VETERINARY MEDICINE

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Summary

Veterinary medicine's ultimate purpose is to promote, maintain and restore the health of animals, people and the ecosystems which they inhabit. Veterinary research is directed at understanding and managing the determinants of health and disease at the level of both individuals and populations in order to inform veterinary practitioners, policy makers, animal owners and managers, and other health professionals who share or have a stake in veterinary medicine's purpose. The science of veterinary medicine continues to be rooted in comparative medicine which provides a powerful and historically successful approach to understanding biological phenomena that underlie health and disease. The practice of veterinary medicine continues to be informed by the values and needs of societies as they relate to animals.

The efforts of veterinary medicine will continue to focus on ensuring the health and welfare of animals. Veterinary education prepares veterinarians to recognize, prevent and remedy threats to animal health and welfare and places veterinarians in the position to advocate for the wellbeing of domestic and wild animals. The range of activities and perspective relevant to the practice of veterinary medicine requires veterinarians to understand diverse topics from animal husbandry to molecular diagnostics; from economics to diagnostic imaging and from ethics to ecosystem functions. Increasingly, veterinarians are working as teams to address the evolving expectations for animal care and veterinary scientists are reaching into a greater array of questions to provide a firm basis in research to support the goals of the profession.

Clinical practice of veterinary medicine not only strives to apply evidence based medicine but also integrate social issues involving economics and ethics especially as it involves animal welfare. Many if not most private veterinary practitioners will continue to practice on urban pet animals using technology that closely matches that in human medicine. Rural practice will be largely of two types; a multi-species focus in the case of meeting small holder needs and population level services for larger enterprises. In both cases and in both developing and developed nations technical assistants will play a larger role in veterinary practice teams.

Veterinary medicine will continue to play a pivotal role in public health by responding to changing threats from zoonotic diseases and unsafe food that are a consequence of an unrelenting increase in global biological, physical, economic and social connectedness. The larger medical community, recognizing the interdependence of health in all species, has embraced the concept of “one health”. Demands for timely and accurate disease surveillance will increase. The means to promptly assess and contain risks must be developed if a proactive risk management approach is to replace the current reactive approach to disease control. The polar challenges of reaping the benefits of molecular biology and modern technology on the one hand and dealing with anthropogenic disturbances to the earth’s ecological systems on the other will drive veterinary research and education in the coming decades. Progress in informatics and dealing with complexity will be a key to progress in both situations.

1. Introduction

Veterinary medicine develops, evaluates, and applies scientific and social information to help solve disease problems and reach health goals in animal-related systems. “Veterinary medicine” encompasses “veterinary research” and “veterinary practice”. “Veterinary research” is aimed at *developing and evaluating* the information required to support the decisions of “veterinary medicine”; “veterinary practice” involves the *application* of this information to the decisions required for achieving animal, public and ecosystem health goals. The models and methods used in the practice of veterinary medicine require an integration of scientific evidence with ethics and values to make decisions about the health of animals, people, and larger systems that may involve several species. The scope of veterinary medicine is large and can include the care of an individual sick animal, the promotion of food security and agricultural productivity, the protection of human health, or the maintenance of a healthy ecosystem. The scientific evidence that underlies veterinary medicine arises not only from veterinary research but

also from research in other natural and social sciences. Although historically grounded in the biomedical sciences with applications in mainly individual animals, veterinary medicine continues to expand its range. Veterinary practitioners and researchers are engaged not only in traditional disciplines, such as pathology, microbiology, anatomy, physiology, epidemiology and clinical sciences, but are also exploring a wider field of activity including conservation biology, population health, environmental health, and ecosystem health. As the systems of concern to veterinarians extend beyond individuals to populations and ecosystems, veterinarians are turning towards a systems approach to problem solving and are beginning to employ methods from complexity science, network analysis, and mathematical and computer-based modeling.

Veterinary medicine is characterized by four core features. First and foremost veterinary medicine exists to serve the public welfare by addressing issues and questions that tend to arise from a practical problem that, in some form, involves the health of animals. The questions vary widely. They may be concerned with genetic mechanisms of diseases or with the policies and procedures to promote population productivity. They may focus on the mode of action of a drug used to remedy a disease or with the nature of the agri-food system required to promote human health and well-being. But, typically, questions addressed in both veterinary practice and veterinary research, arise because someone ultimately needs information to cope with a disease problem or health goal associated with animals.

Second, veterinary medicine is comparative. It transcends species boundaries and studies phenomena basic to the diseases and health management of all species. Because of the diversity of species and situations confronting veterinarians, it is rarely possible to generate data for all health issues of all species in all situations. Often veterinary medicine seeks commonalties in mechanisms of diseases or approaches to health that can be used across species and situations. One of the defining contributions of veterinary medicine to society has been its historical role in comparative biomedical research wherein animal models of diseases are used to inform human medicine. The comparative approach has been essential for medical progress and continues to be the foundation for contemporary veterinary and human medicine.

Third, veterinary medicine is an applied science. It develops tools, techniques and decision models to influence or control health outcomes in animal-related systems. Veterinary medicine applies the knowledge developed in the natural sciences, within the context of optimal health, the latter concept being influenced not only by biological phenomena but also by ethical, social, and/or economic considerations. Variations in these considerations from person to person, region to region or country to country, result in adaptive application of the scientific information supporting veterinary medicine. An example of adapting health goals to economic considerations would be targeting herd health strategies to achieve a level of milk production for a dairy cow to ensure an adequate profitability for the farmer. An example of ethical considerations influencing health standards would be minimum floor space requirements for pigs that ensure an acceptable level of animal welfare.

Fourth**,** veterinary medicine is multidisciplinary. The need for an applied, health focused context in veterinary medicine gives rise to its multidisciplinary nature. While some

veterinarians and veterinary researchers have a single focus on a very specific subject or methodology, veterinary medicine as a whole encompasses a broad range of specialties and perspectives. Veterinary research may be done by veterinarians or biomedical scientists in veterinary schools or in a variety of other institutions. In parallel to veterinary medicine's growing extension of interest beyond individuals to populations and ecosystems, veterinary practice has similarly evolved from an individual to a team approach involving not only veterinarians but economists, ecologists, agrologists, and other appropriate discipline experts working together to solve the increasingly complex health problems.

2. Origins and Scope

2.1. The Path to 21st Century Veterinary Medicine

Animals have been an intimate part of human life since the dawn of civilization. Animals have always been significant to people, whether providing food, clothing, security, income, transport, or cultural worth. The importance of animals to human society resulted in a growing interest in their function and their interactions with people. There are very early records of individuals who specialized in the care and healing of animals, especially horses. The emergence of veterinary medical knowledge depended in significant measure on factual observations of animals in ancient Egyptian, Greek, Middle Eastern and Asian civilizations. Aristotle and his colleagues performed dissections on hundreds of species of animals, describing their normal forms and their diseases. Early attempts to remedy ailments of horses, mules and livestock date back to these ancient civilizations. Later observations on the spread of contagious diseases of animals laid some of the foundations for epidemiology. Concepts of infection and quarantine of animals were recognized and described three hundred years before Pasteur and general acceptance of the germ theory. The emergence of the contemporary veterinary profession began in the last half of the 18th century when schools of veterinary medicine were established in Europe. This development was precipitated by the need for human resources to deal with the catastrophic effects of specific diseases such as foot and mouth disease, rinderpest and pleuropneumonia on food supplies and economies.

Veterinary medicine's contributions to biomedical science became increasingly more important throughout the 19th century. The early development of veterinary research focused on anatomy and physiology. By the mid 19th century veterinary research was making significant contributions to the understanding of the causes and epidemiology of infectious diseases. For example, some of the first evidence that arthropods can transmit disease-causing organisms, came from studies by veterinary scientists. The flourishing of microbiology that occurred in the last half of the 19th century benefited enormously from both laboratory and field observations on infectious diseases in animals. The recognition of zoonotic parasitic and bacterial diseases highlighted the need for improved slaughterhouse hygiene to protect public health. The finding that bovine tuberculosis could be transmitted to people and the subsequent virtual eradication of this disease from domestic livestock in many parts of the world remains one of the veterinary profession's greatest contributions to public health.

Until the early 20th century, most of veterinary medicine was concerned with maintaining animals for work, for military purposes, and for a safe and secure human food supply. For the first half of the 20th century veterinary medicine was focused largely on food animal production and the hygiene of animal-derived food products. During this period clinical veterinary research was not only adopting new clinical methods from human medicine (e.g. the use of antibiotics) for application in animals but also developing new methods that were later adopted by human medicine (e.g. certain orthopedic and anesthetic techniques).

The enormous growth in companion animal practice that followed World War II meant that a growing segment of veterinary practice became oriented to ends quite similar to those in human medicine and became increasingly concerned with comparable diseases, like cancer and diabetes. The huge growth in public investment in biomedical research following WWII included a commitment by the veterinary academic community to participate in this development. The increased dedication of the veterinary community to comparative biomedical research led not only to research growth in the traditional disciplines but also to the emergence of the clinical specialty of laboratory animal medicine. In the last half of the 20th century the huge increase in the volume of biomedical knowledge coupled with an insatiable demand for more sophisticated veterinary services led to the emergence of formalized veterinary disciplinal specialties that mirror those in human medicine, such as internal medicine, surgery, dentistry and ophthalmology. In parallel it has been more common for veterinarians interested in pursuing a research career to acquire post-graduate research degrees (e.g. Masters, PhD).

The 21st century has arrived with an expanding scope of activities for veterinarians. While clinical specialties and laboratory-based research still dominate the veterinary agenda, new issues confronting humanity are increasingly becoming the subject of veterinary concern. Over the past fifty years the enormous growth in human population, technology, and trade has placed unsustainable stress on the environment. Several important problems involving veterinary medicine have emerged including: loss of biodiversity, increased risk of species extinction, escalation of zoonotic diseases, the need to establish national herd health status to support global trade, and growing interactions between wildlife and domestic animals. The interconnectedness among all species has become striking. In this new circumstance the historical divisions between animal, environmental, and public health not only have less relevance, but frequently serve as obstacles to an integrated approach to health.

Despite the profession's expansion of interests to include more species and more comprehensive health issues, production-limiting diseases and food hygiene remain major areas of concern for most of the world's veterinarians and thus important continuing elements of the veterinary research and practice agendas.

2.2. Scope of Veterinary Medicine

There are three main components in any disease situation: the subject affected by the disease, which could be an individual, population, community or ecosystem; the agent

that undermines health; and the environments in which the subject(s) and agent(s) interact.

Significant efforts have been directed towards the study of disease-related changes in the patient, specifically in the field of pathology. Pathology has been the cornerstone of veterinary research serving as the interface between the clinical disciplines and the more basic biomedical sciences, like anatomy, physiology, biochemistry and microbiology. Veterinary scientists have also expended significant research effort towards understanding how living organisms (parasites, bacteria and viruses), toxins, nutrients, genetic factors and physical forces interact with animals to cause disease. Such research has often resulted in the development of strategies to prevent people or animals from being exposed to disease causing agents, treatments for individuals afflicted by disease, or methods to eradicate these pathogens from the environment.

Animals sometimes may be the source of disease in people. Most obviously animals may cause physical injury to people through biting, kicking, and so on. The role of animals as reservoirs for zoonotic diseases that may be transmitted to people is particularly important. Veterinary public health researchers develop strategies to protect human health by managing our relations with animals. They investigate the means to reduce or eliminate those risks that could either compromise food hygiene or lead to transmission of zoonotic disease in circumstances when people and animals closely interact.

Health promotion is now receiving more attention in veterinary research to provide some needed balance with the longstanding focus on eradication of disease. Initially, veterinary research on health promotion targeted sub-clinical diseases that were reducing the production of farm animals and decreasing farm efficiency and income. These initiatives helped to enhance food security and farm sustainability and profitability while fostering animal welfare. Presently, research is evolving towards a more expansive view of health promotion that includes maintaining the abundance and distribution of wildlife, exploring the health benefits of the human-animal bond, and determining the features of healthy ecosystems.

3. Trends in Veterinary Medicine

Veterinary medicine continues to be a rapidly evolving field. As humankind's relationships with animals change, so does society's expectation for animal care and for the management of health issues associated with animals too. Several trends influence the direction of veterinary practice and research.

3.1. Societal Trends

3.1.1. Population Growth

The growth in populations of people and animals brings with it increasing risks from infectious and contagious disease. These risks may be associated with increases in population density and/or changes in the nature, frequency or types of opportunities to exchange pathogens. The changing interfaces for population interactions that arise from

socially driven environmental change and the increased connectedness among biota associated with globalization can have profound implications for disease prevention and control planning.

The expansion of human and domestic animals into new habitats has increased exposure to pathogens that once were largely sequestered in untrammeled nature. It has put humans and domestic animals in much closer contact with wildlife with potential disease consequences for all three populations.

3.1.2. Industrial Technologies

Industrial technologies are having increasingly more serious impacts on the nature and number of health hazards that animals and people encounter. Industrial wastes can introduce harmful substances into the environment that may have a significant bearing on the health and welfare of individuals, populations and communities. As a consequence more careful attention is being directed towards the changing health status of animals and people exposed to these hazards. Understanding how animals can serve as sentinels for such hazards is a central notion of environmental impact assessments applied to industrial settings.

The shift from family farms to industrial scale farming brings new challenges in animal care. Increases in farm size and specialization in food animal production have both had a profound impact on food animal practice. These larger more specialized enterprises are less dependent on emergency medical services, relying instead on preventive health management services that are demonstrably cost effective while meeting animal welfare standards.

New technologies, such as nanotechnology, advances in information sciences and molecular biology will continue to create both positive and negative contribution to animal health management or food safety. Understanding the implications of these advances will be a constant challenge for veterinarians.

3.1.3. Globalization

Globalization is having a double-edged effect on animal and human health. On one hand, the expanding global movement of people, animals and goods is facilitating the spread of diseases. On the other, the ideas and resources necessary to manage disease problems can be moved more quickly and easily to the appropriate locations worldwide. These circumstances call for new national and international strategies to deal with transportable animal diseases that are becoming more serious threats to public health, environmental integrity and livestock dependent economies. Ongoing concerns of veterinary medicine are the development of new policies for; 1) establishing and classifying the animal health status of nations, 2) assessing the risks associated with specific diseases, and 3) managing or preventing disease beyond simply closing national borders. Improved international cooperation to develop and apply regulatory methods for preventing or dealing with disease at its point of origin or preventing its transmission would seem to be a more productive approach for all nations. Expanding and more liberalized trade policies for animals and livestock products are leading to the increased

use of risk-based methods coupled with “regionalization” approaches instead of the almost automatic freezes in movements of animals and animal products across national borders. This has resulted in demands for new qualitative and quantitative methods in animal health risk assessment. Regulatory approaches to disease control will require new diagnostic technology, like rapid field methods that facilitate the early detection of diseases, pathogens or toxic contaminants in traded species and animal products. While globalization brings risks, the effective sharing of techniques, knowledge and capabilities can bring benefits that will enhance the capacity of the veterinary community to protect the health of animals and society. Meeting challenges in providing and sustaining timely access to new information in poorer countries is essential to taking full advantage of the benefits from increased global communication capacity.

3.1.4. Urbanization

As nations become increasingly urbanized, two important trends emerge. First, as the proportion of veterinarians in companion animal practice increases, it is often at the cost to the number of rural or livestock practitioners. Sparse rural veterinary services already seriously limit farmer income, farm stability and food safety in a number of countries. Any exodus of veterinarians from rural areas, where many diseases of concern to trade and public health arise, will create deficits in national surveillance capacity and new vulnerabilities. Innovative recruitment and retention policies will be required to sustain and build the veterinary services required to serve rural communities and the livestock sector. Publicly supported veterinary services are present in some countries and may find favor among others in the future. Increased reliance on veterinary paraprofessionals is a likely trend.

Second, with the exception of continued concern for animal welfare, more urbanized societies tend to lose interest in rural and animal health issues. Veterinarians must play a larger role developing public policy that recognizes the full value of animals in society. Public policy must acknowledge that animal health is a public good that goes beyond the economic value of animals. Veterinary medicine must become part of a much more all-embracing “one health” view that integrates animal health with ecological, societal and community well being. Animal health policy is a field for research that must receive increased attention if this more comprehensive vision for the future of veterinary medicine is to evolve to meet the shifting expectations of an increasingly urbanized society.

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Biographical Sketches

Craig Stephen obtained his DVM degree from the University of Sasktachewan in 1987. After 4 years of private veterinary practice in a rural mixed animal practice, Dr. Stephen entered a doctoral program in epidemiology at the University of Saskatchewan where he focused on field epidemiology and disease outbreaks as the theme of his research. His doctoral work dealt with an emerging disease of farmed salmon.

Upon completing his PhD in 1994, he took a position as an infectious disease epidemiologist at the University of British Columbia and British Columbia Centre for Disease Control where he remained for three years. In 1995, he founded the Centre for Coastal Health (CCH). The CCH became a model veterinary practice that provides integrated advice on health issues at the interface of people, animals and the environment. He remains the president and director of the CCH. He is an Associate Professor in Ecosystem and Public Health (Faculty of Veterinary Medicine) and in Community Health Science (Faculty of Medicine) at the University of Calgary. He is a Clinical Professor in Health Care and Epidemiology at the University of British Columbia (UBC). He manages the Pacific centre for the Canadian Cooperative Wildlife Health Centre and is an associate member of the UBC Centre for Disease Control. He directs the Animal Determinants of Emerging Disease Research Unit and is the Chair of the British Columbia Environmental and Occupational Health Research Network. He was formally a consulting veterinarian for the Vancouver Aquarium and Marine Science Centre as well for the University of Victoria. His a founding member of Veterinarians Without Borders-Vétérinaires sans

Frontières (Canada). He has published in the areas of zoonotic and emerging disease, environmental health, and fish and wildlife population health.

Jim Bellamy received his early education in Stayner, Ontario. He obtained a DVM degree from the University of Guelph, a PhD in pathology from the University of Saskatchewan, followed by post-doctoral research in immunology at the University of Adelaide, Australia. From 1974 until 1985, he taught clinical and experimental pathology at the Western College of Veterinary Medicine, University of Saskatchewan. In 1985 Dr Bellamy was appointed Chair of the Department of Pathology and Microbiology at the Atlantic Veterinary College (AVC), University of Prince Edward Island and in 2003 became Associate Dean of Graduate Studies and Research at AVC. He was Editor of the Canadian Journal of Veterinary Research for 5 years and has served on a number of provincial and national boards and committees dealing with biomedical research, including those of the Natural Sciences and Engineering Research Council of Canada, the Saskatchewan Health Research Board, the Alberta Heritage Fund, the Agricultural Research Investment Fund of PEI, and the Aquaculture and Fisheries Research Initiative of PEI. Dr Bellamy has published papers and books on enteric pathology, enteric immunology, clinical pathology, artificial intelligence, and medical informatic**s.**

Ole Nielsen was born in Edmonton, Alberta on 03 March 30. He commenced his university education in Agriculture at the University of Alberta in 1949 and transferred to the Ontario Veterinary College, graduating with a with the DVM degree from the University of Toronto in 1956. He undertook graduate studies in veterinary pathology at the University of Minnesota, receiving his PhD degree in 1963 and in the same year became a Diplomate of the American College of Veterinary Pathologists. He was awarded LLD (Hon) from the University of Saskatchewan in 1996 and was made an Honorary Fellow of the University of Guelph in 1997.

Following appointments at the University of Minnesota as Lecturer and Assistant Professor, he joined the Western College of Veterinary Medicine, University of Saskatchewan where he became Professor of veterinary pathology and subsequently Dean from 1974-82. From 1985 – 1994 he was Dean of the Ontario Veterinary College, University of Guelph and became Professor Emeritus in the Department of Pathobiology in 1995. His research and academic interests have included enteric diseases, toxicology, comparative medicine, ecosystem health and veterinary education. He has served on a variety of Boards and committees including the International Laboratory for Research on Animal Disease (Chair) and the International Livestock Research Institute in Nairobi (1988-98) , Board of Agriculture and Natural Resources (BANR)**,** National Research Council, The National Academies, Washington, D.C.: (2003-2005); Saskatchewan Environmental Advisory Council as Chair (1978-82)); Alberta Veterinary Medicine Steering Committee, Alberta Department of Advanced Education as Chair (2004- 2008). He was President of the Canadian Veterinary Medical Association in 1969.

Prof. Nielsen is a member of: the Canadian Veterinary Medical Association; American Veterinary Medical Association; Alberta, Saskatchewan, Manitoba and Ontario Veterinary Medical Associations; American College of Veterinary Pathologists; and Sigma Xi.