This paper addresses current global developments with regards to animal production and health and looks into the new developing areas of work for veterinarians specialized in veterinary public health\textsuperscript{1} in an increasingly threatened world. The paper begins by providing a brief overview of veterinary public health and its role in society. This is followed by paragraphs on veterinary education, and an elucidation of the One Health approach and the excitingly new opportunities for veterinary professionals. Lastly, our collective reflections are summarized in a conclusions section.

**INTRODUCTION**

The livestock subsector is one of the fastest growing parts of the agricultural economy, contributing to roughly 40 percent of the global value of agricultural production. Livestock provides income, high-quality protein-based foods, fuel, draught power, building materials, and manure as organic fertilizer, and thus contributes to food and income security, soil improvement, and nutrition for adults and children. For many small-scale farmers, livestock also provides an important safety net in times of need. When emergencies strike, as they often do, animals are often sold for cash or traded for other food items. Investments in agricultural research and more robust governance are required to ensure that the world’s livestock sector responds to a growing demand for animal products and at the same time contributes to poverty reduction, hunger mitigation, environmental sustainability, and human health.

The principal driving forces behind the growing demand for meat and meat products in middle income and developing countries include population growth, rapid urbanization and the phenomenon of globalization. In order to meet this rapidly rising demand, FAO estimates that global annual meat production will need to expand from the current 228 million tonnes to 463 million tonnes by 2050 with the cattle population estimated to grow from 1.5 billion to 2.6 billion and that of goats and sheep from 1.7 billion to 2.7 billion.\textsuperscript{2} This will require more efficient natural-resource use in the sector and measures to reduce the environmental footprint of livestock production.\textsuperscript{3}

The challenges presented by higher demand of meat and meat products, coupled with climatic changes and the rapidly evolving agro-ecological and land use patterns will invariably impact on the underlying drivers of disease and associated ecological factors. This could result in increased incursions of disease agents and pests in environmental niches shared by animals and humans. It is at this nexus that most of the future changes for veterinary public health professional will lie. Not only will he/she need to deal with the classical dimensions of the veterinary public health (VPH) that are fairly well known, but also with novel public health challenges that may involve new pathogens, new non-infectious diseases, new clinical signs, new hosts, and evolving disease dynamics. These dynamics will require veterinarians to look at new challenges with a different lens, one that brings contemporary realities of a warmer, more crowded, and more interconnected world into focus. While the task is daunting and indeed largely uncertain, we believe that now is the time to explore and to develop the more demanding requirements VPH professionals will need to deploy so that the societal impacts are minimized to the greatest extent possible.

**MATERIALS AND METHODS**

This paper draws from a number of sources. A brief literature review of books, reports, discussion papers, essays, and scholarly articles was undertaken to gather the range of viewpoints opinions and research findings. Our thoughts, borne out of our experience in tracking developments in the VPH field, supplemented the information from the literature review. The headings were chosen to guide readers through the different issues explored, while also seeking to make linkages to multiple health domains.

**VETERINARY PUBLIC HEALTH AND ITS ROLE IN SOCIETY**

It is widely acknowledged that the range of emerging health threats, mostly of animal origin, have increased over the years. These include threats from both infectious and non-infectious agents.
In recent years, the world has witnessed outbreaks of H5N1 highly pathogenic avian influenza (H5N1 HPAI) in Asia, Africa and Europe. The international effort to control and prevent H5N1 HPAI has been truly unprecedented and by highlighting the increasing risk of emergence of pandemic threats has served to increase public awareness and the need for more multi-disciplinary and multi-sectoral collaboration to prevent or rapidly detect and respond to such threats. However, whilst the attention to HPAI has served to galvanise a global response, diseases such as brucellosis, rabies, cysticercosis, echinococcosis, leishmaniasis, and many others that continue to cause illness, death and impose serious burdens, often in the poorest communities, are for the most part left on the margins of health programmes. These neglected zoonotic diseases need to be brought back to the mainstream of public health, particularly in the context of poverty alleviation, food security and global public health. The emergence of bovine spongiform encephalopathy (BSE) and Escherichia coli O157:H7 also created more awareness among the general population about food safety issues. In addition the recent dioxin contamination of pork in Ireland and Germany and the adulteration of milk with melamine in China further illustrate the need for more robust and better coordinated national, regional, and international monitoring, surveillance and regulation. For these supervisory tasks to be successful, it will require investments in national policy, legislative and regulatory frameworks, and animal health and food safety infrastructures to minimize risks to animal, humans, and economies.

Humans, animals, and animal products now move rapidly around the world through air, land, and sea transport. Pathogens are adapting, finding new niches, and jumping across species into new hosts. Professionals trained in veterinary sciences are often the most qualified individuals to deal with these public health issues. Those with training in VPH must be able to develop, implement, and execute public and private health programs designed to prevent and control zoonotic diseases in both animal and human populations. There is an increasing societal need for public health professionals with the competencies, knowledge, and skills to address the multidimensional problems of zoonotic and food-borne diseases.

VETERINARY EDUCATION

The history of veterinary medicine is intimately intertwined with duties to public health. This has remained true for 250 years and is becoming even more important with new, significant threats to public health. As an educational imperative, the work of VPH and the veterinary education needs to be placed within the framework of a trade-oriented and interconnected world, linking the evolving realities of developed, transitional and developing countries. This is because the disease landscape has radically changed in the past 30 years, and how we address hazards and threats has also had to evolve in order to incorporate technological advances and new communication and information tools to make the work of veterinary professionals and public health officials much more efficient.

Veterinary professionals coming out of educational institutions need a good grasp of the overlap between transboundary animal diseases and veterinary public health and that is not limited to zoonotic pathogens; but also encompasses insidious animal diseases and non-infectious health risks that affect people’s livelihoods, social resilience, and food security. Furthermore, veterinarians need to be acquainted with socioeconomic aspects of animal production and health policies, existing national and international regulations, legislation, new concerns regarding animal welfare, and environmental protection, etcetera. There is a need for the integration of new themes/topics in the curricula of graduate and postgraduate veterinary education programs, with specific emphasis on practical epidemiological training, outbreak investigations, enhancing communication and leadership skills, development of cultural sensitivity, the ability to acquire local knowledge in a variety of socio-cultural settings, and an ability to be engaged in multifaceted and multidisciplinary teamwork.

It is for the abovementioned reasons that veterinary training must be creative and flexible to be able to graduate veterinarians who are capable of addressing rapidly changing needs. Veterinarians’ educational background in basic biomedical and clinical sciences is very similar to that of physicians; however, veterinarians must possess a profound knowledge of health and disease in multiple species. Primary veterinary training emphasizes comparative medicine. The veterinary profession has always focused on protecting and improving both animal health and human health. Veterinarians are trained in preventive medicine, population health, parasitology, zoonotic disease transmission and epidemiology. This prepares them well for careers in public health.

In veterinary education, the curriculum themes and topics related to VPH are very often only partly addressed within the context of a limited number of subjects such as infectious diseases, meat inspection, and food safety/hygiene. In fact, until recently, only a small number of veterinary faculties had a specific subject dealing with all the relevant aspects of VPH. Current accreditation requirements for veterinary schools and colleges are still vague with regard to the requirements for public health education. This leaves each college or school of veterinary medicine to implement its own programme of veterinary public health education, often based on prevailing
perceptions of need. This has led to the veterinary profession failing to meet the increasing needs for competent and well-rounded veterinarians trained in population medicine and public and environmental health and with understanding of local, national, regional, and international contexts. Veterinary professionals need to know about international organizations involved with animal and human health, and the internationally-led health initiatives in place. For instance, we note that the roles of the FAO/WHO Codex Alimentarius, the Terrestrial Animal Health codes of the World Organisation for Animal Health (OIE), the International Health Regulations (IHR) by WHO, and more recent developments like the One Health concept are not always well understood by today’s students.

THE ONE HEALTH APPROACH AND THE NEW OPPORTUNITIES FOR VETERINARY PUBLIC HEALTH PROFESSIONALS

The One Health concept describes a holistic approach to address health risks at the animal, human and environmental interface in order to enhance human and animal wellbeing and welfare, and sustainable management of the environment. The concept promotes a holistic view and fosters cooperation, communication and coordination among sectors. A One Health joint strategic document was presented by FAO, OIE, WHO, the United Nations System Influenza Coordination (UNUSIC), the United Nations Children’s Fund (UNICEF), and the World Bank during the Sharm-el-Sheik International Ministerial Conference on Animal and Pandemic Influenza (IMCAPI) held in October 2008 in Egypt. As a follow up to this document, FAO, OIE, and WHO elaborated a Tripartite Concept Note with a vision of a “world capable of preventing, detecting, containing, eliminating, and responding to animal and public health risks attributable to zoonoses and animal diseases with an impact on food security through multi-sectoral cooperation and strong partnerships.” Other, related initiatives have also helped to promote the One Health concept. It is essential for new veterinary professionals to understand principles of One Health and its application in addressing health risks emerging at the interface shared by animals, humans, and the natural environment.

The recognized importance of addressing animal, human, and environmental health and wellbeing has created a need for veterinarians with a level of knowledge and skills beyond those gained during their professional education. Needs and opportunities for veterinarians are expanding rapidly in organizations ranging from public and private agencies dealing with animal and human health, to agencies and corporations charged with safeguarding food safety, consumer protection and food security. The demand is increasing for veterinarians with additional education in food safety, food and animal production, zoonotic diseases, bio-security, research methods, administration, and public policy. The veterinary degree alone is not enough to prepare veterinarians to meet these challenges and opportunities. Veterinarians are the only health professionals trained in ‘multi-species’ comparative medicine and the profession links agriculture, medicine, and even health issues at the household level through their involvement with companion animals. In addition, practicing veterinarians are the first line of defence of newly introduced diseases and will very likely be at the front line in detecting terrorist-engineered epidemics.

The USDA Food Safety Inspection Service (USDA-FSIS) is the single largest employer of veterinarians in the United States and possibly the world. This one agency estimates it will need 500 new veterinarians in the next five years. Other opportunities for service exist at the state, municipal, county, and university level. Masters in veterinary preventive medicine or masters of public health is necessary for many of these career opportunities. In Europe, for example, veterinarians find employment with national animal health departments or veterinary services, food safety/standards authorities, international technical agencies, the European Commission, and with the private sector. In Asia, Australia, Africa and Latin America, similarly, veterinarians find remunerative employment with a wide array of agencies and bodies that do not exclusively deal with traditional aspects of animal health and production.

Global veterinary leadership is needed to reduce the global threat of infectious diseases of major food animal and public health importance. New inspection and certification systems are needed as risks and transmission patterns change. Classical macroscopic meat inspection is insufficient to detect emerging risks from salmonella, campylobacter, E. coli, and various residues, which require new and more risk-based interventions. The farm-to-fork approach requires interlinked prevention, control and inspection services and enhanced communication, coordination, and information exchange. In fact, this becomes crucial during crisis situations when various services and sectors need to respond in a coordinated manner.

Moreover, the creation of food safety agencies at national and regional levels, such as the European Food Safety Authority (EFSA), comes at a time when governments are more responsive to the demands of better informed citizens as risk assessors and regulators of food and feed safety. For example, EFSA works closely with national authorities in the European Union and provides independent risk assessment, and scientific advice on existing and emerging risks and threats. Responsibility for the management and communication of these risks and threats are still largely with competent authorities in each country, which are usually embedded within the ministries of health and ministries of agriculture but are in some cases delivered by specialised agencies. The unique exception is Italy, where the entire veterinary services and food inspection are both located within the ministry of health. The key point here is that veterinary professionals are often hired by these specialized entities to conduct assessments and management of risks that fall outside the
immediate realm of classical veterinary medicine. The scope of practice of veterinarians has thus broadened with time, in response to changing needs and this needs to be reflected in dynamic and evolving academic curricula as well as in the provision of continued professional development programs.

Gradually, in many different countries—especially in Latin America—zoonoses centres are becoming established at regional, national, and municipal levels. Although generally embedded as part of the ministry of health, they keep close links with the official veterinary services and those entities dealing with national parks, ecological systems, and environments as well as various veterinary and medical faculties and health professionals at large. Their establishment, mandate, responsibilities and funding mechanisms are normally determined within a legislative framework and their areas of work generally relate to zoonotic diseases in urban, suburban, and periurban areas. These centres especially deal with diseases transmitted by pets, wildlife and synanthropic animals which are normally not sufficiently addressed by veterinary service teams that are commonly engaged with economically important livestock production and health.

The involvement of veterinary public health professionals in integrated national surveillance systems for zoonotic diseases is pivotal, and this has created many new opportunities. This is because these systems should ideally include surveillance of diseases in various animal species and humans, as well as the strengthening of the diagnostic capacities, the timely exchange of information on animal and human diseases and risk factors, coupled with the development of outbreak investigation and response capacities across sectors. For instance, in several Latin American countries, such as Argentina, Brazil and Colombia the ministries of health are in charge of the control of dog rabies and the provision of human rabies post-exposure prophylaxis. This could have contributed to the successful control of dog rabies in these countries as rabies in dogs in other parts of the world is generally neglected when the responsibility is placed with the veterinary services embedded in ministries of agriculture. The zoonoses centres in Latin America are established at the municipal level and zoonoses departments at the national level. Besides rabies, these centres are also addressing a wider range of diseases and issues at the human-animal-ecosystems interface.

CONCLUSIONS

Veterinarians with specialisations and experiences in (veterinary) public health are in a unique position to strengthen and contribute to the expanding work within the ministries of health and agriculture, public and private institutions and industries with regard to preventing and controlling zoonotic diseases and other health-related risks that originate from animals, their products, and their living environment. This assertion is supported by the increasingly visible cases of food and feed contamination, pathogens exhibiting antimicrobial resistance, and of the much higher awareness of consumers to food safety issues throughout the value chain. Also, in the tropics there are still some diseases that continue to plague local populations even though others have eliminated them completely. The veterinary public health professional stands at a privileged place to witness, and carefully examine the many links that continue to evolve between animals, humans and the environment. The ability to understand complex interactions, working in multidisciplinary teams, and fully embrace the One Health approach will further make the veterinarian a key player in enhancing global health and wellbeing.

REFERENCES