Volume 7 Number 2
Winter 2006

LEADERSHIP in PUBLIC HEALTH

<u>At Issue:</u> Public Health and Veterinary Medicine

SCHOOL OF PUBLIC HEALTH
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UIC University of Illinois at Chicago

A Publication of the Mid-America Public Health Training Center and the Mid-America Regional Public Health Leadership Institute

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Leadership in Public Health
is a publication of the
Mid-America Public Health Training Center*
and the
Mid-America Regional Public Health Leadership Institute*

* Located at the
University of Illinois at Chicago
School of Public Health
Division of Community Health Sciences
Center for Public Health Practice

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Sponsored in part by the
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http://www.phls.org/

This publication was made possible by a grant from the Health Resources and Services Administration (HRSA), DHHS, Public Health Training Centers Program and its contents are solely the responsibility of the authors and do not necessarily represent the official views of HRSA.

Editor's Preface

The "Big Tent" of Public Health houses the broadest array of professions in the Health Care Universe. Dr. Rowitz was perceptive and just when he asked that an issue of Leadership in Public Health be focused on veterinary medicine and public health: The constant outbreaks or threats of new diseases, the increasing evidence for need of improved food safety inspection methods, the largely zoonotic "A list" pathogens that find supposed utility as bioterrorist weapons each have roots and branches from veterinary research.

We often lose sight of the fact that veterinary medicine became a great health profession through its ability to improve the lives of people. In the US, this history started when the USDA, then the Bureau of Animal Industry, eradicated contagious bovine pleuropneummonia in 1889 freeing animal agriculture from being a "cottage industry", proceeded through the 20th century with control of bovine tuberculosis and brucellosis in cattle and in people, stopping human rabies transmitted from domestic carnivores, and continues today as veterinarians fill crucial roles in food safety, agricultural biosecurity, zoonotic disease control, and even enabling pet ownership among immunosuppressed people.

As guest editor of this issue, I have pursued an unhidden and triple agenda: To highlight the role of veterinary medicine in maintaining the health of our animals and our people, to honor all veterinarians through presentation of papers by these few to represent the many, and to call for leaders and leadership in veterinary medicine, to copy without shame the example and model of Louis Rowitz, PhD, and the Mid American Regional Public Health Leadership Institute.

My sincere thanks to Ramon Bonzon, a great networker, to Fasika Alem, she of the impeccable grammar and infinite patience, and to all my friends in the world of public health for their encouragement and empowerment.

My colleagues, let us collaborate for public health advancement.

Kenneth E. Nusbaum

Public Health and Veterinary Education in the United States

James GW Wenzel, DVM, PhD

Dr. Wenzel is an Associate Professor in the Food Animal Section of the Department of Clinical Sciences at Auburn University's College of Veterinary Medicine. He recently completed a study and the resultant report for the United States Department of Agriculture, entitled "Comprehensive Assessment of Veterinary Accreditation Training for Foreign Animal Disease Recognition at Colleges of Veterinary Medicine in the United States," from which much of the data and commentary contained, herein, was gleaned.

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Veterinary Medicine is pivotal among the health professions in knowledge and management of animal health as well as disease in individuals and populations, and no less important among *public* health specialities due, in large part, to its understanding of the broad scope of epidemiology, especially zoonoses, parasitisms, and other human-animal interactions. Thus, it is entirely appropriate that the schools and colleges of veterinary medicine have adapted to changing societal needs in animal and public health.[1]

The Executive Summary of the 1999 KPMG report[2] predicted that the largest increase in demand for veterinary services through 2015 would occur in small animal private practice. A more recent (2003) 'Special Report' has opined that the current majority of veterinarians are involved in meeting the growing demand for practitioners of companion animal medicine.[1]

Approximately 2,500 students graduate from United States colleges and schools of veterinary medicine (CVMs) each year. Predicted shortfalls in the supply of veterinarians through 2008 for positions in the United States Department of Agriculture (USDA) alone exceed 500, and this does not include the probable increase in demand for veterinary expertise in biodefense for the USDA and many other organizations.[3] If only to maintain the current numbers of veterinarians in public practice, at least 20% of new graduates will be required to fill such positions.[1]

The potential shortfall in numbers of veterinarians entering public practice comes at a time when the United States faces an array of biological threats, including accidental or intentional introduction of foreign animal disease (FAD), exotic plant disease, and/or human pathogens; newly emerging or reemerging diseases; and drug resistance among human and animal pathogens. The current Presidential administration[4] and USDA officials[5] have recognized, at least, the need for surveillance and emergency response preparedness. Academic veterinary medicine should examine its educational programs and develop curricula to meet these threats and prepare students for careers in public practice.[6] The American Veterinary Medical

Association (AVMA) Executive Board has voted to encourage the schools and colleges of veterinary medicine to incorporate all or part of the American College of Veterinary Preventive Medicine (ACVPM)-designed model public health and preventive medicine curriculum.[7]

The study from which the data for this report was gleaned was conducted in 2003. It was a review of curricular content and an opinion-gathering exercise at each of the United States CVMs designed to assess those aspects of veterinary education which might be necessary or useful for veterinarians who are Accredited by the USDA. Accredited Veterinarians are licensed practitioners who hold statutory authority to act as agents of the federal government, in cooperation with State animal health authorities, in regulatory matters involving animal trade, and surveillance and disease control. They are also considered the first line of defense against, and most likely to first encounter, FAD incursions. Since many or most veterinary public health issues overlap, to some degree, with the responsibilities of the Accredited Veterinarian, the study provided a reasonable database through which to peruse and analyze public health-related teaching in the curricula of the CVMs.

Methodology

The design and conduct of the study was overseen by a Technical Steering Committee composed of veterinarians from the USDA, state veterinary offices, academia, and the Association of American Veterinary Medical Colleges (AAVMC), many of whom were also members of other groups, notably the United States Animal Health Association. The instruments and methods were also reviewed and approved by the Institutional Review Board for Human Subjects Research at Auburn University (IRB authorization # 03-090 MR 0306).

The Deans of each CVM were contacted by letters from the USDA, the AAVMC, and the principal investigator (PI). Subsequent communications were predominantly between the PI and Associate Deans for Academic Affairs (or their equivalent) to gain access to information about curricular design, organization and content, and to arrange meetings with faculty and students.

Materials (e.g., outlines, bulletins, web sites) were gathered to obtain an overview of curriculum design and course schedules at each CVM. Information was requested about topics which might be covered in each curriculum through an electronic 'Subjects Inventory' worksheet, which was intended to be distributed to, and completed by, the faculty. While the list of specific topics is too lengthy to be included here, the headings and subheadings are listed in Table 1.

During visits to each CVM, meetings were requested with faculty to discuss, among other things, such topics as were listed in the Subjects Inventory. Instructors in the following areas of study were suggested as the most appropriate to meet with: ethics, regulatory medicine, microbiology (especially virology and bacteriology), pathology, epidemiology/public health, large animal (medicine, usually), infectious diseases, and field services (or others who attend to clinical regulatory duties). In addition to refinement of the Subjects Inventory worksheet, discussion was stimulated through the use of a question outline and a list of areas for needs assessment. Most questions were directed at curriculum content and Accreditation-related teaching.

Table 1: Headings and Subheadings of Topics about which Information* was sought in each Veterinary Curriculum through an Electronic 'Subjects Inventory' Worksheet

Animals and the Environment
- cleaning & disinfection

Animal Welfare
- animal welfare acts

Clinical Techniques
- history & physical examination
- clinical procedures

Epidemiology
- biosecurity
- disease control programs
- outbreak investigation

Ethics
- regulatory responsibilities

Foreign & Reportable [Animal] Diseases
- rationale for inclusion/exclusion
- signs & syndromes
- reportable diseases (any species)
- avian reportable diseases
- bovine reportable diseases
- equine reportable diseases
- caprine/ovine reportable diseases
- porcine reportable diseases
- reportable diseases (other species)
- action steps for reportable disease
- response to reportable diseases

Regulatory Priniciples
- regulatory responsibilities
- animal identification
- forms & reports
- control & eradication
- veterinary inspection
- traceback
- organization & bureaucracy

Zoonoses
- public health responsibilities
- personal protective equipment

*Information sought for each topic included course, term and year in which the topic was addressed, approximate time devoted to the topic, type of instruction (eg, didactic, clinical), teaching materials (e.g., texts, web sites, caseload), proportion of students exposed to the topic, and instructors' names.

Meetings with students were also requested if time and schedules allowed. These meetings were also guided by the use of a question outline. Most questions were directed at regulatory activities and FAD recognition and response.

Results and Discussion

Contact Hours in Public Health and Epidemiology Courses

A review of the required and elective, didactic or problem-based course and clinical rotation titles comprising the professional curricula of the 28 CVMs was conducted. The following words and phrases in such titles were considered indicative of course content germane to public health education: animal populations, biostatistics, epidemiology, evidenced-based medicine, food hygiene, food safety, government and corporate, human health, population medicine, preventive health, preventive medicine, public health, regulatory medicine, and zoonoses. Based on an estimate of 15 contact hours per semester credit hour and 10 contact hours per quarter credit hour, the arithmetic mean (+/- one standard deviation) "core" (required coursework) contact hours in the preclinical curriculum devoted to these subjects at 25 CVMs was 68.9 hours (+/- 19.9), with a mode of 60 hours (11 CVMs), and a range of 41 to 120. Three CVMs had predominantly problem-based learning (PBL) preclinical curricula, and were not so quantified. Five CVMs had applicable, core, fourth-year rotations, which ranged in contact hours from 15 to 75. Eleven CVMs had one or more applicable elective courses, with six offering such courses in the preclinical curricula, three offering them during clinical rotations, and two offering both.

Shortfalls

These data compare favorably with results from Riddle *et al*,[8] which indicate a range of contact hours in applicable core courses of 30 to 120 hours. However, no curriculum has allotted to such courses the amount of time suggested by the ACVPM-designed model public health and preventive medicine curriculum, which is a total of 163.5 contact hours for required subject matter and 49 contact hours for optional material. Also, in addition to a recommendation suggesting core courses in epidemiology and public health/population medicine, the previously-cited Special Report[1] in the Journal of Veterinary Medical Education recommends a core clinical rotation in population health and public practice. Indeed, one professor commented, "Clinical Epidemiology is the way to teach Epidemiology." However, the current findings indicate that a minority of CVMs (five) require a clinical experience such as this, and only five others offer such an elective rotation.

Many Topics Covered in Other Courses

The apparent shortfalls in epidemiology and public health education in the veterinary curricula will not be reconciled by the review only of courses by such titles, if at all. Many of the topics common to the ACVPM model curriculum and the Subjects Inventory analyzed for this work are found in courses with disparate names. For instance, the current analysis found that rabies is addressed almost universally in veterinary public health and/or epidemiology courses, but CVMs with non-PBL curricula also cover rabies in a mean of 2.00 courses and mode of one (1) *other* course, most often virology or infectious diseases, but also in pathology, neurology, and/or various medicine courses. The clinical rotations during which rabies is addressed were not quantified, but the topic must certainly be considered in several clinical disciplines in any curriculum.

To make further use of the example of rabies, one might logically and justifiably assume that those aspects of the disease addressed in a virology lecture differ from those discussed in clinical neurology rounds and these from aspects covered in public health and regulatory medicine. There will, however, be some overlapping treatment of most any aspect of the subject between disciplines. Thus, the entire resident professorate must be consulted in review or revision of a curriculum, as they ultimately know and determine their portion of its content.

Other zoonoses were common to the ACVPM model curriculum and the Subjects Inventory. These diseases, and the number (mean, mode) of all courses and rotations in non-PBL curricula in which they were addressed, included anthrax (2.36, 2), brucellosis (4.28, 4), equine encephalitidies (2.92, 3), psittacosis/chlamydophilosis (2.28, 2) and tuberculosis (3.96, 4).

There are other examples of topics common to the ACVPM model curriculum and this study's Subjects Inventory, which may be covered in courses other than those related, in name, to public health and epidemiology. The ACVPM model recommended eight required and four optional hours for coverage of FADs, including most of the Office International des Epizooties' (OIE) 'List A' diseases. The current analysis shows that only 26% of veterinary students participate in a class devoted to FADs (Table 2), but most of the 'List A' diseases are addressed in one or more courses in most of the curricula (Table 3).

Table 2: Numbers and Percentages of Veterinary Students per Graduating Class, Nationwide, having taken or not taken Courses dedicated to Foreign Animal Diseases

	per nationwide class				
	# CVMs	FAD Course Taken?	# Students	% Students	% within Elective
Core FAD Course	7[1]	Yes	533	22%	
Elective FAD Course	5[2]	Yes	89	4%	17%
		No	423	17%	83%
No Dedicated FAD Course	16	No	1401	57%	

[1]Four of these take, in part or as a whole, the form of the Iowa State/Veterinary Information Network on-line FAD course. [2]One of these takes, in part, the form of the Iowa State/Veterinary Information Network on-line FAD course.

Table 3: Number of CVMs at which OIE 'List A' Diseases are Addressed in the Curriculum and in Core Courses, and Statistics on Numbers of Courses in which Addressed

OIE 'List A' Diseases	number of curricula in which the disease was addressed*	number of curricula addressing the disease in core courses*	modal number of courses in which addressed	modal number of core courses in which addressed	minimum number of courses in which addressed	maximum number of courses in which addressed
African horse sickness	27	26	2	1	1	4
African swine fever	25	24	2	1	0	4
bluetongue	24	23	3	2	0	6
classical swine fever	25	23	2	2	0	3
contagious bovine pleuropneumonia	21	19	1	1	0	4
exotic Newcastle disease (z)	25	22	3	3	0	8
foot-and-mouth disease (z)	27	27	3	3	1	5
highly pathogenic avian influenza (Z)	22	21	2	2	0	9
lumpy skin disease	20	19	1	1	0	3
peste-des-petits ruminants	19	19	1	1	0	3
Rift Valley fever (Z)	23	22	1	1	0	4
rinderpest	23	23	2	1	0	5
sheep and goat pox	22	21	2	1	0	4
swine vesicular disease	25	23	1	1	0	4
vesicular stomatitis (z)	26	26	2	3	0	6

*The maximum was 27, as one PBL curriculum was not tabulated.
(Z) - Major zoonotic potential.
(z) - Minor zoonotic potential.

Other topics common to the ACVPM model curriculum and the Subjects Inventory, and the number (mean, mode) of all courses and rotations in non-PBL curricula in which they were addressed, included decontamination and disposal (2.20, 2), disease reporting (2.88, 2), veterinary inspection and import/export (2.08, 1), outbreak investigation (2.80, 3), and principles of surveillance (2.76, 2).

Additional topics may not be covered during coursework at all, but rather as a matter of daily function of students in laboratories and veterinary teaching hospitals. Mandatory familiarity with biosafety and isolation protocols is the norm. Of 105 senior students interviewed on the topic, 100 (95.2%) reported experience working in small and/or large animal isolation facilities. One faculty commented, “Biosecurity and infection control is emphasized throughout the college, especially salmonellosis, rabies, and leptospirosis, among others... This emphasis on disease control is not lost on the students.”

Erosion of Teaching of Epidemiology and Public Health in the Veterinary Curricula

Despite the above findings that indicate that many important topics are addressed in the current veterinary curricula, there is yet reason for concern. Although this study did not include retrospective quantification of veterinary curricula of the past, opinions gathered during interviews with faculty indicate an erosion of contact hours for teaching public health and related disciplines. One faculty comment, indicative of many others, was, “The concepts of select agents, reportable diseases, emerging diseases, disease surveillance, and molecular epidemiology ... indeed much of basic science has been diluted or lost in curriculum revision.” Hoblet *et al*[1] concur with this opinion, suggesting that increasing clinical specialties have resulted in “compression” of core courses, especially those related to population and public health. If the extant expertise in, and exposure to, veterinary epidemiology and public health is not nurtured, the potential exists for its loss.

Also gleaned from faculty commentary was the implication of a lack of interest among veterinary students in these areas of study. “People in veterinary medicine, after some time, see public health as an important issue, but the students don’t see this as important ... it’s just not on their radar screen.” Another faculty member commented, “Many students are myopic in their view of the profession, leaning heavily toward small animal practice. Typical of this attitude is the frequent question, ‘Why do I need this?!’ when confronted with topics in epidemiology, regulatory medicine, and even public health.”

Expanding Graduate and Combined DVM/Graduate Degree Programs

In addition to established graduate programs in public health and related areas at several CVMs, a number of new graduate and combined degree programs have been developed in anticipation of, or response to, the growing need for veterinarians in public practice. As these were incidental to the original project’s data-gathering methodology, and to avoid errors of omission, the reader is directed to a source of all CVM web sites, through which they may find descriptions of most such available programs.[9]

Conclusion

All US veterinary curricula address many public health and related topics, often in courses under disparate titles. Therefore, the entire course of study at a given CVM must be scrutinized to determine all aspects of a topic which may be covered. Indeed, some important lessons (e.g., infection control), may be learned, not in coursework, but through institutional practices and protocols. Regardless, it appears that no CVM has allotted to epidemiology, public health, and related areas of study the amount of time in contact hours suggested by the American College of Veterinary Preventive Medicine's model curriculum. There is increasing awareness of the need to improve the quantity, quality, and attitude toward training in veterinary epidemiology and public health, and this has resulted in endorsement by the American Veterinary Medical Association of the concept, and increasing availability of graduate training programs in related areas of study.

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Acknowledgements

The Author thanks the United States Department of Agriculture for funding the above-mentioned project (contract # 53-6395-3-C004); the Technical Steering Committee members assembled during this project for their wisdom and guidance; and the administrators, faculty and students of the schools and colleges of veterinary medicine for their time and insight.

Veterinarians and Food Safety: The Yin and the Yang

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David A. Stringfellow DVM, MS

David A. Stringfellow, professor of epidemiology and microbiology, earned his DVM degree in 1970 from Cornell University and his MS degree from Auburn University in 1982. Between 1970 and 1977, he gained experience in food animal practice with emphasis on reproduction in dairy cattle. While working for the Pennsylvania and United States Departments of Agriculture from 1977 to 1983, he acquired additional training in the epidemiology of indigenous and foreign diseases of domestic livestock. Subsequently, he joined the faculty at Auburn University and currently holds a dual appointment in the Departments of Pathobiology at the College of Veterinary Medicine (Professor) and Animal Health Research of the Alabama Agricultural Experiment Station (Coordinator). He is coordinator of a course in applications of advanced reproductive techniques and coeditor of the Manual of the International Embryo Transfer Society (www.iets.org). Further, he teaches core lectures to veterinary students in foodborne diseases, food production technology and food inspection.

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The involvement of the veterinary profession in food safety brings to mind early Chinese philosophy of the Han dynasty (Hooker, 1996). During that period (207 BC – 9 AD), the Han thinkers proposed that all in the universe were governed by opposite and often conflicting principles, the Yin and the Yang. Indeed, contributions of veterinary medicine in food safety require contributions from two very different constituents. Traditional involvement of veterinary medicine in food safety has been principally through organoleptic (sight, touch, smell) inspection of carcasses at the abatoir (slaughterhouse) and as regulatory workers (the Yin), while most practicing veterinarians were only rarely conscious of their involvement in protecting the public from food-borne illness (the Yang). To balance the professional "Chi", the role of non-regulatory veterinarians in promoting food safety should be encouraged through emphasis within the professional curriculum and continuing education.

Food safety is a major public health concern in the United States. Each year, an estimated 76 million people contract food-borne diseases, 325,000 are hospitalized and 5,000 die (Mead et al., 2004). Bacteria are the primary cause of food-borne illness in the United States, with *Campylobacter* species, nontyphoidal *Salmonella* species and *Clostridium perfringens* being diagnosed most frequently. Although not all food-borne illness is the result of primary source contamination, animals are reservoirs for many of the infectious agents. Poultry, for example, are a primary source of *Campylobacter* and S*almonella*, and cattle are reservoir hosts for *E. coli* O157:H7 (Allos, 2001; Hancock et al., 1994). A major problem in food-borne disease surveillance is under reporting. Secondary person-to-person transmission or transmission through water may obscure a food-borne source (Mead et al., 2004). Human-to-pet-to-human transmission of food-borne agents can occur, but is rarely reported (Barber et al., 2003). Food safety is further undermined by the fact that food can travel a great distance from source to consumer; the average distance that a pound of ground meat travels is 1000 miles (Rand Corp, 2004).

Veterinarians in private as well as public practice are uniquely qualified to play a role in food safety. Many of the courses in the veterinary curriculum strengthen the background of graduate veterinarians in this area. Specific food-borne disease agents are included in bacteriology, virology, and parasitology. Public health courses stress zoonoses; diseases shared among animals and humans, which include many food-borne agents. Toxicology and pharmacology provide background on toxins and other noninfectious agents that may be introduced into the food chain and on drug withdrawal from food producing animals. Epidemiology provides the tools for investigating food-borne disease outbreaks, while courses in food hygiene specifically address disposition of animals at abattoirs and the safe processing and handling of foods of animal origin.

The first meat inspection laws in the United States were adopted in 1890 and involved only salted pork and bacon that were to be exported (USDA, 2004). Sweeping reforms were instituted in the meat packing industry following the publication of Upton Sinclair's book, "The Jungle", in 1905. This resulted in the passage of the Meat Inspection Act of 1906, which brought about three major reforms (anon, 2004): All animals were required to pass inspection prior to slaughter, all carcasses had to receive post mortem inspection, and cleanliness standards were put in place for all abatoirs. The Food Safety and Inspection Service (FSIS) was established in 1981; however, inspection still primarily involved organoleptic methods for inspection. In 1996, the FSIS passed a new rule that involved prevention and control of pathogens in food through the Hazard Analysis and Critical Control Point (HACCP) method. This method targets specific key areas for pathogen reduction and control (Table 1).

Table 1: Seven principles of HACCP

1. Conduct Hazard analysis
2. Determine critical control points
3. Establish critical limits
4. Establish monitoring procedures
5. Establish corrective actions
6. Establish verification procedures
7. Establish record-keeping and documentation procedures

Source: Hulebak and Schlosser, 2002

The demographics of classes entering veterinary colleges have changed dramatically over the last 30 years, resulting in fewer students with a fundamental background in food production and processing. Today, relatively few students have an agrarian background, and a majority desire to practice companion animal medicine (pets and horses). There is concern about an impending shortage of food animal veterinarians and studies are being initiated to determine the need for, as well as approach for maintaining the availability of, veterinarians for this critical role (O'Rourke, 2004). The American Veterinary Medicine Association (AVMA) and several veterinary associations will support this joint investigation.

Typically, food hygiene courses have been among the least popular areas of study in veterinary curricula. Many entering students and even some graduate veterinarians still equate food safety primarily with meat inspection. However, in reality, food hygiene courses now cover cutting edge approaches for food safety, such as irradiation, and the HACCP approach now taken by the FSIS of the United States Department of Agriculture.

Veterinarians have diverse roles in food safety (Table 2). Food animal practitioners are a second line of defense (the producer is the first) against diseases that might affect the food supply and provide important assistance to producers concerning antibiotic treatment, proper drug withdrawal times and residue avoidance. A major responsibility of the food animal practitioner is assuring that only healthy animals enter the food chain. In addition, veterinarians involved in food animal practice can educate producers concerning food safety on a personal level. Veterinarians working for the federal or state governments also play key roles in protecting the nation's food supply. Academic, industry and government veterinarians are also involved in research on methods for prevention and control of many food-borne illnesses.

Table 2: The responsibilities of different groups of veterinarians concerning food safety. The distribution of effort is indicated by the number of asterisks in each cell.

PRACTICE AREA	DISEASE DIAGNOSIS /PREV.	RESEARCH	REGULATORY	PUBLIC EDUCATION
Federal (USDA/FSIS)	**	**	****	***
State Government	**	**	****	***
Food Animal Practitioner	****		**	***
Companion Animal Practitioner	**			****
Academic Veterinarian		***		****
Industry Veterinarian		***		**

Because only 10% of private-practice veterinarians are exclusively or predominantly involved in food animal medicine (AVMA, 2004), private companion animal practitioners should become involved in protecting the public from food-borne disease. They can be an important source of information regarding food safety for their clients and others in their community. Informational brochures for the waiting room (Table 3) and even educational programs through the telephone are available. Because of their background, non-food animal practitioners can also help by providing insight and decision-making expertise to concerned consumers in the communities in which they work and live.

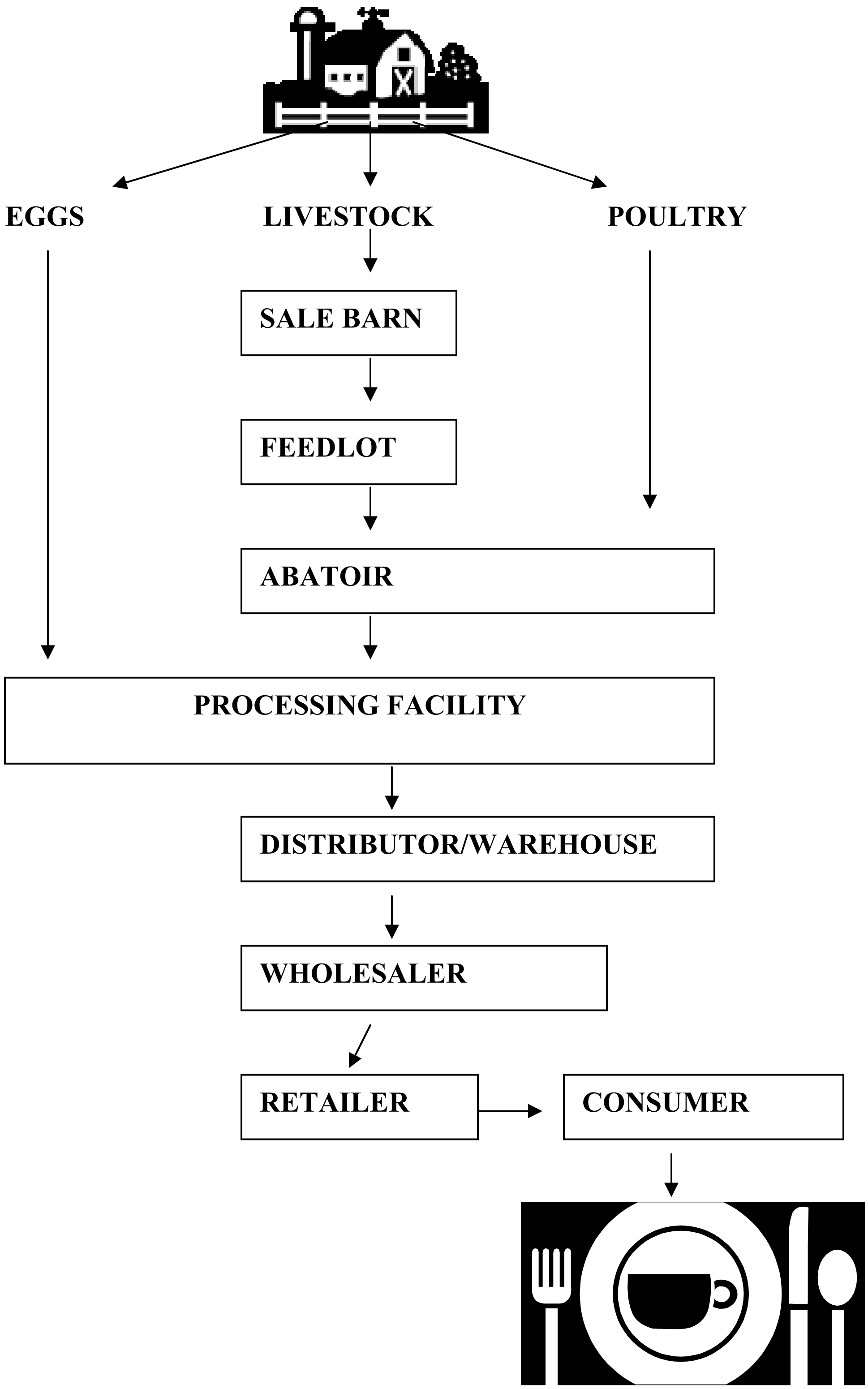
Table 3: Sources of educational brochures on food safety.

Fight back[TR] (www.fightbac.org)		
American Veterinary Medical Association (www.avma.org)		
	Brochures:	Bovine spongiform encephalopathy
		Toxoplasmosis
		NARMS enteric bacteria booklet
United States Department of Agriculture (www.fsis.usda.gov)		
State Departments of Public Health		
University Outreach Offices		

For the public, food safety has become a litigious issue for which they often demand zero risk. This is driven partly by the media's desire to report a conflict and partly by a lack of proper training of children and homemakers in basic food hygiene. The attitude is also a result of a busy life style and the influence of technology on the way we live (Toffler, 1971). Over-emphasis on diseases like bovine spongiform encephalopathy has distracted the public from the more common agents, such as *Salmonella* species.

Providing safe food requires constant oversight from the farm to the table (Figure 1). Veterinarians should be involved in prevention of food-borne illness at all points along this pathway. Private practitioners (both food animal and companion animal) could be involved at the farm level and in the sale barn or at the feedlot. Federal and state veterinarians could be involved on the farm or at the feedlot, as well as in the processing facility. Veterinarians are involved in research on food safety that will play a role in the prevention of food-borne illness from the farm to the table. Furthermore, education roles of veterinarians in food safety occur at the farm and with the consumer. All veterinarians have a responsibility in food safety.

Figure 1: The food process: Farm to Fork.



Adapted from: USDA, 2003

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New Challenges to Rabies Prevention and Control in Veterinary Medicine and Public Health

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Rabies is an acute, progressive encephalitis caused by bites from animals infected with a lyssavirus (1). Arguably, it is the oldest described zoonosis. As an incurable entity, with the highest case to fatality index of any infectious disease, prevention and control parameters are obvious primary public health concerns, due to the futility of conventional treatment. Working in concert over the last 50 years, the veterinary and medical communities at large have been responsible for major progress in rabies curtailment. Critical examples from the recent past provide an object lesson towards future collaborative opportunities, and the need for inventive paradigm shifts, in an effort to minimize any backlash from planned obsolescence or a lack of prominent advocacy, as rabies continues to re-emerge.

Brief History of Rabies in the USA during the 20th Century

At the beginning of the 20th Century, the rabies situation was far from ideal (2). Scores of human cases were reported in the USA. Animal rabies reports were numbered into the tens of thousands per year. Wildlife cases among foxes and skunks paled in comparison to rabid domestic dogs. Clinical diagnosis was the norm, coupled with the histological identification of intra-cytoplasmic inclusions (Negri bodies) within neurons. Although the broad idea of neurotropism was appreciated, pathogenesis was poorly understood. The viral concept was slowly being defined, but virions had not been visualized nor cultured. Vaccines were based upon relatively crude neural tissue harvested from experimentally infected animals, much like the original process developed by Pasteur. Animal rabies control amounted largely to population reduction by lethal techniques.

After World War II, an explosion of altered concepts and new practices were garnered by the birth of veterinary public health and the flowering of biomedical research into a golden age, as recently reviewed (3-7). By the close of the second half of the 20th Century, the complexion of rabies in America had changed drastically (8). Electron microscopy allowed visualization of the first bullet-shaped virions, classifying them with other agents isolated from vertebrates, arthropods and plants (9). Rodents were adapted as a standard laboratory animal model for a variety of uses in virus isolation, related clinical assays, and basic research (10). Pathogenesis was clarified as the centrifugal spread of virions from the bite site via the neural axoplasm, replication in the CNS, and centripetal passage to the salivary glands and saliva (11). The period of salivary shedding prior to clinical signs was defined in dogs, cats, and ferrets, allowing the observation of potentially rabid animals that commonly expose people, rather than euthanasia and brain examination as the only method of risk assessment (12). A concentrated focus in molecular biology defined the agents as having single-stranded, negative-sense RNA as its genetic makeup, with only five basic genes coding for 5 viral antigens (13). Basic surveillance had improved and the overall burden of disease had fallen to less than 8,000 documented animal cases per year (14). More than 100 diagnostic facilities, spread throughout the 50 states, were examining approximately 100,000 suspect animal cases per year, and a national protocol for the direct fluorescent antibody test was established (http://www.cdc.gov/ncidod/dvrd/rabies/professional/publications/DFA_diagnosis/DFA_protocol-b.htm). The development of monoclonal antibodies, and later genetic sequencing techniques, allowed the differentiation of antigenic variants of rabies virus, and a heretofore unexpected diversity of host-virus-environment interactions (15). Rabies viruses were perpetuated in cell culture, making pure, potent, safe, and efficacious vaccine production a reality (16). The concept of realistic herd immunity was directed to dog populations, shifting local animal control from sole reliance upon euthanasia of strays to mandatory rabies vaccination, applied licenses, early spay-neuter clinics and responsible pet ownership (17). Human cell culture vaccines flourished, and purified rabies immune globulin was added and emphasized in the vaccination protocol for effective prophylaxis (18). Rabies cases in *Homo sapiens* declined to an average of 1-2 cases per year (19). Canine rabies was eliminated throughout the country. Associations with new hosts, such as raccoons, coyotes, and bats were appreciated. The concept of oral vaccination of wildlife was born, allowing a powerful adjunct procedure for free-ranging fauna never before realized (20).

Some Current Challenges

The start of the new millennium did not appear as bright as the milestones set as measuring points. By the close of the 20th Century, several cell culture vaccines for human prophylaxis had been licensed, and three of these products were marketed in the USA; RVA, HDCV and PCEC (18). At the end of 2004, only one vaccine was readily available. One producer of the rabies vaccine absorbed (RVA) had ceased production. The distribution of the human diploid cell vaccine (HDCV) product was halted after a voluntary recall by the manufacturer, because the specter of potential live rabies virus contamination was raised (21). This placed the burden of supply of the purified chick embryo cell vaccine (PCEC) unto a sole producer, resulting in relative limitations of product. As illustrated by recent shortages of influenza vaccine, global supply and human prophylaxis are more precarious than realized. Although these biologicals are life saving after exposure, in many respects, rabies can be considered an orphan disease, both at the national and international level. A century after Pasteur's groundbreaking vaccination, technology has outpaced the ability to reliably deliver such products in a timely and economical fashion.

A similar situation exists in regards to rabies immune globulin (RIG). After exposure, RIG is infiltrated into a wound to neutralize rabies virus. It provides a passive temporal supply of antibody, until the patient mounts an active immune response within a week of vaccination. However, human RIG is too expensive for the developing world. Heterologous products, generated in horses, are used to supply local needs of exposed patients (22). If smaller fragments are produced after pepsin digestion, such molecules may be cleared too rapidly to reduce the chance of serum sickness from equine proteins, and thus not offer maximum antibody coverage prior to vaccination induced host immune responses, especially in severe exposure scenarios (23). A cocktail of monoclonal antibodies could solve this dilemma, if their spectrum of neutralization activity was broad, and their economical production was feasible (24).

With the exception of Antarctica, and several locations that have been spared enzootic establishment, rabies is global in distribution. Multiple countries have demonstrated that canine rabies elimination is feasible. Nevertheless, at least 3 examples of dog rabies importation occurred in the USA during 2004: a rabid dog from Mexico was released in Texas; a rabid dog from Puerto Rico was introduced into Massachusetts; and a rabid dog from Thailand was transported via airplane to California. Similar events have occurred in Europe. Until such time that additional success stories of canine rabies elimination occur more widely throughout Latin America, Asia, and Africa, re-introduction will pose a threat to those areas free of dog rabies. Besides renewed education directed towards individual pet owners, animal reproductive control, combined with vaccination, should be strongly considered as another community animal control tool.

Although rabies is often considered one disease in the Family *Rhabdoviridae* and Genus *Lyssavirus*, the etiological agents are quite diverse. Rabies virus is a cosmopolitan type species, and the only major member known in the New World, but other rabies-related viruses persist in the Old World (25). Since the 1950's, approximately one new member of the Genus was added each decade. The last major representative was in 1996, with the inclusion of Australian bat virus, from a continent believed 'rabies-free'; making it the 7^{th} lyssavirus species, or genotype (26). During the beginning of the 21^{st} Century, 4 new lyssaviruses from bats were documented in Eurasia (27). No other cases have yet been described, perhaps owing to surveillance limitations. Importantly, as observed with the isolation of Mokola virus from rabies-vaccinated animals in sub-Saharan Africa, the degree of cross-reactivity among traditional vaccines prepared from fixed rabies viruses and these new lyssaviruses is less than total. In addition, the epidemiology of these agents is not well understood. Thus, pathogen discovery should remain a priority, regardless of what is believed to be known about conventional rabies virus, because the biological curiosity of today may become the introduced disease of tomorrow, thanks to the ease of global travel and the risk of introduced translocation.

Epidemiological Issues

Owing to its entrenchment, rabies has a broad spectrum of potential vectors. Warm-blooded animals are vulnerable to experimental infection, but mammals serve as natural hosts. While all *Mammalia* may be susceptible, lyssaviruses persist principally among the *Chiroptera* and *Carnivora*. Within each of these taxa, particular variants appear compartmentalized among different species, such as bats, raccoons, skunks, foxes, etc. Generally, bat viruses tend to circulate among bats, as is true for those viruses adapted to terrestrial carnivores. Spill-over infection results when one animal bites another, such as an infection from a fox to a cow, or a skunk to a cat. Often, these are dead-end infections, without prolonged transmission. Phylogenetic studies suggest that extant lineages of lyssaviruses may have arisen from the infection and establishment of bat viruses in other species (28). Such host switching not only provides an example of the vagility of lyssaviruses over geological time periods, it also raises a note of caution with the probability of host shifts occurring over shorter periods of time. Recent examples include the demonstration of a nidus of infection from bats to skunks in Arizona (29). If such phenomena become more widespread, it may jeopardize control programs on a wider level, because bats are ubiquitous in many ecosystems and may infect a variety of species during predation activities by carnivores or via bite during the final stages of disease (30, 31).

From a global perspective, dogs are the major reservoir for rabies. Wildlife, such as mammalian carnivores, is also involved with human fatalities, but to a much lesser extent. For example, despite its entrenchment for over 50 years, raccoon rabies has only resulted in a single documented fatality in the eastern states (32). Currently, most cases in the USA are due to variants associated with bats (33). Curiously, these bat rabies virus variants are not related to typical species (e.g. big brown bats) diagnosed in public health laboratories, but rather to less common species (e.g. silver-haired and eastern pipistrelle bats). Moreover, some of these bat variants may have virulence properties that can enhance their ability to infect non-neuronal cells at lower ambient temperatures (34). How these cases occur without a firm history of animal bite has caused a conundrum for some, as well as a dilemma for the prevention of additional cases.

Human Cases

Almost all human rabies cases are caused by a bite, but other pathways are involved occasionally. The majority of the so-called ‘cryptic’ cases of rabies associated with viral variants from bats appear related to traditional bite exposures (35). For example, these relatively rare situations may occur because the person was not aware of the risk of rabies from a bat bite, trivialized the event because of the minimal injury from the small teeth, or may be related to an exposure that was not readily recognized. Non-bite exposures cause rabies very infrequently, and include accidental infection with residual virus in poorly inactivated rabies vaccine, as well as aerosol infection in the laboratory. Indirect, non-bite exposures, such as petting a dog that fought with a rabid animal, have never been documented to cause rabies. Human to human transmission is possible, but not readily documented in recent years, with rare exceptions. Historically, at least 8 cases were reported after transplants of corneas, obtained from donors that had contracted rabies unbeknownst to the recipients. In 2004, 4 transplant recipients died of rabies after receiving organs and tissues from an infected donor (36). Retrospective investigation discovered that this donor had been exposed to a bat, but did not report the incident to public health authorities nor seek prophylaxis. Such incidents are indeed unfortunate, but predictable as to the consequences; that is, the transfer of rabies virus-infected tissues and organs to patients. Additional unrecognized cases have likely occurred and additional cases may happen, if vigilance is not maintained at multiple levels: education about avoiding exposure; prophylaxis if exposed; detection of illness, diagnosis of infection, and exclusion of some donors based upon history and clinical signs. Although human cases in the USA are rare, the disease itself is not, and potential human exposure is relatively common. Rabies should be included in the differential diagnosis of any unexplained encephalitis, regardless of a history of animal exposure.

Rabies is almost invariably fatal once symptoms are manifest, regardless of heroic intervention. Guidelines have been developed for the palliative management of patients, as well as potential experimental approaches to treatment (37). These suggestions were based not only upon the observation of abortive infections in animals, but also from a few historical cases of apparent recovery in humans. For example, in 1970, a young boy in Ohio was bitten by a rabid bat, developed rabies despite vaccination, and became the first patient to recover after development of clinical signs. In the ensuing 35 years, 4 other patients have also survived the disease. However, all had received either pre-or post exposure prophylaxis. In 2004, a Wisconsin teenager was bitten by a bat, and developed signs of rabies in the month following the exposure. Remarkably, she became the first person to survive clinical rabies without immunological intervention (38). Clearly, neither the reasons for her survival, nor the particular benefits of her medical treatment, are well understood. Basic research into the mechanisms of rabies pathogenesis, as well as the applied development of appropriate animal models, may permit better insights towards actual treatment of patients with clinical rabies with prescribed regimens. Thus, renewed investigation of anti-viral therapeutics for negative-stranded RNA viruses should be encouraged (39, 40).

Wildlife Control

Control of rabies in free-ranging animals evolved from concept to field application to regional success in western Europe and parts of North America (41,42). Biotechnology continues to offer solutions to complex problems surrounding vaccination of wildlife. The original use of oral vaccines in the 1970s included modified-live viruses, attenuated via traditional passage in cell culture. The next generation, during the 1990s, witnessed the selection of escape mutants selected under neutralizing monoclonal antibody pressure and the design of the first recombinant vaccinia virus vaccine. Additional recombinant vaccines are expected for field use in this decade, either based upon other orthopoxviruses or adenoviruses (43,44). In addition, considering the progress in reverse genetics, the opportunity exists to use rabies virus itself as a cloning vector. Thus, rabies viruses can not only be attenuated directly and specifically by molecular methods, their immunogenicity may be enhanced by the insertion of foreign genes (45). The utility of such future approaches, especially as viewed in the context of wildlife rabies vaccination, may offer assistance in the application to stray dogs, especially if immuno-contraceptive vaccines could be incorporated and overcome academic and regulatory hurdles (46,47). DNA vaccines have many useful attributes of thermostability and ease of production, but kinetics and administration in a single dose still pose an obstacle in application to rabies prophylaxis (48). Transgenic plants have also been suggested as a means of producing veterinary biologicals, but issues of concentration, yield and efficacy remain (49). Challenges abound, and potential paradigm shifts aplenty, but which will be put into actual operation to change the way we operate in disease management?

Perspective

Rabies continues to haunt our nightmares and strain our imaginations. It is just one agent that threatens human livelihood, but as a major zoonosis, once ignored, is difficult for a prompt or appropriate response. The biomedical and veterinary progress in rabies prevention and control over the past 50 years cannot be squandered in a new century. Against these viruses, there is no shortage to the plethora of exciting solutions. What will be required includes continued vision, leadership, and advocacy to guide the way in promotion of the quintessential examples of public health in action, with significant human and veterinary applications (50).

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Veterinarians in Public Health: Assuring the Conditions in Which People Can be Healthy

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Marguerite Pappaioanou received her BS and DVM from Michigan State University, her MPVM and PhD from the University of California at Davis, and is a Diplomat in the American College of Veterinary Preventive Medicine. Between 1983 and 2005, she served in several capacities at the Centers for Disease Control and Prevention, including as Associate Director for Science and Policy in the Office of Global Health, from 1999 to 2005. Currently, she is Professor of Infectious Disease Epidemiology, at the University of Minnesota, School of Public Health and holds a joint appointment with the College of Veterinary Medicine.

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On graduation from veterinary school in December of 1972, I planned to be a small animal practitioner for life. Now, 32 years later, I look back on a rich, fulfilling and exciting career in public health working at the Centers for Disease Control and Prevention (CDC). The path I followed was neither contemplated nor anticipated in veterinary school, but because of the broad scope of the profession, and the education and training that veterinarians receive, the transition to public health was not only feasible, it was completely natural.

Following graduation, I practiced small animal medicine for three years. During those years, while traveling internationally for vacation, I became intensely interested in working in international health, especially in the area of zoonotic infectious diseases. I decided to enroll in graduate school to obtain a Masters in Preventive Veterinary Medicine and a Doctor of Philosophy (in comparative pathology, majoring in epidemiology and minoring in medical statistics and parasitology) degree from the University of California at Davis. I also served for a short time as an Assistant Professor of Epidemiology at UC Davis' School of Veterinary Medicine. During this period, however, I developed a strong desire to become directly involved in public health practice. So in 1983, I applied and was accepted into the Epidemic Intelligence Service (EIS) at CDC. The EIS is a two-year on-the-job training program in public health for doctoral level professionals. The majority of people who apply and enter the program are physicians, but since the program's inception in 1951, approximately 200 of over 2600 EIS Officers (~ 7%) have been veterinarians.[1] EIS Officers are assigned to posts at headquarters in specific disease or injury prevention and control programs, or at state health departments where they work in a variety of disease and injury prevention and control programs across the spectrum of public health.

As an EIS Officer and for two years following EIS, I was assigned to the Malaria Branch at the CDC headquarters in Atlanta. Malaria, a parasitic disease, is a major cause of mortality and morbidity worldwide, resulting in approximately 300 million acute cases of malaria annually, and at least 1 million deaths. Malaria is a huge financial burden on many countries. Malaria-endemic countries control malaria-related morbidity and mortality through the use of antimalarial drugs, insecticide-treated bed nets, and other preventive measures. Resistance of malarial parasites to commonly used drugs is increasing and spreading geographically all the time. Some drugs that are used are less expensive than more recently developed drugs, which often are more effective. While with the Malaria Branch, I collaborated with scientists at CDC and health officials of malaria-endemic countries in Africa, to evaluate the effectiveness of antimalarial drugs being used or considered for use in national malaria control programs.[2] Back at the CDC, in the US, I collaborated with other scientists to test the efficacy of candidate malaria vaccine antigens in non-human primate animal models,[3] studied the effect of concurrent use of chloroquine for antimalaria prophylaxis on the immune response to vaccination with Human Diploid Cell Rabies Vaccine, following the death of a Peace Corps Volunteer from rabies[4] (and which led to a revision in rabies vaccination strategy for travelers), and used decision analysis to assess the effectiveness of different interventions on preventing malaria in US travelers abroad.[5]

In 1987, the HIV/AIDS epidemic in the US was extremely serious. The U.S. lacked adequate data on the magnitude and pattern of the HIV epidemic in the U.S. – information needed to guide HIV prevention and control efforts more effectively. An opportunity arose to collaborate in the design and implementation of a family of sentinel surveillance for HIV/AIDS in 39 cities and States across the United States. I participated as part of a public health team, along with State and city health department officials and colleagues at CDC, in the design and implementation of a family of HIV seroprevalence surveys in childbearing women, at Sexually Transmitted Disease Clinics, Women's Health Clinics, TB treatment clinics, and Drug treatment clinics, in 39 states and cities.[6,7] Results from these surveys yielded data that were used by State health departments to understand the magnitude and character of the epidemic in their communities and to plan more effective prevention and control strategies. These data also were used to help CDC understand the epidemic nationally.

In 1990, I became director of a US Agency for International Development (USAID) funded project—the Data for Decision Making Project, which was aimed at building the capacity of Ministries of Health in the areas of epidemiology, management, leadership, communications, and economic evaluation. USAID, over several decades, had put much effort into the development of health information systems and the conduct of applied research studies, but there was little evidence that any of this data and information had been used. The goal of the Data for Decision Making Project (DDM), therefore, was to strengthen the skills of health professionals in developing countries to obtain and use epidemiologic and other types of data for formulating effective health policies and managing disease and injury prevention and control programs. DDM Projects initially were designed and implemented in Bolivia, Cameroon, Philippines, and Mexico, and resulted in increased evidence-based public health decision making.[8]

In 1996, the Director of CDC convened a national Task Force on Community Preventive Services, to consider evidence on the effectiveness of population-based interventions (e.g., mass media campaigns, laws on use of bicycle and motorcycle helmets, reminder notices to parents to bring their children in for immunizations, etc.), and based on the evidence, make recommendations on what interventions were most effective. These recommendations were to be a resource to state and local health departments for deciding on what interventions they should consider implementing to improve the health of their populations, and to achieve Healthy People 2010 goals and objectives.[9] In 1996, the methods needed to synthesize research evaluating population-based public health interventions did not exist. Studies that evaluate the effectiveness of population-based interventions often have used different study designs, measure exposure to a given intervention differently, and measure different health outcomes. From 1996 to 1999, I served as Executive Secretary to the Task Force on Community Preventive Services, directing a multidisciplinary team of physicians, behavioral scientists, and economists to develop the methods needed to synthesize results of evaluation research on the effectiveness of population-based, public health interventions,[10] to present those findings to the Task Force at periodic meetings, and to coordinate contributions of scientists from across the Department of Health and Human Services to this effort.

In 1999, I accepted the position of Associate Director for Science and Policy, in the Office of Global Health. My duties include strengthening and facilitating partnerships between CDC and other global health partners to improve global health, coordinating CDC's international activities across the agency, advising the Director of the Office of Global Health on CDC's global health policies, and participating in international discussions on ethics issues involved with protecting human subjects in international research.

During the course of my career, I have had many opportunities to contribute to public health in the U.S. and abroad, which has been both exciting and fulfilling. Many people are surprised when I tell them that I am a veterinarian and that I work in public health. The common perception in our society is that all veterinarians are engaged in clinical practice—that is, diagnosing and treating diseases and injuries of animals. And many believe that those who are not in clinical practice are not practicing veterinary medicine, which is not the case. Although much of what I have been engaged with professionally has not involved diagnosing and treating animals, my veterinary perspective, comparative medical training, and experience prepared me to be able to work successfully in several different public health areas.

The Institute of Medicine (IOM) has defined public health as "what we, as a society, do collectively to assure the conditions in which people can be healthy".[11] Much of what veterinary medicine is about fits this definition, and encompasses the core public health competencies and essential public health services described by the IOM (Assessment, Policy Development, Assurance, and Research). There is a long history of veterinarians making important contributions to protect human health and well-being in food safety, environmental health, zoonotic infectious diseases, and other areas across the broad spectrum of public health.[12-15] As of August 2004, there are approximately 80 veterinarians working on staff at the CDC as epidemiologists in disease prevention and control programs. Four veterinarians oversee laboratory animal medicine and the medical care of animals used in research. Veterinarians who are on staff at CDC as epidemiologists are involved in the prevention and control of emerging infectious diseases, bioterrorism and emergency preparedness and response, food safety, HIV/AIDS, and vaccine preventable diseases, environmental health, occupational health, emergency preparedness, injuries, reproductive health, and laboratory safety. Several are serving in leadership positions—as section, or branch chiefs, and associate directors for science. Approximately 2,400 veterinarians work in public health related positions in nine U.S. federal government departments (Health and Human Services (including CDC, NIH, FDA), Agriculture (including APHIS, FSIS, ARS, CSREES, other), Defense (including Army and Air Force), EPA, Interior, State, Commerce, and Veterans Affairs), state health departments, industry, academia, and in other non-governmental organizations as laboratory animal veterinarians, epidemiologists, researchers, program analysts, directors, managers, and policymakers. These veterinarians represent a small (0.5%) but important component of the approximately 498,000-person U.S. public health work force.[16]

Additionally, approximately 50,000 veterinary clinical practitioners are working at the front line of public health.[17] They are essential for early detection of and response to unusual disease events, potentially related to emerging zoonotic infectious diseases, or a bioterrorism event. They prevent zoonotic infectious diseases in humans through vaccination of dogs, cats, ferrets, and other species of pets for rabies, and treatment of birds for psittacosis, of dogs and cats for parasites and dermatologic mites and fungi that can infect people. They counsel clients on how to prevent dog bite injuries and prevent becoming infected from zoonotic infectious diseases from pets or the environment, and on zoonotic, foodborne and other infectious diseases of animals that are of concern to human health. They protect human mental health by providing medical care to beloved companion animals, and protect human safety and well being by protecting the health of working animals.

The veterinary oath states that veterinarians, in addition to "protecting animal health, relieving animal suffering, and conserving livestock resources", will use their "scientific knowledge and skills for the benefit of society through the promotion of public health and the advancement of medical knowledge".[17] Moreover, the education and training that veterinarians receive is very applicable to the practice of public health. Veterinarians receive both broad and specialized training in the basic biomedical and clinical sciences – comparable to that of human medicine – but for multiple species and with a strong emphasis in comparative medicine. The veterinary medical curriculum typically includes greater emphasis on the topics of parasitology, zoonoses, and the relationships between host, agent, and environment, than that of human medicine or other allied health professions. Veterinary medical training emphasizes protecting the health of animal populations (e.g., herds, flocks), an approach which is particularly applicable to public health and the study of diseases in populations. And finally, because their patients cannot speak, developing strong observational skills, an important skill of public health practitioners, is an important component of the veterinarian's training.

Given the growing challenges of emerging zoonotic infectious diseases, food safety given the globalization of our food supply, and keeping our ecosystems and environments healthy, the inclusion of veterinary medical perspective, expertise, and experience with public health programs will reap considerable benefit in improving the health and well being of society. But veterinary medicine is a small profession compared to that of other health professionals (i.e. approximately 80,000 veterinarians in the U.S.[17] compared to ~ 800,000 physicians[18] and > 2 million registered nurses[19]), with small numbers employed at public health agencies relative to other disciplines (e.g., at CDC, the approximately 80 veterinarians represent just under 2% of the approximate 4,500 professional workforce). Thus, it often is an added challenge to ensure that their expertise and experience are at the table in public health initiatives and programs.

To meet the needs of society, Colleges of Veterinary Medicine are making great efforts to increase the numbers of veterinarians pursuing careers in public health. Several highly visible meetings have been held to raise awareness and develop consensus within the profession,[20, 21] and special initiatives have been developed and are underway.[22] These efforts have been important in highlighting the important contributions that veterinary medicine has made to date, and in increasing opportunities for veterinary medicine to provide leadership and engage more fully in public health than has been the case the last few decades. Veterinary colleges are adopting additional public health courses and modules in their curricula, and developing dual DVM-MPH programs to better prepare veterinarians for public health work.[23]

Veterinary medicine has a long history of shaking hands with public health[12,13] and remains committed to do so. The contributions to public health that I and other veterinarians at CDC, other federal agencies, state and local health and agriculture departments, industry, academia, and non-governmental organizations have had the opportunity to make follow on the footsteps of many veterinarians before us. Many contributions have not directly involved diagnosing and treating animals, but have followed naturally from the broad scope comprising veterinary medicine, which includes public health. It will be an important milestone in the development of an effective public health workforce, when public and allied health professionals are aware of and have arrived at a true understanding that the special and unique perspective, expertise, and experience of veterinary medicine is important and essential to include when assuring the conditions in which people can be healthy. Veterinary medicine is committed to protecting human health and well-being, and looks forward to engaging with its public health partners to make the world a healthier place for all.

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Consequences of Foreign Animal Disease: Collaboration Needs between Public Health Agencies and Food Animal Veterinarians

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This paper is based on a poster first presented at the Sam Nunn Policy Forum on Bioterrorism, March, 2004 at Georgia Tech in Atlanta, GA. Funded in part by a contract with the Alabama Department of Public Health.

Along with a concern for incidents of bioterrorism against the American people, agriterrorism has emerged as an area of action for the United States Department of Agriculture (USDA) and for Colleges of Veterinary Medicine, and the role of veterinarians has been reinforced through Homeland Security Presidential Directive -9[1]. Recent acts of agriterrorism have not been documented in the current "war on terrorism" in the US but numerous foreign animal disease outbreaks have occurred in recent years (Table 1) and more can be expected due to increasing globalization, international travel and trade, and an insatiable appetite for new types of pets and animals. Current models of agriterrorist assault are posited on introduction of foreign animal diseases into several areas of animal or crop production in the US. A perfect example, however, of the effects of an agriterrorist attack on the US was modeled by the discovery of a single case of bovine spongiform encephalopathy in the State of Washington in December 2003. Exports to major beef importing nations were immediately halted and sources estimate a loss of export income of $8 million per day. Effects on the stock market paralleled a consumer panic and a drop in beef futures. USDA response teams were mobilized and Ron DeHaven, the spokesman for the Animal and Plant Health Inspection Service of the USDA was a regular feature on the evening news.

Table 1: Recent US Outbreaks of Foreign Animal Disease

YEAR	DISEASE	COMMENT
1999	West Nile virus	Zoonotic. No significant food animal impact
2000	Screw worm	Zoonotic
2001	Infectious salmon anemia	Cost Maine $50 million/yr
2002	Spring viremia of carp	Imperils international koi and cyprinid fish trade
2002	Exotic Newcastle disease	Minor zoonotic, $160 million to eradicate
2003	Monkey pox	Zoonotic
2003	Bovine spongiform encephalopathy (Mad cow)	Zoonotic. One case closed US to beef exports; cost $8 million/day.
2004	Highly pathogenic avian influenza	Zoonotic potential. Surveillance and eradication in progress.

The focus of US preparedness for an agriterrorist attack has been on surveying the foreign animal disease training of US trained veterinarians and developing training materials dealing with identification of foreign animal disease[2]. Little attention has been paid to the human damage that resulted from the outbreak of foot-and-mouth disease in the United Kingdom in 2001[3]. In that outbreak, although controlling and eradicating the disease were the prime goals, miscommunications and isolation wreaked havoc on the lives of farmers and farm communities. This paper addresses the need for communication between food animal veterinarians and local public health agencies to address two issues in anticipation of the outcomes of an eradication of foreign animal disease: carcass destruction and stability of farm families following depopulation of livestock.

Carcass Destruction

Eradication of foreign animal disease in the United States is based in large part on "depopulation" or humane destruction of all animals on an infected premise and those "dangerous contact" animals on contiguous properties that may have had contact with infected animals (Table 2). Because of the intensity of agriculture, the number of depopulated animals becomes very large fairly quickly and requires an efficient means of carcass disposal[4]. The recent depopulation of California poultry farms infected with exotic Newcastle disease resulted in the destruction of 3.2 million birds and cost $160 million. Among considerations of selection of method of carcass disposal are cost, area available for disposal, water table, nature of etiologic agent, depth to bedrock, and attitudes among the community. Thus birds infected with avian influenza can be buried because even large numbers take up relatively little volume, and the agent is inactivated during decomposition. However, cattle dying of anthrax or bovine spongiform encephalopathy cannot be buried because of the persistence of the sporulated bacteria or the prion in the soil. For all practical intents, only two means of carcass disposal are available: burying or burning (Table 3).

Table 2. Major foreign animal diseases necessitating depopulation of US livestock.

Disease	Susceptible Species	Comment
Foot-and Mouth Disease	Ruminants, Swine	3 other agents cause similar vesicular lesions
Rinderpest	Cattle	Potential wildlife reservoir
Rift Valley Fever	Ruminants	Zoonotic
Avian Influenza	Domestic fowl	Zoonotic potential
Exotic Newcastle Disease	Domestic fowl	Zoonotic (mild)
African Swine Fever	Swine	Caribbean basin (?). May infect US feral swine
Classic Swine Fever	Swine	"Hog cholera," current European outbreak. May infect US feral swine

Table 3. Means of Carcass Destruction

METHOD	ADVANTAGES	DISADVANTAGES
Incineration	Effective in destroying most infective agents	Air pollution, public disapproval, ineffective against prions
Burial	Fast, cheap	Ground water pollution. Seed soil with anthrax, prions
Composting	Low environmental degradation	Slow. Not useful for larger numbers of carcasses
Rendering	Recycles animal products	Danger of BSE-like epidemic. Environmental contamination during shipping.
Alkaline digestion	Kills all agents	Currently limited to small volume of tissue
Napalm	For "discussion" only. Destroys pyre in 60 min[12]	Public resistance.

Of the several reasons for interactions between food animal veterinarians and the public health community, carcass disposal is a relatively simple and important topic on which to begin a professional conversation: the criteria for selecting a means of carcass disposal are limited as are the options. The reasons for discussing carcass disposal include community welfare, community acceptance, and development of news releases with community leaders to explain why a certain means of carcass disposal is being undertaken. It is doubtful that any community would embrace carcass incineration due to its ghoulish appearance, abundance of smoke and odor (Figure 1) but complaints can be minimized and the procedure carried out if the public is informed of the reason for the burning.

Other elements of farm depopulation are crucial to the mental and physical health and safety of those involved. If firearms are used, the firing line must be policed and safe, both persons and animals must be protected from trampling, and the use of euthanasia gases and solutions must be completely controlled. Under no circumstances should owners be forced or allowed to destroy their livestock. Regardless of the means of carcass disposal, heavy equipment such as backhoes and bulldozers is needed for movement of earth and carcasses, for clearing of land to prevent the spreading of fires, and for protection of water courses from runoff.

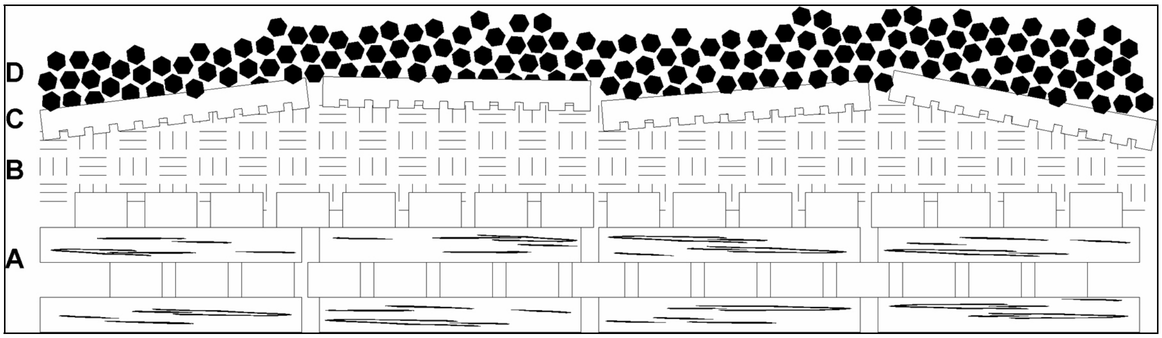

Figure 1: Pyre building. A bottom course of 4 layers of railroad ties (A) at right angles to each other form the base to provide draft. This is overlain with a layer damp straw (B) to slow burning. Overturned pallets (C) are lain over the straw to contain 1-2 feet of coal (D). Dead cattle are lain on the coal belly up and euthanitized small stock are placed on them. The whole mass is covered with diesel fuel and ignited. Pyres will burn 3-4 days with nearly complete destruction of carcasses. (Personal communication James GW Wenzel, College of Veterinary Medicine, Auburn University. Dr Wenzel assisted with control of the UK FMD outbreak 2001.)

An apocryphal story of burying carcasses originated in the UK Foot and Mouth Disease (FMD) outbreak: a herd of cattle was killed and slated for burial. When the machinery crew arrived, they buried the cattle under the red X. Shortly after, the farm family noted that their well water was tinged pink. The red X indicated where the cattle were not to be buried due to the potential for contamination of ground water (Personal Communication, Corrie Brown, Athens, GA). These sorts of miscommunication can be handled in advance of the event by agreeing on a standard set of signs and distributing those agreements to all parties.

Mental Health for Farm Families

Farming is a lifestyle dedicated to the development of “lines” and “strains” as well as a means of earning a living. All members of farm families are often engaged in animal care and every veterinarian recognizes the value of the nursing care provided to sick animals by farm wives and daughters. Thus the element of husbandry, the “bond to the house” or home, and the attitude of “we take care of the animals, and the animals take care of us” [5] attaches people to animals in a bond that is increasingly explored in both pets and livestock. The loss of animals is more than the loss of income alone; it is a severance of strong emotional ties with living creatures. This disruption of lifestyle causes many problems: the loss of income and delay of indemnity, continuing economic demands, emotional stress on the farmer and the farm family [6,7], and isolation or ostracism from the community due to depression or bearing the charge of being “the one who let in the evil” (Table 4).

Table 4: Effects of herd depopulation on farm families

Some or all members of the family may exhibit one or some of the signs listed below: • Changes in eating or sleeping habits • Poor memory • Problem concentrating • Difficulty in making decisions • Loss of engagement with previous interests • Difficulty in completing routine tasks and daily obligations • Feelings of guilt and hopelessness • Preoccupation with thoughts of death and suicide

Reactive efforts implemented in the United Kingdom following the outbreak of foot-and-mouth disease in 2001 included walk-in counseling at farmers' markets and telephone helplines which provided information and advice.[8] During times of epidemic control efforts, the food animal veterinarian may be the most highly educated person seeing the farm family, and the veterinarian may be the person whose advice would be accepted when providing a referral to public health or welfare agencies for needed support. However, other than relatively recent information about grief and grieving in small animal medicine, the average food animal veterinarian is probably not well qualified to define signs of mental disturbance, nor does the food animal practitioner have the diagnostic or organizational knowledge readily available to provide a referral to a mental health agency.[9] Thus, advance familiarization with signs of mental disturbance and a list of referral numbers would be an asset in community mental health. Depression may last for years beyond resolution of the current crisis necessitating the need for ongoing surveillance and provision of resources.[10]

Especially important is the linkage of the economic health of the farm to the economic health of rural communities: for every eight farms that fail, a business closes.[9] Yet after a depopulation, even due to weather like Hurricane Floyd, animal production facilities frequently close or move on. Installation of policies like moratoria on mortgages and sources of information on indemnity and emergency loans may serve to keep farms in place and to buoy the emotions of farm families (Table 5).

Table 5: Services and referrals that may be implemented by public health agencies

Mental Health Location of temporary offices in areas frequented by farmers Telephone hotlines Evaluation Treatment & referral Suicide prevention Financial Health Emergency loans and temporary assistance Food bank approval Mortgage moratoria Indemnification processing assistance (focal point for area farmers) Community Awareness Explanation of carcass disposal Explanation of zoonotic potential

Problems of Liaison

As unscientific as it sounds, food animal veterinarians are good guys, and are eager to work with co-professionals to improve their practice. However, food animal veterinarians are also self-employed and are in a constant economic struggle to pay their own bills. A depopulation program in their practice areas inevitably leads to a loss of clients, whereas a depopulation event in another part of the country or another country may cause dislocation of veterinary expertise and an overloading of the veterinarians in residence. If public health officials are to collaborate with food animal veterinarians, some incentive must be provided in terms of monetary award or facilitation of the practice. Avenues available to motivate food animal veterinarians to undertake new learning are largely through continuing education credits made available through local veterinary medical associations (VMA).[11] Most states have a requirement for annual continuing education to renew licensure, with credits issued 1:1 for hours in class. A large part of this requirement is met through monthly dinner meetings, and diverse speakers may be welcomed. This would provide an ideal opportunity to speak to a considerable number of veterinarians in an area and determine who is interested and where the leadership is. The Animal and Plant Health Inspection Service of the United States Department of Agriculture (APHIS USDA) is currently investigating repetitive accreditation for food animal veterinarians, but as a means of communication, that resource is not yet exploitable.

The suggestion has recently been made that rural and suburban small animal clinicians are an important source of management advice for owners of herds or flocks of 20 or less. Thus, when a pet is in for examination, the client might ask the veterinarian about herd health. Engaging these clinicians in a scheme of surveillance and consulting would engage this previously unrecognized resource in the diagnosis and control of food animal disease; at a minimum, pet practitioners could be provided with referral contact information for small scale farmers.

An alternative proposal involves peer counseling or advising from workers in allied occupations in the community.[13] Thus postal workers, delivery drivers, and grocery clerks would wear some sort of “Ask me!” button and would be provided with resource materials for referral and information. Certainly, involvement of more community members increases the outreach capabilities to address the consequences of an outbreak of foreign animal disease in our farm-dependent communities.

Conclusion

Preparation for either an agritoerrorist event or an outbreak of foreign animal disease must include communication between the local public health agencies and the veterinary community. Two issues predominate: selection of a means of destruction of carcasses of animals depopulated to control disease, and provision of mental and financial health care to farmers and farm families whose livelihood has been destroyed. This need was demonstrated during the foot-and-mouth disease eradication in the UK but has not been well considered in preparedness measures in the US.

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Acknowledgements

The Authors thank the Alabama Department of Public Health for funding and Cindy Mitchell, Head, C. A. Cary Veterinary Library, Auburn University for help identifying psychological and social reference materials.

James Harlan Steele, DVM, MPH: A Biography

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George W Beran, DVM, PhD, LHD, is an emeritus professor in the Department of Veterinary Microbiology and Preventive Medicine at Iowa State University. He is a diplomate of the American College of Preventive Medicine, and has represented the Food Safety Program of the American Veterinary Medical Association in testimony before the Secretary of Agriculture, and a consultant to both WHO and FAO. Dr Beran's research interests extend from eliminating Salmonella in food and animals and controlling rabies, and he has had roles in many international disease control programs. Dr Beran is also a leader in the American Veterinary Medical History Society.

The Gold Headed Cane award was presented to Dr James H. Steele in 1966; his 53rd year, but importantly, his 26th year of professional involvement in public health, in a career that in 2005 extends 65 years. During this major portion of the century, Dr. Steele envisioned, led, and participated in all developments of what we today call "Veterinary Public Health". He and his fellow participants, in the First Expert Committee on Zoonoses meeting of the World Health Organization in 1950, described Veterinary Public Health as "the application of the veterinary medical arts to the resolution of community and public health problems".

Dr. Steele embodies a lifetime of scholarship in the epidemiology of disease. He is an internationally recognized scholar in the agents of disease, their hosts and the ever changing environment in which they interact. His knowledge base is historic, current, and futuristic, well founded and broad. His vision is that the origin of all diseases is of animal origin, eventually adapting to multiple forms of life, including insects as hosts and vectors, and to human beings. Anthropologists in recent years conclude that early forms of humankind went through many evolutionary steps before manifesting the present form of *Homo sapiens*. Unanswered is the question of what caused mortality in pre-humankind. Disease may have evolved along with the evolution of the early primates and even died out to appear again later as humankind was established some millions of years later. Human encounters with animal host pathogens began during the eras of hunting and gathering, but increased greatly in magnitude as these animals were domesticated. Initial adaptation of pathogens from animals to humans frequently led to disastrous plagues, but prolonged and intensified contacts have led to patterns of mutual adaptation allowing both pathogens and hosts to survive, yet always subject to new disasters when any combination of human hosts, animal and insect hosts and environment changes.

Dr. Steele's knowledge of the past, including historic milestone events like Edward Jenner immunizing his 8 year old son against smallpox in an experiment that would never pass the US Food and Drug Administration today, like Theobald Smith's recognition of the transmission of Texas Fever among 'ticky' cattle, and like Louis Pasteur's 100% successful public demonstration of his vaccination of sheep against anthrax, violating all concepts of probability of individual animal response. Just as disease involves teams - hosts, pathogens, and conforming environments - so too must public health, the prevention and control of disease, involve teams -

scientists of its human hosts, scientists of animal hosts, scientists of disease agents and their vectors, and scientists of environments. Veterinarians are as essential to these teams as any other members; this is the thesis of Dr. Steele's vision of Veterinary Public Health, and the substance of his great contribution to world health.

It all began in 1937, when young Jim Steele from urban Chicago, Illinois enrolled at Michigan State College's (University) college of veterinary medicine. The dean of veterinary medicine, Dr. Warld Giltner, DVM/DrPH and Dr. H. J. Stafseth, professor of pathogenic bacteriology, encouraged their students to service in public health, food inspection and animal disease control programs. Jim Steele was strongly challenged in understanding the epidemiology of animal disease and public health during the college brucellosis outbreak among veterinary students in 1938. He enrolled in extra courses in bacteriology and public health, and in his senior year, he received permission to work in the Michigan State Health Department doing rabies diagnosis and making vaccines and hyperimmune sera in lieu of veterinary clinics. Dean Giltner assisted him in receiving a U.S. Public Health Service Title 6 fellowship to the Harvard University Master of Public Health program. There, Dean Cecil Drinker was a great help to this young and unusual veterinarian in an essentially human medicine degree program. Dean Drinker helped Dr. Steele both as a mentor and financially during this year of study, as his wife, Aina, was taken ill with tracheobronchial tuberculosis.

Now Jim found the public health studies more important than ever. He saw the application of veterinary medicine in every step of the MPH program. When he found that most positions in public health required a medical degree, he contemplated, "Should I go on in human medicine?" Dr. Drinker's advice was succinct: "Dedicate your career to public health under your own colors as a veterinarian, not under two flags as an MD and a DVM". This advice became Dr. Steele's own advice to literally hundreds of young and not so young veterinarians, who in turn were to come under his influence.

After some disappointments in a job offer with the famous Dr. Karl F. Meyer at the University of California, Dr. Steele turned to the U.S. Public Health Service's regional office in Chicago, where he sought a position as an epidemiologist. The medical officers, including Dr. Henry Holle, Medical Director, and Dr. Mark Ziegler were impressed. They arranged a position for the new public health veterinarian as a sanitarian in the Ohio Health Department.

Thus, Dr. Steele's career began. Later, he served as a sanitarian in Puerto Rico. After the war, he was assigned to the NIH Infectious Disease Laboratory where he worked on brucellosis with Dr. Carol Larson, on rabies with Dr. Karl Habel, and on equine encephalomyelitis. He also served as a consultant to the Surgeon General of the U.S. Public Health Service (USPHS) to promote veterinary programs at the organizational meetings of the World Health Organization and the Food and Agriculture Organization of the new United Nations, and as an advisor in war ravaged areas. Dr. Steele's dream was being realized; he was very happy and appropriately challenged. He participated actively in meetings, planned and proposed approaches, published reports, and interacted with officials in Washington and abroad.

While he was in Washington, DC, Dr. Joe Dean and Dr. Joe Mountin, USPHS senior medical officers, interviewed Dr. Steele. Dr. Mountin challenged him, "What are you veterinarians going to do for public health now that the war is over?" After weeks of discussion and proposals, Dr.

Mountin approved an Office of Veterinary Public Health, which came into being in January 1946. During the time in Washington, Dr. Steele was active in the epidemiology and control of transmission of diseases from animals to human beings; the zoonoses. His work, presentations and writings identified him as a national leader and an international consultant in the epidemiology and control of zoonotic diseases. His active consultancies to the World Health Organization and to the newly organized regional office of the World Health Organization (WHO) for the Western Hemisphere, the Pan American Health Organization (PAHO), have continued to the present. He has worked actively with public health officers in the US Agency for International Development; especially with Dr. Phillip Lee, who recognized the importance of veterinary public health in developing nations.

In September 1947, Dr. Steele was named Chief of the Veterinary Public Health Division of the Communicable Disease Center in Atlanta, and in 1950 he was named Chief Veterinary Officer and advisor to the Surgeon General. The decades that followed were a period of creative visions and implementation. Veterinary Public Health became a national program, the most comprehensive and active in the world. Veterinary research and assistance in prevention and control efforts for many zoonotic diseases (rabies, brucellosis, environmental listeriosis, salmonellosis, leptospirosis, mycotic infections, arboviral infections, Q fever, parasitic and emerging diseases) were developed at the national level.

In 1950, the Veterinary Public Health Division was made part of the Division of Epidemiology. Young veterinary graduates were recruited into the Epidemic Intelligence Service (EIS) and the 5-7 week training program in epidemiology coordinated by Dr. Alexander Langmuir. A number of these EIS veterinary officers were assigned to state health departments for two years, demonstrating the value of public health veterinarians. Many then went on to earn MPH degrees, then joined state health departments or other public health entities in career positions. In 2004, 42 state health departments had public health veterinarians, all with responsible positions in epidemiology, infectious disease and zoonoses control, and environmental health.

Other EIS alumni have been and are engaged in many positions which fulfill and extend Dr. Steele's vision of Veterinary Public Health. These include teaching in veterinary colleges as epidemiologists and preventive medicine professors, and in colleges of human medicine in occupational and environmental health and in disease research. Veterinarians also serve as public health officers through food safety inspection with special emphasis on irradiation of meat and meat products, as encouraged by Dr. Steele. They include public health veterinary functions in the Centers for Disease Control and Prevention, National Institutes of Health, the Rocky Mountain Laboratory, the Food and Drug Administration and other health related agencies in infectious diseases, cancer and drug control. The expanding positions seeking specially skilled veterinarians and the increasing numbers of veterinarians with advanced education and experience in public health all owe at least some debt to Dr. Steele's direct emphasis, example and encouragement.

Throughout the quarter of a century that Dr. Steele served in the Communicable Disease Center and the Office of the Surgeon General, he continued extensive initiation, participation and expansion of Veterinary Public Health in the U.S. and worldwide. In 1947, he organized the Conference of Public Health Veterinarians, which continues to this time as the American Association of Public Health Veterinarians. In 1950, he was a founding officer of the American

Board of Veterinary Public Health, which continues as the American College of Veterinary Preventive Medicine. In 1964, he was founder of the American Veterinary Epidemiology Society, of which he served as president until 1990.

During this time, WHO, PAHO and FAO consultancies took him to countries on all continents. Two anecdotes stand out during this period. First, at each annual EIS Alumni Conference held in Atlanta (this year is the 54th annual EIS conference), in a traditional slide show of officials and staff of the EIS training program, a slide of Dr. Steele's office with an empty chair behind his desk highlighted the extent of his travels. In 1959, after a consultancy in Southeast Asia to assess veterinary public health implications of swine influenza, Dr. Steele returned to Atlanta where he became severely ill. His attending physicians diagnosed hepatitis, but the CDC Research Laboratory and Plum Island Foreign Animal Disease Center identified fowl plague virus in a clotted blood sample. When the chief of the U.S. Department of Agriculture's Veterinary Research Services learned of an isolate of fowl plague virus having been made in an unknown (to them) species, he responded that CDC be instructed to destroy the virus and all things containing it! Fortunately for the world and Dr. Steele, the latter half of this was not carried out.

In 1968 and until his retirement from the U.S. Public Health Service in 1971, Dr. Steele was the first veterinarian to be commissioned Assistant Surgeon General for Veterinary Affairs, which took him back and forth between Washington DC and Atlanta, and consulting and advising in eight other countries. He also served as Deputy Assistant Secretary under Dr. Phillip Lee, Director of the USPHS and Assistant Secretary of Health. From 1971 to 1983, he was professor of Environmental Health Sciences, and from 1971 to 1978 he was Head of the Department of Environmental Sciences at the University of Texas School of Public Health at Houston. Since retiring, he has continued as professor emeritus, lecturing and advising graduate students from around the world. An endowed professorship, the James H. Steele Chair of Epidemiology, was established on his 80th birthday with support of friends and colleagues. A lectureship followed, which recognizes the leadership of James H. Steele. He founded and served as first president of the World Veterinary Epidemiology Society in 1971. He is truly the master consultant and advisor in Veterinary Public Health to WHO, PAHO, CDC, OIE, and international congresses worldwide.

Dr Steele was editor-in-chief of the eight volume first edition of the "Handbook of Zoonoses" (CRC Press, Boca Raton, FL) and consulting editor with Dr. G. W. Beran for the second edition. He is co-author with Dr. C. O. Thoen of *Mycobacterium bovis:* Infections in Animals and Humans" (Iowa State University Press, Ames, IA). His publications are and will remain classic records and guides in Veterinary Public Health. They number thousands of presentations and hundreds of papers in journals worldwide. These publications and activities are being organized by the Texas Medical History Library, and a website is being created at the University of Texas, Health Science Center at Houston, School of Public Health.

Awards and honors have come to Dr. Steele from around the United States, many countries of the world and numerous international organizations. He lists the Gold Headed Cane award as among the greatest honors. In addition to these recognitions, the following statements by recipients of the Gold Headed Cane award help to summarize the contributions of this great scientist and leader in Veterinary Public Health:

Dr. James H. Steele is a renowned scholar of public health, from ancient times to the present. He is totally visionary and at the same time totally practical in advocating the role of veterinary medicine in public health for today and tomorrow. He is a person of impeccable integrity, totally ethical, and of highest character. He organizes and participates with leaders in public health of all disciplines and focuses veterinary public health in the greater health team. He assists promising young people from all over, especially from developing countries, to achieve graduate studies which were completely out of their reach, often by hosting them in his home. He is a generous philanthropist, assisting humanitarian organizations related to health. He has an incredible memory both for people and for scientific achievements. He is an appropriate model for the highest achievements in public health.

(G. Beran, 1993)

….Dr. Steele is an outstanding example with respect to bringing people together and preparing veterinary students for their professional future with enthusiasm and an up-to-date curriculum.

(D. Grossklaus, 1976)

If there is one factor that put Jim Steele in a class by himself within the veterinary profession, it was his ability to recognize and be prepared to meet a changing environment locally and worldwide.

(F. Mulhern, 1978)

Dr. Steele's knowledge and ability to understand what was happening in the health field, both nationally and internationally, his vision of what was needed and might be possible to accomplish, and the large group of individuals with whom he kept in contact have made him a resource to public health at all levels.

(J. Held, 1982)

More than anyone else, Dr. Steele must receive credit for the renaissance and expansion of veterinary participation in public health branches of government, not only in the U.S. but elsewhere in the world.

(C. Schwabe, 1985)

We as a society, face increasing threats from the sorts of diseases that Dr. Steele has studied. New thinking, in keeping with dramatic changes in our society, our institutions, our industries, is called for – Dr. Steele, even though he is usually the oldest person in the room, is usually the most *avant garde* force for change.

(F. Murphy, 1986)

….Dr. Steele's fine qualities have undoubtedly served to strengthen the relationship of his country (USA) with the rest of both the northern and southern hemispheres.

(J. Figueroa, 1987)

Dr. Steele truly opened the door to an understanding of the relationship between human pathogens and animals and the disease complexes that result. In so doing, he gave the veterinary profession the specialty of veterinary public health.

(H. Mussman, 1991)

Dr. Steele is arguably the most knowledgeable person in the world about the interplay of animal and human diseases and the role animal diseases play in human health and well being.

(W. Pritchard, 1992)

James Harlan Steele, a "man of many seasons," has worked and played, in the very best sense of the word, longer that any peer or other distinguished veterinary public health specialist entering this millennium.

(T. Murnane, 2000)

My View from Vet School: Public Health and Veterinary Medicine Need Each Other Now!

Kira Christian, DVM, MPH

Dr. Christian graduated from Michigan State University's College of Veterinary Medicine in May 2005 where she served in leadership roles such as President of the Student Chapter of the American Veterinary Medical Association and President of the Student Chapter of the American Animal Hospital Association. Prior to veterinary school, she attended the University of Illinois at Chicago's School of Public Health, where she received an MPH in epidemiology while helping to manage the Illinois Maternal and Child Health Leadership Institute's DataUse Academy. Dr. Christian is currently practicing small animal medicine in Atlanta, Georgia.

For more information, contact Kira Christian; kachristian@gmail.com

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This is a time critical for public health. As threats of bioterrorism and agroterror increase, budgets are decreasing and resources are dwindling. Employees at public health departments have seemingly more pressing daily concerns than considering threats against national security, for example. As public health moves toward increased collaborations and partnerships with "first responders", the importance of veterinary medicine in public health must be addressed. As a leader in veterinary public health, my goal will be to increase the role and the visibility of veterinarians in the public health infrastructure.

Health promotion and disease prevention are, generally speaking, the foundation of what originally brought me to study both public health and veterinary medicine. As an undergraduate student studying chemistry at Michigan State University (MSU), I thought that becoming a human health practitioner would give me the skills to help the human population achieve better health. However, while in public health school from 1999 through 2001 at the University of Illinois at Chicago (UIC) I studied epidemiology, which gave me the skills to apply analytical epidemiology to any population, not just the human one.

Much of the training I received in my epidemiology classes focused on infectious disease: HIV, influenza, or tuberculosis. In 2001, West Nile virus was a new and exciting disease. I imagine that after my time at UIC, during late 2001, anthrax was a mainstay in conversations, and in 2003 professors likely took the opportunity to use SARS and monkeypox as lessons in infectious disease epidemiology.

It is not a coincidence that many infectious disease discussions, inside and outside of veterinary colleges, now revolve around what have been traditionally regarded as animal diseases. Animal diseases such as anthrax and bovine spongiform encephalitis (mad-cow disease) are now earning spots on front pages as they encroach upon human health and consciousness, accidentally or intentionally. These front-page stories were ordinary classroom examination material during the first portion of my vet school curriculum, and are now, during the final phase of the curriculum, on my rule-out lists and discussed routinely with clinicians.

Imagine the following scenario. As a public health professional at your local public health department, you receive a phone call from a concerned emergency physician describing a patient she has just examined: fever, a papular rash, swollen lymph nodes, and aching muscles. The physician thinks the patient has monkeypox and has called you for assistance: she wants to know *every*thing there is to know about monkeypox. What do you do? You will need to consult an expert in animal disease. Who will you turn to? A veterinarian. This scenario, although imaginary for the purpose of this writing, could happen. Scary? Yes. Does public health need veterinarians? Yes.

Looming in the future are threats that we hear and read about in the media: Foreign animal diseases; Biological and agricultural terrorism; Emerging, re-emerging, and zoonotic diseases; Food-borne illnesses; Environmental contamination. These threats will become realities in the very near future, or now, as evidenced by anthrax, West Nile virus and monkeypox, to name a few. Who are the experts on these diseases that can all be the result of terrorism? Who learns about the agents that can so easily threaten the health of humans and bring down entire economies? Veterinarians.

A few scientists posit that many, if not most, of our infectious diseases have their historical roots in animals. In fact, many of these diseases owe their propagation and success in humans to ignorance of animal health. It is time for the worlds of public health and veterinary medicine to gently collide and create a global force strong enough to recognize and stop the threats mentioned above, and threats that have not surfaced yet. Veterinarians, whether in a meat processing plant, inspecting pigs about to be shipped across the United States, or inspecting animals upon arrival into an international airport, are on the front lines; protecting both animals and humans from biologically and economically devastating epidemics.

Lonnie King, DVM, MS, Dean of Michigan State University's College of Veterinary Medicine, a pioneer in veterinary public health and a leader among leaders in veterinary medicine states that "the veterinary profession must expand to meet evolving societal needs" in regard to public health. I agree, and to that I will add that the public health profession, despite decreasing resources and increasing demands, must also expand and incorporate a new generation of veterinarians into its decision-making process.

Veterinarians are the experts in population medicine, herd health, food safety, and zoonotic disease; there is no better time than the present to combine forces and battle current and emerging threats together.

Upon my graduation in May 2005 from Michigan State University's College of Veterinary Medicine, I plan on being a part of the leadership, perhaps in your office, that brings these two health entities closer together. Throughout my time at vet school, I have been fortunate enough to participate in some unique programs designed to foster this relationship, at both the state and national levels (see listed websites). I've met leaders in both fields and have heard firsthand how veterinarians are needed in public health to make public policy decisions that will transcend both professions.

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