1 One Health in History

Michael Bresalier,[1]* Angela Cassidy[2] and Abigail Woods[3]

[1]*Department of History, Swansea University, Swansea, UK;* [2]*Department of Sociology, Philosophy and Anthropology, University of Exeter, UK;* [3]*College of Arts, University of Lincoln, UK*

Introduction

The purpose of this chapter is to outline the history of One Health. This task immediately raises the question of how to approach the history of a subject that only became known as 'One Health' a few years ago, and is still evolving conceptually under the influence of health challenges, scientific advances, and political, economic, environmental and professional priorities. While there were many precedents to One Health, they did not go by this term, and they occurred at times when health problems, scientific ideas, and the wider world were very different from today. This state of affairs makes it impossible to impose a simple structure on to past events, or to link them, in linear fashion, to present-day One Health.

It is important to highlight this problem because existing histories of One Health usually gloss over it. These accounts are structured around key historical figures and scientific advances, whose contributions to health are used to argue for the importance of pursuing a One Health approach today. The achievements of Rudolf Virchow, Robert Koch, William Osler, John McFadyean, James Steele and Calvin Schwabe are routinely celebrated, along with the health benefits of vaccination, the germ theory and zoonosis control. While the importance of these individuals and activities cannot be denied, their roles within the history of One Health require more critical consideration. The accounts in which they feature are neither politically neutral nor historically well grounded, and have been assembled not for the purpose of understanding the past, but for advancing the case for One Health today. While this strategy may be useful in justifying and winning support for One Health, it has resulted in an extremely partial and selective reading of the past.

Rather than analysing history retrospectively from the perspective of present-day agendas, this chapter adopts a neutral, prospective, evidence-based approach that pays due regard to historical context.[1] Drawing on an extensive body of historical literature and source material, it aims to effect a fundamental shift in the way that the history of One Health is popularly conceived. It takes as its subject matter the constellation of ideas, practices and circumstances that brought human and animal health (and to a lesser extent, the environment) into alignment, the people and institutions involved, and the reasons for change over time. Partly due to space constraints, and also because this history is still under active investigation, it makes no claim to completeness, particularly with regard to very recent events which are well described elsewhere (Lebouef, 2011; A. Cassidy, 2020, unpublished results). While Western medical and veterinary traditions form the primary focus, it acknowledges the importance of cross-cultural exchanges, which were often facilitated by international health organizations concerned with human and animal disease control.

The first section of the chapter analyses intersections between human and animal health in the pre-modern era, to reveal how deeply animals and animal health were embedded within human medicine. The second section extends from the late 18th-century foundation of the veterinary profession until the turn of the 20th century. It tracks the evolving relationship between the veterinary and

*michael.bresalier@swansea.ac.uk

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medical professions, and how, as scientific ideas and practices changed, new links were forged between human and animal bodies and diseases. The third section extends this analysis into the 20th century, focusing particularly on the changing status of animals within medical research, and on international efforts to develop comparative medicine and veterinary public health. The conclusion reflects on the importance of these findings for history and for One Health today.

Pre-modern Connections

Looking back on the pre-modern era, commentators often highlight the existence of a fundamental, well-entrenched distinction between humans and animals, which derived from the Christian belief that only humans had souls (Hardy, 2003). In fact, this divide has been overstated, for the perceived boundaries between humans and animals were often blurred and unstable (Fudge, 2000). In health and medicine there historically existed three key points of intersection. First, animals were used to work out the anatomy and physiology of human bodies. Secondly, they were studied in comparison to humans in order to work out the relations between them. Thirdly, the theory and practice of animal medicine attracted the attention of human doctors, usually as an end in itself, but occasionally as a basis for comparison with human medicine. Aspects of these connections can be identified in very ancient civilizations (Gordon and Schwabe, 2004). However, as all three featured in ancient Greek thought, which exerted a powerful influence in the West right up to the 17th century, this will form the starting point of our survey.

Around one-quarter of the surviving works produced by the Greek philosopher Aristotle in the 4th century BC are devoted to animals, most importantly *History of Animals*, *Parts of Animals* and *Generation of Animals*. While Aristotle distinguished humans from animals through their possession of a rational soul, he also sought to relate them, by documenting differences and similarities in the form, function and purpose of their parts, and drawing up a taxonomic system. The numerous dissections he conducted in the course of this work illustrated the possibility of learning about humans from animals (Clutton-Brock, 1995). Taboos on the use of human bodies led the famous Greek doctor, Galen, working in 2nd-century Rome, to follow Aristotle's lead. In an extensive and influential body of writing he documented the results of his numerous observations and experiments on animals. The errors he made in extrapolating from animal to human anatomy were not discovered until Andreas Vesalius (1514–1564) revived human dissection at Padua University in the 16th century (Guerrini, 2003).

Vesalius, and several of his contemporaries and successors, also vivisected animals in their attempts to work out the differences between living and dead bodies, and to describe and explain how body parts functioned (Shotwell, 2013). Vivisection was problematic: debates surrounded the value of knowledge drawn from animals and the suffering involved (Guerrini, 2003). Nevertheless, it enabled Realdo Columbo (1516–1559) and Fabricius (1537–1619) to identify the pulmonary transit of the blood and the function of the venous valves, respectively. After studying under Fabricius, William Harvey took up an Aristotelian programme of research on animals that resulted in his novel and, at the time controversial, proposal that blood circulated. Meanwhile, as part of the wider investigation of nature, medical doctors followed Aristotle in dissecting dead animals, for example at the elite Paris Academy Royale des Sciences during the 1660s and 1670s. This activity, described as 'comparative anatomy', drew on animals derived from colonial conquests that were contained within European leaders' menageries (Cunningham, 2010).

The health of humans and animals, and their relations to the environment, were defined by the same medical theory: humouralism. Drawing on the ideas of Hippocrates and Galen, this formed the dominant system of medical thought until the 18th century. It held that all bodies were composed of four humours, influenced by factors such as feeding, climate, ventilation, exercise and sexual behaviour. Disease resulted from an imbalance between the humours (Curth, 2002). Bodily health was also influenced by changes in the environment, which the Hippocratic text, *Airs, Waters, Places*, held responsible for the rise and fall of epidemics (Wilkinson, 1992; Nutton, 2004). These ideas implied that similar interventions, such as bleeding, purging, lifestyle changes and improvements in the environment, could restore or maintain the humoural balance in both human and animal bodies. Formally trained healers usually focused on one or the other. Physicians, surgeons and apothecaries treated humans, while animals received dedicated attention from medieval veterinarians at the Mamluk courts,

and from British farriers, French marechals, Spanish beitars and their equivalents in other countries (Conrad *et al*., 1995; Shehada, 2012). However, such healers were expensive and few in number. Consequently most humans and animals relied on self-help, clergymen, gentry, and the various self-styled healers that made up the 'medical marketplace'. Here, the division between species was less well defined (Curth, 2002).

The 17th and 18th century movement away from ancient Greek thought brought humans and animals into even greater proximity. The new experimental philosophy of nature, and Rene Descartes' (1596–1650) conception of animals as 'automata' (self-operating machines), resulted in the more extensive use of animal vivisection in medical research and teaching (Guerrini, 2003). For example, Swiss physiologist Albrecht von Haller (1708–1777) used live animals to work out human neurological functions (Eichberg, 2009). At Leiden in the Netherlands, and later in Edinburgh, Scotland, anatomy lecturers vivisected dogs and dissected humans simultaneously, in order to demonstrate to students the structure and the function of body parts (Guerrini, 2006). A new scheme of classifying animals, drawn up by Swedish naturalist, Carolus Linnaeus (1707–1778), placed humans, apes, monkeys and bats within the same order of primates, and brought humans and orangutans together in the genus *Homo*, thereby challenging notions of a human-animal divide (Ritvo, 1995). Subsequently, in Paris, additional classification schemes were drawn up using dissected animals from the Versailles menagerie. Here, the key figures were George Buffon (1739–1788), the medically trained comparative anatomist, Louis Daubenton (1716–1799), and Georges Cuvier (1769–1832) (Cunningham, 2010).

One of Daubenton's pupils, the physician Vicq d'Azyr (1749–1794), went beyond comparative anatomy to develop a truly comparative form of medicine. His initial concern was cattle plague or rinderpest. This disease was prevalent throughout Europe in the 18th century. It inspired much medical comment and attempts to control it by quarantine, modelled on responses to bubonic plague in humans (Wilkinson, 1992). After reporting upon this disease to the French government, d'Azyr was made secretary to a Royal Commission of Enquiry into epidemics and epizootics, and steered its 1778 evolution into the Societe Royale de Medicine. His investigations drew on medical meteorology and topology to correlate human and animal epidemics with climatic and geographical conditions. D'Azyr also performed animal experiments. He believed that by understanding the functioning of organs in health, it was possible to make sense of their dysfunction in disease (Hannaway, 1994). Perceiving no dividing line between human and animal medicine, he argued that 'considerations on the diseases which attack man are applicable without any exception to those which attack animals. Medicine is one: and its general principles, once set out, are very easy to apply to different circumstances and species' (Hannaway, 1977, p. 438).

A similar stance was adopted by a number of British surgeons, who became actively involved in equine health care during the second half of the 18th century. Arguing that 'physic' (conventional medicine) was the same whether practised on humans or horses, they wrote medicalized manuals of farriery and established infirmaries for the treatment of horses and tuition of pupils. For them, farriery was part of natural history or comparative anatomy. It was therefore a polite practice, suitable for a gentleman (MacKay, 2009).

Comparative anatomy was consolidated as a medical practice by the surgeon, John Hunter (1728–1793). He established his own menagerie, and spent hours each day dissecting and experimenting upon animals. He incorporated their bodies into his museum, which numbered over 500 species with 13,000 specimens at the time of his death in 1793 (Chaplin, 2008). Hunter's influence on the field of surgery and its growing profile kept animals at the forefront of medical research in subsequent years (Lawrence, 1996). It was one of his pupils, Edward Jenner, who showed in 1796 that cowpox inoculation could protect humans from smallpox (Fisher, 1991).

Enter the Vets

The connections outlined above reveal that in many ways, pre-modern medicine really was 'one'. So how did the creation of the veterinary profession impact this situation? The first schools were established in Lyon (1762) and Alfort (1777). By 1791 they existed throughout much of Europe: in Dresden, Freiburg, Karlsruhe, Berlin and Munich in Germany; Turin, Padua and Parma in Italy; as well as Vienna, Budapest, Copenhagen, Sweden and London (Cotchin, 1990). Historical accounts often portray their creation as a significant break with

the past which led to a newly enlightened approach to animal healing (Wilkinson, 1992; Swabe, 1998). However, this interpretation is deeply flawed, for as shown above, animal bodies and their treatment in health and disease had already attracted substantial attention from medical doctors.

It is perhaps more accurate to view the veterinary schools as an expression of pre-existing medical interest in animals, because although circumstances varied from school to school, doctors often played important roles in driving and shaping veterinary education. The doctors' commitment to studying the health and medicine of animals is shown by the fact that they did not automatically cede this field to the new veterinary profession. Rather, as shown below, they intensified their investigations during the first half of the 19th century and drew on vets as collaborators. Therefore, although in time the connections between human and animal health lessened, this was not an immediate or inevitable consequence of the veterinary profession's formation (A. Woods, 2020, unpublished).

In the 1780s, against the wishes of founder Claude Bourgelat, the physician Vic d'Azyr refashioned the Alfort veterinary school into a research institution and assumed the chair of comparative anatomy. Teaching was extended to human fracture care and midwifery to enable vets to offer extended services in rural communities. For political reasons, these changes were reversed in 1788 (Hannaway, 1977, 1994). However, from the 1790s, a number of Alfort veterinary and medical staff (including Francois Magendie in the 1820s) engaged in the systematic vivisection of horses, making this one of the first contexts for development of experimental physiology in France (Elliott, 1987). The subsequent expansion of this field within Germany, France and, later in the century, to Britain (in the face of anti-vivisectionist opposition) considerably enhanced the use of animals as experimental tools within medicine (Bynum, 1994). For proponent Claude Bernard these uses were entirely justified, for 'to learn how man and animals live, we cannot avoid seeing great numbers of them die' (Bernard, 1957, p. 99).

In London, surgeons and (less commonly) physicians acted as governors for the Veterinary College (established in 1791), ran examinations for students, and were well represented on the student body: 130 surgeons had qualified as vets by 1830. Edward Coleman, principal of the College from 1796 to 1839, was also a surgeon, appointed on the strength of his research on animals and ability to teach farriery. He modelled veterinary education on that of human surgery. Veterinary students were encouraged to attend lectures in the London medical schools, while medical students had the opportunity to attend lectures on veterinary topics. However, little research was undertaken at the College. This drew criticisms from the medical press, which campaigned with disaffected vets for the reform of the school. In 1844, vets displaced doctors in the control of student examinations. Concurrently, reforms in medical education restricted the courses on offer. These shifts enhanced the institutional separation of the professions (A. Woods, 2020, unpublished).

However, as shown by the many reports on animal health issues that appeared in the medical press, doctors retained their interest in this topic, to the extent that veterinary surgeons sometimes accused them of stealing their patients. Doctors also conducted numerous investigations into animal disease pathology and epidemiology. Their infrequent use of the term 'comparative' to describe such investigations suggests that they regarded them as part of mainstream medicine. Their aims were to document animal diseases, to describe their analogies with human diseases, and to learn about the nature of disease in general. These investigations featured a remarkable and formerly unrecognized degree of collaboration between doctors and veterinary surgeons. Vets drew doctors' attentions to interesting cases and outbreaks, facilitated their access to live animals and dead bodies, and offered personal insights based on clinical experience. Less frequently, doctors assisted vets in their animal disease investigations. Grass-roots collaboration between the professions was therefore important to the development of mid-19th-century understandings of human and animal disease (A. Woods, 2020, unpublished).

Medical interest in animals was promoted further by two key scientific developments. First, investigations during the 1830s suggested that glanders in horses, rabies in dogs, and anthrax in animals were causally connected to the equivalent diseases in humans (Wilkinson, 1992). Secondly, there emerged a Romantic or philosophical form of comparative anatomy which suggested that humans and animals were formed on the same general plan. In their efforts to comprehend this plan, doctors compared the anatomy and pathology of the bodies and embryos of multiple animal species (Jacyna,

1984; Hopwood, 2009). Humans and animals were thereby brought together in ways that are usually attributed to Darwinism and the germ theory, 30 years later. This finding reveals that contrary to popular belief, the latter events did not spell a complete break with the past. Rather, they formed part of an ongoing process of making and remaking links between human and animal bodies, and diseases.

Veterinary education emerged later in North America than in Europe. While some of the earliest qualified vets were European émigrés, physicians were also extremely active. In the period 1820–1870 they investigated and reported on livestock diseases, campaigned for veterinary education, and established and taught at early veterinary schools that were mostly short lived (Smithcors, 1959). In 1863, Scottish vet Duncan McEachran founded the Montreal Veterinary College. Believing that veterinary medicine was a branch of human medicine, he modelled teaching on that of the McGill medical school. One of his best known collaborators was William Osler, a former student of Virchow's and lecturer in medicine at McGill, 1874–1884. Osler taught veterinary students, undertook research (mostly unpublished) into diseases of animals, and asserted the value of comparative medicine to medical audiences. Although today he is often heralded as a figurehead of One Health, he was not unusual at the time. His predecessors and successors at McGill also taught veterinary students, and several, such as J.G. Adami, produced more extensive and significant research in comparative medicine (Teigen, 1984, 1988).

Following the 1859 publication of Darwin's *Origin of the Species* which claimed that all living organisms descended by evolution from a common ancestor, some doctors attempted to trace the evolutionary history of disease by examining its manifestations in different animal species. The most famous participant was Eli Metchnikoff, whose Nobel Prize-winning theory of phagocytosis was inspired by evolutionary thinking (Tauber, 1994). Animal diseases were also important in the development of germ theories of disease. In Britain, their acceptance was precipitated by the devastating 1865–1867 epidemic of cattle plague, whose pathology and epidemiology was subjected to scientific investigation by medical doctors (Worboys, 1991). Elsewhere, seminal research on germs focused on the nature, prevention and spread of animal diseases. In France, Louis Pasteur produced vaccines against chicken cholera, anthrax and rabies. His German counterpart Robert Koch investigated anthrax and tuberculosis, as well as tropical animal diseases which inspired his concept of the carrier state.

Vets made important contributions to all these investigations, which used a myriad of animals for the purposes of research, diagnosis and the production of vaccines and sera (Bynum, 1990; Wilkinson, 1992; Gradmann, 2010). Existing aetiological connections between human and animal diseases were redefined in terms of germs. A new category of diseases, the zoonoses, emerged to incorporate these and parasitic diseases like trichinosis, for which the life cycle and spread via the meat trade were worked out from the mid-1850s to the 1870s by Virchow, among others. They formed the focus of a new field of veterinary public health (VPH).

Today, Darwinism, the discovery of germs, and the rise of bacteriology, are heralded as key events in the development of One Health approaches. Closer scrutiny, however, suggests that these events had the reverse effect. In redefining disease as the straightforward product of infectious agents invading susceptible bodies, they downgraded the importance of the environment to health (Worboys, 2000). In bringing human and animal biology closer together, they heralded changes – described below – in the epistemic status of experimental animals, from representatives of particular species to 'model' humans. In inspiring the mainstream adoption of the term 'comparative pathology', they marked the compartmentalization of animal disease from mainstream medicine, while the emergence of VPH resulted in a newly competitive relationship between doctors and vets over control of zoonotic diseases (Hardy, 2002; Waddington, 2006).

Medical and veterinary perspectives on zoonoses often differed because doctors prioritized human health, and vets prioritized health of animals and agriculture. In 1901 Robert Koch famously reversed his earlier opinion that human and bovine tuberculosis were not alike, adding to a climate of uncertainty about the nature, extent, or even existence of transmission pathways. Doctors and vets clashed over the health threats posed by meat and milk, the regulation of these foodstuffs, and how to define a healthy animal. The stakes were raised by Western governments' growing assumption of responsibility for health, and their increasing reliance on experts. Veterinary and medical disciplinary differences were given structural and political expression by

their employment in separate government departments. Doctors generally had the upper hand, because their profession possessed higher status and had forged a public role years before the creation of state veterinary services. Throughout Europe and North America, dissatisfied vets organized and lobbied for state recognition and legal protection.[2] They gained some ground towards the end of the century, in inspecting meat at slaughterhouses and regulating the supply of hygienic milk. However, the nature and extent of these roles varied considerably between and within nations (Schmaltz, 1936; Koolmees, 2000; Hardy, 2002; Jones, 2003; Orland, 2003; Waddington, 2006; D. Berdah, London, UK, 2013, personal communication).

Animals and Humans in 20th-century Medicine

The 20th century was characterized by considerable ambiguity in the perceived relations between humans and animals in health and disease. This was particularly apparent in the status of animals within medical research, which underwent an important epistemological shift around the turn of the 20th century. Earlier, scientists had drawn on a diversity of species, including but not confined to earthworms, horses, birds, frogs, pets, zoo animals, horses, livestock and fish. They were usually familiar with these animals, having encountered them in farming, field sports, natural historical pursuits, zoos, and urban streets populated with horse-drawn transport, stray dogs, and livestock for sale and slaughter (Kete, 2007). The sheer ubiquity of animals made it easy to acquire them for experiment in life, and dissection after death. The resulting research was truly comparative. It sought to build general truths through examination of similarities and differences between animals. Acknowledging, with a nod to evolution, that species differences were to be expected, researchers did not assume that a finding was true of all animals until they had demonstrated it in a host of different species (Logan, 2002).

Subsequently, however, scientists moved away from demonstrating generality to presuming its existence. Animal diversity became a confounding factor rather than a research strength. It can be no coincidence that as towns grew larger, as animals disappeared from the streets and urban upbringings became the norm, scientists began to restrict their gaze to a handful of animal species that could be kept within the laboratory. Paralleling the rise of standardization and mass production within industry, scientists entered into the mass production of standardized laboratory animals whose features could be quantified or mechanically assessed. By the interwar period, with diversity reduced further through standardized husbandry and environments, these animals formed the mainstay of scientific work on cancer, genetics, and drug standardization. Their uses continued to expand throughout the second half of the century. By then, however, biomedical scientists were no longer engaging with them as animals, but as functional equivalents or 'models' of the human body whose scientific legitimacy was underpinned by the theory of evolution (Clause, 1993; Logan, 2002; Löwy, 2003; Rader, 2004; Kirk, 2008).

One interesting inversion of this state of affairs occurred in the context of veterinary medicine in the later 20th century. The increasing importance of human relationships with pets, and owners' greater willingness to invest financially in this relationship, resulted in the growing veterinary use of insulin treatment, orthopaedic surgery and transplant surgery. Originally these technologies were trialled on animal models before entering human medical practice. Now, their use in animal patients was informed by clinical trials and experiences in humans, who effectively became the models (Degeling, 2009; Gardiner, 2009; Schlich *et al*., 2009).

The increasing use of standardized animals within medical research caused some vets in Europe and North America to carve out a new role in caring for them. In the light of continuing public concerns about animal experimentation, they guided medical scientists on how to maximize experimental outcomes while minimizing animal welfare costs (Kirk, 2009). Such work was reminiscent of how vets had facilitated medical research on animal diseases during the mid-19th century, but the science, the setting and the animals were now very different. However, not all vets embraced the changing status of the laboratory animal. Starting in the 1920s, some voiced criticisms of animal models, and called instead for the study of spontaneous disease events in zoo, farm, wild and pet animals (Allbutt, 1924). They argued, as in the 19th century, that diversity was important to the creation of scientific knowledge, and they perceived disease problems in different species as analogous rather than identical. They referred to this form of investigation as 'comparative medicine' – although

confusingly, the use of this term today applies to the care of laboratory animal models as well.

Interwar comparative medicine advocates included O. Charnock Bradley (1871–1937), Principal of the Royal (Dick) Veterinary College, Edinburgh, and T.W.M. Cameron, professor and Director of Parasitology at McGill University (Bradley, 1927; Cameron 1938a, b). Investigation of comparative medicine gathered momentum in the decades after World War II. Meetings at the New York Academy of Medicine, University of Michigan, Rockefeller Foundation, University of Pennsylvania and the London Zoological Society aimed to demonstrate its practical value and to debate its incorporation within medical, veterinary and graduate school curricula (Jones, 1959). In 1958, a joint Washington meeting of medical and veterinary experts attached to the World Health Organization (WHO) and the Pan-American Sanitary Bureau (PASB) proposed creation of a new programme in comparative medicine, with the aim of expanding the kinds of animals and animal diseases used in basic medical research (Smith, 1961). W.I.B Beveridge, Director of the Institute of Animal Pathology at Cambridge University, was the lead consultant (Beveridge, 1969). Initially concentrating on cardiovascular disease and cancer, the official task of this programme expanded in the early 1960s to include comparative virology, neuropathology and mycoplasmology, as well as work on the welfare of primates in medical research centres (Kaplan, 1961; Cotchin, 1962).

From the 1920s onwards, advocates of this form of enquiry adopted an almost identical refrain. They argued that comparative medicine could tackle a wider range of diseases than could be experimentally induced, and would produce fundamental insights common to all species. Although it required knowledge of species' similarities and differences, veterinary surgeons already possessed such insights. Moreover, the approach would help to bridge professional, epistemological and practical divisions between veterinary and human medicine (Bradley, 1927; Cameron, 1938a, b; Beveridge, 1972). Renewed calls for unifying veterinary and human medicine were made within this context, on the assumption that these were two strands of 'one' medicine.

Today, the coining of the term 'One Medicine' is usually attributed to Calvin Schwabe, a vigorous proponent of comparative medicine, who employed the term frequently in the third edition of his volume *Veterinary Medicine and Human Health* (1984). However, it was used on many earlier occasions to illustrate the nature and value of comparative medicine (Bradley, 1927, p. 129; Shope, 1959; Beveridge, 1969, p. 547). During the mid-20th century, it was particularly associated with authors from the University of Pennsylvania veterinary school (Schmidt, 1962; Allam, 1966; Cass, 1973) and the University of Minnesota.[3] It is likely that Schwabe adopted the term 'One Medicine' from mid-20th-century currents of thinking within comparative medicine.

By the 1970s the results of comparative medical research into chronic human disease were still rather uneven. It seems that the skills required for conducting this research were rather difficult to obtain, and that few scientists were convinced by its claimed superiority over other methods or by broader visions of 'One Medicine'. The failure to advance comparative medicine was indicative of the growing differences between the professions in their research orientation and in the status they awarded to animals. Such differences were consolidated by 20th-century research and development infrastructures, which allocated human and animal health to different funding streams, research institutions and international organizations.

Yet at the same time, certain individuals, working in specific settings on particular disease problems, brought human and animal health into closer alignment. One key institution was the Rockefeller Foundation, which made the study of animal pathology central to many of its medical, scientific and public health programmes (Corner, 1964). Theobald Smith, the first director of its Department of Animal Pathology at Princeton (established in 1915), had made his name at the Bureau of Animal Industry, where he applied a comparative ecological approach to the study of Texas fever (Méthot, 2012). Both he and his successor, Richard E. Shope, who discovered the influenza virus of pigs and proposed its role in human influenza, were medically trained. Yet they saw animal pathology as the necessary foundation of *all* medicine (Shope, 1959). One particularly productive line of work, begun by Peyton Rous on chickens and continued later on rabbits in collaboration with Shope, was the role of viruses in cancer causation (Rous, 1910; Shope, 1933). Elsewhere in the USA, the University of Pennsylvania, the Mayo Clinic at the University of Minnesota (incorporated in 1915) and the Hooper Foundation for Medical Research at the University of California

(established in 1913) were among a cluster of institutions that supported medical–veterinary interactions in research and postgraduate education (Steele, 1991). In France and Germany, the Pasteur and Koch institutes remained committed to a comparative approach, as did other medical research centres in Europe (Gradmann, 2010). In Britain, the Medical Research Council established a programme of research into dog distemper which helped scientists to discover the human influenza virus in 1933 (Bresalier and Worboys, 2014).

Twentieth-century relations between health and the environment were similarly characterized by variability and ambiguity. By enabling the targeted control of infectious agents, the development of vaccines and antibiotics diverted attention away from the environmental factors that influenced their emergence, spread and clinical impacts. These interventions were so successful in the West that despite a few opposing voices, by the 1960s and 1970s it was widely believed the conquest of infectious disease was in sight (Anderson, 2004). In certain colonial and post-colonial settings where infectious diseases remained a problem, however, the environment could not be ignored. In the case of trypanosomiasis during the first half of the century, a highly ecological set of investigations resulted which drew on entomology, medicine, veterinary medicine and agricultural science to generate a dynamic picture of the disease (Tilley, 2011).

The elevation of development as an economic and political priority made colonial and post-colonial settings important to the integration of human and livestock health and nutrition (Staples, 2006). In 1948, as part of an international drive to improve human health through disease control and better nutrition, the WHO set up a VPH unit within its Division of Communicable Diseases (WHO, 1958). Headed by the American Martin Kaplan, who had degrees in veterinary medicine and public health, it developed close relations with the Food and Agriculture Organization of the United Nations (FAO), other UN agencies, and the Office International des Epizooties (OIE) (Kaplan, 1953). A series of joint WHO/FAO meetings in the 1950s led to collaborative programmes on zoonoses, meat hygiene and veterinary education. It also brought a working definition of VPH as comprising 'all the community efforts influencing and influenced by the veterinary medical arts and sciences applied to the prevention of diseases, protection of life, and promotion of the wellbeing and efficiency of man' (WHO/FAO, 1951).

In framing animal health as a crucial problem of human health and development, the FAO and WHO positioned veterinarians, trained and working within public health, as vital to realizing these goals (Bresalier, 2018). However, most countries lacked such personnel (WHO/FAO, 1956), therefore establishing new education and training programmes became a key focus. Through the 1950s and 1960s, the WHO and FAO acted to support and fund veterinary and VPH education in the developing world. These activities relied on expertise drawn from the USA, which led the post-war development of VPH at national, state and local levels, as well as internationally through the Pan-American Health Bureau (PAHB). The leading figure in these initiatives was James H. Steele (Steele, 2008). Trained in both veterinary medicine and public health, he was a prodigy of the Swiss-American veterinary pathologist Karl M. Meyer, himself a vocal proponent of the integration of human and animal medicine. It was Meyer who established the Hooper Foundation as a world-leading research centre on zoonoses and food safety.

As is evident from the above, post-colonial and international health contexts were very important in shaping the careers and ideas of many of the key figures who aligned themselves with a 'One Medicine' agenda. Their work within developing countries also enabled them to engage in cross-cultural encounters and exchanges with pastoral and agricultural peoples, which informed their thinking about the relationship between human and animal health, disease and medicine (Kaplan, 1966; Green, 1998; Beinart and Brown, 2013). The influence of these experiences and contexts can, for example, be detected in Calvin Schwabe's frequently cited work, *Veterinary Medicine and Human Health* (Schwabe, 1964, 1969, 1984). More generally, this history indicates that many of the roots of present-day One Health lie in earlier currents of veterinary thought and practice that were deeply entangled with projects of development, international health, aid and post-colonial reconstruction.

Conclusion: From One Medicine to One Health

In analysing the changing relations between the health of humans, animals and the environment, this chapter demonstrates the many and varied

links between them. Human medicine, in particular, has a rich history of engagement with animals, their diseases, and the people and institutions dedicated to animal health. Correspondingly, since the late 18th-century creation of their profession, vets have supported, collaborated and sometimes competed with this medical programme. These interconnections can be explained, in part, by reference to prevailing scientific ideas, practices and disease problems, but they can only be fully understood by examining the people involved, their institutional settings, and the wider professional, political, economic and environmental contexts. The historical specificity of these factors, as well as the variability of the health activities they influenced, makes it impossible to construct a simple, linear narrative linking past to present. Nor is it possible to draw direct lessons from history, or to claim – as do many existing histories – that the work of certain historical figures demonstrates the importance of pursuing One Health today.

This does not mean, however, that the past is irrelevant to the present. One key finding to emerge from this account is that links between the health of humans, animals and the environment were often investigated at grass-roots levels in the course of everyday veterinary and medical science and practice. For the most part, these activities were not articulated into a definite agenda of 'comparative pathology', 'comparative medicine', 'veterinary public health' or 'One Medicine'. Only at certain historical junctures did practitioners choose to adopt these terms, usually in order to validate or win wider support for operationalizing their activities. Pushing beyond these labels and the rhetoric that surrounded them and looking at what was actually happening on the ground reveals that integrated approaches to health were much more widespread and more significant than previously realized. It is no understatement to say that health and medicine today are heavily shaped and underpinned by the many precursors to One Health.

One Health itself, as a self-consciously labelled set of activities and agendas, has emerged very recently out of a complex and rapidly shifting coalition of international health bodies, veterinary associations, academic advocates, environmental organizations and pharmaceutical companies. While its history has been fully explored elsewhere (e.g. Lebouf, 2011; Chien, 2013; A. Cassidy, 2019, unpublished), this chapter concludes by sketching out the broad contours of these developments in order to put the rest of this volume into context.

During the 2000s, elements of the ongoing traditions of comparative medicine and VPH came together into a rearticulated vision of 'One Medicine, One Health'. This involved the alliance or convergence of veterinary and human medical research and/or clinical practice, including collaborative research, and shared clinics, vaccination strategies, equipment and drug development (e.g. King *et al*., 2008). In parallel, a different (albeit overlapping) set of actors and agendas came together around the term 'One World, One Health'™ (OWOH). In contrast to the veterinary–medical focus of One Medicine, OWOH tended to address a broader range of disciplines across the life and environmental sciences while maintaining a relatively tight focus on issues such as 'emerging infectious diseases'. The idea of 'One World' (OW) has its origins in mid-20th-century debates about international relations and the formation of the United Nations Educational, Scientific and Cultural Organization (UNESCO) (Sluga, 2010). It was significantly taken up by health actors during the 1990s, when the global scale and potential wildlife origins of the human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS) pandemic were recognized (Whiteside, 1996; King, 2004). In 2004, the first of a series of meetings between human public health, conservation and infectious disease experts was organized by the US-based Wildlife Conservation Society on the theme of OWOH. The idea then found strong purchase in international responses to the outbreak of highly pathogenic avian influenza (HPAI), and was adopted by the WHO, FAO, OIE and others in a shared statement of cooperative intent (FAO *et al*., 2008) following the HPAI crisis (Scoones and Forster, 2008; Scoones, 2010).

Through the 2000s, these two sets of agendas became increasingly intertwined, and since the end of the decade they have increasingly shared the broader, snappier and more widely used banner of 'One Health' (Zinsstag *et al*., 2005; FAO *et al*., 2010). The recent adoption of the language of One Health by key organizations across the worlds of veterinary and human medicine, international health and other agencies, national governments and research funding bodies, represents the integration of these various agendas. Advocates, based particularly in the USA and Switzerland, have organized workshops, conferences, reports, websites and journal publications to promote it. As an organizing concept, it has proved flexible enough

to encompass very different languages, ideas and working practices, yet coherent enough to enable communication across disciplinary and organizational divides (Lebouef, 2011; Chien, 2013). However, questions remain about the long-term viability, practical utility, sustained interdisciplinarity and persistent anthropocentrism of One Health (Lee and Brumme, 2013; Bardosh, 2016; Cassidy, 2016; Manlove *et al*., 2016; Kamenshchikova, 2019), as well as how it can productively engage with questions of colonial and post-colonial legacies, power, and ongoing tensions between local and 'global' approaches to health (Scoones, 2010; Green, 2012; Beinart and Brown, 2013; Yates-Doerr, 2015; Cunningham *et al*., 2017; Rock *et al*., 2017).

Like its predecessors, the rise of One Health cannot be explained solely by advocacy, internal scientific logic, or as the natural and inevitable outcome of long-standing efforts to bring humans, animals and the environment closer together. A product of 21st-century concerns, it forms part of a wider cluster of research and policy agendas, including 'food security', 'biosecurity', 'global health' and 'translational medicine', which also aim to break down barriers between disciplines. Intriguingly, each of these addresses issues relevant to, or even overlapping with One Health, but is oriented towards a different group of disciplines (e.g. 'food security' tends to appear in the environmental and agricultural sciences.) Rather than competing for resources or legitimacy, these agendas may instead be mutually reinforcing. Jointly, they could be described as part of a collective response to a (re)-emerging set of highly complex concerns which extend across traditional disciplinary boundaries – over environmental damage, climate change and scarce resources, food availability and disease/health (Bardosh, 2016; Cairns and Krzywoszynska, 2016; Cassidy, 2016; Felt *et al*., 2016; Harrison *et al*., 2019; Senanayake and King, 2019) and finally, how animals contribute to shape modern medicine (Cassidy *et al*., 2017; Woods *et al*., 2018; Kirk *et al*., 2019; Koch, 2019; Schoefert, 2019). This is the arena in which the future of One Health will be forged, but in looking ahead, we should not forget its multiple historical precedents, and their influence on the present.

Notes

[1] For another balanced historical perspective on this topic, see Kirk and Worboys (2011).

[2] Numerous papers on this topic were delivered to the 2012 Congress of the World Association for the History of Veterinary Medicine. For a summary see Woods (2012).

[3] Today Pennsylvania Vet School has its own trademarked slogan, 'Many Species, One Medicine'™, attributed broadly to another 19th-century 'founding father', Benjamin Rush MD (Hendricks *et al*., 2009).

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