crucial input in eradicating disease, increasing animal production and reducing losses due to diseases. Currently, foodborne diseases and zoonoses have raised awareness in developed countries, which have excellent systems for disease surveillance and reporting both in humans and animal populations. Due to lack of modern, integrated surveillance and reporting, the burden of zoonoses and foodborne diseases in developing European countries is much harder to assess. Differences in countries' animal health status (demonstrated through disease surveillance) have been a main pivot point for international trade of animals and animal products. However, rapid and dramatic evolvement of the health trends in the world changed the principles of animal disease surveillance. Approaches requiring lower cost (i.e. risk-based surveillance) are now proposed, not only due to less available public funding, but also because the costs are harder to justify to policy makers if a disease is exotic and/or rare. Therefore, the veterinary profession has faced insufficient interest of governments and funds for further research into many persistent endemic animal diseases and zoonoses. On the other hand, eradication of selected diseases in some areas while elsewhere they still persist, and the continuous emergence of new diseases, cannot guarantee permanent epidemiological stability. As food safety and security become more important, global trends and events have highlighted the biological, health and economic inseparability of the relationships between humans, animals as pets and/or food sources and wildlife within the social and ecological framework of living space that these species share. Veterinarians are called on and expected to offer strategic and operational solutions for better integration of public health systems (i.e. One Health), animal health, food safety and environmental protection. At the same time, the profession faces challenges in the organisation and implementation of surveillance and disease mitigation measures.

1. Animals as source of food, prosperity, health and disease

Humans have been both oriented and dependent on animals as source of food, materials, protection and wellbeing throughout history. Even though it could be argued whether many of the animal species would be better off without sharing habitats with us, it is certain that without animals, we would not have reached today's anthropological, civilizational and technological development, perhaps even mankind's survival would be at stake [1].

The importance of animals as a source of protein for human consumption has significant impact on development of the veterinary profession. The 1996 World Food Summit defined food security as “a



situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious foods that meets their dietary needs and food preference for a healthy life” [2]. However, modern times have brought new challenges such as overpopulation, climate change, urbanisation, globalisation and consequent disease (re)emergence in our efforts to ensure sufficient food supply [3].

By integrating animals in our lives and societies, we unknowingly integrated their specific microbiota. Hence, from early times, the occurrence and spread of human diseases was closely related to microorganisms found in animals. Due to the small size, density and few contacts of the early human communities, in order to survive, causative agents of diseases had to adapt either as chronic agents or to find secondary hosts. Humans also became secondary hosts to many animal diseases. Therefore, it is not surprising that over 60% of infectious human diseases today are zoonotic [4].

Without underestimating or understating the positive effects of microorganisms, especially in production of food, the resulting death toll in human populations far surpasses any other cause of human mortality such as war or famine [5]. Besides direct effects on human health and life, animal infectious agents, zoonotic or not, can cause death of animals, decline in animal production and degradation of the quality of animal products, leading in the end to less available food for humans (reduced food security). Animal diseases are also obstacles to international trade of animals and animal products, as well as substantial financial burdens to national veterinary and public health services and producers/industry. In the wider perspective, this has huge influence on the economy of region/countries and, therefore, affects the overall wellbeing of mankind.

These threats are currently addressed in two ways: in developed countries, activities are focused on reducing and controlling animal diseases endangering human health, compromising trade status and animal welfare, while in developing countries, the main issues remain increasing animal production in order to supply increasing demand for animal protein. In both scenarios, the veterinary profession has crucial input with responsibility to provide disease eradication, increasing animal production and reducing losses due to diseases.

2. Zoonoses and foodborne diseases in Europe today

According to the joint report of the European Food Safety Agency (EFSA) and the European Centre for Disease Prevention and Control (ECDC), the most common zoonotic disease in the European Union (EU) is campylobacteriosis, followed by salmonellosis, yersiniosis, vero toxic *Escherichia coli*, listeriosis, echinococcosis, Q fever, brucellosis, West Nile virus disease, tularaemia, trichinellosis, tuberculosis (*M. bovis*) and rabies [6] (Table 1).

Table 1 Reported cases, hospitalisation and fatal outcomes of zoonotic diseases in humans in the European Union during 2013 [6]

Disease	Number of cases	Number hospitalised	Fatal outcome	
			Number	Case fatality rate (%)
Campylobacteriosis	214,779	11,922	56	0.05
Salmonellosis	82,694	7,841	59	0.14
Yersiniosis	6,471	481	2	0.05
Vero toxic <i>Escherichia coli</i>	6,043	922	13	0.36
Listeriosis	1,763	735	191	15.6
Echinococcosis	794	127	2	0.88
Q fever	648	NA	2	0.61
Brucellosis	357	139	1	0.99
Tularaemia	279	39	0	0
West Nile virus disease	250	52	16	3.4
Trichinellosis	217	106	1	0.56
Tuberculosis (<i>M. bovis</i>)	134	-	-	-
Rabies	1	1	1	100

The top five diseases from this list are predominantly transmitted to humans through contaminated food of animal origin, while the frequency of finding the causative agents in animal population is also increasing (i.e. in the same period *Campylobacter* has been found in 30.4% of animal samples in Nordic countries) [7].

Foodborne diseases and zoonoses have raised awareness and are very important in developed countries, which have advanced systems of data gathering, disease surveillance and disease reporting both in human and animal populations. Simultaneously in these countries, animal health protection is vastly regulated, and technology of animal origin food production incorporates many systems of safety and quality assurance (i.e. farm biosafety, good production/management/agricultural practices, HACCP and traceability from farm to fork) [8].

Health management at the country level (or even at the EU level, represented by the Directorate General for Health and Food Safety – DG SANTE of the European Commission) for humans and animals is increasingly integrated through the “One Health” approach, which together with oversight of the entire food production chain, enables high protection of consumers, early response in case of incidents (therefore reducing the potential economic losses) and better access to international markets. The achievements of veterinary medicine in laboratory diagnostics, surveillance, food production practices and food quality standards had led to beneficial effects on animal health status and improved food safety. On the down side, there is reduced interest, justification and available funding for further investigation of infectious diseases of food animals [9].

The burden of zoonoses and foodborne diseases in developing European countries is much harder to assess, due to inadequate disease surveillance systems and less regulated and implemented corrective measures to ensure animal health and food safety, with less oversight. Many countries report worsening of the animal health and public health situations. However, these observed trends are not easy to interpret. Firstly, in many of these countries, animal disease reporting systems are based on reporting the absolute frequency (number) of cases or outbreaks (infected households/farms), while the population data (denominator) is generally unavailable or unreliable. Secondly, epidemiological intelligence campaigns are heavily dependent on current general public/political focus, and due to lack of available public funds, are never truly systematic. Monitoring and disease control programs are very expensive and technically demanding activities which exceed the competencies, budget capacities and public fund management of health services (animal and human) in many developing countries.

3. Disease surveillance

Animal disease is an economic problem with veterinary implications, not a veterinary problem with economic implications, because it affects people’s wellbeing. More than anything else, coherent disease surveillance and reporting systems have influenced the current difference in health and consumer protection status of many EU and other developed countries compared to the rest of the world [10]. In contrast to the clinical approach of understanding diseases, the population-based approach (epidemiological surveillance) starts with the animal unit, moves to the level of farm, then to the local area, the country or region or even the whole world. Animal disease surveillance, according to the World Organisation for Animal Health (OIE) (Chapter 1.4. of the Terrestrial manual), is aimed at demonstrating the absence of disease or infection, determining the presence or distribution of disease or infection or detecting as early as possible exotic or emerging diseases. This is a science-based tool to monitor disease trends, to facilitate the control of disease or infection, to provide data for use in risk analysis for animal or public health purposes, and to substantiate the rationale for sanitary measures.

Together with rapid and dramatic evolvement of health trends in the world, the principles of animal disease surveillance have also changed. Due to expansion of international trade and globalisation, disease agents are transferred through food, vectors, reservoirs, latent carriers and diseased individuals in short times over great distances, potentially able to arrive in our backyard from exotic or far-flung destinations with different standards of health protection. At the same time, due to the integration and

industrialisation of food production, raw materials originating from around the world are used for mass production of food and reach huge numbers of world consumers.

By exclusion of tariff-based trade barriers (adoption of the World Trade Organisation Agreement on the Application of Sanitary and Phytosanitary Measures) and recognition of international standard-setting bodies (i.e. the OIE for animal health, *Codex Alimentarius* for food and feed), differences in countries' animal health status (demonstrated through disease surveillance), has been a main pivot point for international trade of animals and animal products. Hence, countries that have employed scientific solutions and cost-effective decision-making mainly provided by veterinary services/professionals not only have disease surveillance systems that enable them to export, but also can influence the standard-setting processes at the international level. For example, the currently propagated risk-based surveillance applied in demonstrating disease absence enables the garnering of sufficient and suitable scientific evidence, similarly to the population-based studies [11]. However, with risk-based surveillance, much smaller sample sizes are required (because suitable population groups are sampled according to estimation of disease risk), and therefore, costs are much less than with the older system [11]. The need to reduce costs is not only due to reduced availability of public funding, but also because resources allocated to disease surveillance (preventing losses) have opportunity costs, where the benefits can be foregone as a result of allocating them to disease mitigation instead of other productive use [10].

On the other hand, as is evident by the emergence or re-emergence of many diseases even in developed countries, eradication of selected diseases in some areas while elsewhere they still persist, and the continuous emergence of new diseases, cannot guarantee permanent epidemiological stability. Therefore, it remains for the veterinary services of developing countries to make a progressive leap in focusing their disease surveillance strategies on sound epidemiological data and move away from improvisation for the benefit of their own national consumers, producers and economies. In addition, more interdisciplinary and collaborative efforts and funding are needed to ensure worldwide inclusiveness in achieving and upgrading animal health and food safety to international standards. In decision-making regarding disease surveillance, balance should be reached between the appropriate level of protection and cost-effectiveness. Improvisation in corrective measures is not justified by an "anything is better than nothing" approach, because such measures are not only inefficient, but often have adverse effects with dramatic consequences on public health and animal production. This can lead to the situation whereby eradication of disease becomes unattainable for a very long time [12].

4. What is our future role in food related issues?

Public veterinary services have complex structures and competencies, not only because they are already a part of a defined and complex administrative framework, but because of the wide spectrum of veterinary activities and responsibilities which are steadily increasing throughout the world. From the establishment of the first Veterinary Faculty in 1761, in Lyon (France), the prime role of veterinarians for many decades (treating horses) gradually expanded into clinical practice for other types of domestic animals as their breeding and their farm exploitation grew in economic importance [13].

At the beginning of the last century, the global commitment to eradicate the frequent diseases of animals and people such as rinderpest, foot and mouth disease, tuberculosis and brucellosis, to name just a few, initiated development and implementation of national, and partly global, programs for the control of these diseases. At the same time, with the development of animal production, the diseases (including the cost of treatment) were recognised as a significant burden on profitability, and therefore, veterinarians were redirected to the population approach and prevention. Later, commercial farms introduced computer programs and modern technology for monitoring animal health and production data with a focus on the control and reduction of "production" diseases (such as mastitis, reproduction disorders etc.) (14). The highly-contagious animal diseases and zoonoses have been eradicated in most of the developed countries, and disease-free status was then maintained by the "zero" risk principle (demanding the absolute evidence of non-existence of diseases in the exporting

country) in international trade. The private sector interest in preventing the emergence of diseases, as well as shifting responsibility and funding for animal health protection and food safety from governments to producers, have directly affected the trend (recorded in recent decades) of veterinarians orienting towards more profitable jobs (companion animal medicine). At the end of the 1900s, the veterinary profession was faced with insufficient interest of governments and funds for further research into many persistent endemic animal diseases and zoonoses [9], neglecting the role of wild animals as reservoirs of disease agents (15), as well as the lack and/or weak development of interdisciplinary approaches. Instead, the primary political interest was in preserving the sanitary status of states/regions/countries (free of disease) strictly in the interests of economics and trade.

Shortly after that, the world was faced with old and new health challenges, now with even more dramatic consequences. Global trends and events have highlighted the biological, health and economic inseparability of the relationships between humans, animals as pets and/or food sources and wildlife within the social and ecological framework of living spaces that these species share. Food safety and security have become more important than ever in human history, and scientists have identified fully some new and extremely influential concerns for which we remain unprepared: overpopulation, climate and ecosystem change and urbanisation. However, some other evolving issues, with more local/national influence must not be underestimated in the global arena, such as: biosecurity, bioterrorism, antimicrobial resistance, animal welfare, increasing volume of international trade and influence of media and politics. Concerns in the sphere of food security, besides the formerly defined components (availability of food, access to food and for the food to be culturally appropriate) might be expanded today to biological and health safety. At first glance, food security appears to be primarily a supply-and-demand-related issue. However, new evidence reveals that it is a hybrid of supply, quality and health issues as well, so compromised food safety and health is also a food security issue (Table 2).

Table 2 Review of current and expected challenges and concerns of food veterinarians in the sphere of food safety, health and food security

Challenges facing veterinary medicine	Possible consequences	Action required and demands
Overpopulation; Climate change and ecosystem; Urbanisation; Bioterrorism; New agents; Emerging diseases; Fast international spread; Antimicrobial resistance; Animal welfare; Biological and chemical hazards; Lack of research funding.	Economical and social insecurity; Disturbance in food supply; International trade; Case fatality rate; Health vulnerability; Lost of public trust.	Changes in education for food veterinarians; One health; Interdisciplinary approach; Leading role of veterinarians in food security; New surveillance and survey systems; Access to and proper distribution of information; New biosecurity and biodefense frame.

Besides prediction of new emerging disease agents, for which control approaches have not yet been identified or tested, many zoonoses have been relatively well-known (although they can never be fully known) and recognised for the last 50 years or more, and they are the subjects of long-term monitoring and control programs in public and animal health and food surveillance systems. However, the observed trends indicate that even these diseases continue to appear and increase, so therefore, the scientific discipline and knowledge expected to support the mitigation and prevention of these zoonoses still requires upgrading and further research. Significant improvements in knowledge and scientific infrastructure have been made in dealing with health and food safety issues, but clearly, health hazards and foodborne illness will not disappear. Obviously, problems related to the occurrence

and spread of zoonoses among humans and animals without discrimination occupy both developing and developed countries, with subtle diversity of consequences for each society or community. Even the most developed countries with advanced surveillance systems grossly under-report cases of foodborne illnesses [3].

In conclusion, zoonoses are still, and will remain, a global health issue, common in their nature (animal to human transmission), but not with the same solutions for the poor and the rich, private sector (producers) and government, animal health carers and human health providers. The demand for better knowledge and more efficient solutions and approaches is intensive and dynamic and today is directed by national and global food and health security. Veterinarians are called on and expected to offer strategic and operational solutions for assessing risks, analysing challenges and applying scientific knowledge. The resulting need for better integration of public health systems, animal and plant health protection, food safety and environmental protection, has led to new approaches (One Health) and challenges in the organisation and implementation of mitigation measures and surveillance. Our role, as veterinarians, is development of the new type of competencies and institutions required to deliver the appropriate science and technology, risk-based regulatory management and communication policies and practices related to agriculture, animal and public health, environment and climate change, wildlife and biodiversity, social and economic development and growth.

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