

# One Health in the context of medical and veterinary education

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## Summary

This paper discusses how best to develop the educational platforms that can foster a wider appreciation of the importance of the One Health concept in medical and veterinary education. There are many compelling examples, from genetics to infectious diseases, where significant advances have been made in medicine and veterinary medicine by applying the principles of One Health, i.e. by recognising the interconnectedness between medicine, veterinary medicine and related sciences. In the medical and veterinary curriculum the objective should be to ensure that all opportunities are taken throughout preclinical and clinical teaching to incorporate the lessons which have been learned from the success stories in One Health. This will ensure that advances continue to be made and that a more pervasive and forward-looking scientific culture sustains One Health in the future.

## Keywords

Biomedical research – Global medical problem – Global veterinary problem – Medical education – Scientific basis of disease – Veterinary education.

‘Between animal and human medicine there is no dividing line – nor should there be. The object is different but the experience constitutes the basis of all medicine.’

Rudolf Virchow (1821–1902)

## The Nature of One Health

One Health is not a ‘stand-alone’ subject that can be taught as a single entity within the medical or veterinary undergraduate degree. Rather, it is a concept which recognises the interconnectedness between medicine, veterinary medicine, epidemiology, biomedicine and other sciences in human and animal health. It should be a continuous seam of knowledge running throughout the curriculum in medical and veterinary education.

Where the ethos of One Health has been an integral part of veterinary education it has led to some of the most significant advances in human and animal medicine. One notable example where focus on One Health in veterinary education has paid off arose through the pioneering spirit

of Sir William Weipers, who was Head of the School of Veterinary Medicine in Glasgow from 1949 to 1974. Under his leadership, veterinarians and non-veterinary staff at the school made a number of major discoveries that have contributed to the development of the One Health approach to human and animal medicine. Staff carried out important research into cancer viruses, parasite vaccines and treatments for hypertension and gastric ulcers in humans. The latter were developed by Sir James Black, and his efforts earned him the Nobel Prize for Medicine (1).

Although One Health is broadly about public health, this in itself is a broad platform and also involves a wide range of other issues which impact on One Health. These include socioeconomics, biodiversity, environment, land use, intensive agriculture, the agri-industries and climate change. All of these areas impact on the health and well-being of people and

animals and the spread of disease. One Health requires a cross-disciplinary approach and needs strong partnerships and collaborations between medical and veterinary professionals and those working in related scientific fields. One Health should be at the forefront in veterinary education to ensure that veterinarians can play a full part in the broader scientific agenda that underpins One Health.

The lead taken by the World Medical Association and World Veterinary Association needs to be built on (2). The signing of a joint Memorandum of Understanding between the two associations is an important step. It recognises that human health, animal health and ecosystem health are so complexly inter-related that they can only be artificially divided. It is the aim of One Health to promote, improve, and defend the health and well-being of humans and animals by enhancing cooperation and collaboration between physicians, veterinarians and environmental health professionals. The overarching objective in One Health should be to promote strengths in leadership and management to achieve a step change in the way in which medical, veterinary and other scientific professionals work together. Such an approach will extend the knowledge base in veterinary and medical science and secure its application to the health issues of the 21st Century.

## The educational challenges for One Health

Given the nature of One Health, how should we best develop the educational platforms that will foster the capacity to deliver the laudable intentions of the One Health agenda? The educational objectives should be to develop a cadre of intellectually motivated veterinarians who can function at the cutting edge of discovery and research and provide authoritative leadership in One Health in the 21st Century. This is a major undertaking for educators. There are many challenges, but some of the key areas in which One Health has an important role to play are outlined below.

### **Understanding emerging infectious diseases, especially zoonotic diseases**

About two-thirds (60.3%) of emerging and re-emerging infectious diseases are zoonoses. The majority of these have their origin in wildlife (71.8%) and they are growing in number (3, 4). Emerging infectious diseases are global threats and in recent years have caused serious problems for public health. Their rapid detection, surveillance, control and containment are essential to epidemiological understanding and the quantitation and management of risk. Veterinary scientists have a key role to play in increasing our understanding of emerging infectious diseases and improving their control.

### **Food safety, food production, and the security of the food chain**

Controlling foodborne zoonoses requires an understanding of the pathogens involved, their mechanisms of spread, and how the systems of animal production, processing and distribution of food can all contribute to the spread of foodborne diseases. We live on a global farm and, with rapid transportation of animals and their products, what is a minor problem for a farmer in one part of the globe can become, within days, a major food security issue for other parts of the world. Since the speed of transportation is often faster than the incubation period of the disease this can result in the covert spread of potential epidemics (5).

### **Fundamental biomedical research**

There are countless examples from infectious disease biology, disease pathogenesis, molecular biology and genetics where the study of animal disease has led to new understanding of human health problems. These range from defining the aetiological role of viruses in human and animal cancers to animal models of infectious and genetic diseases, all of which have increased our understanding of how these diseases affect humans. Since basic biomedical sciences are evolving faster than at any time in history, it is essential that today's veterinarians continue to be fully engaged in this scientific revolution so as to maintain the proud history of the developments in One Health.

### **The impact of genomics and genomic technologies**

The sequencing of human and animal genomes has ushered in the era of genetic medicine. We now work to discern the genetic basis of diseases and use molecular technologies to understand and manipulate the animal and human genome. This raises both ethical and societal concerns about the interaction between humans and animals that the veterinarian cannot ignore. In canine medicine the sequencing of the canine genome has opened up unprecedented clinical opportunities for genetic analysis of breed-related clinical syndromes; this will also improve our understanding of inherited disorders that affect multiple species, including humans (6).

### **Antibiotic resistance**

The emergence of livestock-associated antibiotic-resistant organisms as a result of the widespread and inappropriate use of antibiotics for either treatment or growth promotion has resulted in the selection of resistance strains of conventional microorganisms (e.g. the methicillin-resistant *Staphylococcus aureus* or MRSA) (6). Antibiotic resistance is a major public health risk and an important global problem that is threatening to spread through the food

chain. Pathogen genome sequencing is now well advanced; it is providing new insights into the detection and spread of antibiotic resistance genes in animals, humans and microbial populations, and it is shedding light on their mechanisms of action in causing antimicrobial resistance. It is essential that veterinarians contribute in this area so that we can advance knowledge on the molecular epidemiology of antibiotic resistance. It is a key issue in environmental health. Recently, whole-genome sequencing has been used to track transmission of MRSA carrying the resistant genes between cattle and humans. This illustrates the very real potential role of livestock as reservoirs for resistant genotypes of MRSA (7).

### **Biodiversity**

Understanding the importance of the interplay between the environment and land-use ecosystems, and their relationship to human and animal health, is an extremely important global issue that is an integral part of One Health. Global ecosystems support human and animal health, and disruption of the balance in global ecosystems has compromised animal and human health in the past. Infectious diseases such as Nipah virus and Hendra virus diseases arise from habitat destruction and changes in land use, and are well-known examples of what can happen when the delicate balance of the ecosystems that sustain the planet is overlooked. It is an area where veterinarians are in a strong position to provide leadership and advocacy. There needs to be a far greater appreciation by institutions, governments and policy-makers of the importance of environmental and biodiversity issues in One Health.

### **The use of animals in research**

Research using whole animals has been fundamental to our understanding of whole animal and whole organ physiology and disease. It is likely to continue to provide important insights in the near future. The ethical issues raised by animal experimentation and the use of animals in research is one area where the veterinarian should be providing guidance and leadership, given that the use of animals in research is a subject of intense public debate (8).

In summary, all of these areas illustrate that scientifically educated veterinarians with cross-species perspectives are urgently needed so that they can provide authoritative leadership and can function in these challenging scientific environments. This is important for the perception of the veterinarian by the general public.

In human medicine the public expects cures for important diseases and is regularly informed about recent advances in research. The public expectation is that the medical professional will provide authoritative advocacy in problems in human medicine, be they in infectious diseases, genetic

diseases, genomics, surveillance, cancer research or other medical disciplines and specialities.

Can the same be said for the veterinarian? Without question the public holds the veterinarian in high esteem in animal care and welfare, both of which are extremely important. But is the public perception of the veterinarian one of 'a man of science' or of a Dr Doolittle whose professional activities are driven by a commercial imperative? A concern for the veterinary profession is that the public perception of veterinarians is not so much 'One Health' as 'One Wallet'.

## **The undergraduate experience in medicine and veterinary medicine**

Degree courses in medicine and veterinary medicine have two parts: a preclinical science-based course in the biomedical sciences and a clinical course devoted to ensuring that the graduate is clinically competent. The difference between the two is that the preclinical course is divergent and can embrace a wide scientific agenda, whereas the clinical course needs to be convergent and focus on what needs to be known for the medical graduate or the veterinarian to be professionally competent.

In the preclinical part of the course, what matters is not so much 'the need to know' as 'the need to understand' and to have a thorough appreciation of the intellectual framework of cutting-edge science. It is about training the student how to think rigorously and creatively and to enjoy the excitement and challenge of biomedical science. What is crucial is that the student gains exposure to the latest developments in modern biomedicine (for instance, in genetics, immunology, mathematical modelling, epidemiology, biodiversity, molecular biology, etc.). The Flexnerian view of the importance of a scientific education during the preclinical education of medical or veterinary students cannot be overstated (9).

Academic developments in veterinary medicine need to be underpinned by a vibrant culture of research and inquiry. Veterinary undergraduates need to be educated in the substance of science and not in its shadow. All too often this is not achieved because the statutory requirement in veterinary medicine for accreditation on graduation squeezes out intellectual and curiosity-driven inquiry. This impacts negatively on the opportunities for research by veterinarians. In the term 'Academic Veterinary Medicine' the word 'academic' does not mean 'irrelevant'.

## How to ensure that the One Health concept is included throughout the curriculum

There are many opportunities in the undergraduate veterinary curriculum to emphasise the One Health agenda. The objective should be to ensure that the One Health agenda is incorporated into the overall curriculum whenever the opportunity arises. For example, what could appear to be more boring to the undergraduate than ‘meat inspection’ in an abattoir? The reality, however, is far from boring – the abattoir and the processing of animals for food is where the students see the public health agenda writ large. It is an incredible opportunity to experience first-hand the complex issues surrounding animals and their welfare, the food chain, foodborne diseases, food security, the ethics of the systems of producing animals for food and so on.

Another example lies in the companion animal field, in the study of genetic diseases of the dog. In this field, cutting-edge genomics and whole-genome sequencing has hugely impacted on clinical veterinary medicine. In places it has led to significant new advances in our understanding of the genetic basis of disease, and this has benefited both humans and animals. This has arisen because, in canine genetic diseases, selective breeding for desired traits has resulted in the co-selection of a range of genetic diseases. The dog has the largest number of naturally occurring genetic disorders of any non-human species. There are about 430 inherited disorders and many of them (about 70%) are inherited as autosomal recessive traits, including X-linked traits and other complex polygenic traits that result from inbreeding. There is a rich seam of opportunity here to exploit cutting-edge genomics to improve clinical understanding of these disorders in both animals and humans. Greater understanding of the genetic basis of narcolepsy in the dog opened up the whole field of narcolepsy research and led to the definition of the molecular pathways in this disorder in humans. It is a classic example of the importance of One Health in understanding disease processes (10).

The domestic dog closely shares the same environment with humans and is exposed to a wide range of environmental and microbiological challenges that will never be faced by laboratory rodents. The dog is an intermediate model between rodents and humans and, being in itself a clinical entity requiring diagnosis and treatment, it is also more than just a ‘model’. Significant advances in knowledge in such areas as cancer research, autoimmunity and obesity in humans have come from the study of genetic diseases of the dog. These are amongst some of the best examples of the ‘experiments of nature’ which have been of proven value in human medicine.

These two examples (chosen from amongst many) illustrate how the One Health agenda can be included in the standard undergraduate curriculum without the need for massive reorganisation. The guiding principle should be that clinical education in either medicine or veterinary medicine is science-led and evidence-based. It is also essential that veterinary and medical undergraduates are exposed to concepts and issues in biodiversity, ecology and environmental health and that these topics are built into the curricula.

Postgraduate education in human medicine, veterinary medicine and science lends itself well to One Health education. There are many opportunities for graduates, be they medical, veterinary or basic science students, to engage with the One Health experience. Below, the author provides two examples of how the One Health ethos in postgraduate education has been developed. There are many others and more could be developed. The value of these courses is that they have the potential to be inclusive of graduates from medicine, veterinary medicine and basic science. Both didactic teaching and project work ensure that students on these courses engage collectively and collaboratively with the One Health spectrum.

### **London School of Medicine and Tropical Health Master’s in One Health (Infectious Diseases)**

This joint programme between the London School of Hygiene and Tropical Medicine and the Royal Veterinary College in London aims to provide a comprehensive foundation of the principles of diseases in the context of sociological systems, global health and food safety. It also aims to provide skills in One Health methodologies and transdisciplinary interactions, using a systems approach. The MSc programme addresses a broad range of topics under the One Health paradigm. Graduates from this programme are taught by experienced scientists and will acquire the knowledge and skills to be able to respond rapidly and effectively to outbreaks of disease as well as control endemic disease at the interface between humans, animals and the environment.

### **The Calvin Schwabe Project at the University of California – Davis**

Calvin Schwabe is rightly regarded as one of the key leaders in developing One Health (11, 12). The project named after him has the goal of encouraging a new generation of veterinarians to develop expertise in the integration of better health for humans, animals, and their environment. This project will expand the career pathways for veterinary students, and hopefully other graduates, in disciplines such as public practice, wildlife and ecosystem health, food safety, herd health, disaster preparedness, rural health, and zoonotic disease threats.

## Maximising the opportunities for education in One Health

The scientific environment wherein we educate the medical or the veterinary student is crucial to the development of the One Health ethos. Some of the key requirements both in terms of infrastructure and courses are as follows.

### **Co-location of veterinary schools and medical schools on the same campus**

Where this can be achieved it provides considerable opportunities. For example, it can result in the combined preclinical teaching of veterinarians, medics (physicians) and natural scientists. It is simply a waste of both intellectual resources and manpower for the bulk of preclinical sciences to be taught separately to medical, veterinary and biomedical science students.

### **Development of intercalated honours degrees, summer schools and internships**

An intercalated year of study within the undergraduate medical or veterinary curriculum is often the first place that the undergraduate gets the opportunity to develop their research skills and gets time to think. All too often the standard veterinary curriculum becomes so overburdened by the 'need to know' that the 'need to think' becomes secondary. Project-based work allows the student to engage with the cutting edge of a particular field under supervision from experts in the field. These can range across many different specialities. At the University of Cambridge in the United Kingdom there is a compulsory intercalated year for all medical, veterinary and natural-science students. Projects can be carried out in any Department in the University and this results in an extensive portfolio of research projects. It often leads directly into PhD programmes.

For example, a recent new course at the veterinary school ('Dynamics of Infectious Diseases') has brought together mathematicians, epidemiologists and geneticists, as well as veterinary, medical and science students focused on infectious disease dynamics in the context of global animal and human health and biodiversity. The course is structured to encompass the concept of disease dynamics at increasing levels of scale, i.e. ranging from the sub-microscopic scale of pathogen host/cell interactions, progressing through the interactions within the whole organism, to the interaction within groups of susceptible and infected animals (including different species) on a local, regional, national and, finally, global scale.

Co-location of medical and veterinary schools and associated biomedical institutions provides similar opportunities for

internship programmes, summer schools and combined veterinary/medical PhD programmes.

### **The need for a postgraduate pre-registration year for clinical veterinarians**

There is a real need for a pre-registration year for clinical veterinarians following completion of their undergraduate degree. This is required so that they can be approved by the regulatory authorities as licensed to practise veterinary medicine and surgery – a legal requirement. The current requirement to produce the licensed and omni-competent veterinarian on graduation, without the need for a pre-registration year, compromises the opportunities for the intellectual and scientific development of veterinary undergraduates during their degree course. No other professional in the medical, engineering, architectural or even legal sphere can engage with the public without further postgraduate training and registration.

This requirement for accreditation on graduation means that more time has to be found in an already overcrowded curriculum for extensive clinical instruction on a large number of species, ranging from pets to food animals, including fish. This can exert a pressure on the earlier parts of the curriculum to reduce time available for preclinical education. This results in the attenuation of the time and opportunities for education in the basic biomedical sciences. Given the current breadth of skills needed in veterinary medicine and surgery the need to teach students to be clinically omni-competent in all areas should be resisted by educators. Clinical competency is a life-long learning process that does not end at graduation – it merely begins. Life-long clinical expertise can only develop within an intellectual framework, and that is why intensive scientific education in the basic biomedical sciences is essential. It enables veterinarians to define the intellectual framework of modern veterinary medicine.

If public support from national and international bodies is to continue and expand there must be veterinarians who can communicate the intellectual aspirations of their chosen profession. With the right intellectual framework the scientifically educated veterinarian is uniquely placed to contribute to One Health and to provide distinguished leadership in One Health.

### **The role of policy-makers and funders in One Health education**

Funding for the robust development of One Health will not come from the private sector. If the public sector (i.e. Governments, State Institutions, Public Health organisations etc.) are to put resources behind the development of One Health then such support requires public recognition of the value and significance of this approach.

It is important that funders of research and education recognise that trans- and interdisciplinary research and teaching in One Health is vital. There is a need for both national and international research funders to provide the opportunities for long-term strategic research awards in One Health and a portfolio of senior and junior tenure-track fellowships for aspiring graduates interested in One Health. The Wellcome Trust in London has been essential to building capacity in this area. Loan redemption schemes for medical or veterinary graduates could provide huge incentives for graduates to take up these important fellowship opportunities. ■

In terms of infrastructure there may be much to be said for establishing academic centres of excellence in One Health and consideration should be given by the World Organisation for Animal Health to establishing a College of One Health at regional or global level.

## « Une seule santé » dans le contexte de l'enseignement de la médecine humaine et vétérinaire

I. McConnell

### Résumé

L'auteur examine les possibilités d'élaborer des plates-formes didactiques permettant d'améliorer à terme l'appréciation du concept « Une seule santé » dans l'enseignement de la médecine humaine et vétérinaire. De la génétique au traitement des maladies infectieuses, plusieurs exemples irréfutables témoignent des avancées importantes accomplies en médecine humaine et vétérinaire grâce à l'application des principes « Une seule santé », c'est-à-dire à la prise en compte des interdépendances entre la médecine, la médecine vétérinaire et d'autres sciences connexes. Il s'agirait de faire en sorte que les programmes d'enseignement de la médecine humaine et vétérinaire saisissent toutes les opportunités d'intégrer dans l'enseignement préclinique et clinique les leçons qui ont été tirées des réussites remarquables d'« Une seule santé ». Cela permettra de continuer sur cette lancée tout en mettant en place une culture scientifique plus complète et visionnaire en appui d'« Une seule santé » à l'avenir.

### Mots-clés

Base scientifique des maladies – Enseignement de la médecine – Enseignement de la médecine vétérinaire – Problème médical mondial – Problème vétérinaire mondial – Recherche biomédicale. ■

## «Una sola salud» en el contexto de la enseñanza médica y veterinaria

I. McConnell

### Resumen

El autor examina la mejor manera de instituir dispositivos educativos que puedan favorecer un reconocimiento más generalizado de la importancia que reviste el concepto de «Una sola salud» en la enseñanza médica y veterinaria. Desde

la genética hasta las enfermedades infecciosas, existen muchos y elocuentes ejemplos de importantes avances obtenidos en la medicina y la veterinaria aplicando los principios de «Una sola salud», esto es, teniendo en cuenta los vínculos que existen entre la medicina, la veterinaria y otras ciencias conexas. Los planes de estudios médicos y veterinarios deberían tener por objetivo asegurar que, en todas las etapas de la enseñanza preclínica y clínica, se aproveche al máximo la posibilidad de incorporar las lecciones que hayan deparado las experiencias fructíferas de aplicación de «Una sola salud». Ello garantizará que se pueda seguir progresando y que en el futuro haya una cultura científica más extendida y prospectiva que fundamente la noción de «Una sola salud».

#### Palabras clave

Base científica de la enfermedad – Enseñanza de la medicina – Enseñanza de la veterinaria – Investigación biomédica – Problema médico mundial – Problema veterinario mundial.



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