

# One World – One Medicine – One Health: emerging veterinary challenges and opportunities

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The terms 'One Medicine' and 'One Health' have been used to describe the concept of an integrated approach to animal, human and environmental health and to acknowledge that we are all part of 'One World' in which animals, people and the environment are interdependent and must rely on each other for basic survival. Throughout this article the authors will use 'One Health' in reference to the integration of veterinary and human medicine in order to mitigate disease and promote wellness.

## Summary

The interdependence of humans, animals, and their environment has never been more important than now. The most prominent issues putting pressure on global health today include the dramatic emergence and spread of zoonotic diseases, contamination of food, water and soil, bioterrorist events, and degradation of resources and habitats. Current global health challenges have prompted a call for more holistic, collaborative, action-oriented approaches toward the goal of logical and practical solutions. Veterinarians have pivotal obligations, opportunities, and contributions to make in enhancing public health, recognising and responding to zoonotic disease transmission, maintaining food and water quality, and promoting wildlife and ecosystem health.

## Keywords

Global health – One health – One medicine.

## Introduction

One medicine is not a new idea. In the 19th Century, Robert Virchow, the German physician and pathologist, stated, 'Between animal and human medicine there is no dividing line, nor should there be. The object is different, but the experience obtained constitutes the basis of all medicine' (10). Subsequent medical and veterinary workers noted the impact of animal diseases and ecological change on public health. The Canadian physician William Osler was the first to use the term 'One Medicine' in the English language literature (2). Calvin Schwabe, veterinary epidemiologist and parasitologist, reintroduced the 'One Medicine' concept in his 1984 book *Veterinary Medicine and Human Health* (14). An expert on zoonotic diseases, Schwabe supported the active integration of human and

veterinary medicine. He stressed the increasing interdependence of animals and their products with human health problems and encouraged both the medical and veterinary professions to take action to prevent these diseases from occurring. Since Schwabe's publication, the One Health concept has advanced our understanding of the interactions between human and animal health. Nearly 875 of the 1,461 infectious diseases of people are of animal origin. In the last 30 years the prevalence of infectious disease has increased such that 75% of the emerging infectious diseases in humans are of animal origin (15, 16). The increasing occurrence of emerging infectious diseases indicates that bridging animal, human and environmental health through the One Health concept is becoming even more critical. Veterinarians can ideally provide this bridge with their in-depth understanding of biological systems, knowledge of disease processes and epidemiology,

experiences with diagnosing and managing diseases in large populations of animals, and success in eliminating and preventing infectious diseases. Veterinarians can be, and often are, the first line of defence for zoonotic diseases as well as for various toxicants that occur naturally or by intentional terrorist attack. Veterinarians are in contact with a wide variety of domestic and free-ranging animals, effective and efficient diagnostic systems, and local and national regulatory systems for animal health, food safety, and public health. One Health represents a unique and significant opportunity for veterinary medicine to collaborate with human medicine and public, wildlife and environmental health for the greater good. An integrated approach is the key to promoting One Health, and this approach is best developed by ensuring that veterinarians are extensively involved in collaborative teams, particularly in leadership roles.

## Emerging critical global issues that demand veterinary attention

### International trade and travel

The movement of people, animals, and agricultural products can quickly spread disease pathogens around the world. Globalisation of the food supply has spread livestock and agricultural crop diseases into previously unaffected areas. Inadequate cargo inspections worldwide allow infected animals, insect vectors, and diseased plant products undetected introduction into geographic areas where natural parasites, predators, and host resistance may be lacking. For example, the Asian tiger mosquito, *Aedes albopictus*, a vector of the dengue fever virus, has become established in the United States of America (USA) through the introduction of imported used tyres into parts of the eastern and southern areas of the country (T.J. Zavortink, personal communication [R.M. Bohart Museum of Entomology, University of California, Davis]). Rinderpest was introduced into Africa in the late 1880s and destroyed more than 90% of Kenya's native buffalo population, which had no natural immunity to the disease (5).

### Global climate change

Vector-borne zoonotic diseases such as yellow fever and certain encephalitides may become more widespread as the geographic range of their mosquito vectors increases. Warming temperatures and shorter winters played a part in the establishment of the tropical diseases dengue and malaria in more temperate areas of the world during the 1980s and 1990s (5).

### Habitat destruction

Deforestation can force wildlife reservoirs of zoonotic diseases into closer proximity with humans. The sudden emergence of Nipah virus disease in pigs and humans in Southeast Asia in the late 1990s may have been caused by rapid deforestation to clear land for farming and timber production. The natural reservoir for Nipah virus appears to be fruit-eating flying foxes (bats in the genus *Pteropus*). As deforestation reduced their native food sources, flying fox populations were thrust into closer contact with commercial fruit orchards and fruit trees on pig farms, where the virus spread to pigs and then to humans (3).

### Overpopulation

As human populations encroach upon wildlife habitat, people come into contact with more wild animals and the diseases they carry. Ebola and AIDS probably jumped from chimpanzees to humans as population pressures increased the consumption of bushmeat, exposing people to infected blood and tissues during butchering. Wildlife health is impacted, too, as native species are exposed for the first time to human and domestic animal diseases. In the 1990s an outbreak of canine distemper in domestic dogs caused high mortality in lions and other carnivores in Serengeti National Park in Tanzania (13).

### Ecotourism

Ecotourism is championed as a vehicle for developing countries to benefit financially in exchange for habitat conservation, but tourism activities can introduce diseases to wildlife (4). For example, the potential for transmission of human disease to mountain gorillas is higher than any other animal. A study based on data obtained from the Ugandan Health Ministry's Health Monitoring Information System indicated that serious diseases such as malaria, measles, and tuberculosis were among those most likely to be transmitted to gorillas by human visitors (4). Veterinary and public health planning and oversight are essential for maintaining the health of animals affected by ecotourism.

### Food safety

A number of emerging infectious zoonotic diseases threaten the safety of our food supply and the control of these diseases requires the collaborative efforts of various health workers. Veterinarians, public health and human health professionals must be continually involved in the trace-back and control of food-borne illnesses such as bovine spongiform encephalopathy (BSE) and infections caused by *Escherichia coli*.

### Bovine spongiform encephalopathy

A degenerative neurological disease of cattle similar to scrapie in sheep and Creutzfeldt-Jakob disease (CJD) in people, BSE was first diagnosed in the United Kingdom (UK) by veterinarians (4, 6). The number of cases increased rapidly in the UK because of a change in the processing of feed rations containing protein and calcium derived from meat and bone meal. A few years after BSE was diagnosed in cattle, an unusual form of CJD appeared in young adults in the UK (1). The origin of infection for this variant CJD was traced back to cattle infected with the prions of BSE, the tissues of which had been consumed by the affected patients. Since 1996, BSE has resulted in more than 180,000 cattle deaths and more than 200 human fatalities (6, 17). The disease has been most prevalent in the UK, but several thousand cases have also been reported in native cattle in 21 other countries (17). To bring this disease under control in animals and people, strict restrictions have been placed on the feeding of ruminant meat and bone meal to domestic animals and captive wildlife in many countries throughout the world. Veterinary clinicians and veterinary meat inspectors are on the alert for affected animals to prevent them from entering the feed or food supply chain and many countries have implemented surveillance systems to examine brains of cattle to ensure BSE is not in their herds.

### *Escherichia coli* O157:H7 contamination of leafy greens

The recent outbreaks of *E. coli* O157:H7 in the USA associated with spinach and lettuce has presented a dilemma for regulatory and public health officials. Although cattle were originally thought to be the reservoir host for the outbreaks, the fields where the produce was grown had no direct link to cattle. Investigators looked at irrigation water, composted manure, and even birds as the potential cause of the contamination. Recently, the role of feral pigs surfaced as a source of contamination (8). After mingling with cattle in the pastures more than a quarter of a mile away, the pigs moved onto the leafy green fields and defecated in the fields. Harvesting by mechanised cutter harvesters with a vacuum system picks up the leafy greens and other debris such as faeces which is then transferred to containers. The containers go to processing sheds where the leafy greens are dumped into vats with chilled water for washing. The cooling process places the *E. coli* O157:H7 in contact with the internal and external surfaces of the leafy greens (11). In this particular outbreak, leafy greens were the principal vector enabling the *E. coli* O157:H7 to move from cattle, through feral pigs and on to the consumer.

This spread of food-borne zoonotic disease is attributed to:

- intensified food production to meet increased consumer demand for fresh produce

- centralised food processing followed by widespread distribution

- expanding markets for regional and ethnic foods, resulting in global trade expansion with the potential for introduction of food-borne diseases into new geographic areas (9).

Co-operation between the veterinary and medical professions must be strengthened to combat these and other emerging threats to the world food supply. It is of ever-increasing importance to provide safe and adequate food and water for the world's human population.

### Intentional adulteration of food

Intentional adulteration of food is the means by which terrorists can sicken large numbers of individuals with the intent of destabilising the country, overwhelming healthcare facilities, or causing economic losses to the food providers and suppliers. It can also come about when products are added to falsify ingredient results. Recently, a series of incidents resulted in global food-related health concerns for both animals and people. Testing for protein routinely involves measuring elemental nitrogen without consideration of true protein. Melamine, along with cyanuric acid, contains relatively large quantities of nitrogen in its chemical structure, so it is sometimes illegally added to food to increase the perceived protein content. In 2004, a large number of pets in Asia developed renal disease which was initially attributed to fungal toxins but later associated with the presence of melamine in pet food. In 2006, a similar acute renal condition occurred in dogs and cats in the USA. The United States Food and Drug Administration oversaw the outbreak and, through the efforts of the State Diagnostic Laboratories in New York and California, crystalline structures of melamine and cyanuric acid in the kidneys were identified as the cause. The outbreak was resolved through the recall and removal of the contaminated pet foods from stores. In 2008, a severe renal condition occurred in China involving hundreds of thousands of young children consuming infant formula (milk substitute). Melamine was again detected in the formula. The role of veterinarians was critical in identifying the presence of the adulterant in pet foods, which in turn notified the world to the use of melamine as a cause of acute renal disease.

### Bio-defence

Some zoonotic diseases are unfamiliar to the general medical community and exist as potential agents of bioterrorism against human populations because of their virulence, lack of treatment options, and ease of production, transmission, and infection. Zoonotic bioterrorism agents can also target agriculture, causing economic disruptions and undermining consumer

confidence in food supplies. Outbreaks of livestock diseases can result in mass culling of animals, import and export restrictions on livestock, and fears of human contagion and pandemics. Both veterinary and medical expertise is critical in formulating prevention and response plans for possible acts of bioterrorism involving zoonotic diseases.

### **Accepting the future – Confronting the challenges – Seizing the opportunities**

Many countries around the world have embraced the One Health Initiative. The basic foundation of One Health begins with education and collaborative research. This can be illustrated by action in the USA. The American Medical Association, American Veterinary Medical Association (AVMA), and the Centers for Disease Control launched the One Health Initiative at the AVMA annual convention in 2007 (12) as a framework for effective action. Vital components of the One Health Initiative include:

- meeting new global challenges ‘head-on’ through collaboration among multiple professions: veterinary medicine, human medicine, environmental health, wildlife health, and public health
- developing centres of excellence for education and training in specific areas through enhanced collaboration among colleges and schools of veterinary medicine, human medicine, and public health
- expanding veterinary curricula to include more emphasis on One Health issues
- encouraging veterinarians to pursue advanced scientific training (Master of Public Health [MPH], Master of Preventive Veterinary Medicine [MPVM], Doctor of Philosophy, and Physician Assistant/Nurse Practitioner degrees).

The Association of American Veterinary Medical Colleges (AAVMC) took an initial step in 2000 to address educational needs by promoting veterinary public health training. As a result the AAVMC colleges increased their MPH degree training capabilities from four colleges to twenty-two (7). The veterinary profession and colleges in

most countries have increased their training opportunities to address the emerging issues associated with zoonotic diseases and the implementation of effective public health policy. In the USA it was also recognised that One Health would require enhanced collaboration and daily interaction with medical, public health, and veterinary scientists in their respective schools/universities, as well as with government agencies, regulatory agencies, and other research, diagnostic, and allied human health institutions. For example, in the USA, veterinary medicine professionals work closely with:

- National Institutes of Health
- the Department of Health and Human Services
- the Centers for Disease Control and Prevention
- the Food and Drug Administration
- the Department of Homeland Security
- the Department of Agriculture
- the Environmental Protection Agency
- state agencies for public health, food and agriculture, fish and game, and water and air
- universities running programmes that bridge veterinary medicine, public health, agriculture, and the environment, such as the Calvin Schwabe One Health Project at the University of California Davis

To truly address One Health in a global context, similar support must be made available in developing countries through government and agency collaborations and funding, allied professions, international organisations, philanthropic foundations and publicly supported programmes. Only with global commitment and support will greater control and prevention of costly and often deadly diseases and conditions be achieved.



## Un monde – une seule médecine, une seule santé : l'émergence de nouveaux défis et de nouvelles possibilités pour les vétérinaires

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### Résumé

Jamais l'interdépendance n'aura été aussi forte qu'aujourd'hui entre les humains, les animaux et l'environnement. À l'heure actuelle, les principales menaces qui pèsent sur la santé mondiale sont l'émergence et l'expansion dramatiques des maladies zoonotiques, la contamination des denrées alimentaires, des eaux et des sols, les attaques bioterroristes et la dégradation des ressources et des habitats. La dimension mondiale de ces nouveaux défis sanitaires invite à privilégier les démarches holistiques, collaboratives et pragmatiques tendant vers des solutions logiques et pratiques. Les vétérinaires ont un rôle essentiel à jouer à travers les obligations, les possibilités et les contributions qui sont les leurs dans les domaines de l'amélioration de la santé publique, de la détection des maladies à caractère zoonotique, de la protection de la qualité sanitaire des aliments et de l'eau et de la promotion de la santé de la faune sauvage et des écosystèmes.

### Mots-clés

Santé mondiale – Une seule médecine – Une seule santé.



## Un mundo – Una medicina – Una salud: nuevas dificultades y oportunidades en el terreno de la veterinaria

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### Resumen

La dependencia recíproca entre el ser humano, los animales y el medio en el que viven nunca ha sido tan importante como ahora. Entre los problemas sanitarios mundiales que más acuciantes resultan hoy en día destacan la brusca aparición y propagación de enfermedades zoonóticas, la contaminación de alimentos, aguas y suelos, la perspectiva del terrorismo biológico y la degradación de recursos y hábitat. Los actuales problemas sanitarios de alcance mundial han propiciado un llamamiento en favor de planteamientos más holísticos, colectivos y resolutivos al servicio de soluciones lógicas y prácticas. Los veterinarios tienen obligaciones, oportunidades y aportaciones que hacen de capital importancia a la hora de mejorar la salud pública, detectar y atajar la transmisión de enfermedades zoonóticas, preservar la calidad de los alimentos y recursos hídricos y fomentar la salud de los animales salvajes y ecosistemas.

### Palabras clave

Salud mundial – Una medicina – Una salud.



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