# Feature

ONE HEALTH

# The evolution of One Health: a decade of progress and challenges for the future

The One Health concept is gathering momentum and, over the next 12 months, Veterinary Record will be publishing a series of articles to help encourage that process. Written by specialists in a range of fields, the articles will consider the meaning of One Health, the interactions between animal and human health and how a collaborative and interdisciplinary approach could help to solve emerging global problems. To set the scene, Paul Gibbs outlines the recent history of One Health, discusses current challenges and muses on what the future might hold.

IN the early years of the 21st century, emerging zoonotic viruses that had the potential to cause pandemic disease, including extensive human mortality, created several international crises (Gibbs 2005). Governments and scientists worldwide recognised that greater interdisciplinary collaboration was required to prevent and control zoonoses, and that such collaboration should include not only physicians and veterinarians, but also wildlife specialists, environmentalists, anthropologists, economists and sociologists, among others. The expression 'One Health' was proposed as a concept to foster such interdisciplinary collaboration. It has been adopted with great enthusiasm by the veterinary profession and by the international agencies charged with control of zoonoses, most notably the Food and Agriculture Organization (FAO), the World Health Organization (WHO), and the World Organisation for Animal Health (OIE). Worldwide, the veterinary profession has promoted the concept of One Health to address such issues as food safety, food security, antimicrobial resistance, climate change and the human-animal bond.

Now, a decade later, it is time to consider whether One Health will prove to be a short-lived response to a spate of emerging diseases that apparently threatened to engulf the world, or a paradigm shift that will lead to a wider and deeper commitment to interdisciplinary action addressing the protection and needs of society in the 21st century.


**In 2005 *The Veterinary Record* and *BMJ* published an influential joint issue on the theme of 'one medicine'**

'It is time to consider whether One Health will prove to be a short-lived response to a spate of emerging diseases that apparently threatened to engulf the world, or a paradigm shift that will lead to a wider and deeper commitment to interdisciplinary action addressing the protection and needs of society in the 21st century'

## Developing collaboration

In 1999, a series of themed conferences was organised by the Society for Tropical Veterinary Medicine and the Wildlife Diseases Association under the banner 'Working together to promote global health'. The second of these conferences, held in 2001 in Pilanesberg, South Africa, addressed issues at the domestic animal/wildlife interface relating to disease control, conservation, sustainable food production and emerging diseases (Gibbs and Bokma 2002). Lee and Brumme (2013) consider this meeting and the resultant 'Pilanesberg Resolution' as key to the early development of One Health.

In 2004, Martin Alder on *The Veterinary Record* and Graham Easton on *BMJ* began to explore how they could draw attention to ways in which the veterinary and medical professions could collaborate for mutual benefit. They recognised that the medical and veterinary professions have different roles, but have a common interest in many diseases and share many challenges (Alder and Easton 2005, Anon 2005). Diseases such as bovine spongiform encephalopathy, severe acute respiratory syndrome (SARS) and highly pathogenic avian influenza (HPAI H5N1) had highlighted the need for professional collaboration not just locally and nationally, but on a global scale. In November 2005, under the title 'Human and animal health: strengthening the link', the two journals published a joint issue containing various articles on the theme of 'one medicine'.

Around the time that *The Veterinary Record* and *BMJ* were planning their joint issue in London, Robert Cook, William Karesh and Steven Osofsky of the Wildlife Conservation Society (WCS) in New York organised a conference to highlight the importance of understanding wildlife diseases and ecology when addressing the emergence of new diseases. At the conference, the WCS introduced the term

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'One World-One Health'™ to embrace both medicine and ecosystem health, and listed 12 recommendations for establishing a more holistic approach to preventing epidemic disease and maintaining ecosystem integrity for the benefit of people, domesticated animals and the foundational biodiversity that supports us all (www.oneworldonehealth.org). This series of recommendations became known as the Manhattan Principles, in recognition of the fact that the meeting was hosted by Rockefeller University in New York.

Both of these initiatives were catalysts for Roger Mahr, president of the American Veterinary Medical Association (AVMA) at the time, to develop his ideas on One Health and greater collaboration between the veterinary profession and the medical profession in the USA. In 2006, the AVMA established the One Health Initiative Task Force and, in 2007, the American Medical Association unanimously approved a resolution calling for increased collaboration between the human and veterinary medical communities. The term 'One Health' had entered the medical and scientific lexicon.

Since then, the concept of One Health has received global recognition. Some of the main milestones in One Health over the past 10 years are outlined in Fig 1.

## Definitions of One Health

While defining the boundaries of One Health is difficult, at its heart One Health promotes health through interdisciplinary study and action, across all animal species. In this context, 'health' is defined by the WHO as a state of complete physical, mental, and social wellbeing and not merely the absence of disease or infirmity (WHO 1948). There are many embellishments on the central theme of One Health, a few of which are presented in the box on p 87. Definitions of One Health tend to reflect the mission of the respective organisations. As Humpty Dumpty remarks to Alice in *Alice through the Looking Glass* (Carroll 1865) 'When I use a word, it means just what I choose it to mean – neither more nor less'.

- 2004: The Wildlife Conservation Society publishes the 12 Manhattan Principles
- 2007: The American Medical Association passes the One Health resolution promoting partnership between human and veterinary medicine
- 2007: The One Health approach is recommended for pandemic preparedness
- 2008: FAO, OIE, and WHO collaborate with UNICEF, UNSIC, and the World Bank to develop a joint strategic framework in response to the evolving risk of emerging and re-emerging infectious diseases
- 2008: One Health becomes a recommended approach and a political reality
- 2009: The One Health Office is established at CDC
- 2009: USAID establishes the Emerging Pandemic Threats program
- 2009: Key recommendations for One World, One Health™ are developed
- 2010: The Hanoi Declaration, which recommends broad implementation of One Health, is adopted unanimously
- 2010: The Tripartite Concept Note is published
- 2010: Experts identify clear and concrete actions to move the concept of One Health from vision to implementation
- 2010: The United Nations and the World Bank recommend adoption of One Health approaches
- 2010: The European Union reaffirms its commitment to operate under a One Health umbrella
- 2011: The 1st International One Health Congress is held in Melbourne, Australia
- 2011: The 1st One Health Conference in Africa is held
- 2011: The High Level Technical Meeting to Address Health Risks at the Human-Animal-Ecosystem Interface builds political will for the One Health movement
- 2012: The Global Risk Forum sponsors the first One Health Summit
- 2013: The 2nd International One Health Congress is held in conjunction with the Prince Mahidol Award Conference

**FIG 1: Milestones in the global recognition of One Health, abstracted from www.cdc.gov/onehealth/people-events.html**

The One Health Initiative (www.onehealthinitiative.com) considers the One Health concept as a worldwide strategy for expanding interdisciplinary collaborations and communications in all aspects of health care for people, animals and the environment. This definition is broader than most and sweeping in its scope. Notwithstanding the lack of any formal definition, the concept of One Health has captured the enthusiasm of many seeking to improve animal and human health through stronger interdisciplinary collaboration. Indeed, it may well be the elasticity of the concept that makes it attractive to so many disparate groups.

## Selected achievements in the past 10 years

### Control of infectious diseases

One Health was born out of, and fueled by, fear. In 2004, there was global anxiety that a zoonotic disease, HPAI H5N1, could cause a pandemic in the human population, rivaling, and possibly exceeding, the estimated 50 million human deaths associated with Spanish influenza at the end of the First World War (Gibbs 2005). The introduction of the One Health initiative provided international agencies (FAO, OIE, WHO and the World Bank) with a vehicle for interinstitutional and interdisciplinary collaboration to address the threat of emerging zoonotic diseases, and it enabled these international agencies and national authorities to come to the table as equal partners in the search for solutions to the threats posed by this highly virulent strain of influenza.

The global response to avian influenza was launched in January 2006 against a One Health backdrop at the international ministerial and pledging conference of Beijing, cohosted, organised and sponsored by the Chinese government, the European Commission and the World Bank. This led to collaboration between key political actors (the European Union [EU], USA and the United Nations) and five subsequent years of cooperation on the control of avian influenza. Further international ministerial conferences were held in Bamako, New Delhi, Sharm El-Sheikh and Hanoi. As a follow up to these meetings, in 2010 the World Bank published a framework for the control of animal influenzas through the application of One Health principles (World Bank 2010). The World Bank estimated that between 2005 and 2009, 4.3 billion US dollars were pledged for the international control of HPAI. The One Health collaboration developed to control HPAI H5N1 is testimony to the concept's value.

During this period when the focus of international agencies was on avian influenza, there was recognition that the One Health approach had a wider

application. In October 2008, the FAO published a framework for reducing the risks of infectious diseases at the animal-human ecosystems interface (FAO 2008). This framework, which was developed by FAO/OIE/WHO/UNICEF/World Bank and the UN System Influenza Coordination, addressed emerging diseases with the potential for significant transboundary or socioeconomic impacts arising at the animal-human ecosystem interface and, while the focus was mainly on emerging zoonoses, it was recognised that implementation of the framework in developing countries could serve to address endemic zoonoses. The report identified that control and prevention of such diseases is in everyone's interest, and requires long-term investment from private and public sources.

The immediate threat of a human pandemic caused by HPAI H5N1 has now receded. The international coordination established under the principles of One Health remains in place and was activated when pandemic H1N1 influenza emerged in 2009 and spread rapidly around the world. Fortunately, this virus was not a virulent influenza virus. The surveillance systems that were set up during the HPAI H5N1 crisis now detect newer strains of avian influenza that have the potential to cause widespread human disease. With regard to pandemic influenza, the world is better protected through One Health in action.

While the coordinated international response to influenza remains the poster child of One Health in action, other disease control programmes that do not have the high public profile of influenza have benefited by receiving greater attention and financial support. The integrated control and prevention of endemic zoonoses in developing countries is one such area.

**Interest in avian influenza led to the recognition that One Health had a wider application. Here, a veterinarian anaesthetises a common eider duck before surgically placing a satellite transmitter to track migratory patterns and assess the zoonotic potential of Wellfleet Bay virus**

As an example, Integrated Control of Neglected Zoonoses in Africa (ICONZ), a five-year research project coordinated by the University of Edinburgh and funded by the EU, examines a number of integrated animal interventions for the control of neglected zoonoses. There is a strong element of innovation and public engagement in the project.

ICONZ involves 21 European and African universities and research institutes working on case studies of zoonotic disease clusters in seven African countries: Morocco, Mali, Nigeria, Uganda, Tanzania, Mozambique and Zambia. The need for zoonosis control programmes to consider both human and animal health factors, along with monetary and other benefits to society, can encourage participation from public health services in interventions that may otherwise never be cost-effective from a health sector point of view alone. This large collaborative project, targeting the neglected zoonotic diseases, is filling vital knowledge gaps, particularly on the burden of neglected zoonoses, and provides a strong evidence base to support policy decisions at the international, regional and national levels in developing countries (Okello and others 2011).

The examples above mostly focus on zoonoses originating from domestic animals that are used for food, but the wildlife and small animal dimensions of One Health also warrant attention (Day 2010, Rostal and others 2012).

Global control of rabies is an excellent example of a One Health problem that is generating renewed interest. In 2011, a memorandum of understanding was signed to promote increased One Health collaboration between the World Small Animal Veterinary Association (WSAVA) and the OIE. In November 2013, the partners held a symposium entitled 'One Health: Rabies and Other Disease Risks from Free-Roaming Dogs'. At this meeting, the OIE and WSAVA encouraged the use of public-private partnerships to implement appropriate prevention and control methods for rabies. In close collaboration with major donor organisations, the OIE has established regional vaccine banks to support the fight against rabies. The WSAVA's One Health Committee has rabies as its key focus and is already active, having launched a dog collar and wristband campaign last year as part of an ongoing control programme in Africa. Through its charitable foundation, the WSAVA Foundation, it is also supporting

## Definitions of One Health

'One Health is the collaborative effort of multiple health science professions, together with their related disciplines and institutions – working locally, nationally, and globally – to attain optimal health for people, domestic animals, wildlife, plants, and our environment.'
**One Health Commission**

'A collaborative, international, cross-sectoral, multidisciplinary mechanism to address threats and reduce risks of detrimental infectious diseases at the animal-human-ecosystem interface.'
**Food and Agriculture Organization**

The **World Organisation for Animal Health**, while not specifically defining One Health, endorses the approach as 'a collaborative and all-encompassing way to address, when relevant, animal and public health globally. This collaboration should not be limited to only the international level, but must be translated as a new and fundamental paradigm at national levels'.

The **One Health Global Network** considers that the aim of One Health is to 'improve health and wellbeing through the prevention of risks and the mitigation of effects of crises that originate at the interface between humans, animals and their various environments'.

The **One Health Committee of the World Small Animal Veterinary Association** comments that 'One Health or One Medicine proposes the unification of the medical and veterinary professions with the establishment of collaborative ventures in clinical care, surveillance and control of cross-species disease, education, and research into disease pathogenesis, diagnosis, therapy and vaccination. The concept encompasses the human population, domestic animals and wildlife and the impact that environmental changes ('environmental health') such as global warming will have on these populations.'

The **One Health Initiative** considers One Health to be 'a worldwide strategy for expanding interdisciplinary collaborations and communications in all aspects of health care for humans, animals, and the environment'.

Mission Rabies, a project led by Worldwide Veterinary Services to eliminate the disease in some regions of India. The Global Alliance for Rabies Control has established Partners for Rabies Prevention, a group that includes all of the major international agencies involved in rabies control.

### Control of non-infectious diseases and conditions

The aforementioned programmes are international in scope and directed at zoonoses, but there are other One Health activities that do not involve zoonotic diseases. The activities grouped under comparative and translational medicine in Fig 2 give an indication of the scope of these activities. There are many topics that might not have been considered to be relevant to One Health a few years ago, but are now seen as contributing to the promotion of health in the wider context. The human-animal bond is one example, and the use of dogs to detect early cancer in people and as indicators of metabolic crises is another. The growing appreciation of One Health in comparative and translational medicine will be discussed in more detail in a forthcoming article in this series.

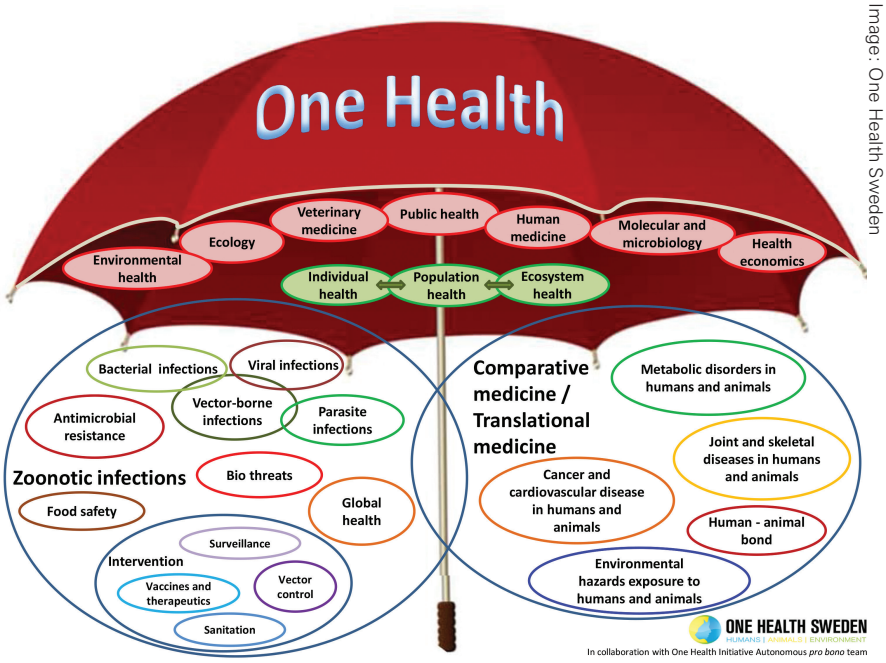


Image: One Health Sweden

**FIG 2: Scope of One Health according to the One Health Initiative (www.onehealthinitiative.com)**

## Research and funding

Research is critical to identify the most effective ways to promote health. Because most research funding is directed to specific diseases, many funding agencies initially had difficulty identifying effective ways in which to support the interdisciplinary nature of One Health. For example, most of the research funding directed to the pandemic threat of HPAI H5N1 was directed to the important area of molecular characterisation of the virus and pathogenesis. Funding agencies also have the problem that funds, other than those generated in a crisis, can rarely be redirected quickly. Early leadership from the EU, the US Agency for International Development (USAID) and the Department for International Development (DFID) in the UK has shown that One Health can be supported financially. The EU has funded projects such as ICONZ, and USAID has established an emerging pandemic threats programme. The programme is composed of four complementary projects: PREDICT, PREVENT, IDENTIFY and RESPOND, with technical assistance from the Centers for Disease Control and Prevention. This global programme draws on expertise from across the animal and human health sectors to build regional, national and local One Health capacities for early disease detection, laboratory-based disease diagnosis, rapid response and containment, and risk reduction. PREDICT focuses on the detection of zoonotic diseases at the wildlife-human interface. Specific activities include: strengthening surveillance and laboratory capacities in order to monitor wildlife and people in contact with wildlife for novel pathogens that may pose a significant public health threat; characterising human and ecological drivers of disease spillover from animals to people; strengthening and optimising models for predicting disease emergence and using this information to improve surveillance; and supporting outbreak response when requested.

In the UK, the Biotechnology and Biological Sciences Research Council (BBRSC) supports several international activities, including the STAR-IDAZ Global Network, and co-funds projects with the National Science Foundation in the USA.

An excellent example of proposed funding in One Health was recently announced by the BBSRC: in conjunction with the DFID, the Economic and Social Research Council, the Medical Research Council and the National Environment Research Council, it issued a joint call for research proposals under the umbrella of the Zoonoses and Emerging Livestock Systems programme.

With regard to private foundations, in the UK, the Wellcome Trust funds two One Health projects in Africa within its international strategy portfolio. In the USA, the Bill and Melinda Gates Foundation offered funding in March 2013 for One Health within the 'Grand Challenges in Global Health' programme.


Image: Medical Detection Dogs

**A cancer detection dog trained by the charity Medical Detection Dogs**

## One Health in education

The concept of One Health – namely, promoting interdisciplinary collaboration – demands an educated workforce trained in its principles and application if it is to be successful. One Health education can be divided into education of those already working in the relevant professional disciplines, and of students seeking professional qualifications to enter one of these disciplines. There are many excellent opportunities for training in One Health.

### Education for professionals

To familiarise professionals with One Health, numerous international, regional, and national conferences, symposia, and workshops have been organised. Two international congresses have specifically addressed One Health, the first in Australia in 2011 and the second in Thailand in 2013. Each was attended by several hundred professionals. A third international congress is planned for 2015 in Amsterdam

(www.iohc2015.com). Most of these conferences have stressed the relevance of One Health to the control and prevention of emerging diseases and pandemic threats. With the establishment of One Health committees within international organisations such as the WSAVA and national organisations such as the AVMA, the concept has been introduced to a wider audience. By adding One Health as an additional parallel stream to the programmes of national meetings, the breadth of the portfolio has been expanded to include topics for those interested in companion animals and exotic species.


Image: Greg Gray

**Graduates from the University of Florida highlight the subject of their masters degree at their graduation ceremony in December 2013**

Antigone and OH-NEXTGEN are EU-funded programmes that provide One Health short courses. Antigone is an acronym from ANTicipating the Global Onset of Novel Epidemics. OH-NEXTGEN is targeted at the next scientific generation in the Sahel and Maghreb. ADVANZ is another EU programme that provides information on zoonoses for use by decision makers and local media in low resource countries, mostly in Africa. The United States Department of Agriculture (USDA) and many state organisations in the USA provide courses on emergency response that are underpinned with One Health principles, but One Health is not explicit in the course titles. For example, the USDA has supported Iowa State University in the production of a portfolio of courses for veterinarians through its Center for Food Security and Public Health. The University of Florida also provides certificate training for professionals interested in One Health.

### Education for university students

The OIE has been a leader in recognising that an understanding of the principles of One Health should be at the core of veterinary education. Since 2009, it has convened three global conferences addressing how the curriculum in veterinary schools should be restructured to accommodate changing patterns in global trade and disease transmission. In September 2013, the OIE published guidelines for a core curriculum in which One Health is specifically mentioned (OIE 2013).

In 2011, the Association of American Veterinary Colleges addressed the issue when it published a Roadmap for Veterinary Medical Education in the 21st Century. In this roadmap it recommended that all veterinary students achieve competency before graduation in three main areas: multispecies knowledge plus clinical competence in one or more species or disciplines; One Health competency related to the intersection of animal, human and environmental health; and the development of professional competencies.

With so many competing demands on the veterinary curriculum, any restructuring is a daunting task. In North American veterinary schools, training of veterinary students in the second competency – One Health – has been addressed in different ways. Most schools teach the principles of One Health in the early years of the curriculum by integration into existing courses complemented by further study within elective courses in the clinical phase of the student's education. For veterinary students with a keen interest in One Health, intercalated masters degree programmes in public health (MPH degree) have been developed.

> 'There are those in the field of human medicine who see One Health as a field being championed primarily by veterinarians and are suspicious of the motives'

Several schools have developed 'One Health clubs' such as Students for One Health at the School of Veterinary Medicine, University of California, Davis. All clubs host speakers on topics related to One Health and several arrange workshops and international activities.

A PhD degree specifically in One Health is available through the University of Florida. It is thought to be the only doctoral degree currently offered in One Health, but several universities, including the Royal Veterinary College in London and the Royal (Dick) School of Veterinary Studies at the University of Edinburgh already offer specific masters degrees in One Health.

### Educating school students

The USA faces a national shortage of paraprofessionals who are trained in the One Health approach to provide support to professionals in human, environmental and animal medicine. The National Academy of Sciences Veterinary Workforce Study (National Research Council 2013) identified that 'primary veterinary services are still needed in rural areas, but often these communities cannot financially support positions for full-time food animal veterinarians, leaving gaps in animal care and raising concerns about the level of animal disease surveillance in the field'. The Foreign and Zoonotic Disease Center at Texas A&M University provides training programmes for paraprofessionals using One Health principles. The centre also offers general courses in One Health to high schools in several states in the USA.

### Educating the general public

Several institutions provide educational material for the public, such as the newsletter published by the National Parks Service in the USA (National Parks Service 2013) and a video by the FAO for pastoralists in Africa (www.youtube.com/watch?v=RFtilUyJpz0&list=PLB58F4D829B7883FD). However, in general, the advocates of One Health have focused on professional and student education.

## Challenges to the future

### The need for an agenda

Concerns over the effective implementation of One Health have been expressed by those within the veterinary profession (Okello and others 2011, Zinsstag and others 2011, Gibbs and Gibbs 2013, Häsler and others 2012), within the medical profession (Atlas 2013), by wildlife specialists (Rostal and others 2012) and by environmentalists (Preston and others 2013). The recent and rapid emergence of One Health has attracted the attention of health policy analysts, social scientists, and humanities scholars; they, too, have identified similar concerns (Leboeuf 2011, Chien 2012, Lee and Brumme 2013, A. Cassidy, personal communication).

There is a general acknowledgment of the potential of One Health to strengthen collective action across sectors. Lee and Brumme (2013) suggest that the vision of One Health is hindered both by dysfunction in the governance of global health and shortcomings in articulating a One Health agenda. In an extensive analysis of the history of collaboration between the medical and veterinary professions and the derivation and use of terms such as One Medicine and One Health, which has recently been submitted for publication, Angela Cassidy of King's College London explores the implications of different definitions of One Health (A. Cassidy,

personal communication). She cites the One Health Initiative's version of One Health as an example of a 'strikingly broad' definition, which conveys well the general idea of collaboration and convergence, but does not engage with the specifics of how this should take place. Lee and Brumme (2013) see the diversity of One Health terminology as a key weakness and argue that an agreed operational definition is required before advocates can implement their goals any further. Others, however, see the breadth of One Health, as embraced by the variations in definition, as a distinct advantage, as it creates the 'umbrella' under which slightly different visions can be accommodated while working together (Leboeuf 2011, Chien 2012). In this context, the adoption of the term by international agencies has allowed them to reframe the threat of avian influenza so that it is in line with their own remit and the individual agency's legitimacy is enhanced while minimising interagency tensions. Chien argues that One Health is a sufficiently concrete concept to articulate common concepts across specialist domains, yet flexible enough to allow for multiple interpretations of the concept.

Meisser and colleagues (2011) assessed the implementation of One Health in Switzerland by interviewing 16 key experts in the Swiss health system, most of whom were not veterinarians. They concluded that One Health can support opinion leaders in their quest for solutions. A study in Africa reported similar findings (Okello 2012). Cassidy (personal communication) conducted interviews with research scientists in the UK. From preliminary data, many regard One Health as an opportunity to obtain large research grants and to collaborate with others outside their own discipline. Other research scientists saw One Health primarily as a useful way to 'rebrand' or 'advertise' the work that they were already doing in order to gain support, but they did not see One Health as a concept that would drive new research ideas or greater collaboration. Cassidy reports that many scientists felt uncomfortable with taking this approach, but recognised the necessity in the current competitive academic environment.

Interdisciplinary collaboration is at the heart of the One Health concept, yet the execution of One Health, excepting influenza, has largely remained within the discipline of veterinary medicine and animal health. Notwithstanding the endorsements by different medical organisations, as listed on the One Health Initiative website, mainstream medical support for One Health has largely been confined to individuals with close veterinary contacts; indeed, some in the medical profession are reported to see One Health as a veterinary 'land-grab' (Cassidy, personal communication). Atlas (2013) considers that there are those in the field of human medicine who see One Health as a field being championed primarily by veterinarians and are suspicious of the motives. Häsler and colleagues (2012) note that the reaction from people working in the health professions is polarised; those in the human health sector have not engaged with One Health, whereas the majority of professionals working in animal and environmental health are interested in the concept.

> 'If One Health is to survive and historians are going to reflect positively on the veterinary role in One Health, it is axiomatic that the veterinary profession of today, and into the future, must be well trained in its precepts'

Notwithstanding the difficulty in defining an agenda in the face of indifference from some potential partners, how should the agenda be identified as One Health enters the next decade? Osburn and others (2009) suggested that emerging diseases, food security, food safety and climate change should be high on the list of priorities. The tripartite meeting in Mexico (FAO/OIE/WHO 2011) has a similar list. Cassidy points out that terms such as food security are also rearticulations of pre-existing concerns and, like One Health, their disciples advocate interdisciplinary collaboration. Rather than competing for resources and legitimacy, it is possible that the respective agendas are mutually reinforcing.

### Defining the costs and benefits

Regardless of the boundaries of One Health and the range of interdisciplinary collaborations that will emerge in the next decade, the accountability of One Health must be addressed, as identified during the FAO/OIE/WHO tripartite meeting in Mexico. The Stone Mountain Working Group that examined whether a One Health approach had value for disease protection and control concluded that a careful accounting of costs, both short term and long term, is necessary to show the economic benefits of a One Health approach (Rabinowitz and others 2013). It is therefore important that the productivity and conclusions from the early projects that received funding under the specific umbrella of a One Health promise, such as ICONZ and PREDICT, are carefully evaluated, so that the value-added approach of One Health (both economic and social) to the control and prevention of disease and environmental degradation can be validated. One Health must be recognised as a tool for adding value to disease control and research. Zinsstag and colleagues (2011), Häsler and others (2013) and the World Bank (2012) have provided methodology and case studies to demonstrate the economic advantage of One Health and engagement with stakeholders. Coker and others (2011) outline a conceptual framework for policymakers to support One Health research.

### Communicating the importance of One Health

The premise upon which One Health was founded a decade ago is that infectious disease could be a major constraint on the progress of civilisation in the 21st century. At that time, there was intense media interest in the emerging diseases of SARS and HPAI H5N1. While the media still report on new emerging diseases, such as Middle East respiratory syndrome coronavirus (MERS-CoV), there is little interest in the One Health concept. A literature and internet search has not identified a survey to assess the awareness of One Health by the general public. Surely it is legitimate to ask 'Why is One Health not known by the general public'? Is it not as important, arguably even more important, than climate change? In attempting to frame a response, we return to the comment by Lee and Brumme (2013) that the current vision of One Health is hindered by shortcomings in articulating a One Health agenda.

How can this be corrected? Recognising the scope and interdisciplinary nature of One Health, its proponents have been reticent to create a professional society (with an associated journal) or to impose a bureaucracy beyond what already exists. Is this reticence appropriate? The FAO/OIE/WHO tripartite group principally promotes the control of zoonoses through One Health; this is important and to be applauded, but One Health is broader than zoonoses and needs a champion beyond these agencies. The One Health Commission in the USA may provide a model, but it is currently a national organisation and to be effective should involve a greater range of disciplines within its membership and promote a stronger international perspective. Perhaps an international body similar to the International Panel on Climate Change should be established to analyse and project the importance of One Health.

## Conclusion

The question central to this review of whether One Health represents a short-lived response to a spate of emerging diseases that threatened to engulf the world in the first few years of the 21st century, or a paradigm shift that will lead to a wide and deep-rooted commitment to interdisciplinary action for the protection and needs of society in the 21st century.

Cassidy (personal communication) speculates that the rise of the One Health concept can be understood not only as the consequence of active advocacy, but also as the convergence of a series of alliances,

specific events and related agendas at this particular time. This raises the question of whether this convergence will continue in the longer term. If it does not, then One Health may have an uncertain future. While MERS-CoV and new variants of avian influenza viruses have recently emerged and require vigilance, there have been no viruses since the emergence of HPAI H5N1 and novel H1N1 influenza viruses that significantly threaten the world with a pandemic. There are already small signs, such as the cutback in influenza surveillance in wild birds in the USA, that the convergence that Cassidy refers to may indeed be weakening.

But there are several 'mega-concerns' beyond emerging diseases and zoonoses where the application of One Health principles could be valuable. With a burgeoning human population that is projected to peak at around 9 billion in 2050, concerns over food security need to be addressed (Kelly and others 2013). Food safety, combating microbial resistance to antibiotics, climate change and wildlife conservation are further mega-concerns where One Health can make contributions.

As One Health enters a second decade, the final paragraph from the Manhattan principles of 2004 is as relevant today as it was 10 years ago:

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

One Health provides the veterinary profession with the opportunity to rise to the challenges of the 21st century that the Manhattan principles outline. If One Health is to survive and historians are going to reflect positively on the veterinary role in One Health, it is axiomatic that the veterinary profession of today, and into the future, must be well trained in the precepts of One Health, be a strong advocate of multidisciplinary approaches to solving the complex challenges of One Health, and provide decisive leadership. The sustained response of the veterinary profession in meeting the precepts and being a champion of One Health is a litmus test for the future of the profession (Gibbs and Gibbs 2013).

Drawing the analogy of the germinating seed, One Health is still a tender shoot. The veterinary profession has led the renaissance in what has become known as One Health, but One Health needs continued nurturing from the profession. In the introduction to 'Virus of the Mind', which discusses memes, Richard Brodie (1996) outlines the four stages through which a new paradigm must progress in order to gain widespread acceptance: (1) complacency/marginalisation; (2) ridicule; (3) criticism; and (4) acceptance. If we accept that One Health is a new paradigm, attitudes to One Health are now at the third stage – that of criticism. Paradoxically, this should be comforting to the proponents of One Health because when a concept reaches the stage of serious criticism, it suggests that it is on the verge of gaining widespread acceptance.

In the next decade we will know whether One Health is truly a paradigm shift or a successful, but short-lived, response to a spate of important viral diseases that plagued the world at the beginning of the 21st century.

Now is not the time to rest on the accomplishments of the past.

'It is not the strongest of the species who survive, nor the most intelligent; rather it is those most responsive to change' (attributed to Charles Darwin). One Health is that response!

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## References

ANON (2005) Working with the medical profession. *Veterinary Record* **156**, 493

ALDER, M. & EASTON, G. (2005) Human and veterinary medicine. *BMJ* **330**, 859

ATLAS, R. M. (2013) One Health: its origins and future. *Current Topics in Microbiology and Immunology* **365**, 1-13

BRODIE, R. (1996) Virus of the Mind. Hay House. pp 1-248

CARROL, L. (1865) Alice's adventures in wonderland. Macmillan, London

CASSIDY, A. (2014) One Medicine? Contemporary movements for animal and human health. Submitted for publication, not published.

CHIEN, Y-J. (2012) How did international agencies perceive the avian influenza problem? The adoption and manufacture of the 'One World, One Health' framework. *Sociology of Health and Illness* **35**, 213-226

COKER, R., RUSHTON, J., MOUNIER-JACK, S., KARIMURIBO, E., LUTUMBA, P., KAMBARAGE, D., PFEIFFER, D. U., STÄRK, K. & RWEYEMAMU, M. (2011) Towards a conceptual framework to support one-health research for policy on emerging zoonoses. *Lancet Infectious Diseases* **11**, 326-331

DAY, M. J. (2010) One Health: the small animal dimension. *Veterinary Record* **167**, 847-849

FAO (2008) FAO/OIE/WHO/World Bank/UNICEF/UN. System influenza coordination. Contributing to One World, One Health: a strategic framework for reducing risks of infectious diseases at the animal-human-ecosystems interface. Geneva.

FAO/OIE/WHO (2011) High-level technical meeting to address health risks at the human-animal-ecosystems interface. www.fao.org/docrep/017/i3119e/i3119e.pdf. Accessed January 14, 2014

GIBBS, E. P. (2005) Emerging zoonotic epidemics in the interconnected global community. *Veterinary Record* **157**, 673-679

GIBBS, E. P. J. & BOKMA, B. H. (2002) The domestic animal/wildlife interface: issues for disease control, conservation, sustainable food production and emerging diseases. *Annals of the New York Academy of Sciences* **969**

GIBBS, S. E. J. & GIBBS, E. P. J. (2013) The historical, present, and future role of veterinarians in One Health. *Current Topics in Microbiology and Immunology* **365**, 31-47

HÄSLER, B., GILBERT, W., JONES, B. A., PFEIFFER, D. U., RUSHTON, J. & OTTE, M. J. (2012) The economic value of One Health in relation to the mitigation of zoonotic disease risks. *Current Topics in Microbiology and Immunology* **365**, 127-151

KELLY, A. M., FERGUSON, J. D., GALLIGAN, D. T., SALMAN, M. & OSBURN, B. I. (2013) One health, food security and veterinary medicine. *Journal of the American Veterinary Medical Association* **242**, 739-743

LEBOEUF, A. (2011) Making sense of One Health. Cooperating at the human-animal-ecosystem health interface. IFRI Health and Environment Reports, 7. Institut Francais des relations internationals (IFRI), Paris

LEE, K. & BRUMME, Z. L. (2013) Operationalizing the One Health approach: the global governance challenges. *Health Policy and Planning* **28**, 778-785

MEISSER, A., SCHELLING, E. & ZINSSTAG, J. (2011) One health in Switzerland: a visionary concept at a crossroads? *Swiss Medical Weekly* **141**, w13201

NATIONAL PARKS SERVICE (2013) NPS One Health Network News. www.nps.gov/public_health/info/newsletters/2013/OneHealth_newsletter_Fall13.pdf. Accessed January 14, 2014

NATIONAL RESEARCH COUNCIL (2013) Workforce Needs in Veterinary Medicine. The National Academies Press, Washington DC

OIE (2013) Veterinary education core curriciulum. www.oie.int/Veterinary_Education_Core_Curriculum.pdf. Accessed January 14, 2014

OKELLO, A.L. (2012) Beyond avian influenza: policy considerations for the implementation of a One Health approach in developing countries. PhD thesis, University of Edinburgh

OKELLO, A. L., GIBBS, E. P., VANDERSMISSEN, A. & WELBURN, S.C. (2011) One health and the neglected zoonoses: turning rhetoric into reality. *Veterinary Record* **169**, 281-285

OSBURN, B., SCOTT, C. & GIBBS, P. (2009) One world-one medicine-one health: emerging veterinary challenges and opportunities. *Revue scientifique et technique* **28**, 481-486

PRESTON, N. D., DASZAK, P. & COLWELL, R. R. (2013) The human-environment interface: applying ecosystem concepts to health. *Current Topics in Microbiology and Immunology* **365**, 83-100

RABINOWITZ, P. M., KOCK R., KACHINI, M., KUNKEL, R., THOMAS, J., GILBERT, J., WALLACE, R. AND OTHERS (2013) Toward proof of concept of a one health approach to disease prediction and control. *Emerging Infectious Diseases* doi:10.3201/eid1912.130265

ROSTAL, M. K., OLIVAL, K. J., LOH, E. H. & KARESH, W. B. (2012) Wildlife: the need to better understand the linkages. *Current Topics in Microbiology and Immunology* **365**, 101-125

WHO (1948) Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19-22 June, 1946; signed on 22 July 1946 by the representatives of 61 States and entered into force on 7 April 1948

WORLD BANK (2010) Animal and pandemic influenza: a framework for sustaining momentum: synopsis of the fifth global progress report. http://documents.worldbank.org/curated/en/2010/07/12915838/animal-pandemic-influenza-framework-sustaining-momentum-synopsis-fifth-global-progress-report. Accessed January 14, 2014

WORLD BANK (2012) People, pathogens and our planet volume 2: the economics of One Health. www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2012/06/12/000333038_20120612014653/Rendered/PDF/691450ESW0whit0D0ESW120PPPvol120web.pdf. Accessed January 14, 2014

ZINSSTAG, J., SCHELLING, E., WALTNER-TOEWS, D. & TANNER, M. (2011) From 'one medicine' to 'one health' and systemic approaches to health and well-being. *Preventive Veterinary Medicine* **101**, 148-156

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