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Bedside and Community: 50 Years of Contributions to the Health of Albertans by the University of Calgary

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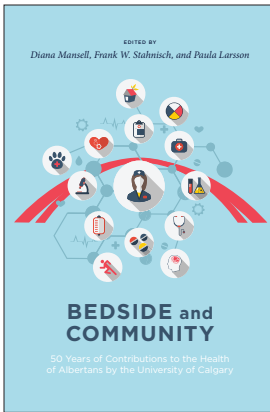
Mansell, D., Stahnisch, F., & Larsson, P. (Eds.). (2020). *Bedside and Community: 50 Years of Contributions to the Health of Albertans by the University of Calgary*. Calgary, AB: University of Calgary Press.

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BEDSIDE AND COMMUNITY: 50 Years of Contributions to the Health of Albertans by the University of Calgary Edited by Diana Mansell, Frank W. Stahnisch, and Paula Larsson

ISBN 978-1-77385-073-3

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The University of Calgary Faculty of Veterinary Medicine: At the Interface of Animal and Human Health

Alastair Cribb

The relationship between humans and animals has evolved from one focused on animals primarily as a source of food and transportation to a more complex one that involves our stewardship role on earth, the emergence of infectious diseases transmitted from animals to humans, and improved physical and mental health through pet ownership, to list but a few diverse areas.¹ Veterinary medicine and the veterinary profession have also evolved to match this changing relationship. The interface of animal and human health, existing in the environment that we all share, is often portrayed as a triangle.² However, as our knowledge has increased and our societies have changed, the relationship between human and animal health is recognized as being much more complex than a two-dimensional triangle can convey. Human well-being remains highly dependent on animal health, whether it be animals serving as a source of emerging disease or animals providing the economic and nutritional foundation for a healthy lifestyle. On the flip side, human activities influence animal health, whether it be how we care for and use domestic animals or our impact on wild populations through changes in the environment.³

It was the interactions between animal and human health that led the Alberta government to announce in 2004 that it was supporting the

establishment of the University of Calgary Faculty of Veterinary Medicine (UCVM). Established with the intent of graduating students who would serve rural Alberta, support its food-animal industries and research communities, conduct research at the animal-human interface, and support veterinary diagnostics, UCVM was approved by the University of Calgary Board of Governors in June 2005.⁴ The work of building the program began in earnest in 2006. The first students entered the doctor of veterinary medicine (DVM) program in 2008, the same year that the first graduate student completed their degree under the supervision of a UCVM faculty member. This chapter briefly describes the foundation and growth of UCVM, highlighting education, research, and service activities at the animal-human interface.

While there had been talk of a new veterinary education program in Alberta in 2002 to supplement the existing program at the Western College of Veterinary Medicine in Saskatoon,⁵ there was a significant shift when the first case of bovine spongiform encephalopathy (BSE) was discovered in a dairy cow in Alberta in May 2003. The discovery of BSE devastated the province's cattle industry.⁶ The impact was swift and severe, ultimately costing the province \$6 billion dollars in economic losses. The potential human health impacts of BSE led to a loss of major export markets and the need to impose rigorous standards on the cattle industry.⁷

BSE was not the only disease with animal-human health links in the news that year. Severe acute respiratory syndrome (SARS) hit Toronto and Vancouver in early 2003. A potentially fatal disease, the SARS virus, identified and sequenced in Canada, was determined to be a coronavirus believed to have originated in civet cats in the Far East.⁸ In July 2003, West Nile virus was confirmed in Alberta. First described in North America in the eastern United States, it had been slowly making its way across the continent. Highly pathogenic avian influenza H5N1 ("bird flu") was also in the news in 2003. Although the bird flu had first appeared in 1997 in Hong Kong, it re-emerged in 2003. In addition, H7N7 caused human disease in the Netherlands in April 2003. H5N1 subsequently swept through Asia and parts of Europe.⁹ The public was once again alerted to the human health consequences of animal disease.

Politicians were now receptive to the need for understanding the important links between animal and human health. Lyle Oberg, provincial minister of learning, and Shirley McClellan, minister of agriculture, were

among the first politicians in Alberta to recognize the need for an increase in veterinarians who were well educated in production animal health, public health, and comparative biomedical research, and for veterinarians prepared to work in rural Alberta. This “new” recognition of the importance of animal-human health interactions, combined with the previously identified need for veterinarians able to serve the evolving production animal industries and rural Alberta, was important in the development of a veterinary college in the province.¹⁰

Not that a link between veterinary and human medicine was new. Veterinary education in Canada has had a strong link with human medicine from its early days. For example, renowned Canadian physician Sir William Osler (1849–1919) was a giant of human medicine, celebrated for his contributions to the advancement of medical education.¹¹ He was also one of the first and strongest proponents of comparative medicine in Canada. While teaching at McGill University, he lectured in both the medicine and veterinary medicine programs, and encouraged the participation of veterinary students in medical courses (and vice versa).¹² Ultimately, then, the proposal for a faculty of veterinary medicine that was closely aligned with a faculty of medicine had a precedent in Canada.

Lyle Oberg, with the backing of then premier Ralph Klein, was to become the primary champion of the veterinary college in the province. As he explored the options, he became more convinced of the need for veterinarians to be able to support Alberta industries and research. In 2003, a veterinary program was not on the University of Calgary’s agenda, but animal health certainly was. Many scientists and clinicians in the U of C Faculty of Medicine were conducting research that relied on animal models of disease or were directly relevant to animal health. The new Bachelor of Health Sciences Program was being launched and faculty members had noted a strong interest in animal-health-related research topics among students being recruited to the program. So, when Dr. Grant Gall, then dean of the Faculty of Medicine, met with Oberg to discuss educational programs, he was receptive when the topic of animal health was raised.¹³

The Faculty of Medicine led a proposal from the University of Calgary to be the home of a new veterinary college in Alberta. The DVM program initially proposed was modelled on a hybrid of the bachelor of health sciences and the medical degree programs. A three-year clinical presentations curriculum, with specialized streams in production animal/

equine, eco-health and public health, and investigative medicine, was envisioned.¹⁴ Medical faculty would teach the basic science courses, many in combined classes with medical students. The program would capitalize on existing infrastructure and use a distributed veterinary teaching hospital model for clinical education. There would be a heavy research focus, with particular attention given to issues at the interface of animal and human health.¹⁵ Although there would be many changes as the program developed, the foundation of a faculty of veterinary medicine with the link between animal and human health at the core of its education and research programs was set.

The public announcement was made in August 2004. When U of C president Harvey Weingarten sent a notice out to the university community on the morning of the announcement he captured the key concepts:

Why was the argument for a vet school in Calgary so compelling and persuasive? Among other reasons, our plan called for us to link animal health education and research with the current extensive human health research and education initiatives within the Faculty of Medicine. The integration of human and animal health is perceived by experts to be where the animal health and veterinary medicine worlds are heading and our proposal puts us immediately at the forefront of such initiatives.¹⁶

This was echoed in the formal press release, which led off with the following paragraph:

The Alberta government is establishing a new leading-edge veterinary medical school that will put the province at the forefront of research into animal diseases and food supply safety. This unique veterinary school will provide research into the detection, containment and eradication of diseases that can spread from species to species and affect humans, and prepare veterinary medical practitioners and researchers focused on food supply safety. The school will also specialize in producing large-animal veterinarians to address shortages of these types of specialists in the province.¹⁷

Speaking on behalf of the Alberta Veterinary Medical Association, president-elect Danny Joffe provided the following:

Our Association supports an enhanced veterinary curriculum that meets the long term needs of Albertans from both a public health and animal health and welfare perspective. We look forward to working collaboratively with experts in the field to ensure a new college does just that.¹⁸

Ultimately, the U of C Board of Governors approved a proposal in June 2005 to establish the Faculty of Veterinary Medicine with a directive that it would be research-intensive, with the primary focus on production animal medicine and research and on the interface of animal and human health. The expected characteristics of the students completing the program were laid out as follows:

- Graduates will have a general veterinary education with an emphasis in the areas defined by one of the three streams.¹⁹
- Graduates will have sufficient knowledge of basic and clinical sciences to enter into general veterinary practice.
- Graduates will have the clinical skills necessary to perform all procedures commonly encountered in general veterinary practice. In addition, they will have greater facility with the procedures encountered in the areas of practice encompassed by one of the three streams.
- Graduates will have sufficient understanding of the basic sciences related to veterinary medicine to enter into graduate study in an area related to animal health broadly defined.

- Graduates will have an understanding of the relationship between veterinary practice and research, human health, and the environment. They will appreciate the unique knowledge and skills that veterinary medicine offers society in these areas.²⁰

The faculty's research and graduate education programs were also to focus on the environment-animal-human health interface, creating new knowledge and finding solutions. This would then position Alberta as a global leader in the development of solutions to animal-health-derived problems, which in turn influence both human health and economic well-being. The vision statement adopted by the new faculty, "Bringing innovation and community together to advance animal and human health," confirmed this commitment.

The sentiment encapsulated in the vision statement was also incorporated in the mission of UCVM, along with the commitment to excellence in education, clinical service, and research in the key areas of the program:

The Mission of UCVM is to meet the veterinary, animal, and public health needs of Alberta through:

- excellence in delivery of a comprehensive undergraduate veterinary medical education, emphasizing production animal health, ecosystem and public health, equine health and investigative medicine;
- excellence in clinical, diagnostic and professional teaching and service, in collaboration with our partners in the Distributed Veterinary Learning Community;
- excellence in the creation and distribution of new knowledge through research, graduate veterinary education, and continuing education in animal health, disease, and welfare, and its relation to human health.

- Our education, research and service activities will contribute to the promotion and protection of animal and human health and welfare in Alberta, Canada and internationally.²¹

University of Calgary Faculty of Veterinary Medicine and “One Health”

The origins of UCVM, as described above, are firmly rooted in the concept that the animal-human-environment health interface is important. Comparative medicine, zoonotic disease, and public health have long been a foundation of veterinary education, as espoused by Sir William Osler and many others. The importance of managing zoonotic diseases through control in animals has been an important part of veterinary practice. In the last fifteen years, however, the recognition that approximately 60 per cent of human infectious diseases and 75 per cent of emerging and re-emerging infectious diseases have their origin in the animal kingdom has once again raised the profile of animal-human health interactions.²² This recognition, combined with other global changes, contributed ultimately to the re-framing of comparative medicine and public health under the banner of “One Health.”²³ One Health is a broad concept that captures many different aspects of the animal-human interface. One accepted definition is “the collaborative efforts of multiple disciplines working locally, nationally, and globally, to attain optimal health for people, animals, and our environment.”²⁴ This definition emphasizes the professional relationships and interactions that are required to address complex issues. In a recently published textbook of One Health case studies by UCVM members, Susan Cork, David Hall, and Karen Liljebjelke defined One Health “as a transdisciplinary approach to the sustainable management of complex health problems arising from the interaction of animals, humans and their environment.”²⁵ This approach focuses, too, on the integration across disciplines, with a clear focus on solving a complex problem. For some, it is only One Health if it involves all three components: animals, humans, and the environment. For others, anything that transcends the boundaries of veterinary or human medicine is One Health, including comparative biomedical research and the exchange of knowledge across

the clinical application or practice of veterinary and human medicine. To veterinarians, the idea that animal health is important for human health is not new, and the focus at UCVM has been on this interface in its many forms, without trying to constrain it under a particular label.

The Educational Program

The many facets of the link between animal and human health are highlighted throughout the DVM program. Students are challenged to explore the interface of animals, people, and social and physical environments, as well as policies and programs to protect and promote health. As the principles of comparative medicine and One Health are considered foundational in the veterinary community, they are addressed in many different courses, but there are some courses specifically dedicated to highlighting these areas.²⁶ For example, in the first year of the program “Animals, Health and Society” (Veterinary Medicine 323) explores the role that veterinarians play in promoting animal and human health through animal health management. It is organized around an ecological framework that explores the interaction of ecological, medical, environmental, and social factors that influence health and welfare in animals and their contribution to human health. The focus of the class is how to think about health in the practice of veterinary medicine and to discover ways that diseases can be prevented and health can be promoted.²⁷ It shows first-year veterinary students that studying the determinants of health residing at the interface of people, animals, and their shared environment supports healthy human-animal relations. DVM students are expected to be able to recognize the primary determinants of health influencing the system and/or species of concern, and how individuals, populations, and environments interact to affect health at individual and population levels. They should develop communication skills, intellectual acumen, leadership, collaborative skills, and clinical skills to work in a multi-disciplinary team to develop and implement solutions to complex problems that impact animal and human health. They need to understand the roles and responsibilities of veterinarians in animal and public health (locally and globally) and the responsibilities of other agencies, individuals, or governments.²⁸ Zoonotic diseases are a core competency of veterinarians, but the impact of animal health on human health is much broader, and so is the role of

the veterinarian. This is reflected in the expected educational outcomes for students in the program.

Research Programs at the Animal-Human Health Interface in the University of Calgary Faculty of Veterinary Medicine

A fundamental premise for creating a veterinary college that would highlight and focus on the animal-human health interface was that it would facilitate and embrace a close association between animal- and human-health researchers. To facilitate the interactions between researchers in the Faculties of Medicine and Veterinary Medicine, the decision was made to physically integrate and intercalate the two programs on the Foothills Campus.²⁹ Although the Faculty of Veterinary Medicine would ultimately build a unique clinical teaching and animal research centre at the Spy Hill Campus (the Clinical Skills Building), 85 per cent of its faculty and staff were originally based at the Foothills Campus. The goal was to bring researchers with similar interests (e.g., infectious disease, stems cells, and regenerative medicine) into physical proximity, thereby encouraging informal interactions, regardless of their home faculty.³⁰ Many faculty members received adjunct or joint appointments in the sister faculty and many UCVM researchers became formally affiliated with one of the seven health research institutes in the Faculty of Medicine. From comparative biomedical research that sets the foundation for applied, population, and clinical research in human and veterinary medicine, to clinical research that directly addresses issues of importance in animal and human health, UCVM members' contributions to advancing and addressing human health in Alberta and beyond have been impressive given the faculty's short history. Among many important research areas, UCVM members are leaders in infectious disease and reproduction as well as regenerative medicine.³¹ Infectious disease research at UCVM spans all departments, and much of this research has human health implications. The following stories highlight some of the examples of research that have addressed the animal-human health interface. While faculty members from UCVM are highlighted below, many of the research programs have involved collaborations between human and veterinary researchers.

Herman Barkema, DVM PhD, an internationally recognized researcher into infectious diseases in cattle, is a professor in epidemiology of infectious diseases with the Department of Production Animal Health, a Natural Sciences and Engineering Research Council of Canada Industrial Research Chair in Infectious Diseases of Dairy Cattle, a fellow of the Canadian Academy of Health Sciences, and a professor in the Department of Community Health Sciences in the Cumming School of Medicine. He studies Johne's disease, an infectious, chronic inflammation of the gut caused by *Mycobacterium avium subspecies paratuberculosis*. It is a major health concern for cattle, bison, and caribou, and is estimated to cost the Canadian cattle industry \$90 million a year. Barkema also studies mastitis, an inflammation of the mammary gland that reduces milk production and quality, and the main reason cattle producers use antibiotics.³² Barkema's work is aimed at ensuring a safe and sustainable food supply through control of infectious diseases in cattle. For example, along with colleagues in the Faculties of Medicine and Veterinary Medicine, he recently completed a collaborative report on the use of antimicrobials in animals and the association with antimicrobial resistance, a current global concern.³³ However, he was also the major protagonist behind the Alberta Inflammatory Bowel Disease Consortium, which sought to bridge the gap between veterinary and human medicine by looking for links between disease processes in humans and animals, and investigating possible links between the infectious agent of Johne's disease in cattle and inflammatory bowel disease in people.³⁴

The work of Jeff Biernaskie, PhD, has the potential to help both humans and animals. He discovered the existence of a multipotent dermal stem cell in adult skin, a cell that can self-renew and create new skin cells. He is using novel animal models, including reindeer antlers, to understand stem cell function and develop new approaches to wound healing and skin regeneration. The goal is to be able to regenerate fully functioning skin in place of scar tissue.³⁵

Jay Cross, DVM PhD, has spent years understanding how the placenta develops and is maintained throughout pregnancy. A fellow of the Canadian Academy of Health Sciences and the Royal Society of Canada, his work has been instrumental in helping us understand basic physiologic processes across species. In addition to helping us understand the basic biology of pregnancy, his extensive work has given us a better understanding

of clinical conditions such as preeclampsia. Preeclampsia is a pregnancy complication characterized by high blood pressure that can lead to serious—even fatal—complications for both mother and baby. In 2013, Cross and his collaborators discovered that a mutation in a gene necessary for the metabolism of folic acid not only impacts immediate offspring but can also have detrimental health effects, such as spina bifida and heart abnormalities, on subsequent generations.³⁶ The detrimental effects of folic acid deficiency during pregnancy on development are well known. As a result, Canada and many other countries have implemented folate fortification programs that require folic acid to be added to cereal products. However, very little was known about how folic acid deficiency caused the diverse range of health problems in offspring. Cross's research has indicated that it may take more than one generation to eliminate the health problems caused by folate deficiency. The principles demonstrated by this work have implications for both animal and human health.³⁷

Avian influenza is one of many diseases that can be transmitted from animals to humans. Up to 75 per cent of emerging infectious diseases in people originate in animals. Finding ways to rapidly identify these zoonotic diseases and to prevent their spread is an important area of research. In 2014, nearly 250,000 chickens and turkeys were euthanized after an outbreak of avian flu on 11 poultry farms in British Columbia. A decade earlier, 70 million chickens, turkeys, and other domestic birds were slaughtered in Canada's most serious avian flu outbreak, in which the virus spread to 42 commercial farms and 11 backyard coops in British Columbia's Fraser Valley. Dr. Faizal Careem's laboratory explores the avian immune responses to try to identify stimulants that can be injected into eggs to prevent avian influenza infections and protect human health, avoiding the type of mass depopulations currently employed.³⁸

Canadian water sources for drinking and agriculture are threatened by waterborne bacterial pathogens. As many as 400,000 people around Alberta rely on well water, but only a handful of them know whether their water is safe to drink or whether it has been compromised by livestock waste and other contaminants.³⁹ Researchers in the Faculty of Veterinary Medicine work to help understand the risks and control mechanisms for waterborne pathogens. Dr. Sylvia Checkley and other UVM colleagues, working with the Alberta Provincial Laboratory for Public Health (ProvLab) and the federal government's FoodNet Canada, have explored

what factors contribute to contaminated wells and how to control them.⁴⁰ Dr. Checkley spends half of her time working with the ProvLab, Alberta's public health laboratory. She serves as an environmental epidemiologist helping to monitor and protect the province's water supplies.

Controlling pain is equally important in veterinary and human medicine. Chronic pain in particular can be hard to manage. Chronic pain afflicts one in five adult Canadians and an unknown number of animals. Understanding how our bodies respond to pain and finding ways to control it are critical to improving health and wellness in all species. The failure to maintain adequate pain control decreases the quality of life for many chronic pain sufferers and complicates many conditions, including cancer, stroke, diabetes, traumatic injury, and a host of other diseases.⁴¹ Tuan Trang, PhD, focuses his research on improving the effectiveness of opioids, one of the most effective analgesics for serious pain, as well as decreasing the side-effects associated with opioid therapy. His work also explores the role of specialized cells that support neurons in mediating chronic pain.⁴² His work has now spawned clinical trials in human and animal patients, looking at repurposing an old drug to manage chronic pain.⁴³

Clinical and Diagnostic Activities at the Animal-Human Health Interface

Every day, veterinarians impact human health, either directly or indirectly, through their work with animals, whether it be ensuring the health and well-being of animals in the food chain in order to protect food safety, vaccinating animals for rabies (a zoonotic disease), or improving mental and physical health by caring for animals.⁴⁴ There are many examples, but I would like to use two examples to highlight the involvement of UCVM faculty, staff, and students in protecting and enhancing human health through their professional activities.

UCVM launched Pet Health Clinics with the Calgary Urban Project Society (CUPS) to host six free veterinary clinics for pets of people living below the poverty line each year.⁴⁵ The program, a regular part of the third-year DVM curriculum, provides benefits for both the student and the client, creating a win-win situation. The love of a pet can help counter the social isolation of poverty and homelessness. The students are able to hone their professional skills and at the same time serve the community

and help those who are less fortunate. “For those who have experienced poverty, homelessness and the social isolation that often accompanies it, the role of a pet becomes all the more critical,” noted Amanda St. Laurent, with CUPS. “Caring for a pet can provide a sense of normalcy, responsibility, stability, unconditional love and a reason to face a new day.”⁴⁶ The mental and physical health benefits of owning pets are now well recognized. The opening of a dialogue regarding someone’s pet can lead to discussions that help to deliver other health and support services for those attending the clinics.

The presence of zoonotic disease in our pets is another important public health issue. Dr. Cameron D. Knight, a UCVM pathologist, was the first to report the H1N1 influenza virus in cats in Canada in 2015.⁴⁷ Although human infection from cats has not been reported, it is important to understand cross-species transmission. Alberta was also the first reported location for H1N1 in swine in North America. *Brucella canis*, an infectious bacterial disease rarely diagnosed in the province, was also identified in dogs in Alberta in 2015 after importation from the southern United States and Mexico. UCVM clinicians Serge Chalhoub, DVM DACVIM, Chantal McMillan, DMV DACVIM, and Sylvia Checkley, DVM PhD, led an investigation to define the problem and provide guidelines for managing animals who have tested positive or who have been exposed to dogs carrying *Brucella canis*.⁴⁸ These cases remind us of the importance of ensuring the health of our pets. The results of this investigation are being used to encourage the government to change guidelines on the importation of dogs to protect human health.

Setting the Educational Framework for One Health

The examples provided above only capture a few of the many important research, education, and service activities at the animal-human-environment interface. Teaching and communicating One Health, and encouraging practising veterinarians and doctors, as well as public health practitioners, academics, and researchers, to incorporate the approach and concepts into their regular activities, remains a developing area. To aid these efforts, UCVM faculty members and international colleagues have produced an exciting textbook that highlights many more examples of One Health in practice. *One Health Case Studies*⁴⁹ was published in 2016

and was incorporated by Dr. David C. Hall in August 2018 into the first interdisciplinary course (UNIV 401)⁵⁰ in One Health to be taught at the University of Calgary.

By integrating social and policy perspectives with analyses and projects tackling the interactions between animals, humans, and their respective environments, this course signals an important commitment to the integration of concepts and principles stemming from population health, public health, and ecosystem health.

Conclusion

The University of Calgary Faculty of Veterinary Medicine was created in large part as a response to a series of animal-human health events that had significant effects in Alberta and across Canada, as well as the recognition that the declining numbers of veterinarians serving rural Alberta had potential animal- and human-health consequences. The faculty was developed with a plan to focus on health at the animal-human-environment interface and has continued to pursue a course that aligns with this early vision. The power of comparative biomedical and health research benefits both animal and human health. The advances and contributions that have been made by UCVM since it opened in 2005 would not have been possible without the close physical proximity and strong research collaborations with the Faculty of Medicine (now the Cumming School of Medicine). It was a bold vision and one that was not without its challenges. Yet both faculties and their research programs are richer for the relationship.

There is much more that can be done and should be done to build on the collaborations in education, research, and professional services that have been developed. As the University of Calgary celebrates fifty years and looks ahead to the next fifty, building on the unique partnerships that exist between animal and human health should be one of its priorities.

NOTES

- 1 For comparison, see Abigail Woods, “One Health, One Medicine: Reconnecting Humans and Animals within Medical History,” *Western Humanities Review* 69, no. 3 (2015): 148–69.
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- 3 Ibid.
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- 7 On the previous situation in Britain and some of the Canadian reception, see Michel C. F. Shamy, “While England Ate: Government and the Risk of BSE, 1979–1996,” in *The Proceedings of the 21st Anniversary History of Medicine Days Conference 2012: The University of Calgary Faculty of Medicine, Alberta, Canada*, ed. Aleksandra Loewenau, Kelsey Lucyk, and Frank W. Stahnisch (Newcastle upon Tyne, UK: Cambridge Scholars Publishing, 2015), 2–27.
- 8 Y. Guan, B. J. Zheng, Y. Q. He, X. L. Liu, Z. X. Zhuang, C. L. Cheung, S. W. Luo, P.H. Li, L. J. Zhang, Y. J. Guan, K. M. Butt, K. L. Wong, K. W. Chan, W. Lim, K. F. Shortridge, K. Y. Yuen, J. S. Peiris, and L. L. Poon, “Isolation and Characterization of Viruses Related to the SARS Coronavirus from Animals in Southern China,” *Science* 302, no. 8 (2003): 276–8.
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- 10 Ibid.
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- 12 Philip M. Teigen, “William Osler and Comparative Medicine,” *Canadian Veterinary Journal* 25, no. 4 (1984): 400–5.
- 13 See also chapter 1 in this volume by Frank W. Stahnisch.
- 14 Bachelor of Health Sciences (BHSc), “Program Proposal Integrated Pipeline Program for Applicants from Aboriginal Backgrounds” (2013), 2–3. Available from Cumming School of Medicine.
- 15 Cribb and Allford, *University of Calgary Veterinary Medicine 2004–2008*.
- 16 Harvey Weingarten, “Notice to the University Community” (August 2004). Available from the University of Calgary Faculty of Veterinary Medicine.

- 17 Ibid.
- 18 Danny Joff (president-elect), "Address to the Alberta Veterinary Medical Association" (2004). Available from the University of Calgary Faculty of Veterinary Medicine.
- 19 The three streams were subsequently renamed as four areas of emphasis: production animal health, equine health, investigative medicine, and ecosystem and public health.
- 20 Cribb and Allford, *University of Calgary Veterinary Medicine 2004–2008*.
- 21 See "Mission," Faculty of Veterinary Medicine, <http://vet.ucalgary.ca/home/mission> (accessed 25 October 2016).
- 22 Mark E. J. Woolhouse and Sonya Gowtage-Sequeria, "Host Range and Emerging and Reemerging Pathogens," *Emerging Infectious Diseases* 11, no. 12 (2005): 1842–7.
- 23 Woods, "One Health, One Medicine," 148–69.
- 24 "One Health: A New Professional Imperative," American Veterinary Medical Association Final Report 2008, https://www.avma.org/KB/Resources/Reports/Documents/onehealth_final.pdf (accessed 25 October 2016).
- 25 Susan Cork, David Hall, and Karen Liljebjelke, *One Health Case Studies: Addressing Complex Problems in a Changing World* (Sheffield, UK: 5M Publishing, 2016).
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- 27 For some of the conceptual foundations, see also Melanie Rock, Eric Mykhalovskiy, and Thomas Schlich, "People, Other Animals and Health Knowledges: Towards a Research Agenda," *Social Science and Medicine* 64, no. 9 (2007): 1970–6.
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