The professionalization of One Health through an analysis of *Burkholderia mallei*

by

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Abstract

One Health is the union of animal, human, and environmental health with the understanding that all three are interdependent. Many diseases have impacted the history of One Health. Glanders, caused by *Burkholderia mallei*, played an especially prominent role in the professionalization of the three domains of One Health. Inductively examining primary sources from veterinary medicine, human medicine, and environmental health, nine notable people and nine significant moments stand out as evidence of glanders propelling the development of One Health. These individuals include scientists and veterinarians like Erik Viborg, who identified the connection between farcy and glanders; John Gamgee, who argued that glandered horses must be culled to prevent further infection from spreading in a stable; and Friedrich Loeffler, who helped to establish laboratory protocols for *B. mallei*. Significant moments include, but are not limited to, the adoption in Great Britain of *The Veterinary Surgeons Act of 1881*, which distinguished between qualified and unqualified practitioners; 1837, the year that the Academy of Medicine in France debated the veracity of glanders' transmission from animals to humans; and 1906, when a *Special Report on Glanders* reiterated Canada's Regulations Relating to Glanders which specified the roles of veterinary inspectors. Three components of professionalization were analyzed during the time span of 1761-1918: the development of professional identity and legitimization among like professionals and government entities, the evolution of recognized professional organizations with qualifying standards, and the creation of specialized training and formal education. A number of lessons emerge from this historical analysis of glanders and One Health professions. Diagnostic tools not only function as clinical instruments but as technologies that can legitimize a profession; therefore, investment in One Health diagnostic tools should be understood as an investment in the credibility and recognition

of professions who use it, not just a laboratory advancement. Modern One Health frameworks should be expected to be unevenly adopted across countries, institutions, and professions. Finally, modern One Health leaders should prioritize the recognition and affirmation of environmental health specialists and others working in environmental health.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

APHA	American Public Health Association
AVMA	American Veterinary Medical Association
BAI	Bureau of Animal Industry
bTB	Bovine Tuberculosis
BW	Biological Warfare
CBPP	Contagious Bovine Pleuropneumonia
CDC	Centers for Disease Control and Prevention
DO	Doctor of Osteopathic Medicine
DVM	Doctor of Veterinary Medicine
EHS	Environmental Health Specialist
FMD	Foot-and-Mouth Disease
FRCVS	Fellow of the Royal College of Veterinary Surgeons
GBP	Great British Pounds
MD	Doctor of Medicine
MOH	Medical Officer of Health
NGO	Non-Governmental Organizations
RCVS	Royal College of Veterinary Surgeons
SARS	Severe Acute Respiratory Disease
U.K.	United Kingdom
U.S.	United States
WHO	World Health Organization
WWI	World War I

WWII	World War II

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Chapter 1 - Introduction

Background

One Health is the union of animal, human, and environmental health with the understanding that all three are interdependent. Each domain of the One Health framework equally impacts the other two. Zoonotic diseases, those that have the capacity to be transmitted between animals and humans, play a role in all three domains of the framework. Emerging zoonotic diseases are diseases that are either re-emerging in a population or appearing in a population for the first time.[1] Over the last thirty years, the increase in emerging zoonotic diseases (Severe Acute Respiratory Disease (SARS), Avian Influenza, West Nile virus disease, and others) demonstrates the urgent need for interdisciplinary One Health collaboration.[2] As the Earth warms, changes in temperature alter disease transmission.[3] Warmer temperatures are a catalyst for geographic expansion of disease vectors, shorter incubation periods for viruses, and unpredictable weather events; these impact all areas of the One Health framework.[4]

Within the One Health framework, veterinarians play a key role. Through their education, veterinarians receive interdisciplinary training to equip them to interact with issues and problems within and across the three areas of One Health. Veterinarians by trade contribute to the well-being of animals, and the well-being of animals directly involves the environment. In turn, animals and the environment impact humans. Not surprisingly, One Health has been positively received by the veterinary profession.[5] To appreciate the importance of the One Health

[1] World Health Organization, "Zoonotic Disease."

[2] Ibid.

[3] Pachauri et al., *Climate Change 2014*.

[4] Stone, "Climate Change and Infectious Diseases."

[5] Gibbs and Gibbs, "The Historical, Present, and Future Role of Veterinarians in One Health." p. 42

framework in veterinary medicine, scholars must understand the professionalization of a number of disciplines, allied together under the category of veterinary public health. Peter Koolmees defines veterinary public health as "all the interactions between animals and animal products on the one side and human health on the other."[6] Such a definition implies not a single profession but rather a multiplicity of scientific communities and disciplines—from microbiology and other biological sciences to public health and various social sciences. Like veterinary public health, the One Health profession includes a multiplicity of professions, scientific disciplines, and communities of practitioners. These include, amongst others, medical doctors, environmental health scientists, microbiologists, chemists, risk analysts, epidemiologists, and, to be sure, veterinarians.

Globalization, One Health, and the Veterinary Profession

The need for professional competence in the One Health framework arose with globalization. Globalization can be defined as "the growing interdependence of the world's economies, cultures, and populations, brought about by cross-border trade in goods and services."[7] Though records of animal disease date back as early as 500 AD, globalization began to take place in the 1st century when the silk road connected trade between China and Europe.[8] Between the 1st century and the industrial revolution, the world became increasingly more globalized. As globalization grew, so did human medicine. Table 1 integrates the five periods in

[6] Koolmees, Peter. "Chapter 4: Veterinary Inspection and Food Hygiene in the Twentieth Century." In Food, Science, Policy and Regulation in the Twentieth Century, edited by David F. Smith and Jim Phillips, 53-68. New York: Routledge, 2000, p. 53

[7] Kolb, "What Is Globalization?"

[8] World Economic Forum, "A Brief History of Globalization."

the history of medicine (as defined by Sakai and Morimoto) and various eras or "waves" of globalization (as named by the World Economic Forum).[9]

Table 1: History of Medicine and History of Globalization

Time Period	History of Medicine	History of Globalization
1st-7th Century	Western Classic Medicine (previous to the 15th century)	1st Silk Road (1st-5th centuries)
8th-16th century	Western Classic Medicine (previous to 15th century), Traditional Western Medicine (16th-18th centuries)	2nd Silk Road (13th-14th century) Spice Routes (7th-15th centuries) Age of Discovery (15th–18th centuries)
17th-18th Century	Traditional Western Medicine (16th-18th centuries)	Age of Discovery (15th–18th centuries)
19th-20th Century	Early Modern Medicine (19th century), Late Modern Medicine (1900-1980s)	First Wave of Globalization (19th century -1914, World War I (WWI)) Second Wave of Globalization (1945, End of World War II (WWII)-1989/1991, Fall of Berlin Wall and Soviet Union Collapse) Third Wave of Globalization (2000s)
21st Century	Exact Medicine (1980s-present day)	Globalization 4.0 (Present day)

SOURCES: Combination of data from the following two sources: Sakai, Tatsuo, and Yuh Morimoto. "The History of Infectious Diseases and Medicine." *Pathogens* 11, no. 10 (2022): 1147. https://doi.org/10.3390/pathogens11101147; World Economic Forum. "A Brief History of Globalization." January 17, 2019. https://www.weforum.org/stories/2019/01/how-globalization-4-0-fits-into-the-history-of-globalization/.

Traditional Western Medicine (16th-18th centuries) included anatomical research, lecture-based education, and clinical observations with the most prominent infectious diseases being syphilis, malaria, and smallpox. This corresponded with a period in globalization often described

[9] Sakai and Morimoto, "The History of Infectious Diseases and Medicine"; World Economic Forum, "A Brief History of Globalization."

as the Age of Discovery.[10] Between the 16th and 18th centuries, animal disease threats often disrupted transcontinental, transoceanic, and therefore globalized trade; this period of time highlighted the need for veterinary public health regulation.

Glanders, a zoonotic disease, illustrates this situation; trade disruptions occurred as cases appeared in both horses and their human handlers. As concern over diseases increased, veterinary scientists documented their observations. Jacques de Sollysel,[11] stablemaster of King Louis XIV, author, and Master of the Horse to the French Ambassador, wrote about the disease in the late 17th century.[12] Sollysel (pictured in Figure 1) is said to have considered glanders and farcy related, but did not recognize the two as the same disease (it is now known that farcy is the cutaneous form of glanders).[13] Sollysel studied equine medicine in Lyon, France, and, after serving as an official in the entourage of the French Ambassador's, dedicated the remainder of his life to the Paris Riding Academy. His life and career reflect the state of veterinary knowledge prior to the existence of formal veterinary schools.

[10] Ibid.

[11] Various primary sources refer to Sollysel as "Sallysel," and in this thesis the author will refer to him as Sollysel.

[12] Wilkinson, "Animals and Disease: An Introduction to the History of Comparative Medicine."

[13] Vincent, "Glanders Senior Thesis."; Boardman, *Handbook of the Turf*.

Figure 1: Jacques De Sollysel

SOURCE: Edelinck, Gérard. "Portret van Jacques de Solleysel,." 1666-1707. https://commons.wikimedia.org/w/index.php?search=solleysel&title=Special%3AMediaSearch.

Solleysel lived from 1617-1680, dying roughly 80 years before the first formal veterinary school was founded and roughly two-hundred years before the establishment of the germ theory. Before germ theory was accepted by the masses, many people believed that disease was attributable to *miasma*—namely, air that was contaminated with some form of infectious material.[14] The theory of miasma reflects the extent that people understood science, that is, very little. While the theory

[14] Halliday, "Death and Miasma in Victorian London."

of miasma would be ultimately disproven, its advocates were often supporters of sanitary reform and their actions contributed greatly to improved sanitation standards across England.[15] It is now known that disease outbreaks from this period can be directly linked to limited knowledge on effective sanitation measures, quarantine, and disease transmission.[16] Glanders disease is an example of a zoonotic disease that was quite relevant to the time period, but was not fully understood. Glanders is caused by a bacterium (later, in 1882, identified as *Burkholderia mallei*), and is transmissible to donkeys, goats, and sheep, though cases are most often seen in horses.[17] Before the professional development of veterinarians in Europe, "kurschmieden,"[18] provided animal care and treatment. It is these kurschmieden who would have taken care of horses with glanders. Due to their zoonotic nature, diseases such as bovine tuberculosis (bTB) and anthrax similarly caught the eye of those working in animal husbandry and health science. Produced by a bacterium, bTB causes scrofula in humans. Scrofula, or cervical lymphadenitis, occurs when humans drink milk from cows infected with bTB.[19] In Europe, scrofula was historically regarded as "the king's evil" and it was believed that in order to heal, patients needed to be touched by a gold coin that the king himself had touched (Figure 2).[20]

[15] Playfair, "Pathologically Wrong."

[16] Johnson, "Veterinary Public Health: An Historical Perspective."

[17] Sukmanadi et al., "Glanders," 2025.

[18] A German word used to describe farriers who were educated, through hands-on experience, in basic veterinary medicine; Billings, *The Relation of Animal Disease to the Public Health, and Their Prevention*. p. 283.

[19] Moulis and Martin-Blondel, "Scrofula, the King's Evil."

[20] Krugman and Chorba, "When a Touch of Gold Was Used to Heal the King's Evil."

Figure 2: 17th Century Coin Used For "Healing" Scrofula

SOURCE: Woolf. *The Sovereign Remedy: Touch Pieces and the Kings Evil*. 1685-1688. British Numismatic Society.https://commons.wikimedia.org/w/index.php?search=kings+evil+coin&title=Special%3AMediaSearch.

Concurrent with outbreaks of bTB, the "black bane" epidemic occurred. Historians and scientists now believe this epidemic was caused by anthrax, named for the black ulcers left on the skin of those infected. Koch identified anthrax's causative agent, *Bacillus anthracis*, in 1876.[21] The "black bane" killed over 60,000 humans and animals—immunization for anthrax would not be available for close to 200 years.[22] As Traditional Western Medicine (see Table 1) continued to develop, widespread instances of animal and human disease across Europe catalyzed the formation of structured veterinary schooling.

[21] Sravanthi et al., "Robert Koch."

[22] Cieslak and Eitzen, "Clinical and Epidemiologic Principles of Anthrax."; Bower et al., "What Is Anthrax?"

First regarded as an inferior branch of human medicine, veterinary medicine was originally known as "veterinary art." Distinguished historian of veterinary medicine Abigail Woods argues this point:

> "[V]eterinary medicine, as initially defined, taught and studied at Britain's first veterinary school, was not a domain apart from human medicine, but rather was continuous with it. This continuity was social, cultural, educational, and epistemological."[23]

In 1761, Claude Bourgelat established the first official college of veterinary medicine, "École Nationale Vétérinaire de Lyon," in Lyon, France.[24] Bourgelat founded the school in an effort to combat the ongoing threat of rinderpest in Europe.[25]At École Nationale Vétérinaire de Lyon, there was no age requirement and initially classes held students aging from 11 to at least 30.[26] A former student later recounted that Bourgelat disregarded individuals' previous scientific educations as physicians fearing that they would eventually overlook the job of veterinarians and continue with human medicine, as it was more profitable.[27]

For formal veterinary schools to succeed, there needed to be students. Delabere Blaine, a veterinarian and author of the *Outlines of the Veterinary Art*, described three groups of people who would be expected to study veterinary medicine in the 18th century: individuals with wealth sufficient to finance their curiosity, surgeons (who had already "travelled three-fourths of the road toward making a good veterinarian"), and those who were already *de facto* practitioners of

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[23] Woods, "From One Medicine to Two: The Evolving Relationship between Human and Veterinary Medicine in England, 1791–1835." p. 22.

[24] American Veterinary Medical Association, "Pioneering a Profession."

[25] Gibbs and Gibbs, "The Historical, Present, and Future Role of Veterinarians in One Health."

[26] American Veterinary Medical Association, "Pioneering a Profession."

[27] Ibid

veterinary medicine, such as farriers.[28] Blaine noted the intersection between animal and human health, stating that, in order to be a good veterinarian, "he must by no means sit down contented with the analogy between human and brute subject, or he may be led into very great error."[29] In writing this, Blaine amplified scientific work being done at the London Veterinary College (now referred to as the Royal Veterinary College (RVC)), incidentally, the oldest English-speaking veterinary school in the world.[30] Charles Benoit Vial de Sainbel established the RVC in 1791 after studying under Bourgelat in France.[31] Through establishing the RVC, Sainbel helped further the westward expansion of veterinary science, from France to the United Kingdom.

The turn of the 19th century marked the first wave of globalization and a time in which Early Modern (human) Medicine (Figure 1) began to take shape with Edward Jenner's discovery and creation of the vaccine.[32] Despite Europe and the United Kingdom establishing the first colleges of veterinary medicine, those who practiced veterinary medicine were still not treated with the same respect as physicians. Blaine (in his 1802 edition of *Outlines of Veterinary Art*) writes that veterinarians had until recently "been regarded as a subject beneath the dignity of a man of education, and the practice as derogatory to the character of a gentleman."[33] Despite this, formal schools for veterinary medicine in the United Kingdom continued to be established and, in 1823, William Dick founded the Highland Society's Veterinary School in Edinburgh (now

[28] Blaine, *The Outlines of Veterinary Art*, vol. 1. p. 25

[29] Ibid.

[30] University of London, "The Royal Veterinary College."

[31] Erickson, Eclipse and the London Vet College.

[32] World Economic Forum, "A Brief History of Globalization." ; Riedel, "Edward Jenner and the History of Smallpox and Vaccination."

[33] Ibid.

referred to as the Royal (Dick) School of Veterinary Studies).[34] The son of a farrier, Dick founded the school with the endorsement of the Highland and Agricultural Society of Scotland.[35]

While veterinary medicine was still struggling for professional recognition in Europe, the growing movement of animals was simultaneously spreading disease beyond its borders. In 1830, Richard Vines authored *A Practical Treatise on Glanders and Farcy in the Horse*. In this work, he notes that the character of glanders "varies according to the season of the year, as well as the state and condition in which the animal is placed, at the time of being attacked."[36] He further emphasizes that confinement increases the likelihood of infection, observing that horses kept in such conditions were more prone to developing glanders. Because confinement frequently occurs during transoceanic transport, the spread of glanders may be attributed to globalization. Vines also highlights the economic impact of glanders, noting that individual losses in Britain could reach "hundreds of pounds" within a single year. Before the automobile, horses were the pillar of economic stability, and diseases that threaten them were particularly dangerous. Prior to the establishment of the germ theory, knowledge of glanders and its treatment was limited. This lack of understanding impacted not only individual horse owners in Britain, but the nation as a whole. Vines indirectly emphasizes the national need to understand glanders when he says that the loss of horses "renders it a subject well worthy [sic] the attention of Government."[37]

Glanders was not the only disease associated with globalization. Contagious bovine pleuropneumonia (CBPP) and bTB also hindered trade operations and further emphasized the

[34] MacDonald, "Society as Veterinary Surgeon." p. 29

[35] The Royal (Dick) School of Veterinary Studies, "History."

[36] Vines, *A Practical Treatise on Glanders and Farcy in the Horse, 1830*. p. 39

[37] Ibid. p. XIX

need for formally trained veterinary professionals. Caused by the bacterium *Mycoplasma mycoides*, CBPP has a long history throughout Europe. It first arrived in the United States (U.S.) in 1843 when an infected Dutch cow aboard an English ship arrived in New York. The cow was soon purchased by Peter Dunn, a Brooklyn milkman and taken to the Blissville stables where CBPP consequently spread.[38] The disease plagued both Europe and the United States, arriving in America through the importation of cattle from Europe.[39] Although rinderpest, the impetus for Bourgelat's establishment of École Nationale Vétérinaire de Lyon) and CBPP are not zoonotic, they nonetheless featured alongside zoonotic glanders, bTB, and anthrax; veterinarians were needed for all of these problems.

One Health encompasses not only human and veterinary medicine, but also environmental health. John Shaw Billings, a public health pioneer who helped create the National Library of Medicine at the National Institutes of Health, wrote about the struggle for professionalization in environmental health. Billings stated that there "is not sufficient demand for thoroughly educated scientific men as health officers," health officers being synonymous with environmental health officers, medical officers of health (MOHs), and sanitarians.[40] On the same topic, Billings also writes that

> "[a]nother feature of this discouraging prospect is the uncertainty of tenure of office, owing to political changes; and it is this, mainly, which *prevents young men of brains and education from taking up sanitary work as a permanent profession*. This, however, is merely one branch of the vexed question of civil-service reform, and I do not propose to discuss it. I will only say, [sic] that no health officer in this country who is required, or

[38] Nicholas and Kastner, *Lung Plague*.

[39] *Contagious Bovine Pleuropneumonia Standard Operating Procedures: 1. Overview Of Etiology And Ecology*.

[40] Billings, "The President's Address." p. 7

> ought to be required, to devote his whole time to sanitary study and work, and who is qualified for his post, *receives one-half the compensation which he could earn in other professional work*."[41]

In writing this, Billings outlines not only the struggle for professionalization of environmental health workers, but also the struggle for those working as sanitarians or MOHs to receive adequate pay. Though the workers themselves were not receiving suitable recognition and compensation, institutions attempted to make progress in the area of environmental health.

One example of this environmental health development occurred in Brooklyn, New York, in 1857, during the period of Early Modern Medicine (Figure 1).[42] As a response to ongoing outbreaks of cholera, the Board of Sewage Commissioners was established. Figure 3 depicts the appearance of these early sewer systems. Construction began on these systems in the late 1800s and concluded in the early 1900s.

[41] Ibid. Italics added

[42] Cowell, "POTW."

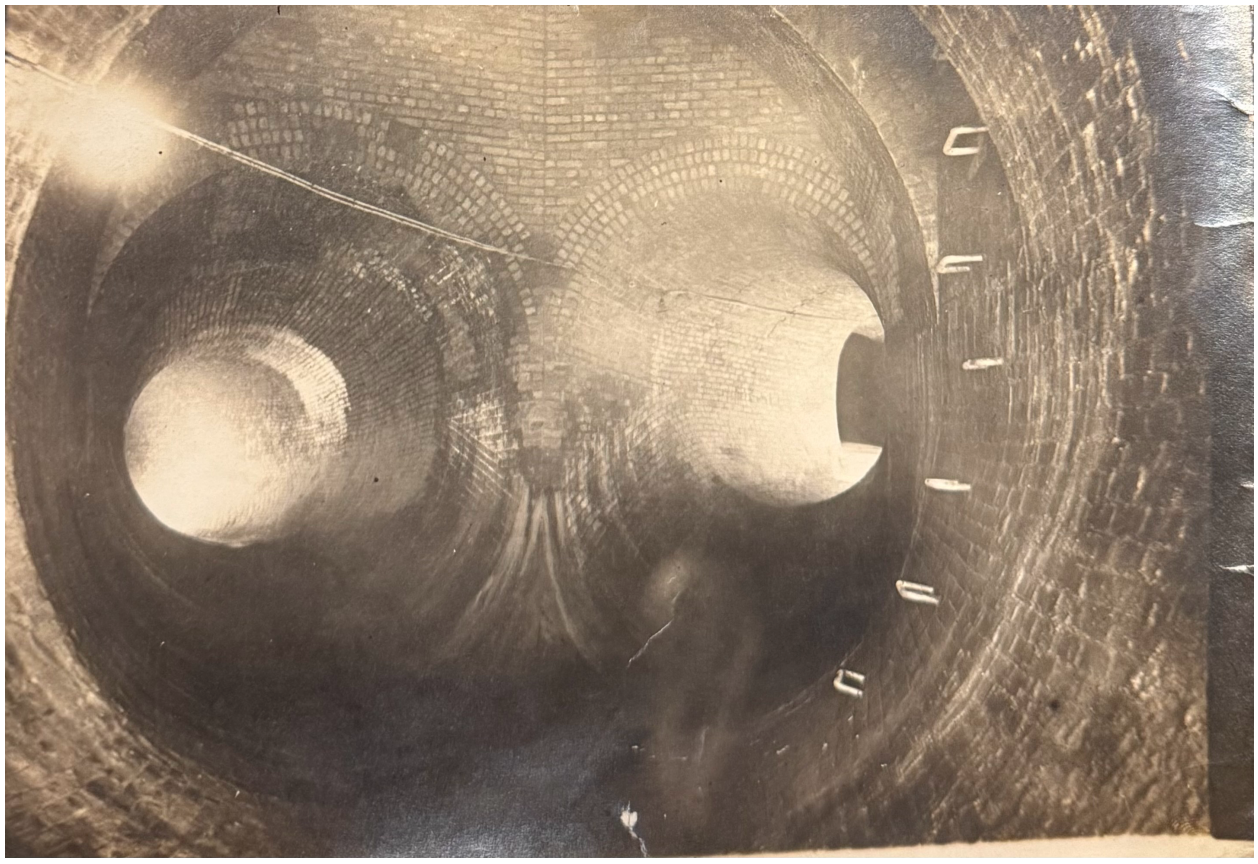
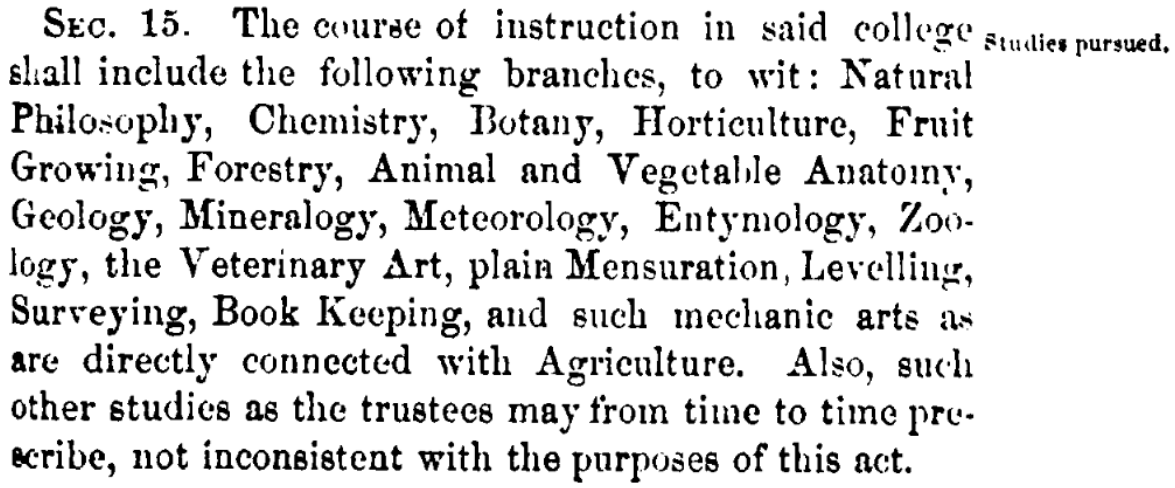


Figure 3: Bellmouth at Lewis Ave and Chauncey Street

SOURCE: Saward, Ernest. *Bellmouth at Lewis Ave and Chauncey St*. April 1916. Photograph. Brooklyn sewers construction photograph collection, call #ARC.209, Box: Prints by accession 61 ARC.209 Box 2 of 2 (Material Type: Graphic Materials). Center for Brooklyn History.

Still in use today, the Williamsburg section of the Brooklyn sewer system is the oldest in the U.S.[43] While the eastern United States began to make public health advancements, the west followed quickly behind. In 1858, the 7th Iowa General Assembly passed a series of laws. Chapter 91 of these laws included an act to establish a State Agricultural College (which would become Iowa State University). Among the stipulations for establishment, Section 15 of the act stated that this college must provide veterinary art as a course of instruction (Figure 4).

[43] Historic Towns Of America, "Brooklyn Sewer System (Est. 1857)."



SEC. 15. The course of instruction in said college shall include the following branches, to wit: Natural Philosophy, Chemistry, Botany, Horticulture, Fruit Growing, Forestry, Animal and Vegetable Anatomy, Geology, Mineralogy, Meteorology, Entymology, Zoology, the Veterinary Art, plain Mensuration, Levelling, Surveying, Book Keeping, and such mechanic arts as are directly connected with Agriculture. Also, such other studies as the trustees may from time to time prescribe, not inconsistent with the purposes of this act.

Studies pursued.

Figure 4: Chapter 91, Section 15 Laws of Iowa, 1858

SOURCE: Laws of Iowa, Agricultural College, Chapter 91, Section 15 (1858). https://www.legis.iowa.gov/docs/publications/iactc/7.1/CH0091.pdf.

While Iowa State University worked to establish its veterinary school, cases of glanders persisted. In his 1862 book, the *Illustrated Horse Doctor*, Edward Mayhew describes glanders as "the most loathsome disease to which the horse is subject."[44] Mayhew accounts for the conditions that are most favorable for glanders. He outlines that the combination of age, food intake requirements, and pressures from travel and trade (such as excessive labor and "damp lodging") create desirable conditions for a horse to have a suppressed immune system and therefore be more susceptible to glanders. Mayhew's 1862 work acted as a precursor for a formal veterinary society in the United States and in 1863, a group of veterinarians from seven different states met for a meeting in New York. This group would become the United States Veterinary Medical Association, and later, the American Veterinary Medical Association, the body still regulating and setting standards for veterinarians today.[45] Glanders eventually caught the eye of

[44] Mayhew, "The Illustrated Horse Doctor." p. 274

[45] American Veterinary Medical Association, "History of the AVMA."

local public health officials in New York. Despite a lack of formalized veterinary education and federal regulatory bodies to dictate trade, health regulations were being established at local levels. In Brooklyn, an 1873 manual for local health regulators outlined the following prohibition:

> "[N]o person shall keep, retain, or allow or employ to be kept or retained, at any place within or adjacent to the built-up portions of the City of Brooklyn, any horse, ass or colt, having the disease known as glanders or farcy."[46]

This regulation is an early example of disease control. As controlling disease meant more efficient and successful trading, efforts to control disease became more common in both Europe and the U.S. Despite One Health advancements in Britain, the U.S. had not yet established a sufficient regulatory infrastructure. Eventually, formalized veterinary education in the U.S. began to catch up with the spread of disease. In 1879, Iowa State University became the first College of Veterinary Medicine in the U.S., acting as a launching pad for formalized veterinary medicine in the United States (while not U.S.'s first veterinary school, Cornell University was home to the nation's first veterinary professor, James Law).[47] As U.S. veterinary medicine established itself, veterinary public health experts began working to establish the U.S. as a reputable agricultural trade partner. Just one year later, in 1880, Charles Lyman, an American working at Harvard University, was sent to Britain to advocate for the disease-free west. The disease-free west argument stated that though there was detection of CBPP in eastern states,

[46] Brooklyn Board of Health, *Manual of the Board of Health of the City of Brooklyn.*

[47] "Iowa History." ; While veterinary courses began at Iowa State University in 1872, the school was not formalized as a veterinary school until 1879.

cattle west of the Allegheny Mountains were disease free.[48] This was important as it exemplified that quarantine measures and disease control *could* control CBPP and therefore cattle exported from the west would not pose threat to existing British cattle; however, this argument was not accepted by the British. Dr. George Brown, head of Britain's Veterinary Department, which was then housed within the Privy Council, also did not accept this claim. Brown stated that there was not satisfactory regulatory infrastructure to uphold this claim, eventually swaying Lyman to agree. The interaction between Brown and Lyman, who were each themselves representatives of Britain and the U.S. respectively, highlights international trade disputes that were likely to persist unless the United States made further progress in veterinary public health. Britain's demands were clear: either the U.S. established more credible and consistent regulatory criteria or Britain would not continue a trade relationship with the U.S.[49]

Following the CBPP-related trade dispute between Britain and the U.S., the U.S. established the Bureau of Animal Industry (BAI), which was profoundly influential in shaping national animal health policy and trade regulation.[50] In 1884, the BAI was signed into law by President Chester Arthur as a part of the Animal Industry Act; Chapter 15 of the act, titled "Bureau of Animal Industry," outlined the establishment of the bureau and appointment of duties:

> "[To] [i]nvestigate and report upon the condition of the domestic animals and live poultry of the United States, their protection and use, and also inquire into and report the causes

[48] Kastner et al., "Scientific Conviction amidst Scientific Controversy in the Transatlantic Livestock and Meat Trade."

[49] Kastner, "Sanitary Related International Trade Disputes: A Multiple-Factor Analysis Based on Nineteenth-Century Precedents."

[50] Records of the Bureau of Animal Industry, 17.1.

> of contagious, infectious, and communicable diseases among them, and the means for the prevention and cure of the same, and to collect such information on these subjects as shall be valuable to the agricultural and commercial interests of the country." [51,52]

1884 was a transformational year for veterinary public health in the U.S. That year, Frank Seaver Billings, an American veterinarian who trained at the University of Berlin before moving to Lincoln, Nebraska, authored his book *The Relation of Animal Disease to the Public Health, and Their Prevention*. His 1884 account of glanders notes that the transmission of disease followed the westward expansion of civilization.[53] In one example, Billings recounts a letter sent to him from Lyman in Springfield, Massachusetts, where a horse was taken to a "quack" on the "no cure, no pay" principle.[54] The term "quack" was often used to describe "unorthodox medical practitioners" providing dangerous and baseless "medications" to the public.[55] Contrary to the advice given to the stable owner by Lyman, the horse remained in its stall, succumbing to glanders while infecting horses in neighboring stalls. Billings uses this example to advocate for further institutionalization and formalization of veterinary education in the U.S and wrote the following:

> "The prevention of the already described *human* diseases [anthrax and glanders] due to causes originating in our domestic animals, the suppression and prevention of devastating animal pests, can *only* be attained by the development of veterinary science, and at the

[51] Animal Industry Act, U.S. Code Title 7, Chapter 15, Section 391.

[52] Ibid

[53] Billings, *The Relation of Animal Disease to the Public Health, and Their Prevention*.

[54] Ibid.

[55] Stebbings, "The Policy of the Eighteenth Century Medicine Stamp Duty." p. 2

hands of scientifically educated veterinarians. This can only be attained by having a completely organized and State-regulated veterinary institute."[56]

Billings helped lay the groundwork for modern veterinarians' role in the One Health framework of today, and though the concept of One Health was not yet common knowledge in the 19th century, many public health figures began adopting One Health practices. In January of 1888, the Medico-Chirurgical Society of Edinburgh held a gathering of both physicians and veterinarians—a true assembly of One Health officials. At this meeting, a Scottish veterinarian, Dr. Thomas Walley, presented on the transmission of bTB from tuberculous cows. Just one month later, Walley was welcomed into the society, representing an important step forward in One Health collaborations.[57] The idea of the One Health framework dates back to the original recognition of "zoonosis," by Dr. Rudolf Virchow at the end of the 19th century during his work with *Trichinella spiralis*—a parasite found in swine.[58] Today, in the dual age of Exact Medicine and Globalization 4.0 (see Table 1), veterinary public health has evolved to encompass three key topics: animal health and food safety, the maintenance of international trade integrity, and pandemic and zoonotic disease prevention.[59] These three topics illustrate how veterinary public health works hand-in-hand with the One Health framework.[60]

As alluded to in the above partial history, scientists and veterinarians contributed to a legitimization of the One Health framework as well as the professionalization of veterinary medicine throughout the 18th, 19th, and 20th centuries. This includes people working directly

[56] Billings, *The Relation of Animal Disease to the Public Health, and Their Prevention*. p. 228

[57] Kastner and Haynes, "Physicians Welcome a Veterinarian to Problem-Solve on Tuberculosis."

[58] Schultz, "Rudolf Virchow."

[59] See Table 1 for a complete list of time periods in the history of medicine and globalization.

[60] World Health Organization., "One Health."

with, and adjacent to, the veterinary profession. These figures will be referenced in more detail throughout the thesis. Table 2 illustrates a timeline of selected veterinary public health and One Health pioneers—from Claude Bourgelat in the 18th century to James H. Steele in the 19th century.[61] Table 2, when considered alongside Table 1, reminds scholars that the story of professional development is a story of not just time periods (e.g., western medicine, Globalization 4.0, etc.) but also of *people*. These people included scientists and practitioners in veterinary medicine, human medicine, and environmental health. While there is no neat-and-tidy categorization scheme, these three professional areas are designated for each key figure in Table 2.

Table 2: Timeline of Key Veterinarians and other One Health Figures

Key Scientists and Practitioners (and profession)	Relevant Contributions to One Health
Claude Bourgelat (1712-1779) *(veterinary medicine)*	Founded the first formal veterinary school "École Nationale Vétérinaire de Lyon," in Lyon, France in 1761. Contributed largely to the exploration of CBPP in Europe.
Rudolph Virchow (1821-1902) *(environmental health and human medicine)*	Known for the establishment of cellular pathology after his observation that "every cell stems from another cell". Virchow coined the phrase "zoonosis" in the late 19th century. He worked alongside John McFadyean and William Osler to incorporate the idea of "One Medicine" (a 19th century analysis of One Health) into human and animal care education.

[61] Degueurce, "[Claude Bourgelat and the creation of the first veterinary schools]"; Nicholas and Kastner, *Lung Plague*; Monath et al., "Introduction: One Health Perspective."; "U.S. Code Title 7, Chapter 15, Section 391"; "About Johns Hopkins Medicine, "About John Billings."; Nebraska Authors, "Frank S. Billings."; Schultz, "In Memoriam."

John Shaw Billings (1838-1913) *(human medicine and environmental health)*	Contributed greatly to the creation and gathering of resources for the National Library of Medicine at the National Institutes of Health. Billings greatly contributed towards advancing public hygiene and sanitation.
Frank Seaver Billings (1845-1932) *(veterinary medicine)*	Author of "The Relation of Animal Diseases to the Public Health and their Prevention" (1884). Received his veterinary degree from the University of Berlin and established the Patho-Biological Laboratory at the University of Nebraska.
William Osler (1849-1919) *(human medicine)*	Known as the "Father of Modern Medicine," worked alongside Virchow and McFadyean to incorporate human health concerns into veterinary education.
John McFadyean (1853-1941) *(human and veterinary medicine)*	Worked in both animal and human medicine, receiving formal education in both. Collaborated with Rudolph Virchow and William Osler to incorporate veterinary science into human healthcare. Challenged and disproved Robert Koch's statement that bTB was of little concern surrounding human transmission through dairy products.
Aleen Cust (1868-1937) *(veterinary medicine)*	First woman to qualify as a veterinary surgeon after graduating from Edinburgh Veterinary College. While she graduated in 1900, she would not receive her formal diploma until 1922.
James Steele (1913-2013) *(veterinary medicine)*	Noteworthy veterinarian who founded the CDC's veterinary public health division. Steele was particularly known for his advocacy for the One Health framework.

Research Question, Methodology, and Anticipated Scholarly Contribution

Using the tripartite categories identified above (that is, veterinary medicine, human medicine, and environmental health), the author is interested in documenting noteworthy *people* and *moments* that advanced the cooperative nature of One Health. Such an admittedly enormous research undertaking could be unwieldy, of course. To address this reality, the author will limit their inquiry to (a) the time period 1761 to 1918 (from the establishment of the first formal

veterinary school until the end of World War I); (b) the disease glanders; and (c) the specific fields of veterinary medicine, human medicine, and environmental health. Glanders disease figures prominently during the selected time span, and all three professions were called upon to deal with it. Through the selected time period and focus on this disease, this thesis will characterize notable policy advancements in relation to policy and professional advancements in the One Health framework. With this limited scope of research in mind, the following research question emerges:

> **How did the professionalization of One Health (and its constituent fields of human medicine, veterinary medicine, and environmental health) during the 18th, 19th, and 20th centuries develop with reference to the disease of glanders?**

To answer this question, an inductive approach is used allowing for themes to emerge throughout the exploration of primary and secondary source documents (rather than testing a predetermined hypothesis). Maxine Reneker describes the nature of such qualitative research, stating that "researchers develop concepts, insights, and understanding from patterns in the data, rather than collecting data to assess preconceived models, hypotheses, or theories."[62] Three selected components of professionalization in relation to glanders will inform each chapter's structure: development of professional identity and legitimization among like professionals and government entities; creation of specialized training and formal education; and evolution of recognized professional organizations with qualifying standards that shaped the development of One Health professions.[63] The thesis answers the research question by examining historical primary and secondary sources, including archival sources, across human, animal, and

[62] Reneker, "A Qualitative Study of Information Seeking among Members of an Academic Community." p. 499

[63] Levine, "Professionalization of Social and Behavioral Scientists."

environmental careers to analyze the professionalization of each field through the lens of glanders disease control. Figure 5 portrays a defined summary of the three considered components of professionalization used to guide this thesis project.

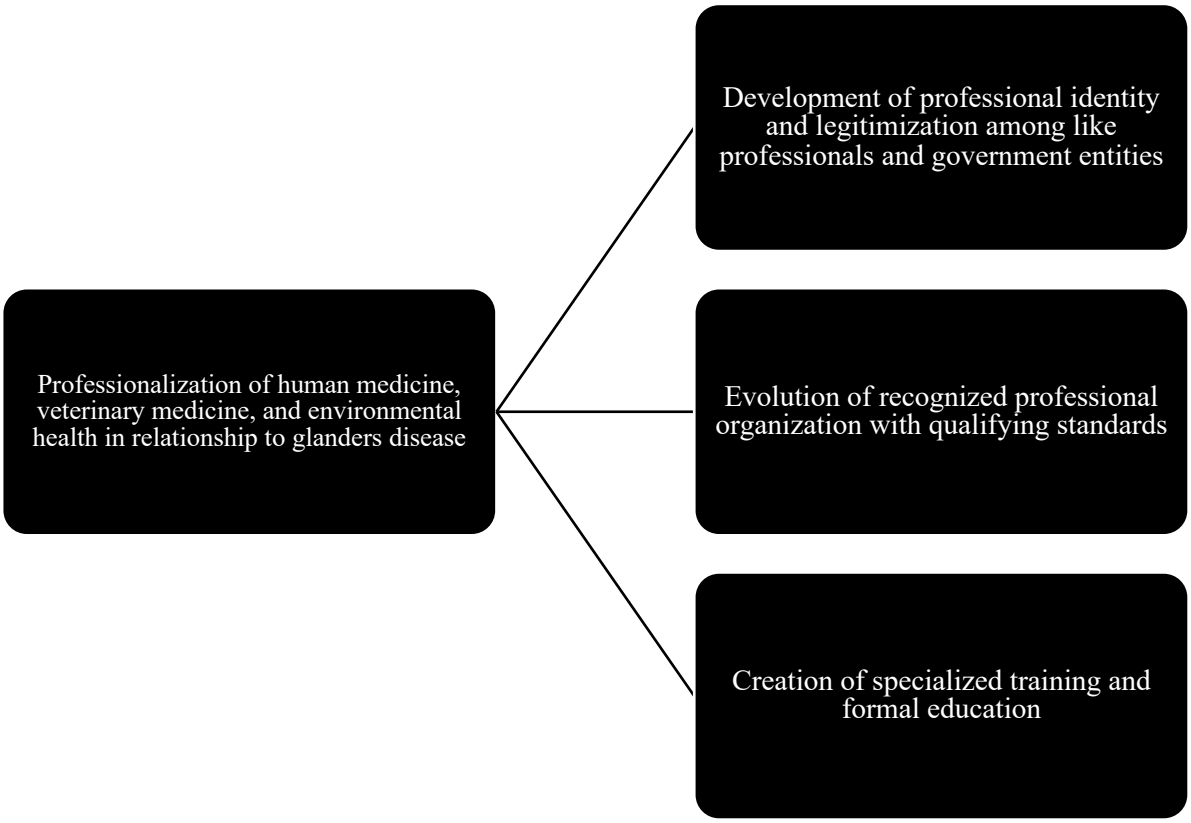


Figure 5: Three components attributed to professionalization

Note: The three components attributed to professionalization are non-exhaustive and other components of professionalization may be considered; for the purpose of this thesis, these three components will be analyzed.

Across the selected time period (1761-1918) and within each component of professionalization, the inductive methodology will support the identification of *one moment* and *one person* in each constituent field of One Health (that is, human medicine, veterinary medicine, and environmental health) as it relates glanders. This approach allows for *both* individuals and noteworthy events to emerge throughout the research process. This thesis's structure mirrors this methodology. Chapter 2 will identify one moment and one person relating

to development of *professional identity* across human medicine, veterinary medicine, and environmental health. Chapter 3 will echo this structure but identify one person and one moment relating to the *establishment of recognized organizations* for each constituent profession. Chapter 4 will continue the investigation by identifying one moment and one person relating to the *creation of specialized training and formal education*. Table 3 schematically portrays the systematic approach.

Table 3: Outline of Research Focus Areas in Chapters 2, 3, and 4 Illustrating People and Moments Per Each Category of Professionalization as it Relates to Glanders

The development of the professionalization of One Health with reference to Glanders, 1761-1918			
	Veterinary Medicine	Human Medicine	Environmental Health
Chapter 2	One person and one moment contributing to professional *identity*	One person and one moment contributing to professional *identity*	One person and one moment contributing to professional *identity*
Chapter 3	One person and one moment contributing to professional *organization*	One person and one moment contributing to professional *organization*	One person and one moment contributing to professional *organization*
Chapter 4	One person and one moment contributing to professional *training*	One person and one moment contributing to professional *training*	One person and one moment contributing to professional *training*

Chapter 5 will conclude the thesis and reflect on lessons learned. The insights of the thesis will be applicable to the One Health profession generally, and the management of glanders and zoonotic diseases specifically.

Chapter 2 - Development of Professional Identity

Introduction

The development of professional identity is a relevant step in the evolution of any profession. For the purpose of this chapter, the author will adopt the following definitions of professionalization as outlined by historian Jören Rüsen:

> "The first (a) is professional in the sense of being able to live by the trade (in the meaning of occupation, such as the French word 'profession'). The second (b) is professional as a qualified person who is recognized by society (not least by his or her fellows in academia) as competent to practice the trade with a closure directed against nonprofessionals."[64]

Rüsen's two professional definitions help to further guide this chapter and assess people and moments that relate to establishing professional identity. Throughout the chapter, each moment and person per each area of One Health will be assessed as it relates to Rüsen's definition of developing professional identity. This thesis considers the historical development of a number of named professions as it relates to the One Health framework. Providers of human medicine will be hereafter referred to as "physicians." Providers of veterinary medicine will be hereafter referred to as "veterinarians." As there is no formal "provider" for environmental health (akin to a veterinarian or physician), the progression of environmental professionalization will be examined in relation to "Environmental Health Specialists" (EHS); however, historically, and as referred to in Chapter 1, officials working in environmental health were often acknowledged as sanitarians or MOHs. Though there are myriad professionals who have, and continue to, work

[64] Rusen, *History, Professionalization Of.*

across the three disciplines of One Health, for the sake of this thesis, the three professions, as they are known today, are defined as follows:

Veterinarians

A person who has completed a Doctor of Veterinary Medicine (DVM) (or equivalent) providing them with expertise on the treatment and health of animals. Veterinarians also contribute to research and analysis of animal-only and zoonotic diseases and inform animal/food safety regulatory standards across governmental and non-governmental organizations (NGO).[65]

Physicians

A person who has completed a Doctor of Medicine (MD) or Doctor of Osteopathic Medicine (DO) (or equivalent) providing them with expertise on the treatment and health of humans, contributes to the research and analysis of human-only and zoonotic diseases, and has the capacity to inform health regulatory standards across governmental and NGO organizations.[66]

Environmental Health Specialists

A person who has completed relevant education and works in a capacity to conduct research and investigations relevant to protecting environmental health.[67] Sometimes (both historically and presently) referred to as sanitarians or MOHs, EHSs have the capacity to inform environmental health regulatory standards across governmental and NGO organizations; this may include, but is not limited to, the natural and built environment.

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[65] Attrey, "Role of Veterinary Experts in Food Safety."

[66] AMA Policy Finder, "Definition of a Physician, H-405.969."

[67] The Bureau of Labor Statistics defines typical-entry level education as a bachelor's degree

Mindful of the above definitions, this chapter now turns to an exploration of how the uniquely One Health challenge of glanders influenced the development of professional identities within veterinary medicine, human medicine, and environmental health.

Veterinary Medicine

During the 19th century, veterinarians struggled to establish an independent professional identity. In 1866, an early edition of the *Veterinary Surgeons Bill*[68] was read for the second time in the British House of Commons. During this reading, Vice-President of the Privy Council, Henry Austin Bruce,[69] stated that he did not believe that veterinary science, as it existed in 1866, was "sufficiently advanced to entitle the members of the College to a monopoly of the practice."[70] Bruce believed that veterinary science was not yet advanced enough for members of the Royal College of Veterinary Surgeons (RCVS) to have specific legal rights to practice medicine distinguishing themselves from people providing veterinary medicine without training. Eight years earlier, as human physicians had long been recognized as a professional entity, the Medical Act of 1858 gave British physicians specific privileges; however, the House of Commons was reluctant to give the veterinary professionals that same recognition.[71]

Despite the House of Commons' reluctance to recognize the identity of the veterinary profession, veterinary services remained a necessary part of society. At this time, horses played a vital role in ensuring military success. Horses were essential for transportation and cavalry operations. A horse's ability to travel great distances significantly influenced military tactics.[72] In

[68] Passed officially by the British Parliament in 1881.

[69] In the House of Commons, Bruce was responsible for human medicine and veterinary medicine affairs.

[70] Fisher, "Not Quite a Profession: The Aspirations of Veterinary Surgeons in England in the Mid Nineteenth Century." p. 284

[71] Ibid.

[72] Dvorak and Spickler, "Glanders." Sofaly et al., "Chapter 8: Military Equine Programs."

his article, "Glanders," featured in the 1902 edition of the *Journal of Comparative Pathology and Therapeutics*, W.M. Hunting, a Fellow of the Royal College of Veterinary Surgeons (FRCVS), wrote about the spread of glanders throughout Britain and the world. In the age of Late Modern Medicine and the First Wave of Globalization (see Figure 1), war and globalized trade were the major causes of the spread of glanders. Hunting expands on this:

> "The spread of glanders from country to country by war and commerce is an important matter. We [those in the Britain] have imported the disease from Canada and from the United States. We have exported it to Holland and Belgium. Our wars have carried it from India to Egypt, from Liverpool to Cape Town. We imported glanders to South Africa from Canada and the U.S.A., and it is to be hoped that no horses from South Africa will be sent to other countries for some months unless they have been tested with mallein."[73]

Because of the role horses played, it was in the best interest of the military to keep horses healthy. Glanders, in horses and other animals in the Equidae family (horses, donkeys, zebras, etc.), appears as "nasal, pulmonary, or cutaneous, contingent on the location of the initial lesion."[74] Cutaneous glanders is also known as "farcy," and is often seen as such in historical literature. Depending on the type of glanders that an animal has, the disease may impact the upper respiratory tract, the skin (through the appearance of nodules, called "farcy buds"), or pulmonary regions including the lower respiratory tract.[75] Glanders is most commonly spread by

[73] The mallein test is most frequently used to diagnose glanders. Mallein is a purified protein derivative, like tuberculin, used to diagnose tuberculosis. See de Carvalho Filho et al., "Development and Validation of a Method for Purification of Mallein for the Diagnosis of Glanders in Equines" and Hunting, "Glanders." p. 225

[74] Sukmanadi et al., "Glanders," 2025. p. 3917

[75] Dvorak and Spickler, "Glanders."

indirect, or direct, contact with other infected animals, and proven transmitted through fomites (inanimate objects contaminated with a pathogen, and in the case of glanders in horses, may be grooming tools or bridles).[76]

Through the First Wave of Globalization and age of Early Modern Medicine (see Table 1), if diseased, a horse no longer had the capacity to support the military. At this time, individuals working to keep horses healthy were usually known as farriers.[77] In 1785, during a meeting of the Agricultural Society of Odiham in Hampshire, England, the importance of farriers was described:

> "Farriery [sic] is a most useful science and intimately connected with the Interests of Agriculture; that it is in a very imperfect neglected state and highly deserving the attention of all friends of Agricultural economy."[78]

As glanders played a major role in military expeditions, the need for a dedicated profession to maintain control over the disease became more urgent. In 1796, the British Army's Board of General Officers distinguished veterinary surgeons from human surgeons, ridding the profession[79] of the "farrier" nomenclature. This distinction marked an important way forward for veterinarians. Aligning with Rüsen's second definition of professionalization, veterinary surgeons began gaining societal recognition, though the profession was still developing. Just one year following the distinction of veterinary surgeons from human surgeons, Erik Nissen Viborg[80] demonstrated that "inoculation with matter from farcy buds could induce glanders in horses and

[76] Sukmanadi et al., "Glanders," 2025.

[77] Pattison, "The Beginning–A Veterinary School for London in 1791," p. 1.

[78] Ibid p. 2.

[79] Specifically, the British military was ridded of the nomenclature of "farrier." Outside of the military, farriers still existed.

[80] Seen in literature as both "Erik" and "Ericus".

assess."[81] Viborg (see Figure 6) was a Danish veterinarian and botanist. He began his life following in his father's footsteps studying theology; however, Viborg took a great interest in applied sciences and joined the Danish Veterinary School first as a student and later as a professor.[82]

Figure 6: Erik Nissen Viborg

SOURCE: Dansk. *Erik Nissen Viborg (1759-1822), Veterinær Samt Hobbybotaniker*. 1820. Det kongelige Bibliotek - http://img.kb.dk/portraet/DP033614.jpg. Uploader was Hchristophersen at da.wikipedia. https://commons.wikimedia.org/wiki/File:Erik_Viborg_1759-1822.jpg.

[81] Wilkinson, "Glanders," 1981. p. 365

[82] The Danish Veterinary school was the first veterinary school in Copenhagen, founded by Peter Abildgaard in 1773; Nielsen, *The Veterinary Profession in Denmark*. p. 307

Viborg was recognized for his glanders research and for understanding "practically all that was known about glanders up to the time of the discovery of *Bacillus mallei*."[83,84] His research concluded, correctly, that farcy (the cutaneous form of glanders) and glanders (the pulmonary form of glanders) stemmed from the same pathogen. Viborg also recognized that these forms of glanders were caused by a "virus" capable of being killed by heat (while it was not correct that glanders is caused by a virus, it is notable that he recognized the agent could be heat-killed).[85] Viborg's recognition of inoculation causing farcy buds indirectly supports part (b) of Rüsen's professional definition exemplifying that, as a veterinarian, he was competent enough to practice the trade[86] and therefore contributed to the development of veterinarian's professional identity as not only providing medical care to animals, but contributing to veterinary research.[87]

Human Medicine

Prior to the widespread societal recognition and professionalization of veterinary and human medicine, quacks were among those claiming to provide medical services to both humans and animals. In 1804, Ietros[88] wrote on the British quack's ability to "increase rather than diminish the number of patients of the regular practitioners, as quack medicine are generally calculated to amuse without curing the sick."[89] However, quacks also referred to qualified[90] members of the medical community who engaged in the selling of medicines. The growing

[83] *Bacillus mallei* was *Burkholderia mallei*'s former name.

[84] Wilkinson, "Glanders," 1981. p. 373

[85] Ibid.

[86] Competent enough to practice veterinary medicine in that he was able to make a scientific distinction.

[87] Part (b) is professional as a qualified person who is recognized by society.

[88] Unknown first name.

[89] Iteros, "Letter I."

[90] Qualified in that they had received formal medical training.

accounts of quack medicine became so prominent in 18th century England, that a rare tax was enforced on the medications. Aggressively promoted to the public, quack medicine adverts appeared in newspapers and there were at least two-hundred recognized quack medicines in 1748 including the following: Dr Johnson's Yellow Ointment, Daffy's Elixir, Friar's Balsam, Dr James' Fever Powders and Velnos' Vegetable Syrup.[91] In July 1785, the Medicine Stamp Duty Act was first addressed by the House of Commons. In the 18th century, tax reforms were suggested by revenue boards,[92] the stamp duty being no exception. The Revolutionary War left Britain two-hundred and thirty-four million Great British Pounds (GBP) in debt; annual tax revenues amounted to thirteen million GBP (of which eight million GBP went to relieving the debt). The original medicine tax focused on the public harm done by the quack and not the specific medicine, as anyone could purchase a license to sell. As written in Stebbings' retelling of the 18th century policy,

> "The most vociferous opponent of the tax, Francis Spilsbury, not only believed that Cavendish had introduced the tax because he thought quack medicines were harmful, but maintained that he had introduced the Act by saying that since quack medicines had done much harm to the public, it was fair game to tax them."[93]

Over 100 years later, the United States dealt with a prominent quack of its own. In the world of human medicine, John Brinkley made a name for himself, but not for good reason. Brinkley wanted to become a doctor, but did not have the capacity to study and complete medical training. After failing out of Bennett Eclectic Medical College in Chicago, he traveled to Kansas City and bought a medical diploma from Kansas City Eclectic Medical University. He

[91] Stebbings, "The Policy of the Eighteenth Century Medicine Stamp Duty."

[92] Revenue boards historically imposed taxes in Britain.

[93] Stebbings, "The Policy of the Eighteenth Century Medicine Stamp Duty."

then began "practicing" medicine, but developed a reputation for the number of "unfortunate patient outcomes, including deaths, that occurred under Brinkley's care."[94] Eventually, in 1930,[95] the Kansas Medical Board revoked his medical license.

Despite the controversy surrounding Brinkley's practices, and the eventual loss of his medical license, the scientific understanding of disease and medicine was still limited and widely debated. During the first half of the 19th century, it was not widely accepted, by physicians, veterinarians, or quacks, that glanders could be transmitted directly from animals to humans; even Viborg, someone who knew all there was to know about glanders, did not subscribe to this idea. Historical literature explicitly mentioned and recognized diseases such as rabies and plague because their symptoms are easily identifiable, but glanders posed greater diagnostic challenges. Glanders, in humans, is difficult to diagnose. Symptoms may be confused with other diseases, like tuberculosis, and therefore cases of glanders were often classified as tuberculosis in historical records. Edmond Nocard, a notable microbiologist and veterinarian, wrote about this in his book Nocard, *The Animal Tuberculoses and Their Relation to Human Tuberculosis*, writing that "there comes the question whether the lesion is due to glanders or tubercle, and here again inoculation is the most certain means of deciding."[96] Nocard worked extensively on mallein and tuberculin tests, which identify cases of glanders and tuberculosis respectively. His comment exemplifies the difficulty in distinguishing the diseases and the necessity for testing to differentiate.[97] Glanders in humans also occurred irregularly, often as individual cases in farriers,

[94] Landess, "State Medical Boards, Licensure, and Discipline in the United States." p. 337

[95] While 1930 is after the allocated timespan that this thesis covers (1761-1918), moment is mentioned due to its relevance to the author's home institution, Kansas State University.

[96] Nocard, *The Animal Tuberculoses and Their Relation to Human Tuberculosis*. p. 123

[97] Institut Pasteur, "Edmond Nocard, Discoverer of the Nocardia Bacterium."

but not as a typical outbreak of multiple cases as seen in other diseases like tuberculosis (TB).[98] Dr. John Gamgee writes on this in his journal, the *Edinburgh Veterinary Review and Annals of Comparative Pathology*, saying:

> "From time to time cases of glanders or farcy are reported as occurring in the human subject, but the frequency with which support reports meet the public eye bear no relation to the actual number of cases which are observed. As with several other forms of disease due to animal poisons, there are many cases overlooked and never diagnosed."[99]

Gamgee was an Italian-born British veterinarian originally educated in human medicine. He made the transition from human medicine to veterinary medicine when his brother, Joseph Sampson Gamgee (also a notable public health pioneer), made the opposite switch from veterinary medicine to human medicine. Dr. John Gamgee was educated at the RVC in London and graduated in 1852. He then traveled around continental Europe for several years before returning to London in 1855. In 1856, he was invited by William Dick to fill the role of Chair of Anatomy and Physiology at the Edinburgh Veterinary College, so he moved to Edinburgh.

While Gamgee's later career helped advance veterinary medicine and education in Britain, his work was built upon a larger history of investigating animal diseases and their transmission to humans. In 1812, a French surgeon, known only as "Dr. Lorin"[100] diagnosed two[101] human members of the French regiment as having contracted glanders from a glandered horse. Lorin documented that these individuals had received minor injuries to their hands while

[98] Wilkinson, "Glanders," 1981.

[99] Gamgee, "Glanders in the Human Subject." p. 140

[100] First name unknown

[101] Some literature states Lorin diagnosed one individual, others state two.

operating on the animal.[102] In removing the nodules that had formed on the hands of the infected individuals, Lorin was able to cure them of illness. This was the first recorded recognition that glanders could be transmitted from animals to humans.[103] In identifying the transmission between human and animal, Lorin appealed to the second half of Rüsen's professional definition, asserting that, as a physician, Lorin was able to differentiate the causative root of glanders in humans from glanders in horses and, therefore, was a competent physician. Glanders helped legitimatize the profession of physicians and, because of Lorin's observations, the severity of the disease and transmission of glanders to humans from animals would eventually be recognized and understood. In 1908, William Hunting, Chief Veterinary Inspector to the London County Council, relayed the following:

> "Glanders in man is such a loathsome and fatal disease as to deserve more attention than it receives. If the medical profession called for the suppression of glanders as loudly as they did for the extermination of rabies, prevention in all animals would be accelerated. Hydrophobia in man ceased when we had stamped out rabies in dogs, and glanders in man will only cease when the disease no longer exists among horses."[104]

Hunting, a veterinarian, reinforced the significance of Lorin's observation by emphasizing that glanders deserved greater recognition among physicians.[105] Virchow would not coin the term

[102] Wilkinson, "Glanders," 1981; Brush, "Observations on Glanders."

[103] Wilkinson suggests that there was an unpublished understanding of this transmission two years prior.

[104] Wilkinson, "Glanders," 1981. p. 363

[105] An early example of the One Health framework.

zoonosis for another forty-three years, and Lorin's observation helped pave the way for not only physicians, but all professionals linked to One Health.[106]

Several 19th and 20th century veterinarians cited Lorin's work on glanders, including Dr. James Law. A Scottish veterinary surgeon and public health pioneer, Law enrolled at Edinburgh Veterinary College at age sixteen. In 1868, Law moved to the U.S. and became the country's first veterinary professor at Cornell University in Ithaca, New York (see Figure 7).[107]

Figure 7: James Law seated during conference in front of a papier mâché anatomical model of a horse created by Dr. Louis Auzoux

SOURCE: Unknown. *Professeur James Law, Fondateur Du Cornell Veterinary College, Ithaca (État de New York), Assis, En Pose Photographique Lors d'une Conférence.* circa 1900.

[106] Hubálek and Rudolf, "Types of Human Disease by Source of the Infectious Agent."

[107] Nicholas and Kastner, *Lung Plague*.

http://www.news.cornell.edu/stories/2014/10/cornell-rewind-white-buys-europes-finest-books-profs. https://commons.wikimedia.org/wiki/File:JamesLaw-PapierMacheHorse-A10-16a.jpg.

In Law's 1902 publication, *Textbook of Veterinary Medicine*, he cites Lorin as the first physician to recognize the transmission of glanders to humans from animals, an example of the lasting impact Lorin's work had on the human medical profession. Law's statement, as related to the professionalization of physicians in human medicine, helped again to distinguish veterinarians from physicians. By acknowledging Lorin's observations in a veterinary medicine textbook, Law recognized human medical discoveries as relevant to veterinary science, demonstrating that glanders treatment and control required expertise both professions. Law's recognition of Lorin's contributions aligns with Rüsen's definition of professional development. Law's book helped to recognize the human medical profession, distinguishing veterinary medicine from human medicine.

Environmental Health

In the same book where he acknowledges Lorin's work, Law also states that infections of glanders may be caused from "clothing [or a] stable bucket."[108] Law's veterinary medicine textbook provided another example of bridging the One Health gap by recognizing glanders as a concern for both human and environmental health. Law was friends with another public health pioneer, Dr. John Gamgee, some even describing Law as the *protégé* of Gamgee. [109] Gamgee spoke, and wrote, frequently on 'the legacy of Free-trade legislation,' an issue related to CBPP.[110] He also advocated against the consumption of diseased animals as food.[111] In

[108] Law, Text Book of Veterinary Medicine, vol. 4. p. 246

[109] Nolan, "A Great Teacher of Great Men." Nicholas and Kastner, *Lung Plague*.

[110] Nicholas and Kastner, *Lung Plague*. p. xvi

[111] Francis, "John Gamgee (1831-1894)."

advocating against the consumption of diseased meat, Gamgee argued that it threatened humans, animals, and the environment, anticipating the principles later formalized as One Health. Gamgee stated that he would "consider [the sale of diseased meats] effects, *firstly*, on the health of stock; *secondly,* on the health of the people; *thirdly,* in impoverishing the farmers and the country generally."[112] Not only was Gamgee conscious of the impact that diseased meat had on humans and animals (stock), but he also brought attention to the impact it had on environmental health.

As an early advocate for One Health, Gamgee commented on the environmental conditions experienced by a horse with glanders in 1864, Robert Jennings, a veterinary surgeon and professor at the Veterinary College of Philadelphia, authored *Glanders*. In *Glanders*, Jennings quotes Gamgee as stating the following:

> "Horses undoubtedly affected with this dreadful malady should be destroyed as soon as the disease is satisfactorily diagnosed. Various mineral tonics, have been vaunted as specifics, but we cannot conceive on what principle [sic] animals should be allowed to live, endangering the life of those around them with no benefit to themselves."[113]

Jennings then quotes a remarkable-for-its-time (1833) publication that alludes to fomite-mediated transmission of glanders:

> A glandered horse may contaminate the air of a stable to such a degree, that horses breathing the same air may become infected with the disease, although the infected may never come in contact with the infecting horse. Fortunately [sic] glanders is not so

[112] Gamgee, "The Diseases of Animals in Relation to Public Health and Prosperity." p. 258

[113] John Gamgee (unidentified publication) as cited by Jennings in Jennings, Robert. Glanders. Philadelphia, 1864, p. 8

> infectious as some other diseases to which horses are liable, otherwise the breed would soon become extinct."[114]

In writing this, Gamgee appeals to Rüsen's definition for developing a profession. Gamgee makes the argument that, from his veterinary perspective, glandered horses should be destroyed.[115] In asserting that only "satisfactorily" diagnosed cases of glanders warrant this reaction, the veterinary authority was reinforced. However, veterinary regulatory authority did not, at this time, extend to the management of environmental health. During the second half of the 19th century, there was a struggle for environmental health professionals to gain respect as a profession. At the 8th annual meeting of the American Public Health Association (APHA), John Shaw Billings, then president, gave the opening address. On the topic of environmental health professionals and the struggle to establish a professional identity, he said the following:

> "In conversations with prominent health officials, I find that their difficulties and troubles may be placed in two classes. The first are those connected with the fact that they cannot make a living by devoting themselves entirely to sanitary work, as they would like to do; that there is not sufficient demand for thoroughly educated scientific men as health officers to give such pay for their services as they require; and that, therefore, they have to do other things, to practise medicine, etc. Another feature of this discouraging prospect is the uncertainty of tenure of office, owing to political changes; and it is this, mainly, which prevents young men of brains and education from taking up sanitary work as a permanent profession. This, however, is merely one branch of the vexed question of civil-service reform, and I do not propose to discuss it. I will only say, [sic] that no health

[114] Karkeek, W.G. "On the External Causes of Disease (Aerial Poisons, Etc.). p. 8.

[115] Known today as culled.

> officer in this country who is required, or ought to be required, to devote his whole time to sanitary study and work, and who is qualified for his post, receives one-half the compensation which he could earn in other professional work. Those who have done the best work in public hygiene have not reaped corresponding pecuniary rewards; nor is it to be expected, that, in this sense, the study of sanitary science, or the fitting one's self to act as a public health official, will pay the individual."[116]

Billings's address is an example of the struggle faced by EHSs. He acknowledges that, at this time, EHSs could *not* make a living wage in their work, something that Rüsen defines as a necessary factor in the development of professionalization. Almost twenty years after Billings delivered his address in the United States, veterinary inspectors in the U.K. were formally distinguished from private practice veterinarians. These veterinary inspectors also served as early EHSs and investigated and diagnosed glandered horses.[117]

The 1899 British Report of Departmental Committee on Glanders recommended that "where practicable [sic] the local veterinary inspector should not engage in private practice."[118] This recommendation helped to transform veterinary inspectors into early environmental health professionals by separating them from private commercial interests. Instead, these veterinary inspectors established themselves as independent experts who protected public and environmental health by diagnosing glanders in horses. Veterinary inspectors distinguished themselves as such by not only diagnosing the horses, but also recognizing and identifying environmental conditions that may contribute to further the spread of the disease. The committee's recommendation supports Rüsen's definition of professionalization. The

[116] Billings, "The President's Address." p.7

[117] Hunting, "Glanders."

[118] "The Report of the Departmental Committee on Glanders." p. 1

recommendation specifies that veterinary inspectors should not engage in private practice, alluding to their ability to "live by the trade;" and, in living by the trade, veterinary inspectors were recognized by British authorities as a qualified person whose profession was to identify and diagnose glandered horses through not only medical symptoms, but through the attributable environmental conditions.

People and Moments

This analysis identifies three individuals and three moments that illustrate the evolution of recognized professional organizations within the One Health framework as it relates to glanders. Each person and moment are supported by Rüsen's definitions of professional development and professional identity. In veterinary medicine, Erik Viborg concluded that farcy and glanders stemmed from the same pathogen and also recognized that these forms of glanders were caused by a "virus"[119] capable of being killed by heat. In human medicine, Lorin diagnosed two human members of the French regiment as having contracted glanders from a glandered horse. In removing the nodules that had formed on the hands of the infected individuals, he was able to cure them of illness. This was the first recorded recognition that glanders could be transmitted from animal to humans. Finally, in environmental health, John Gamgee made the argument that, from his veterinary and environmental health perspective, glandered horses should be "destroyed," because of their ability to transmit glanders throughout a stable by means of direct, indirect, and fomite transmission.[120]As illustrated at the beginning of this chapter, professionals working in environmental health do not have a single recognizable professional title as do veterinarians and physicians. This chapter identifies a moment when veterinary

[119] While it is not caused by a virus, the bacterial agent causing glanders *can* be heat-killed.

[120] Fomites in a stable may include bridles, saddles, etc.

inspectors were separated from private practice veterinarians to form an early environmental health profession, while still retaining aspects of veterinary medicine. The 1899 recommendation to separate veterinary inspectors from veterinarians in private practice marked an important step toward establishing inspection as a distinct public function, helping to differentiate environmental health responsibilities from clinical veterinary practice.

Table 4: People and Moments Contributing to the Development of Professional Identity across the One Health Framework

Development of Professional Identity			
	Veterinary Medicine	Human Medicine	Environmental Health
Person	Viborg: Identified the connection between farcy and glanders and helped establish legitimacy in the practice of veterinary medicine by advancing scientific understanding.	Lorin: Diagnosed two members of the French regiment as having glanders, tying human medicine and veterinary medicine together by recognizing that glanders can be transmitted from animals to humans.	Gamgee: Argued that, from an environmental health perspective, glandered horses must be "destroyed" to prevent further infection from spreading in a stable.
Moment	1796: British Army coined the term "veterinary surgeon."	1902: Dr. James Law's recognition of Lorin's work in his book *Textbook of Veterinary Medicine*.	1899: *The Report of the Departmental Committee on Glanders* recommended that local veterinary inspectors should not engage in private practice.

Chapter 3 - Evolution of Recognized Professional Organization

Introduction

The second relevant criteria in the development of a profession involves the evolution of a recognized professional organization with qualifying standards. Whereas Chapter 2 examined Rüsen's definition of developing a recognized profession, Chapter 3 draws on American sociologist Harold Wilensky's framework for how occupations gain professional status. In his article, "The Professionalization of Everyone?," Wilensky states that:

> "Any occupation wishing to exercise professional authority must find a technical basis for it, assert an exclusive jurisdiction, link both skill and jurisdiction to standards of training, and convince the public that its services are uniquely trustworthy."[121]

Using Wilensky's framework as a guide, this chapter will examine how glanders specifically played a role in establishing an "exclusive jurisdiction" for One Health-related professional organizations. This chapter identifies one person and one moment within veterinary medicine, human medicine, and environmental health to illustrate how glanders contributed to the evolution of recognized professional organizations.

Veterinary Medicine

The RCVS was created in 1844 after the Royal Charter recognized veterinary art as a profession. However, the RCVS lacked formal parliamentary authority, and could not yet stop unqualified practitioners (quacks) from practicing veterinary medicine.[122] Approximately forty years later, the British Parliament passed the *Veterinary Surgeons Act of 1881*. This Act created an official Register of qualified veterinarians, legally distinguishing the qualified from the

[121] Wilensky, "The Professionalization of Everyone?" p. 138

[122] RCVS Knowledge., "History of the RCVS."

unqualified and imposing penalties on those who illegally practiced. Section two of the Act states:

> "2. In this Act—
>
> 'The Royal College of Veterinary Surgeons' means the Royal College of Veterinary Surgeons incorporated and regulated by a charter and two supplemental charters granted by Her Majesty in the years one thousand eight hundred and forty-four, one thousand eight hundred and seventy-six and one thousand eight hundred and seventy-nine respectively. "The Registrar" means the Registrar for the time being of the said Royal College. "Veterinary surgery" means the art and science of veterinary surgery and medicine."[123]

The Act required publication of the Register of students, established procedures for maintaining it, required qualifying examinations, outlined admission procedures for foreign practitioners, permitted experienced unregistered practitioners to join the Register under limited circumstances, prohibited unregistered practice, and granted the College authority to prosecute violations.[124] These qualifying standards align with Wilensky's conception of professionalization and strengthened the legitimacy of the British veterinary profession. The *Veterinary Act of 1881* strengthened the RCVS by professionalizing and legitimizing the work of veterinarians during a time when glanders posed a great threat to animals and humans. The Act ensured that recognized professionals, rather than unqualified practitioners, treated diseases such as glanders.

While men are most prominently featured in the documented history of science, many women played a role in scientific discovery and the evolution of professionalization. One of

[123] *Veterinary Surgeons Act 1881*.

[124] RCVS Knowledge., "Veterinary Legislation in the UK."

these women was Aleen Cust (see Figure 8). Cust was born in 1868 in Cordangan County, Ireland. She was the first woman to qualify as a veterinary surgeon. Although she completed her veterinary training, the law prohibited her from using the professional title of veterinary surgeon. She studied to become a veterinary surgeon at Edinburgh Veterinary College and completed her studies in 1900, but she was barred by the RCVS from taking their qualifying examinations.[125] She practiced veterinary medicine in Ireland and, despite lacking official recognition as a veterinary surgeon, her veterinary peers recognized her competence.[126]

[125] She would eventually be given her official diploma in 1922; "From the Archives: Aleen Cust - UCD School of Veterinary Medicine."

[126] Ibid.

Figure 8: Aleen Cust, the first woman to qualify as a veterinary surgeon

SOURCE: Unknown. English: Aleen Isobel Cust (1868–1937). n.d. http://www.snipview.com/q/Aleen%20Cust. https://commons.wikimedia.org/wiki/File:Aleen_Cust_portrait.jpg.

In 1915, she left her position as veterinarian William Byrne's assistant to travel to the WWI Western Front in France and attend to horses.[127] Throughout WWI, Germany deployed glanders as an agent of biological warfare (BW) against the U.S., Romania, Spain, and France. Because Cust treated horses during WWI in France, it is likely that she tended to glandered horses. Cust became an official member of the RCVS only in 1922, when she was the first woman to whom

[127] Jones, "Remembering Aleen Cust"; "From the Archives: Aleen Cust - UCD School of Veterinary Medicine."

the RCVS granted membership. Only then was Cust formally acknowledged by society, and the U.K. Parliament, as a veterinarian. The expansion of the RCVS to include women represents its change over time as a professional organization responding to important veterinary contributions made by such women.

Another important figure in the evolution of professional organizations in veterinary health was George Fleming. Fleming, a Scottish veterinarian, served as president of the RCVS when the *Veterinary Surgeons Act of 1881* was passed.[128] In 1875, Fleming published his book *A Manual of Veterinary Sanitary Science & Police*. Throughout his book, Fleming wrote exclusively on "embracing the nature, causes, symptoms, etc., and the prevention, suppression, therapeutic treatment, and relations to the public health of the epizootic and contagious diseases of domesticated animals."[129] As a veterinarian, Fleming wrote extensively on environmental health. For the purpose of this chapter, however, Fleming's contribution to the professionalization of One Health is categorized under his veterinary medicine work, it is important to also note his contributions to the progression of environmental health. Fleming researched, wrote, and published the book during the Age of Early Modern Medicine and the First Wave of Globalization (see Figure 1). This period provides important context because Fleming opened his discussion of glanders by describing its global spread. He writes that veterinarians did not recognize glanders in Mexico until the conflict between the United States and Mexico in 1847. At the time of writing, Fleming also notes that glanders was not found in Australia or India, but present throughout Europe and northern China. The transmission of glanders at this time directly reflects the impacts that globalization had on the spread of disease.

[128] Oxford Dictionary of National Biography., "Fleming, George (1833–1901), Veterinary Surgeon."

[129] Fleming, *A Manual of Veterinary Sanitary Science and Police*, vol. 1.p. 1

Although Australia remained free of glanders when Fleming published his book, the disease first appeared there in 1891 in circus horses that had been imported from the U.S.[130] Fleming uses Australia as an example for implementing permanent precautionary measures:

> "[O]f course everything depends upon the care with which new arrivals are examined, and suspicious cases isolated, until a decision as to their condition can be safely and certainly given. In these suspicious cases, the isolation must be as complete as possible; and every precaution ought to be observed, so long as there remains any cause for doubt. It is desirable that the ports by which horses or other solipeds are admitted be defined, so that this inspection may be assured."[131]

Australia ultimately followed Fleming's recommendations and every horse either infected or exposed was culled and the remaining horses were exported back to the U.S.[132] Fleming's work aligns with Wilensky's criterion for professionalization as he asserted an exclusive jurisdiction by identifying contagious animal diseases as a specialized area of veterinary expertise requiring trained veterinary professionals. Fleming broadened veterinary jurisdiction from clinical treatment to disease prevention and public health, strengthening the profession's claim to authority over animal disease control.

Human Medicine

During the 18th, 19th, and 20th centuries, numerous institutions throughout Europe and the U.S. recognized the organized human medical profession. In 1773, London physicians founded

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[130] *Review of Risks Associated with Glanders (Burkholderia Mallei) in Horses and Horse Semen - Draft Report 2022*.

[131] Fleming, *A Manual of Veterinary Sanitary Science and Police*, vol. 1. p. 549

[132] *Review of Risks Associated with Glanders (Burkholderia Mallei) in Horses and Horse Semen - Draft Report 2022*.

the Medical Society of London as the first association where "different branches of the medical profession could meet on equal terms to learn from one another."[133] Its purpose was to create a space where physicians, surgeons, and other medical providers (like apothecaries) could come together and exchange ideas.[134] During the early years of the society,

> "[a]dmission to membership was by personal nomination, followed by a ballot (three-quarters of votes in favour were required for election), although to help the establishment of the society the founders bypassed this system to elect some leading figures such as James Parkinson who described his eponymous disease in 1817). A special category of honorary members was created for distinguished non-medical scientists such as Humphry Davy, who became famous for his invention of the miner's safety lamp, first used in 1816."[135]

Though admission was by personal nomination, the ballot of "three-quarters of votes in favor" reflected the evolution of a professional organization with specific qualifying standards.

Nearly fifty years after the establishment of the Medical Society of London, the Royal Academy of Medicine in France was founded by King Louis XVIII.[136] King Louis XVIII appointed several members upon the recommendation of Baron Guillaume Capelle, secretary-general of the Ministry of the Interior, and these appointed members then selected the final members.[137] The commission included nine members, only two of which were not already faculty members of the Society of the Paris Faculty of medicine.[138] This is specifically important

[133] The Medical Society of London, "The History of The Medical Society of London."

[134] Ibid.

[135] David, "The History of the Royal Society of Medicine." p. 105

[136] Interacademy Partnership, "Académie Nationale de Médecine, France."

[137] Weisz, "Constructing the Medical Élite in France."

[138] Ibid.

because the King's influence on the proposed medical society. Although the King's personal physician, Antoine Portal, was made permanent honorary president, a commission, chaired by George Cuvier, was created to propose a structural plan of the academy stating that Portal should act in "his capacity as professor (at the College de France) rather than as the king's first physician, emphasizing that he was merely one member among equals."[139] While Portal had originally suggested a commission in which faculty were a minority, Capelle suggested a commission that better represented well-established medical figures, rather than government officials. Because Capelle was a member of the French government, his choice to enforce an alternative commission shows the power that physicians already had in society. Table 5 outlines the commission's proposed first cohort of members and the final ordinance accepted by the King. It is noteworthy that the total number of physicians for the academy was finalized at 285 physicians. In comparison, at the time in 1820, Paris only had a total of 571 registered physicians and surgeons and 197 registered pharmacists, meaning that approximately half of all practicing physicians in the city belonged to the Academy. While qualifying standards are difficult to outline in an academy defined by a monarchy, the establishment of this recognized professional organization is still in line with Wilensky's understanding of defining exclusive jurisdiction.

Table 5: Table of Membership of the French Royal Academy of Medicine (adapted from George Weisz)

Table of Membership of the French Royal Academy of Medicine		
Members	Commission Proposed Members	The King's Ordinance of Members
Titular Members	80	85
Honorary Members	20	60

[139] Weisz, "Constructing the Medical Élite in France." p. 439

Non-Medical Associates	20	30
Resident Associates	40	80
Foreign Associates	20	30
Total	180	285

It was at the French Royal Academy of Medicine, in 1837, that Dr. Pierre-François Rayer presented his argument on why glanders could be transmitted from horses to humans, creating so much conversation around the issue that "the question as to the real nature of the disease was discussed in the Royal Academy of Medicine, [sic] on three consecutive nights."[140] Even though Lorin had already proved its transmission from animal to human, the understanding was not widely accepted by veterinarians and physicians alike. The debate among members of the Royal Academy of Medicine did not lead to a finite decision on whether glanders could actually be transmitted from horses to humans, but rather reflected an evolution of the organization's understanding of glanders. Rather than relying on individual observations, such as Lorin's, the Academy's devoted multiple sessions to discussing glanders, demonstrating its significance as a human health concern. The debate over glanders expanded the Academy's understanding of zoonotic disease transmission. Rayer's presentation and the subsequent debate aligned with Wilensky's positions on professionalization as it asserts an exclusive jurisdiction over glanders' transmission from animals to humans.

[140] Youatt, "Of Glanders and Farcy in the Human Being."

Environmental Health

The growing incidence of glanders underscored the need for advanced diagnostic technologies. Veterinary surgeon John McFadyean (see Table 2) played a significant role in developing the mallein test used to diagnose glanders. McFadyean was born in 1853 in Scotland and became a veterinary surgeon after graduating from the Edinburgh Veterinary College in 1876. McFadyean continued his education and earned his Bachelor of (human) medicine and Bachelor of Surgery degree from the University of Edinburgh in 1882.[141] As both a physician and a veterinarian, his dual training in medicine and veterinary science positioned him to be an early advocate for One Health. After earning his medical degree, McFadyean worked as a pathologist with the intent to study diseases "afflicting domesticated animals."[142] He led an impactful career, disputing Koch's position on bTB's ability to be transmitted to man (Koch believed that it could not be transmitted, whereas McFadyean correctly argued that it could), writing on anthrax, and introducing both the tuberculin test for tuberculosis and the mallein test for glanders.[143] His development and promotion of the mallein test strengthened environmental disease surveillance by improving the detection of glanders. Because the definition of One Health directly ties human health to both veterinary and environmental health, by developing a diagnostic test capable of identifying *Burkholderia mallei*, McFadyean improved disease surveillance, strengthened quarantine efforts, and reduced environmental sources of infection. McFadyean's work reflects what would later be formally understood as environmental health. The National Institute of Environmental Health Sciences defines environmental health as

[141] Innes, "Biographical Sketch."

[142] Ibid p. 90.

[143] Ibid

> "[t]he science of identifying and understanding the impacts of environmental exposures to hazardous physical, chemical, and biological agents in air, water, soil, food, as well as social stressors that may adversely affect human health. The goal of environmental health is to prevent human injury and illness and promote well-being."[144]

The causative agent of glanders, *Burkholderia mallei*, can survive in the environment for anywhere between two and six weeks depending on the specific environmental conditions.[145] By creating a test that identified a biological agent (*Burkholderia mallei)*, disease surveillance and quarantining practices were enhanced. The promotion of the mallein test allowed those working in environmental health to establish a technical basis for their work, aligning with Wilensky's conception of professional development.

As scientific understanding of glanders advanced, government officials worldwide began to recognize the need for formalized interventions to address the threat of disease in humans, animals, and their surrounding environment. In 1885, Canada's federal government introduced the *Animal Contagious Disease Act*. However, at the time of publication, the Act did not yet include horses. The Act focused largely on cattle and the ongoing struggle to address CBPP. Because the Act excluded horses, provincial governments retained responsibility for controlling glanders. By 1897, there was a growing incidence of glanders in Manitoba and the Northwest Territories with approximately 200 reported human cases of glanders.[146]

Scottish veterinary surgeon Andrew Smith called for the inclusion of horses in the legislation in 1883. Duncan McEachran, Chief Veterinary Inspector of the Canadian Department of Agriculture, echoed Smith's requests. Although both men advocated expansion of the

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[144] NIH, "Glossary Term: Environmental Health."

[145] *Glanders Standard Operating Procedures*.

[146] Derbyshire, "The Eradication of Glanders in Canada."

legislation, the Canadian government did not include horses until 1897. In that year, policy makers revised previous legislation and adopted *An Act to prevent the spread of Contagious Disease among Horses and other Domestic Animals* which expanded the definition of animal stating that an "'[a]nimal' means horses, mares, fillies, foals, geldings, colts, bulls, bullocks, cows, heifers, steers, calves, sheep, lambs, goats, mules, jennets, asses and swine."[147]

In McEachran's 1893 report as Chief Veterinary Inspector, he first described the mallein test to diagnose glanders. Once horses were officially added to federal disease control legislation, those working in the Canadian government had a reliable diagnostic tool for controlling glanders. Even before Canada's eradication efforts included the mallein testing of imported animals, their strategies were endorsed by the American Veterinary Medical Association (AVMA) in 1906, recommending that the U.S. develop a similar approach.[148] At this time, the approach of the Canadian Board of Agriculture was for "horses that reacted to mallein were [to be] quarantined and retested, and those that failed to react to subsequent tests were released from quarantine."[149] In 1908, building on scientific advancements promoted by McFadyean, the Canadian Board of Agriculture authorized the slaughter of horses testing positive on the mallein test. Further, the Board placed regulations on the imports of horses, requiring that they received the mallein test (and tested negative) before entering Canada. Once eradication efforts began, and imports were tested, the number of horses destroyed began to decrease, with the number of horses destroyed in 1938 at zero as glanders was officially eradicated.[150] Table 6 outlines the increase of imported horses tested (before and after it was mandated by the Canadian government) and the subsequent

[147] An Act to Prevent the Spread of Contagious Diseases among Horses and Other Domestic Animals.

[148] Ibid.

[149] Derbyshire, "The Eradication of Glanders in Canada." p. 724

[150] Derbyshire, "The Eradication of Glanders in Canada."

decrease in horses destroyed as disease control efforts were successful in eradicating glanders in both Canada and the United States (from where horses were primarily being exported to Canada).

Table 6: Canadian Eradication Data from 1907-1910 adapted from Derbyshire

Canadian Eradication Data from 1907-1910			
Year	Horses Tested	Horses Destroyed	Imports Tested
1907-1908	11,428	1324	0
1908-1909	20,401	981	12,175
1909-1910	24,330	627	17,916

SOURCE: Derbyshire, Brian. "The Eradication of Glanders in Canada." *The Canadian Veterinary Journal* 43, no. 9 (2002): 722–26. https://pmc.ncbi.nlm.nih.gov/articles/PMC339565/.

By adopting the mallein test as promoted by McFadyean, Canada was able to reduce overall exposure to glanders with eventual eradication of the disease entirely. The inclusion of horses in the 1897 Act allowed Canadian officials to apply these disease control measures to protect both public and environmental health. By controlling glanders, a hazardous biological agent capable of infecting both humans and animals, the mallein test directly advanced the professionalization of environmental health. By identifying infected animals and guiding quarantine efforts, the introduction of the mallein test and its incorporation into government practices reduced overall environmental reservoirs of disease. The combination of scientific development from McFadyean and the establishment of governmental authority illustrates Wilensky's perspective of professionalization in which the government integrated specialized scientific knowledge into standardized governmental protocols. The requirement of mallein testing before horses were imported strengthened the Canadian government's capacity for disease control and transformed disease control into an organized and professionalized environmental health practice. Because

mallein testing provided trained officials with a standardized method of identifying disease, the use of the test eventually led to the eradication of glanders.

People and Moments

This analysis identifies three individuals and three moments that illustrate the evolution of recognized professional organizations within the One Health framework as it relates to glanders. Each person and moment also align with Wilensky's statement on the development of an occupation into a recognized profession. In veterinary medicine, George Fleming wrote about glanders and used his position as President of the RCVS to help ensure the passage of *The Veterinary Surgeons Act of 1881* which established veterinarians as a profession and outlined specific repercussions for those who illegally practiced in the U.K. In human medicine, Pierre-François Rayer argued before the French Academy of Medicine, stating that glanders could be transmitted from animals to humans strengthening the understanding in physicians. Finally, in environmental health, John McFadyean promoted the mallein test that the Canadian Board of Agriculture ultimately recognized and incorporated into importation practices. This integration led to the eventual eradication of glanders in Canada, exemplifying the need for recognized environmental health practices and professionals to ensure the safety and security of both Canada's borders (as imported animals carried the disease) and the humans and animals living in Canada. This chapter identifies three people and three moments that each contributed to the evolution of recognized professional organizations (the RCVS, the French Academy of Medicine, and the Canadian Board of Agriculture) as they reacted to threats of glanders and evolved to professionalize all areas of One Health.

Table 7: People and Moments Supporting the Evolution of Recognized Professional Organizations

Evolution of Recognized Professional Organization			
	Veterinary Medicine	Human Medicine	Environmental Health
Person	Fleming: Wrote about glanders and helped pass *The Veterinary Surgeons Act of 1881* as President of the RCVS.	Rayer: Presented his argument to the Academy of Medicine in France stating that glanders could be transmitted from animals to humans, strengthening the understanding in physicians.	McFadyean: Promoted the mallein test.
Moment	1881: *The Veterinary Surgeons Act of 1881* distinguished between qualified and unqualified practitioners.	1837: The Academy of Medicine in France debated the legitimacy of glanders' transmission from animals to humans.	1908: Horses were required to be mallein tested by the Canadian Board of Agriculture before being imported into Canada.

Chapter 4 - Creation of Specialized Training

Introduction

The third relevant criterion for the development of a profession is the creation of specialized training and formal education. As Chapter 3 examines the establishment of recognized professional organizations, Chapter 4 examines the creation of specialized training; therefore, Chapter 4 will further use Wilensky's quote "link[ing] both skill and jurisdiction to standards of training" to inform the analysis.[151] Wilensky argues that:

> "Medicine, since its 'reform' in the United States some sixty years ago [referring to the 1950s], has emphasized its roots in the physical and natural sciences along with high, rigorously defined, and enforced standards of training designed to impart that body of knowledge."[152]

Wilensky discusses the evolution of human medicine as it advanced in the mid-twentieth century; however, this chapter examines veterinary medicine, human medicine, and environmental health between the years of 1761 (the year that Bourgelat established the first formal veterinary college) and 1918 (the end of WWI). This analysis will be conducted by further applying Wilensky's framework as a guide and identifying one moment and one person relevant to the creation of specialized training and formal education as it relates to glanders.

Veterinary Medicine

In 1712, in Lyon, France, Claude Bourgelat was born to a wealthy trader. Though his early years were spent living in wealth, his father's death led to court proceedings which consumed his family's inheritance. Consequently, he spent his adult life with little money. For

[151] Wilensky, "The Professionalization of Everyone?" p. 138.

[152] Ibid.

half of a decade in the 1720s, Bourgelat served as a Musketeer, and in the 1730s, he worked as a lawyer. Eventually, in 1740, he received notice that he was to be an Equerry[153] to the King and Principal of the Lyons Riding Academy. Bourgelat did well in this position and published several books on horsemanship, creating a name for himself in the field of early veterinary medicine.[154]

Figure 9: Claude Bourgelat, founder of the first veterinary school in Lyon, France
SOURCE: Wellcome Images. *Portrait of Claude Bourgelat* n.d.

As the century went on, Europe increasingly faced the threat of rinderpest, affecting the food supply. To address this, King Louis XV gathered a group of well-known horsemen to address the

[153] A senior attendant responsible for horses belonging to high ranking members of the French military.

[154] Vallat, *2011: World Veterinary Year*.

solution and open what would become the first college of veterinary medicine.[155] In 1761, he did just that, and École Nationale Vétérinaire de Lyon opened in France.[156] The establishment of the first veterinary school helped demonstrate that scientific training could support state needs.[157] This influenced other countries, including Britain, where concerns about maintaining healthy animals for military use increased the need for the professionalization of veterinary medicine. Due to ongoing disease threats in Britain, military demand soon played a major role in shaping the profession. By the late eighteenth century, concern over the loss of horses in warfare prompted the British Army to formalize veterinary roles within cavalry regiments.[158] Veterinary surgeons were attached to cavalry units, and many received training at the RVC. Although veterinary medicine focused primarily on food security and military needs, the field has evolved to include twenty-two specialty organizations and forty-eight specific specialties.[159]

As of 2020, 75.2 percent of veterinarians were working exclusively or predominately in companion animal medicine, whereas only 5.6 percent were working exclusively or predominately with food animals.[160] As a result, modern veterinarians must have a working knowledge of a wide array of diseases. Table 8 outlines selected bacterial, viral, fungal, and parasitic zoonotic diseases modern veterinarians commonly encounter with companion animals, serving as an example of how far veterinary medical education has evolved since Bourgelat established École Nationale Vétérinaire de Lyon in 1761.

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[155] VMBS Marketing & Communications, "Year of the Veterinarian."

[156] Woods, "From One Medicine to Two: The Evolving Relationship between Human and Veterinary Medicine in England, 1791–1835."

[157] Degueurce, "Claude Bourgelat and the creation of the first veterinary schools."

[158] Hunter, 2016

[159] American Veterinary Medical Association, "Veterinary Specialties."

[160] "American Veterinary Medical Association, "U.S. Veterinarians 2020."

Table 8: Significant zoonotic disease threats posted from companion animals (adapted from Monath, Kahn, and Kaplan)

Zoonotic Disease	Companion Animal Reservoir	Agent
Brucellosis	Dogs	Bacterium
Campylobacter	Dogs, cats	Bacterium
Cat Scratch Disease	Cats	Bacterium
Cryptosporidiosis	Dogs	Parasite
Giardiasis	Dogs	Parasite
Hookworm	Dogs, cats	Parasite
Leishmaniasis	Dogs	Parasite
Leptospirosis	Dogs	Bacterium
Rabies	Dogs, cats	Virus
Ringworm	Dogs, cats	Fungus
Rocky Mountain Spotted Fever	Dogs	Bacterium
Salmonella	Dogs	Bacterium
Tapeworm	Dogs, cats	Parasite
Toxoplasmosis	Cats	Parasite

SOURCE: Monath, Thomas, Kahn, and Kaplan. "Introduction: One Health Perspective." *ILAR Journal* 51, no. 3 (2010): 193–98. https://doi.org/10.1093/ilar.51.3.193.

Note: This table of zoonotic disease threats in companion animals is non-exhaustive and is intended to serve as an outline for the most relevant zoonotic disease threats a companion animal veterinarian may encounter.

For veterinary practice to begin to expand to its present-day scope, formal educational resources and specialized training were required to teach new veterinarians about diseases in companion animals, large animals, and food animals across all agents of disease. One notable

teacher of early veterinary medicine was Edmond Nocard. Nocard was born in 1850 in Provins, Seine-et-Marne, France. At age eighteen, Nocard began studying veterinary medicine and graduated from the Veterinary School of Alfort in 1873. After completing his veterinary education, Nocard returned to Alfort for a clinical appointment where he became a Professor of Pathology and Clinical Surgery.[161] Eventually, Nocard began also working with Louis Pasteur's laboratory in Paris at the École Normale Supérieure. During his career, he made extensive contributions to the growing understanding of science, identifying the causative agent of CBPP.[162] His contributions to the world of microbiology and veterinary medicine were so profound, a stamp was issued in the late 20th century to honor Nocard and two other notable veterinarians from Nocard's time (see Figure 10).

Figure 10: French stamp created in 1951 to honor Nocard, Bouley, and Chauveau for their contributions to French veterinary medicine

SOURCE: The British Association of Urological Surgeons Limited. "Edmond Nocard (France)." https://www.baus.org.uk/museum/1553/edmond_nocard_france.

[161] G. H. F. N., "Edmond Nocard."

[162] Institut Pasteur, "Edmond Nocard, Discoverer of the Nocardia Bacterium."

In addition to his work with CBPP, Nocard worked on the prevention of rampant animal diseases, "turn[ing] tuberculin and mallein into major weapons in the battle against bovine tuberculosis and equine glanders."[163] Throughout his career, Nocard published myriad pieces of literature. In 1895, Nocard published "The Value of Mallein as a Means of Diagnosis in Doubtful Cases of Glanders" in the *Edinburgh Journal of Comparative Pathology and Therapeutics*.[164] Founded in 1888 by John McFadyean, the journal (now shortened to the *Journal of Comparative Pathology*) served as an educational tool for "reporting research and original scientific findings relevant to the pathology and pathogenesis of diseases of domesticated and other vertebrate animals."[165] Nocard's publication on the use of mallein in the diagnosis of glanders helped to further the growth of veterinary education and create a stronger basis of understanding for veterinarians' diagnostic skill set. Nocard writes that cases of glanders in which a veterinarian was able to make an affirmative diagnosis based on clinical symptoms was exceedingly rare. Nocard argued that the use of mallein to ensure diagnostic accuracy was important because a diagnosis of glanders often resulted in the slaughter of a horse, whereas a missed diagnosis could expose an entire stable to infection.[166] He goes on to explain his experience using the mallein test at the Pasteur Institute and states the protocol for the preparation of mallein testing:

[163] Ibid.

[164] Because Nocard's work was originally written in French, it was translated to English for proceedings of the sixth International Veterinary Congress and published in the Journal of Comparative Pathology and Therapeutics.

[165] Science Direct, "About the Journal."

[166] Nocard, "The Value of Mallein as a Means of Diagnosis in Doubtful Cases of Glanders." p. 227-228.

“To inoculate the culture flasks [sic] we never employ anything except a glanders bacillus whose virulence has been brought to the maximum and maintained there by successive inoculations into rabbits; since 1891 we have not ceased to keep up the cultivation of this extremely virulent strain of glanders bacilli. We proceed as follows: with the blood of a rabbit, dead thirty six or forty eight hours after intravenous inoculation, we inoculate abundantly several tubes of potato; after three days in the incubator at 37°, a trace of the culture is mixed with a little boiled water, filtered through linen, and injected into the auricular vein of a rabbit, whose blood will serve again for the inoculation of other potato cultures, and so on successively. These cultures on potato are not used for the preparation of mallein, but only to maintain the glanders organism with its virulence increased and always equal. To prepare the mallein we employ cultures made in glycerine bouillon, according to the formula1 which we have given for the culture of the bacillus tuberculosis, as follows: Bouillon made with veal or horse flesh, common salt per cent., peptone I per cent., and glycerine 4 per cent. One inoculates at the same time twenty-five or thirty flasks, each containing 250 cubic centimetres of glycerine bouillon; after fifteen or twenty days in the incubator the cultures are sterilised in the autoclave, then concentrated to one -tenth of their original volume by evaporation in a water bath; finally [sic] they are filtered through filter paper. One thus obtains what we have called strong mallein, which is a syrupy liquid, brownish in colour, and having a special odour. The strong mallein contains about 40 per cent. of glycerine, and when protected from light and heat it keeps for a very long time, almost indefinitely; in practice we apply it diluted with ten or eleven times its volume of per cent. carbolic acid solution,

> or, what is more simple [sic], with boiled water; but in this latter case the solution ought to be used immediately about it has been prepared."[167]

In writing and publishing this protocol, Nocard helped further the education of early veterinarians addressing and diagnosing cases of glanders in horses. His writing also helps to further establish specialized training through his written protocol of preparing the mallein for testing, administering the mallein test and observing for either a positive or negative result. Nocard's contributions to veterinary medicine align with Wilensky's definition for the development of an occupation. By publishing an educational resource to be used for a specific diagnostic purpose, Nocard linked "both skill and jurisdiction to standards of [veterinary] training."[168]

Human Medicine

Similar to the development of veterinary medicine and education, the development of laboratory skillsets became an integral part of human medicine. Lippi and Plebani refer to laboratory science in the human medical field as,

> "a clinical science and discipline, devoted to the quantitative measurement, or qualitative assessment, of any substance which can be assayed in any type of biological fluid of any animal species, thus including humans, for either medical or research purposes. The results of these measurements are translated into actionable information for improving the care and/or maintaining the wellness of both a single individual and an entire population."[169]

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[167] Nocard, "The Value of Mallein as a Means of Diagnosis in Doubtful Cases of Glanders." p. 228-229

[168] Wilensky, "The Professionalization of Everyone?" p. 138.

[169] Lippi and Plebani, "A Modern and Pragmatic Definition of Laboratory Medicine." p.1

Because of the role laboratory science plays in the medical field, the development of laboratory science was an especially important part of the development of human medical education. Prior to the development and acceptance of the germ theory, it was widely believed that disease was caused by "bad air" or *miasma*.[170] The works of Louis Pasteur, Robert Koch, and Joseph Lister all challenged this theory and advanced the scientific and societal acceptance of the germ theory. Pasteur's microbiological work proved that it is microorganisms that are responsible for the spoilage and fermentation of food and beverages. This discovery led to Pasteur's development of pasteurization, permanently changing the world of food safety.[171] Lister's work focused heavily on evolving Pasteur's understanding of fermentation and applying it to the prevention of surgical infections. Because of his contributions to the field of surgery, he has been often named the father of modern surgery.[172]

The germ theory of disease "states that pathogenic microorganisms are responsible for causing infectious diseases."[173] Friedrich Loeffler[174] worked closely as a protégé of Koch and helped to establish Koch's postulates. These four criteria (the fourth postulate was added after Loeffler), were written as a guide for identifying a microbe with infectious ability:

1. "The organism must be shown to be invariably present in characteristic form and arrangement in the disease tissue.
2. The organism, which from its relationship to the diseased tissue appears to be responsible for the disease, must be isolated and grown in pure culture.

[170] Halliday, "Death and Miasma in Victorian London."

[171] Jambholkar et al., "Louis Pasteur."

[172] Pitt and Aubin, "Joseph Lister."

[173] Carlsson and Råberg, "The Germ Theory Revisited." p. 1

[174] In English, his name is written as "Loeffler," in Germany it is often written as "Löffler."

3. The pure culture must be shown to induce the disease experimentally.

4. The organism should be re-isolated from the experimentally infected subject."[175]

Koch's postulates, as supported by Loeffler, remain the basis of scientific education. Loeffler not only played a role in the development of the postulates, but during the age of Early Modern Medicine and First Wave of Globalization (see Table 1) contributed to (at least) three major scientific advancements. In 1884, Loeffler isolated *Corynebacterium diphtheriae*, the causative agent for diphtheria. In doing this, he also cultured and proved the organism's reproducibility in susceptible animals.[176] Fourteen years later, in 1898, Loeffler and Paul Frosch demonstrated that the causative agent of FMD was a so-called filterable virus, meaning it is small enough to pass through filters similar to that of a cheesecloth.[177] Loeffler's most relevant contribution to the subject of this thesis, however, occurred before both of these findings. In 1882, following the standards of Koch's postulates, Loeffler and Wilhelm Schütz successfully isolated *Burkholderia mallei*[178] from the spleen of an infected horse.[179] Four years later, Loeffler published his findings *in Arbeiten aus dem Kaiserlichen Gesundheitsamte*, which, translated from German to English, is *Publications from the Imperial Health Office*. The Imperial Health Office was founded in Berlin, Germany in 1876 with the intent to collect and publish health data in Germany. Koch was appointed to the office in 1880, platforming his and his associates (including Loeffler)'s work.[180] Loeffler's 1886 publication in Arbeiten aus dem Kaiserlichen Gesundheitsamte was titled *Die Aetiologie der Rotzkrankheit aur Grund der in Kasierlichen Gesundheitsamte ausgeführten*

[175] Walker et al., "Koch's Postulates and Infectious Proteins." p.2

[176] Kyle et al., "Friedrich August Johannes Löffler (Loeffler), German Bacteriologist."

[177] Longjam, 2011

[178] First known as *Loefflerella mallei.*

[179] Whitlock et al., "Glanders"; Torres, "Glanders."

[180] Münch, "Robert Koch."

experimentellen Untersuchungen (The Etiology of Glanders Based on Experimental Investigations Conducted at the Imperial Health Office) (see Figure 11).

Die Aetiologie der Rotzkrankheit

auf Grund der im Kaiserlichen Gesundheitsamte ausgeführten experimentellen Untersuchungen

dargestellt

von

Stabsarzt Dr. Loeffler.

(Hierzu Tafel 8 und 9.)

Figure 11: Loeffler's glanders publication in Arbeiten aus dem Kaiserlichen Gesundheitsamte
SOURCE: Reichsgesundheitsamt. *Arbeiten Aus Dem Kaiserlichen Gesundheitsamte*. Gesundheitsamt, 1886.

Through his discovery of the causative organism of glanders in 1882 and his publication in 1886, Loeffler contributed greatly to the development and creation of specialized training and formal education. His publication outlined experimental procedures and how his work may be used in future scientific practices which in turn are translated into benefit for human medicine. Loeffler's contributions to the medical field also outline the transition that began to occur between Traditional Western Medicine and Early Modern Medicine (see Table 1). His work fulfills Wilensky's standards of professional development as it relates to linking skills (the isolation and identification of *Burkolderia mallei* as the causative agent of glanders) to standards of training (Loeffler's publication).

Environmental Health

In addition to his contributions to microbiology and the human medical field, Loeffler also made contributions to environmental health. In 1888, Loeffler became a professor of

hygiene at the University of Greifswald.[181] During this period of education and medicine (Early Modern Medicine, see Table 1), hygiene had become an academic medical discipline, focusing on topics such as laboratory skills, preventive public health methods, sanitation, water and food safety.[182] In teaching hygiene at the University of Greifswald, Loeffler translated his microbiology skills into early environmental health education. Another leading environmental health figure during the 19th century was Max von Pettenkofer. Pettenkofer supported the development of the hygiene discipline—a discipline that has been described "as the first interdisciplinary medical field."[183] Pettenkofer was interested in many things including water quality, how disease spread through soil, and home cleanliness. While these topics had been explored in science and public health before, Pettenkofer earned the name as "father of modern hygienic science" by taking these topics and applying them to experimental protocols with the intent to provoke higher understanding.[184] In 1879, Pettenkofer founded his own Institute of Hygiene at Munich's Medical School. His institute was quite influential and influenced the creation of Johns Hopkins School of Hygiene and Public Health founded in 1916, now the Johns Hopkins Bloomberg School of Public Health.[185] While Pettenkofer was working in academia and scientific institutions, he also began advising the government on public health decisions. In 1854, Munich faced a cholera outbreak, and authorities were unsure how to respond. Because of Pettenkofer's established role in hygiene science, members of the municipal government turned

[181] Kyle et al., "Friedrich August Johannes Löffler (Loeffler), German Bacteriologist."

[182] Rosen, *A History of Public Health*.

[183] Locher, "Max von Pettenkofer (1818–1901) as a Pioneer of Modern Hygiene and Preventive Medicine." p. 239

[184] Ibid.

[185] Martin, "Centenary of the Death of the Great Hygienist and Physician Max von Pettenkofer on February 9, 1901."

to him for guidance.[186] It was not uncommon for government officials to turn to science experts for help during epidemics or during the creation of legislation relating to disease regulation. Although Pettenkofer's work focused primarily on human health in Germany, the growing governmental reliance on scientifically trained experts soon extended to veterinary medicine. During the 19th century, European-trained veterinarians increasingly traveled to the U.S. where they applied principles of hygiene and sanitation to infectious disease control, including glanders. J.H. Steele explains that throughout the 19th century this practice became progressively more common:

> "During the early part of the nineteenth century a number of European-educated veterinarians came to American cities, where they were mainly concerned with equine practice. They laid the groundwork for veterinary public health in recommending sanitary conditions for stables and barns. When glanders was identified as a contagious disease among horses and was recognized as potentially affecting man, hygienic regulations were promulgated by boards of health."[187]

While Pettenkofer and Loeffler advanced environmental health through scientific research and formal education, the next step in professionalization involved translating specialized knowledge into standardized guidance for the governmental bodies.

In 1906, John Rutherford, Veterinary Director General and Live Stock Commissioner published his *Special Report on Glanders* for the Canadian Department of Agriculture, Health of Animals Branch. Rutherford begins the report saying:

[186] Ludwig-Maximilians-Universitat Munchen, "The Father of Hygiene."

[187] Steele, *History of Veterinary Public Health in the United States of America*. p. 958.

> "This disease has long been rightly looked upon as one of the most serious and dangerous of animal plagues, and even were there no recent striking developments, or rather circumstances, demanding special attention, a report of this kind would not be out of place."[188]

Prior to Rutherford writing this report, glanders control in Canada was primarily done at the provincial level, resulting in inconsistent approaches to disease control. Although horses were eventually incorporated into the federal *Animal Contagious Disease Act* in 1897, a national control program did not emerge until legislative changes between 1903 and 1905 placed the disease control and prevention of glanders within the federal Health of Animal Branch of the Department of Agriculture.[189] Rutherford's report appeared during the shift between control at the provincial level and control through a centralized governmental program. The federalization of glanders control required standardized procedures that could be implemented nationwide. Rutherford's report served as an educational and technical guide for veterinary inspectors, government officials, and livestock owners to prevent disease transmission through controlling contaminated environments. Rutherford relays the Regulations Relating to Glanders as created by the Canadian Order in Council. These eleven regulations established standardized environmental health responsibilities and shifted focus from treatment of disease to environmental prevention.[190] Regulations 2, 4, and 11 appeal to Wilensky's criterion of linking specialized skills and jurisdiction to standards of training. Regulation 2 states:

[188] Rutherford, *Special Report on Glanders*. p. 1

[189] Derbyshire, "The Eradication of Glanders in Canada."

[190] Rutherford, *Special Report on Glanders*.

"Any Veterinary Inspector may declare to be an infected place within the meaning of the 'Animal Contagious Diseases Act, 1903,' any steamship, or steam or other vessel, or any place or premises where the contagion of Glanders is known or suspected to exist."[191]

Regulation 2 expanded the authority of veterinary inspectors beyond individual animals, giving them permission to declare different environments, not just horses, as infected with glanders. This shifted responsibility toward identifying and managing environmental sources of disease transmission. Regulation 2 supports Wilensky's criterion by establishing authority through distinct responsibility. Regulation 4 states:

"Veterinary Inspectors are hereby authorized to inspect and to subject to the Mallein test any horses, mules or asses affected with Glanders or suspected of being so affected, or which have been in contact with animals so affected, or suspected of being so affected, or which have been in any way whatsoever exposed to the contagion or infection of the disease of Glanders, and for the purpose of making such inspection or test to order any such' animals to be collected, detained. or isolated."[192]

Regulation 4 required veterinary inspectors to understand when Mallein testing should occur, demonstrating the need for specialized training and specific scientific knowledge rather than solely practical experience. This created a standardized expectation for professional competencies and affirms Wilensky's criterion that competent regulation depends on specialized technical expertise. Regulation 11 states:

"Every yard, stable, outhouse or other place or premises, and every wagon [sic], cart, carriage, car or other vehicle, and every utensil or other thing infected with Glanders shall

[191] Ibid. p. 7.

[192] Ibid. p.8.

be thoroughly cleansed and disinfected by and at the expense of the owner or occupier, in a manner satisfactory to a Veterinary Inspector."[193]

Regulation 11 necessitated the cleansing and decontamination of equipment that may be contaminated. This further differentiated the field of environmental health from standardized veterinary medical practice and standardized sanitation procedures across Canada. This regulation further supports Wilensky's criterion as it transformed specialized knowledge into standardized professional practice. Rutherford's report established a common body of knowledge that was to be used by veterinary inspectors across Canada. In writing this report, Rutherford reduced reliance on provincial-level protocols and standardized the role that veterinary inspectors played across Canada.

People and Moments

This analysis identifies three individuals and three moments that illustrate the evolution of recognized professional organizations within the One Health framework as it relates to glanders. Each person and moment also are supported by Wilensky's perspective on the development of an occupation into a recognized profession as it relates to the connection of skill and jurisdiction to standards of training. In veterinary medicine Edmond Nocard developed veterinary educational resources in his 1895 publication of "The Value of Mallein as a Means of Diagnosis in Doubtful Cases of Glanders" relating to the use of mallein in diagnosing glanders. In human medicine, Friedrich Loeffler supported the development of Koch's postulates, isolated *Burkholderia mallei* (originally known as *Loefflerella mallei*), and published his findings in the Arbeiten aus dem Kaiserlichen Gesundheitsamte. Finally, in environmental health, John Rutherford published his *Special Report on Glanders* as the Canadian Veterinary Director

[193] Ibid.

General and Live Stock Commissioner. This report supported the transition of glanders control as it shifted from provincial jurisdiction to federal oversight. His report reiterated the Regulations Relating to Glanders specified the roles of veterinary inspectors as it related to glanders in Canada with regulations 2, 4, and 11 specifying changes to the roles of veterinary inspectors in environmental health.

Table 9: People and Moments Supporting the Creation of Specialized Training

Creation of Specialized Training			
	Veterinary Medicine	Human Medicine	Environmental Health
Person	Nocard: Created veterinary educational resources on mallein as a method for diagnosing glanders.	Loeffler: Helped to establish laboratory instruction through his contribution towards Koch's postulates and isolation of *Burkholderia mallei* and publication of findings.	Rutherford: Published the *Special Report on Glanders* in his position as the Canadian Veterinary Director General and Live Stock Commissioner.
Moment	1895: Publication of "The Value of Mallein as a Means of Diagnosis in Doubtful Cases of Glanders" in the *Journal of Comparative Pathology and Therapeutics*.	1886: Publication of *Die Aetiologie der Rotzkrankheit* in the Arbeiten aus dem Kaiserlichen Gesundheitsamte.	1906: The *Special Report on Glanders* was published and reiterated the Regulations Relating to Glanders which specified the roles of veterinary inspectors as it related to glanders in Canada.

Chapter 5 - Conclusion

Summary and Findings

This inductive thesis sought to understand the impact that *Burkholderia mallei* (glanders) had on the professionalization and development of One Health and its three constituent fields of veterinary medicine, human medicine, and environmental health between 1761 (when the first veterinary school was established in Lyon, France) and 1918 (the end of WWI). The selected time period includes the eras of Traditional Western Medicine, Early Modern Medicine, Late Modern Medicine, the Age of Discovery, and the First Wave of Globalization (see Table 1). The development of One Health occurred alongside broader transformations in both the history of medicine and the history of globalization. The historical frameworks listed in Table 1 provide context through which the professionalization of One Health can be understood. Rather than occurring independently, the people and moments identified in this thesis were shaped by changes in scientific understanding, expanding global trade, and the increasing movements of animals, humans, and disease. To answer the research question, this thesis finds that the professionalization of One Health developed through a consistent three-part pattern in relation to glanders: the development of professional identity (chapter 2), the evolution of recognized professional organizations (chapter 3), and the creation of specialized training (chapter 4). While each profession experienced this pattern at its own rate, glanders repeatedly served as the disease through which the professions advanced. Throughout the three body chapters, nine people and nine moments emerged connecting to the professionalization of One Health as they relate to glanders in veterinary medicine, human medicine, and the environment.

Three People in Veterinary Medicine:

- Viborg identified the connection between farcy and glanders and helped establish legitimacy in the practice of veterinary medicine by advancing scientific understanding.
- Fleming wrote about glanders and helped pass *The Veterinary Surgeons Act of 1881* as President of the RCVS.
- Nocard created veterinary educational resources on mallein as a method for diagnosing glanders.

Three Moments in Veterinary Medicine:

- 1796: Because glanders played a major role in military expeditions, the need for a dedicated profession to maintain control over the disease became more urgent and, therefore, the British Army coined the term "veterinary surgeon."
- 1881: *The Veterinary Surgeons Act of 1881* distinguished between qualified and unqualified practitioners. The Act ensured that recognized professionals, rather than unqualified practitioners, treated diseases such as glanders.
- 1895: The publication of "The Value of Mallein as a Means of Diagnosis in Doubtful Cases of Glanders" in the *Journal of Comparative Pathology and Therapeutics*.

Three People in Human Medicine:

- Lorin diagnosed two members of the French regiment as having glanders, tying human medicine and veterinary medicine together by recognizing that glanders can be transmitted from animals to humans.

- Rayer presented his argument to the Academy of Medicine in France stating that glanders could be transmitted from animals to humans, strengthening the understanding in physicians.
- Loeffler helped to establish laboratory instruction through his contribution towards Koch's postulates and isolation of *Burkholderia mallei* and publication of findings.

Three Moments in Human Medicine:

- 1837: The Academy of Medicine in France debated the legitimacy of glanders' transmission from animals to humans.
- 1886: The publication of *Die Aetiologie der Rotzkrankheit* in the Arbeiten aus dem Kaiserlichen Gesundheitsamte.
- 1902: Dr. James Law's recognition of Lorin's work in his book *Textbook of Veterinary Medicine*.

Three People in Environmental Health:

- Gamgee argued that, from an environmental health perspective, glandered horses must be "destroyed" (culled) to prevent further infection from spreading in a stable.
- McFadyean promoted the mallein test.
- Rutherford published the *Special Report on Glanders* in his position as the Canadian Veterinary Director General and Live Stock Commissioner.

Three Moments in Environmental Health:

- 1899: *The Report of the Departmental Committee on Glanders* recommended that local veterinary inspectors should not engage in private practice.

- 1906: The *Special Report on Glanders* was published and reiterated the Regulations Relating to Glanders which specified the roles of veterinary inspectors as it related to glanders in Canada.
- 1908: Horses were required to be mallein tested by the Canadian Board of Agriculture before being imported into Canada.

Discussion

The thesis demonstrates that glanders was a catalyst for the professionalization of One Health. Glanders exposed weaknesses in diagnostic testing and regulatory standards. Glanders repeatedly challenged existing scientific knowledge, forcing physicians to adopt findings from professionals outside of human medicine. There was much uncertainty in the diagnosis of glanders (in both humans and animals) before the development and implementation of the mallein test. The mallein test was largely promoted by veterinary surgeon John McFadyean. Despite the test being used only as a diagnostic tool, the mallein test emphasized the One Health professional contribution of veterinarians. The need to diagnose animals to prevent the spread of disease to humans forced society to further legitimize the work of the veterinary profession. Because of glanders' zoonotic potential, the research and understanding of the disease became a necessary topic of scientific investigation in One Health, rather than solely a veterinary issue.

Every major institutional advancement illustrated in this thesis occurred as professional entities and governments were responding to problems rather than anticipating them. Worldwide, governments rarely introduced preemptive animal disease control and trade regulations *before* weaknesses became explicitly apparent (such as horses being added to Canadian legislation after glanders threatened humans and animals) and scientific discoveries frequently occurred *after* previous explanations of disease (such as that of *miasma*) became apparently inaccurate.

Professional organizations (such as the evolution of veterinary schools and the enactment of *The Veterinary Surgeons Act of 1881*) often only gained societal recognition after disease exposed inadequate societal standards, recognition, and attention. Finally, educational reforms (such as the establishment of veterinary schools themselves) came only after existing teaching models became insufficient (such as farriers learning only by practice and not receiving formal diagnostic training). The recognition, acknowledgement, and change that came from such exposed weaknesses in diagnosis, regulation, education, and communication encouraged further research, legislative developments, formal training, and professional communication respectively. Therefore, by being forced to address glanders in humans, animals, and the environment, all three areas of One Health experienced professional development. Dr. Lise Wilkinson, an author quoted throughout this thesis, stated from "1820 onwards, the glanders literature reflects a major new departure and the rise of an entirely new discipline, made possible by the growing interest in veterinary science and its interrelationship with medicine," exemplifying the role glanders played.[194] Wilkinson's observation reinforces the findings of this thesis. Her description reflects increasing collaboration between veterinary medicine and human medicine. The "new discipline" she describes refers to a changing scientific culture (one that embraces interdisciplinary One Health collaboration) rather than the development of a new profession all together. The findings of this thesis extend Wilkinson's argument by demonstrating that environmental health also became integrated into the development of interdisciplinary One Health work. This broader interdisciplinary perspective illustrates that glanders challenged far more than veterinary medicine alone. Instead, the disease revealed the

[194] Ibid p. 364

interconnected nature of veterinary medicine, human medicine, and environmental health requiring specific responses across myriad professions.

Because glanders threatened humans, animals, and the environment simultaneously throughout the 18th, 19th, and 20th centuries, disease control required increasingly specialized expertise across all three domains of One Health; therefore, glanders encouraged the development of professional identity and legitimization among like professionals and government entities (as examined in chapter 2 where professional identity became increasingly dependent on scientific competence); the evolution of recognized professional organization with qualifying standards (as examined in chapter 3 where organizations transformed individual expertise into coordinated systems); and the creation of specialized training and formal education (as examined in chapter 4 where specialized education and training ensured consistent professional standards).

The professionalization of One Health was a dynamic, non-linear process characterized by periods of advancement, adoption of new understanding, and institutional reform. This process did not occur at the same rate across professions and countries. In France, the first veterinary school was established in 1761; in the U.K. the first veterinary school was established in 1791; and in the U.S., the first veterinary school was established in 1879. Because professional development occurred at different rates around the world and in each area of One Health, the professionalization of One Health should be viewed as an evolving historical process rather than a specific sequence of isolated milestones.

Although individual discoveries and reforms marked important turning points in the professionalization of One Health, no single event can be identified as completing the process of professionalization. None of the identified people and moments occurred in isolation—reports

written, changes to legislation, and the recognition of qualified professionals all occurred alongside greater institutional change. Individual discoveries alone could not, and did not, professionalize an entire discipline, this being why chapters 2, 3, and 4 identify people and moments, rather than one or the other. This is also seen in the case of Dr. Lorin diagnosing two members of the French Regiment with glanders and his work being amplified by Dr. James Law in his *Textbook of Veterinary Medicine*. The adoption and acceptance of new scientific findings was also a non-linear process. Despite Lorin's proof of glanders' transmission from animals to humans, Dr. Pierre-François Rayer still had to advocate for the French Royal Academy of Medicine to accept cross-species transmission as fact, because much of the research done on glanders during this time was done by veterinarians.

Because veterinarians struggled for recognition as scientific professionals throughout the 18th, 19th, and 20th centuries, it is easy to understand that their research was not accepted as fact by institutions of human physicians. Veterinary medicine had to establish scientific credibility before it could influence policy. However, as the Age of Discovery transitioned into the First Wave of Globalization (see Table 1), the movement of humans and subsequent spread of animal diseases, including glanders, forced society to expand its recognition of professionals in One Health. Likewise, veterinarians, physicians, and environmental health professionals were each required to expand their professional responsibilities as increasing zoonotic disease control and regulation required the attention of all areas of One Health. Developments in professional identity, organized professional organizations, and specialized training across One Health collectively demonstrate a recurring pattern in which glanders repeatedly exposed weaknesses prompting scientific, legislative, and institutional change. This cycle occurred repeatedly, impacting veterinary medicine, human medicine, and environmental health simultaneously.

Consequently, the history of glanders illustrates that One Health is best understood as the product of scientific inquiry and interdisciplinary collaboration.

Lessons Learned for Today's One Health Leaders

As is exemplified in this thesis, glanders supported the professionalization of the three areas of One Health: veterinary health and medicine, human health and medicine, and environmental health. This is seen across all nine selected people and nine selected moments. From this thesis, four lessons emerge:

First, the major advancements made in the history of One Health as it relates to glanders were largely reactionary. Modern One Health governance should aim to be proactive rather than following historical reactionary patterns and continue mobilizing interdisciplinary infrastructure across all areas of One Health. In the current age of Exact Medicine and Globalization 4.0 (see Table 1), this is more important than ever. Modern day challenges such as emerging zoonotic diseases and climate change demonstrate that reactive approaches remain insufficient. Rather than waiting for something to expose gaps in public health infrastructure, governments, institutions, and One Health practitioners should remain vigilant in addressing, preventing, and mitigating One Health-related risk factors (e.g., public health funding lapses).

Second, diagnostic tools function not only as clinical instruments but also as technologies used to legitimize a profession. While the introduction of the mallein test allowed for veterinarians to detect cases of glanders in animals, it also reinforced veterinary authority and gave figures like McFadyean, Nocard, and Rutherford a defensible technical basis for professional recognition. Investment in One Health diagnostic tools should therefore be understood as an investment in the credibility and recognition of professions who use it, not only as a laboratory advancement.

Third, interdisciplinary recognition does not follow a linear timeline. Modern One Health frameworks should expect and embrace uneven adoption across countries, institutions, and professions using history as a guide. While modern One Health goals should aim to be as universally aligned as possible, it should be understood that, depending on the capacity of the institution or nation, shared goals may be reached on different timelines.

Fourth, environmental health remains an undervalued section of the One Health framework. As described in chapter 2, there is no specific parallel environmental health provider to the providers of veterinary and human medicine. To ensure that One Health is truly an equal framework, modern One Health should focus on the amplification of EHSs and others working in environmental health.

These four lessons, considered with evidence identified throughout this thesis, demonstrate that One Health is not a fixed discipline and today's One Health practitioners remain a part of the same unfinished process of scientific advancement, professional recognition, and regulatory authority. The advancement of One Health is not and has not ever been reliant on individuals or any one profession. To continue advancing the professions within One Health, interdisciplinary collaboration should remain a top priority.

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