Potential Enhancements to Public Health instruction in Doctor of Veterinary Medicine Curricula

by

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March 9, 2007

A Master's paper submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Master of Public Health in the School of Public Health, Public Health Leadership Program

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Introduction

Veterinary medicine is constantly engaged in self-evaluation. Professional organizations of veterinary medicine such as the American Veterinary Medical Association (AVMA) and the Association of American Veterinary Medical Colleges (AAVMC) periodically commission studies to check the course and recommend activities to strengthen the health of the profession. A 1989 Pew report\(^1\) recommended a move toward a national strategy of veterinary medical education. In 2003, AAVMC held a major conference calling for action to address veterinary medicine’s role in Biodefense and Public Health. In 2005, two different National Academies’ Research Council Committees concluded that there were major gaps in veterinary medical education with respect to producing graduates competent in areas of public health and population medicine. Clearly, the gaps in these areas of veterinary medical training remain, and will persist until the colleges of veterinary medicine (CVMs) fully implement major steps to fill the gaps.

This paper seeks to survey recent discussions about the level presence of public health training in the Doctor of Veterinary Medicine (DVM) curriculum, and recommend target areas to increase that presence.

Veterinary Medicine in Public Health

The nature of human relationships with animals is becoming increasingly complex, and there are areas of critical intersections with respect to animal and public health. The education of veterinary students not only affects public health, but has a potential major influence on our nation’s economic, social and political health. The specter of emerging infectious diseases, antimicrobial resistance, and bioterrorism reaffirms the importance of relationships between

\(^1\) Pritchard
animal health and public health, yet the overwhelming majority of current graduates from U.S. veterinary schools choose to enter companion small animal practice.

It does not take much research to discover the lack of breadth in most recent graduates' understanding of veterinary medicine. Many students and practicing veterinarians have never heard of Plum Island Animal Disease Center. According to national policy in research, wildlife, agriculture, and surveillance, since it opened its laboratory doors in 1954, Plum Island is the only location in the U.S. where animals infected with certain foreign animal diseases can be found. Nor are most veterinarians aware that there has been recent reorganization at the U.S. Centers for Disease Control and Prevention (CDC), forming a new National Center for Zoonotic, Vector-Borne, and Enteric Diseases, led by former dean of Michigan State University's College of Veterinary Medicine Lonnie King. Unfortunately, too many veterinarians themselves have no idea how much they have to offer Public Health. For example, regulatory medicine is an area of medicine that manages medical policy issues that have the force of law. This includes many endeavors in which veterinarians engage, such as animal welfare, food safety, wildlife, agriculture, health technology development, import/export issues, and research. Veterinarians manage production animals, practice as epidemiologists, and biostatisticians, practice risk communication, and develop public policy. They help maintain the safety of the national food supply and human wildlife interfaces, develop vaccines in both animal and human use, and play a vital role in our national defense and well-being.

**The DVM Education**

When the earliest U.S. veterinary schools were established in the 1850s, the focus of veterinary medicine was largely on production and work animals, reflective of military needs and the

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2 U.S. Department of Homeland Security
3 Wikipedia, Plum Island Animal Disease Center
4 Torres, A
5 Schwabe CW
agrarian nature of our society. In the Twentieth Century, infectious disease declined markedly in the U.S. due to public health action based on advances in microbial sciences. In 1900, 30.4% of human deaths occurred among children under five years of age, whereas in 1997, the percentage dropped to 1.4%. Better hygiene and animal vaccination have also contributed to more effective control of infectious diseases between and amongst animal and human populations.

In many respects, the rise in numbers and healthcare quality of the companion animal mirrors that of better human health status in the U.S. In 1863, AVMA was established; and in 1884, the U.S. Department of Agriculture (USDA) established the Bureau of Animal Industry, which controlled epidemics threatening animal populations and public health in the U.S. National regulations and animal health infrastructure, which includes state and federal government-owned or affiliated diagnostic laboratories, research centers, regulatory agencies, education programs, and surveillance systems, make for a safe food and drug supply as well as control of epidemic disease in our animal populations. However, as each new generation of veterinarians becomes increasingly focused on small animal medicine and surgery, they also become less aware of the critically important public health responsibilities of veterinary medicine, such as population health assessment, policy development, and assurance of effective public health practice. An AVMA study reports that 65% of 2005 veterinary school graduates entered private clinical practice and 59.9% entered companion animal or equine practice. Equine practice is essentially companion animal practice as the horse evolves from working animal to family pet or athlete, both receiving highly sophisticated quality medicine. Further, 30.2% of 2005 graduates entered advanced study programs. Though broadly applicable specialties such as pathology exist, most of these internships and residencies are for companion animal specialties such as

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6 Tumock
7 Schwebe
8 AVMA
cardiology, radiology, and surgery. It may be simpler to give the numbers going into public practice as a low percentage. I think the AVMA has those numbers in their surveys.

The profession needs to respond to emerging public health areas as societal needs change. USDA is the largest employer of veterinarians in the federal government. A report from AAVMC notes that the average age for USDA Food Safety and Inspection Service (FSIS) veterinarians is 54, and approximately 500 veterinarians\(^9\) out of the 1,000 employed\(^10\) are expected to separate from the USDA in the next five years, and approximately half of the veterinarians in the Commissioned Corps of the United Public Health Service are currently eligible for retirement.\(^11\) A February 2007 New York Times article notes that, since 1990, the number of veterinarians focusing on large animals has dropped to fewer than 4,500 from nearly 6,000, making up less than 10% of private-practice veterinarians, and that by 2016, 4 out of every 100 food-animal veterinary jobs would go unfilled.\(^12\) USDA predicts a shortage of 584 Veterinary Medical Officers by 2007. Approximately 700 veterinarians work in state government and new hires are often not possible in tight budget climates. One hundred veterinarians certified in laboratory animal medicine are needed to support the national animal health infrastructure, as well as 150 board certified pathologists.\(^13\) According to figures published regularly by AVMA, the North American Veterinary Schools, and AAVMC, the annual number of graduates from U.S. DVM programs is about 2,500.\(^14\) It is highly unlikely that the CVMs, without a major re-focus or implementation of other strategies, will be able to meet the needs of public health veterinary practice.

\(^9\) Hoblet KH
\(^10\) AVMA, 2005
\(^11\) Hoblet KH
\(^12\) New York Times
\(^13\) AAVMC Task Force
\(^14\) Hoblet KH
There is a steady decline in student interest in food animal practice, as well as erosion of resources in this area of education. The U.S. food supply is one of the safest in the world, and the veterinary profession reflects the broader U.S. culture that trusts its food will always be safe with minimal individual effort. The food processing industry currently focuses on value-added products, which move critical microbial safety steps from consumer hands to industry hands. Yet departing Secretary of Agriculture Tommy Thompson said in 2004, “I, for the life of me, cannot understand why the terrorists have not, you know, attacked our food supply because it is so easy to do.” Attention to wildlife disease has also been negligible in comparison to domestic animal medicine. However, our contact with wildlife continues to increase as human development encroaches further and further into wildlife habitat. This increases transmission pathways of pathogens between human and wildlife and between wildlife and domestic animals. Increased population density, changes in animal production systems and other human-animal dynamics continue to evolve, requiring vigilance of the veterinary medical community.

While these needs are not being met by a supply of veterinarians interested and competent in these areas, CVMs invest resources into sophisticated new diagnostic and therapeutic machines, both driving and being driven by clinical specialization. Students are well-exposed to new and exciting clinical technologies, but graduate with only a limited knowledge of veterinary public health.

**Trending Away From Public Health and Allied Specialties**

Historically, veterinary medicine attracted males with agricultural backgrounds, but the face of the profession is changing. DVM students are increasingly female from urban and suburban environments. There continues to be more disposable income and higher expectations for

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15 Radostits
16 Branigin W, Allen M, Mintz J
17 NRC Committee on Assessing the Nation's Framework for Addressing Animal Diseases
18 Radostits
healthcare for companion animals. This increasing sophistication in animal clinical medicine greatly influences societal relationships with veterinary medicine and influences who enters the profession. The 2002 Canadian Veterinary Medical Association Task Force on Education, Licensing and the Expanding Scope of Veterinary Practice noted that small animal practice dominates veterinary medicine at the expense of other important veterinary needs. Excluding problem-based learning curricula which are difficult to quantify because of their less structured case based format, 84% of veterinary schools offer at least one course to teach epidemiology and 100% had a course dedicated to non-epidemiology public health topics. However, veterinary medicine is losing key pieces of infrastructure such as environmental health interfaces, academic and research centers, laboratory resources, competent food animal veterinarians, specialists, public health and ecosystem health practitioners. These are needed for public health veterinary medicine to sustain itself while the general veterinary medicine leadership remains interested in short term economic goals.

Specialty colleges in public health related fields need not only to invest efforts to attract new diplomates, but also must assess where the best recruiting opportunities are and evaluate how effective their recruiting efforts are. In the U.S., specialty colleges require a residency and a rigorous examination for board certification AVMA reports that there were 8,216 board-certified diplomates in December 2005, with 545 (7%) boarded in preventive medicine in the U.S. Other public health related specialties include laboratory animal (681, 8%), microbiologists (160, 2%), pathologists (1370, 17%) toxicologists (96, 1%), zoological medicine (92, 1%). Those boarded in internal medicine and/or surgery were 2,649 (32%) and continue to increase.

19 NRC Committee on Assessing the Nation's Framework for Addressing Animal Diseases
20 Riddle
21 Radostits
22 AVMA, 2006
Because specialty training frequently requires considerable time commitment, many new graduates are pressured to enter the workforce. A typical academic career to obtain a DVM degree in North America includes three to four years in undergraduate study and four years in a DVM program. Post-DVM training might include four to five years for a PhD degree or four years in an internship and residency. Supplemental funding such as stipends or scholarships is nowhere close to those found in human medicine, and debt load is high upon graduation.

Educators have noted that there are scant opportunities for large animal internships, and since veterinary teaching hospitals (VTHs) are not set up to deliver production animal experience to all but a few specialized students, many seeking large animal clinical careers will enter the workforce without further training. DVMs seeking research careers skip further training and directly enter careers, and professional development and networking opportunities are missed.

Though there are economic disincentives to advanced study, post-DVM credentials affect not only competency and professional maturity, but also future income. AAVMC and other professional societies could take a greater leadership role in finding loan forgiveness and scholarships for students in underserved fields.

The profession has generally failed to effectively market the skill sets of the veterinarian, as well as the depth and multidisciplinary nature of veterinary medicine. For example, most graduates of MD programs involved in research do not hold a PhD, yet it is expected that a DVM researcher should hold a PhD to undertake independent research.

Though there are economic disincentives to advanced study, post-DVM credentials affect not only competency and professional maturity, but also future income. AAVMC and other professional societies could take a greater leadership role in finding loan forgiveness and scholarships for students in underserved fields. The American Board of Veterinary Practitioners, accredited by AVMA in 1978, certifies clinical practitioners in food animal, dairy, beef, swine, equine, canine and feline, feline, and avian medicine. Certification from the American Board of Veterinary Practitioners is based on income-producing real-world activities,
and lifelong learning. Like other board certifications, it requires specialty exams, but does not require post-DVM training that interrupts on-the-job training and income history. Certified practitioners report it opened opportunities, improved performance, and professional development, and increased their value of their services and income.\textsuperscript{28} There are many benefits to both the individual and the profession to increase income levels for public health and population medicine veterinarians. Salaries in federal agencies, and especially in state agencies, are well below levels needed to attract and retain well qualified individuals. \textsuperscript{29} Failure to market has resulted in low salaries and a shortage of qualified candidates.

**The Traditional DVM Curriculum**

A major challenge for DVM education is clear: to offer a real world experience in public health that matches the breadth and depth of that offered in clinical medicine.\textsuperscript{30} A criticism of the DVM curriculum is that it fails to integrate didactic learning with applied problem-solving, or ‘knowing by doing.’ \textsuperscript{31} Although clinical year is when most applied learning is practiced, most of this time is spent in the veterinary teaching hospital working tertiary care. The need for applied non-clinical veterinary medicine remains largely unmet or at least rarely optimized.

In 2004-2005, North Carolina State University CVM offered 42 clinical rotations of two weeks’ duration, 8 of which were required core rotations, including a double (four-week) rotation in small animal medicine, as well as a rotation each in equine medicine, equine surgery, and small animal surgery. In the remaining 15 rotation blocks, a student could have chosen to repeat a core rotation, take one of 27 faculty-organized elective rotations, or one of six self-directed elective rotations. Of the six elective rotations that have no formal structure and are essentially student-proposed independent study, five (83%) were in public or population health relevant

\textsuperscript{28} Radostits  
\textsuperscript{29} Hoblet  
\textsuperscript{30} Hoblet  
\textsuperscript{31} King
topics: externship, ruminant topics, special topics in epidemiology, large animal community classroom, and special topics in theriogenology. Independent study includes the Student Epidemiologist program at the CDC, typically an eight-week field epidemiology program in Atlanta, Georgia. If support structures (e.g., financial support) are a measure of importance in the DVM curriculum, then interest areas in public health appear to be of low priority. However, recent changes have included a specific course in Emerging and Exotic Diseases of Animals and the institution of a joint DVM, Master of Preventive Veterinary Medicine program.

**Changing the Traditional Curriculum to Facilitate More Instruction in Public Health**

Curriculum review has repeatedly been discussed in academic circles and by those frustrated by output of current DVM curricula; most dialogue considers what is being taught and teaching methods. There is concern that field experience is not part of DVM education. Schools should pay greater attention to three key areas in student competency assessment: defining attributes students have acquired by graduation, establishing an internal assessment to ensure students meet faculty expectations, and establishing external outcomes assessment. Other necessary assessments include a review of admissions, faculty, curriculum, research and outcomes. Without a in-depth, specific curriculum and competency assessment tool besides the national board examination, or the North America Veterinary Licensing Examination (NAVLE), the profession cannot hope to understand how to improve the education of veterinary students. AVMA accreditation for veterinary schools requires a review every seven years. The review includes an examination of organization, finances, facilities and equipment, clinical resources, library and information resources, and students. Greater support for public health activities could be engendered, if the AVMA would place more emphasis on public health competencies, and more evenly practice the Veterinarian's Oath, adopted in 1969 and reaffirmed in 2004. The

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32 Lin  
33 King  
34 Held  
35 NRC Committee on Assessing the Nation's Framework for Addressing Animal Diseases
oath begins “Being admitted to the profession of veterinary medicine, I solemnly swear to use my scientific knowledge and skills for the benefit of society through the protection of animal health, the relief of animal suffering, the conservation of animal resources, the promotion of public health, and the advancement of medical knowledge…”

Educators currently underestimate the self-teaching and learning abilities of the DVM student and must let them plan and pursue their individual interests. Omnicompetence is said to be ineffective, wasteful and frustrating for both instructors and students. Generalization leads to creating practitioners who follow routine and act as technical task-masters rather than highly specialized problem-solvers. Concepts to overhaul the existing degree model are currently being discussed in the veterinary medical academic community. Suggestions to lengthen the educational requirements have been unpopular, though there is better-received discussion about requiring real-world practice before licensure.

Some have proposed a model much like for engineers, whose field recognized that the growing body of engineering science could not be mastered by a generalist. An undergraduate engineer shares about one year of core instruction with all engineering disciplines, and then undertakes three years of study in a specific discipline, graduating with a specialty (e.g., mechanical engineer, chemical engineer). The engineering model could potentially create veterinarians who enter at a much higher level of competence than a generalist, with increased enthusiasm, and ability to specialize. Another model is the dual-degree program. Four of 28 schools offer a dual MPH-DVM, some collaborating with medical schools and others with public health schools. Two schools offer a DVM-MPVM degree.

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36 Radostits
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40 Radostits
41 Riddle
A third model, tracking, which requires students to choose a focus area in the first or second year has gained the most momentum and is currently underway at several CVMs. Tracking started at two CVMs and is gaining support across the veterinary academic community. A tracking curriculum at Virginia-Maryland Regional College of Veterinary Medicine (VMRCVM) was implemented in 1989, where a traditional multi-species generalist track is included as one of five tracking programs. Tracking both allows more curricular time in an interest area, but also reduces core requirements in non-interest areas. The VMRCVM has 71% of its curriculum as core instruction, whereas 50% is core in the engineering model. In 2000, an outcomes assessment was conducted to survey faculty, students, staff, alumni, employers, referring veterinarians, clients, and other stakeholders. The government/corporate track rated well, graduate satisfaction was high, and the school feels it has developed an improved model compared to the standard non-tracking curriculum.  

| Table 1. Student selection of tracks, VMRCVM (2001-2004) |
|----------------|----------------|----------------|----------------|----------------|
| Class | Small Animal | Equine | Food Animal | Gov/Corp | Mixed |
| 2001 | 43 | 7 | 9 | 12 | 17 |
| 2002 | 53 | 9 | 6 | 8 | 10 |
| 2003 | 57 | 9 | 11 | 10 | 2 |
| 2004 | 64 | 8 | 8 | 3 | 9 |

University of California at Davis implemented a new tracking program in 1994 with nine tracks and a core curriculum that included clinical experience varying between 58% and 75%, depending on the focus area. Offering a more tailored education is necessarily administratively complex. Course scheduling is complicated, as are facilitating student choices, coping with expanding directions, and providing an expanded clinical experience. However, results from licensing examinations and practice performance supports efficacy.
Table 2. Student selection of tracks, CVM, UC Davis (1996-1997 to 2000-2001)

<table>
<thead>
<tr>
<th>Year</th>
<th>Tracks which include contact with food animal*</th>
<th>Ind</th>
<th>Zoo</th>
<th>Equine and small animal</th>
<th>Total</th>
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<tbody>
<tr>
<td>1996-1997</td>
<td>36</td>
<td>6</td>
<td>1</td>
<td>78</td>
<td>121</td>
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<tr>
<td>1997-1998</td>
<td>28</td>
<td>6</td>
<td>2</td>
<td>68</td>
<td>104</td>
</tr>
<tr>
<td>1998-1999</td>
<td>29</td>
<td>3</td>
<td>2</td>
<td>76</td>
<td>110</td>
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<tr>
<td>1999-2000</td>
<td>25</td>
<td>6</td>
<td>1</td>
<td>79</td>
<td>111</td>
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<tr>
<td>2000-2001</td>
<td>14</td>
<td>10</td>
<td>2</td>
<td>77</td>
<td>103</td>
</tr>
</tbody>
</table>

* These tracks include a combination of mixed practice, large animal, food animal and small animal.

The tracking model is recommended by AAVMC and would increase new graduate competence, allow for alternative admissions criteria, support development of niche specializations, address emerging trends of the profession, and improve graduate satisfaction with a tailored education.

Despite the success of these programs in providing a highly individualized course of study with greater depth, the trend toward companion animal clinical practice persists. Small animal track enrollment increased at VMRCVM from 49% to 70% in three years, and government/corporate tracking dropped from 14% to 3%. At UC Davis from 1996 to 2001, disciplines involving food animals dropped from 30% to 14% and equine and small animal increased from 64% to 75%.

Critics argue that tracking narrows career options due to lack of awareness of other areas because specialization starts so early, and also requires changes in licensure structure. Ideally there will be a coupling of these types of discipline-specific training and a strategy to increase participating in underserved areas of veterinary medicine and enhancing graduate competence.

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46 Hoblet  
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50 Radostits  
51 Radostits
Though some students lack confidence about choosing a discipline, this argues for a better-informed entering student and improved recruiting mechanisms. Recruiting is essential to shaping the future direction of veterinary medicine, and is an underutilized tool for guiding the profession. Admissions criteria for veterinary schools are complex, but most are heavily weighted to academic performance. Veterinary experience required by admissions committees also favors those going to clinical practice. Many CVMs have dropped from their admissions process the candidate interview, which serves as an opportunity to pass valuable information to the candidate, and tests the candidate in communication and interview skills essential for professional development. A 1988 Pew Report on Future Directions for Veterinary Medicine recommended that all veterinarians have baccalaureate general college education. This serves to ensure a mature, well-rounded and well-informed applicant pool. Though some argue that candidates can mislead admissions to get into underserved disciplines, only to switch once admitted, recruitment coupled with tracking can be a powerful tool to correct the course of the profession.

**Student perspective**

Students who participated in the 2003 AAVMC conference on Biodefense and Public Health noted several key points. Science in DVM programs is taught without context or application. Given that the DVM student has arrived at veterinary school with years of didactic science instruction in physics, chemistry, and genetics theory, it seems a missed opportunity to not engage them in applied sciences immediately. With the possible exception of two CVMs which

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52 Radostits  
53 Baker  
54 Sawyer  
55 Pew National Veterinary Education Program  
56 Radostits  
57 LaBranche
use problem-based learning, instructors in DVM programs do not make a good case that veterinary science is an applied science until the latter half of the DVM program.

While there are certain requirements for electives distribution, there are some electives in highly specialized areas which are completely optional. These non-required electives are not attractive due to heavy workloads in the required curriculum, yet these may be the only opportunity students have to learn about marine mammals, invertebrate medicine, public health, or other non-traditional areas of veterinary medicine. When there is a needs gap in the curriculum, the solution is often for students to form a club and cultivate their own relationships and projects. Through this is useful experience in terms of professional development, sustained demands should be better addressed in the DVM curriculum.

A common interface between professionals and students is at optional lunch meetings. These talks are largely held for representatives of companion animal drug companies and pet food companies. These companies often provide a pizza or sandwich lunch in exchange for time promoting their products. Student participants at the AAVMC conference saw an opportunity to invite more speakers from public service and public health areas. Certainly these types of speakers are invited as guest lecturers in public health courses. There can be many more interface opportunities if state and federal public health organizations sponsored lunch talks. Nothing attracts the DVM student more reliably than free food. In his January 20, 1961 presidential inaugural speech, John F. Kennedy created the Peace Corps and posed to “ask not what your country can do for you - ask what you can do for your country,” and interest in public service spiked. This surge has not been sustained five decades later.

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68 LaBranche
69 LaBranche
Interestingly, a 2005 Council for Excellence in Government poll found that Sydney Bristow of the television show “Alias” was “America’s Favorite TV Fed,” echoing the need discussed earlier in this paper for increased efforts in popular culture by the veterinary profession to establish heroes and icons for the profession. Veterinarians are getting more media roles but mainly as small animal practitioners. Patricia McGinnis, president and CEO of the nonprofit/nonpartisan Council for Excellence in Government, noted that “entertainment television actually impacts individual attitudes toward government and public service...43% of viewers of government-themed shows have learned more about a particular political or social issue as a result of watching one of those shows...Viewers between the ages of 18 and 24 seem particularly influenced by government and civic-engagement content they see on television...we are seeing that, more and more, entertainment television is becoming an important civics teacher, career guidance counselor and unofficial civics curriculum for many young Americans.”

Stephen Barr of the Washington Post wrote in 2006 that “the ‘ask not’ generation has quietly left federal service, and a mainstay of the federal government, this the baby boom generation, will be retiring in the next few years. The transition to the next generation may be one of the most important facing the government because polls show that many young people see little appeal in government service.” The Council for Excellence in Government launched an Internet-based project in April 2006 to provide research data and ideas that commencement speakers at middle schools, high schools and colleges can use to advocate working in government. Many projects are effective in generating young people’s interest and the general public’s interest in particular social and career areas. Veterinary public health needs to be much more savvy in terms of marketing, and adopt promotional models used by industry.

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60 Council for Excellence in Government
61 Council for Excellence in Government
62 Barr
DVM students also wrote that the clinical year offers very limited access to real world public health practice, and the lack of funding for real world experience is an obstacle. For example, the eight-week CDC Student Epidemiology Program is open to senior medical and veterinary students. No expenses are covered by CDC. At most CVMs, there are sparse support mechanisms for this type of externship. AVMA offers a $1,000 stipend for up to ten veterinary students to extern at the Governmental Relations Division in Washington, DC. Other public health and civic-minded organizations should facilitate externships by enhancing networking, promotion and other incentives and support.

**Professional Development is Needed in DVM Training to Produce a Competent and Mature Public Health Practitioner**

Study after study has championed strengthening professional competencies such as leadership and management. As noted above, the KPMG study found a major weakness in problem-solving and critical thinking in this profession based in applied science. If DVM curricula would delegate these responsibilities early rather than emphasize didactic learning or clinical skills, it would foster many of these qualities. Early exposure to self-direction is key and better tools to assess students’ problem-solving skills can guide curricular and licensing direction. The current DVM curriculum appears structured so that it is not possible for students to learn enough to be competent and also confident at graduation. Other weaknesses are communications skills, and intercultural awareness, which is particularly important as we recognize the importance of veterinary medicine’s role in global health, public health, and

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63 LaBranche
64 Pappasianou
65 Heath
66 King
67 Blackwell
68 Buss
69 King
70 Sawyer
71 Radostits
72 Buss
73 Buss
emerging diseases. At the same time, the application pool is narrowing with 79.8% of veterinary school applicants in 2006 being women, 39.9% between 20 and 23 years of age, and 76.3% being Caucasian. Mentorship, both recognizing effective mentors and developing mentorship skills, are also lacking in the current academic model. The nature of the DVM programs to create clinician-generalists makes for some important educational gaps in not only professional development, but also in technical areas such as regulatory medicine, which governs all areas of practice; animal health infrastructure, including emergency operations, global and public health; trade and policy matters impacting and impacted by veterinary medicine, many research areas; and epidemiology and surveillance.

DiVersity Matters is an AAVMC initiative to increase the presence of underrepresented minorities in the CVMs. However, it does not address diversity of interest despite the fact that for many years AAVMC has communicated a need for public health and other public service areas of veterinary medicine. Diversity of interest needs its own initiative. Curriculum review is ongoing, and is influenced by funding, curriculum committees, and resources. The DVM curriculum generally trains students to pass the NAVLE and become private practitioners in four years, but must offer educational opportunities to push them to think beyond these traditional clinical roles and geopolitical boundaries. Many different parties control DVM curricula. These include licensing demands, practitioners, faculty, researchers and advisory bodies (e.g., AAVMC). Reliance on discretionary funds to accommodate those interested in public service is criticized as “a shell game” and a sustained national goal to guide the educational needs of veterinary public health remains unresolved.

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74 AAVMC
75 Buss
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Extracurricular Changes are Also Needed

Infrastructure

Recruiting, as well as overall marketing for the profession, needs to more effectively address veterinary public health. Exposure to veterinary medical careers at high school and earlier is key. Veterinarians are highly regarded but only 11-24% of the general public knows veterinarians do research, public health, and food safety. There is power in popular culture, and the profession must find young energetic spokespersons. The enormously popular James Herriott books, about life as a country veterinarian, probably shaped veterinary medicine by both romanticizing its country doctor folksiness, as well as assigning a human face to the profession. Mass media has not released the veterinarian from its clinical boundaries. In 1997, Mattel introduced Pet Doctor Barbie. Animal Planet, a cable television channel, was launched in 1996, and airs programming on wildlife and companion animals. Animal planet programs such as Emergency Vets and The Planet's Funniest Animals and iconic marketing forces such as Barbie do not even remotely suggest an interface between animals and the health of the human population, and de-emphasizes the underserved area of veterinary public health. Leadership of the profession has missed a tremendous marketing and educational opportunity. Human medicine, however, has entertained the public while giving a face to non-traditional specialties such as forensics and pathology. Quincy had a very successful run on NBC from 1976 to 1983. A phenomenon called “The CSI Effect” has been discussed in popular media. Wikipedia notes that universities have seen an increase in students enrolling in forensic and related science programs since crime scene investigation dramas have increased in popularity. Though it is

79 Baker
80 Riddle
81 Baker
82 LaBranche
83 Radostits
84 LaBranche
85 Sawyer
86 Brown
87 Wikipedia
not the function of the entertainment industry to guide the direction of a profession, there is an impact, and certainly an opportunity for a profession to shape and promote itself to future professionals and their parents.

In order to accommodate the necessary changes to meet future demands of the profession, including public health, changes in educational infrastructure must be considered. Targeted recruitment will likely mean an accompanying increase in overall student body to maintain supply of qualified veterinarians. AAVMC has studied the issues related to expanding the DVM programs overall. At veterinary schools, the student: faculty ratio is 1:0.28, whereas at medical schools, it is 1:1.59. This ratio has been steady since 2001, and suggests that increasing student numbers will also require recruiting of new faculty in CVMs.

Much of the academically based research in the U.S. is performed at CVMs. This includes studies in basic sciences such as immunology and microbial sciences which train public health scientists and support public health activities. It is through the VTHs that most DVM students gain practical experience with animals. However, animals in the VTHs are not generally used in research, though they might be enrolled passively in some research studies. Owner consent is required and these are patients, not research animals. Laboratory animal facilities need to be expanded. To train an additional 241 DVM students and 658 graduate students, the CVMs responded that the expansion would require 400 new faculty and 2.25 million square feet of new and renovated research space, as well as a $37 million one-time investment for laboratory equipment. In wildlife studies, which encompasses the critical interface between human and animal activity, there are only two residency programs, which are not open every year. Specialized facilities for wildlife studies are almost nonexistent.

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88 NRC Committee on National Needs for Research in Veterinary Science
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90 NRC Committee on National Needs for Research in Veterinary Science
91 NRC Committee on National Needs for Research in Veterinary Science
databases, often the backbone of public health efforts, are a rarity in veterinary medicine. There are existing collections of lesions and tumors that serve as national databases, but do not represent incidence or prevalence of disease because these are voluntary submissions. Growth is needed in programs, educational staffing and infrastructure in order to accommodate the training of adequate numbers of new veterinarians. Funding considerations must be mined at all levels of the profession. Funds availability often follows changing political priorities, and after the 2001 attacks on the World Trade Center, many dollars were diverted to fight terrorism, including bioterrorism. The veterinary profession needs to advocate for more training and career opportunities in these areas. Individual students must be better prepared in how to secure grants and scholarships. Institutions must not only alter recruitment practices, but guide both their fundraising and academic programs with expansion of student numbers and competences in mind. National organizations such as specialty board colleges, AVMA and AAVMC must also recruit, promote, and facilitate an increase in student numbers.

**Licensing**

If the DVM academic model changes significantly to reflect expertise in specialty areas, state and national licensing structures may need to change. Engineers are licensed in their specialty areas, and moving between areas is not fluid. One of the major issues in licensing is the NAVLE. Some argue that if the examination were to change, curriculum would follow, as most CVMs instruct students not only in how to practice, but also in how to pass the national examination. The test focuses on clinical practice, and the impact is that non-traditional careers are minimized in veterinary education. The National Board of Veterinary Medical Examiners commissioned a job analysis in 2002-2003 in order to develop the test specifications for the entry-level veterinary practitioner. The advisory committee was comprised of eleven

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92 NRC Committee on National Needs for Research in Veterinary Science
93 LaBranche
94 Baker
95 LaBranche
veterinarians, three of whom received DVM degrees within the last ten years. None of the members are specifically public health practitioners, though one is a dairy practitioner and one is a food animal university clinician. In 2003, the Board established a blueprint of the 2005 and 2006 examinations, as shown on Table 3.

<table>
<thead>
<tr>
<th>Species/Area focus</th>
<th>Number of Questions</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canine</td>
<td>72</td>
<td>24%</td>
</tr>
<tr>
<td>Feline</td>
<td>72</td>
<td>24%</td>
</tr>
<tr>
<td>Pet Birds</td>
<td>9</td>
<td>3%</td>
</tr>
<tr>
<td>Other Small Animals</td>
<td>6</td>
<td>2%</td>
</tr>
<tr>
<td>Bovine</td>
<td>51</td>
<td>17%</td>
</tr>
<tr>
<td>Porcine</td>
<td>12</td>
<td>4%</td>
</tr>
<tr>
<td>Ovine/Caprine/Cervidae</td>
<td>9</td>
<td>3%</td>
</tr>
<tr>
<td>Equine</td>
<td>51</td>
<td>17%</td>
</tr>
<tr>
<td>Poultry</td>
<td>6</td>
<td>2%</td>
</tr>
<tr>
<td>Public Health and Food Security</td>
<td>9</td>
<td>3%</td>
</tr>
<tr>
<td>Non-Species Specific</td>
<td>3</td>
<td>1%</td>
</tr>
<tr>
<td>Total</td>
<td>300</td>
<td>100%</td>
</tr>
</tbody>
</table>

A recurring criticism of the NAVLE is that it does not evaluate clinical and professional skills, which are needed in a real world setting. If successful completion of the degree and national board examination cannot guarantee competency, perhaps a mandatory internship of residency should be required before licensure. In the United Kingdom, the Royal College of Veterinary Surgeons proposed requiring one year of post-graduation practice before licensure. Career shifts would require another professional training phase, and a modular certification before full broad licensure might be implemented.

Mandatory clinical internships offer another alternative to the engineering model of specialized licensing. Internship learning curves are steep, providing professional client-service exposure, business management experience, increased professional peer interactions and honing of

96 National Board of Veterinary Medical Examiners
97 Radostits
98 Radostits
personal interests. Weak skill sets noted most often in a 1999 KPMG study were: research skills; speaking/writing; computer skills; personnel management and administration; teaching; and epidemiology. Less than half of private practice employers (40%), and only 28% of veterinarians not in private practice, rate new graduates as having good critical thinking skills when 87% of new graduates rate themselves good to excellent on critical thinking skills.100 These findings support a need for admitting more well-rounded DVM candidates, and improved professional development in the DVM curriculum.

Continuing Education Can Reflect the Importance of Veterinary Public Health

Continuing Education (CE) has been championed as an opportunity to expose more veterinarians to public health. More distance education101 has also been advocated, since many public health concepts do not require special facilities or hands-on wet labs. More offerings are needed in zoonoses, emerging diseases, and terrorism response.102 In 2002, AVMA ceased to review CVM-delivered CE programs. No organization oversees a national CE standard for programs delivered by veterinary schools.103 However, some states do not require CE for licensure.

Veterinary-Public Health Partnerships Require Further Exploration

The AAVMC Public Health Task Force Stakeholders Meeting on April 26, 2005, reported that CVMs need to provide examples and role models from public practice. This includes creative use of adjunct and volunteer faculty, as well as students returning from public practice experiences. Also, they reported a need to advocate a more holistic perspective and teach public health as part of clinical practice. Career counseling must be improved as well. Pre-veterinary medicine recruitment and job placement are weak and also need improvement.

99 Radostits
100 Brown J. Silverman J
101 Sawyer
102 Riddle
103 NRC Committee on Assessing the Nation's Framework for Addressing Animal Diseases
Stakeholders also can collaborate by offering externships and stipends for existing externships. Employers were encouraged to provide for leave and funding for veterinarians to get further post-doctorate training.\textsuperscript{104} Stakeholder groups that use and work with veterinarians know well what the disincentives are.

Organizations such as USDA, state animal health agencies, AVMA, CVMs, and departments of animal science need to develop an overall national plan to guide veterinary medical education.\textsuperscript{105} Instead, each stakeholder works its own needs without regard to an overall plan which could reduce redundancy in effort. There are many potential partnerships that remain unexplored. During the catastrophic foot-and-mouth-disease outbreaks in Ireland in 2001, the school made available some of its faculty for front line duty, assisting with risk communication, and serving as subject matter experts to the Ministry of Agriculture. In 2002, the Ministry was important in securing additional funds to move the school into a new facility. The Ministry also endowed a Chair in veterinary epidemiology and risk analysis at the school.\textsuperscript{106}

Some agencies, such as the Department of Defense have formed partnerships with educational institutions.\textsuperscript{107} Their programs include tuition assistance for DVM and advanced training with a limited term military commitment. The Food and Drug Administration (FDA) has had a Summer Internship Program since 1997. CDC has identified a need for 200 new veterinarians to replace losses in the next decade. In 2004, 50% of the 99 veterinarians in the commissioned Public Health Corps were eligible to retire by 2006.\textsuperscript{108} CDC’s Epidemiologic Intelligence Service (EIS) and graduate stipends support veterinarians. In 1984, USDA-Animal and Plant Health Inspection Service (APHIS) and CDC agreed to fill two EIS slots with APHIS veterinarians. This

\textsuperscript{104} AAVMC Public Health Task Force Stakeholders Meeting on April 26, 2005
\textsuperscript{105} NRC Committee on Assessing the Nation’s Framework for Addressing Animal Diseases
\textsuperscript{106} Monaghan
\textsuperscript{107} Blackwell
\textsuperscript{108} NRC Committee on National Needs for Research in Veterinary Science
was followed by Army and Air Force slots in 1994 and USDA-Food Safety and Inspection Service (FSIS) participation in 2001. 109

There are unrecognized opportunities for AAVMC and the Association of Schools of Public Health to partner as well. 110,111 This could make for student-tailored educations that were broad and cross-disciplinary, while simultaneously being specific to veterinary public health. In April of 2007, AAVMC will co-sponsor a symposium on emergency preparedness. Currently, credit transfer is difficult between even the CVMs, as the scheduling and curricula are so unique to each school. Standardizing or reciprocity agreements would allow DVM students an option to find the courses that fit their educational needs best. Allowing public health schools to enter into reciprocity agreements would benefit not only veterinary students, but also public health students. Likewise, undergraduate and graduate (non-DVM) departments of veterinary science focus on diseases of economic importance. Animal Science has generally expanded to include companion animal physiology and behavior. Wildlife and Fisheries departments lack demands from extramural parties (e.g., commodity groups, industry) to drive research and do not use cutting-edge approaches to animal disease. 112 Collaborative efforts between DVM programs and public health programs would allow for a richer educational experience and allow for a contextual, comparative understanding of global health.

Disincentives to Study and Enter Public Practice Need to be Dismantled

There are major disincentives preventing DVM graduates from entering public health practice. Clinical practice continues to dominate economic issues, and the norm for success is still seen as owning a private practice. 113 After DVM graduates enter a career track such as private clinical practice, it is often very difficult to move to another area of veterinary medicine.

109 NRC Committee on National Needs for Research in Veterinary Science
110 Held
111 Riddle
112 NRC Committee on National Needs for Research in Veterinary Science
113 Brown J. Silverman J
Veterinary public health stakeholders need to facilitate these transitions\textsuperscript{114} in order to allow for personal and professional growth.

Perhaps the biggest disincentive is the debt level at graduation which prevent many from pursuing post-graduate training\textsuperscript{115,116} and push many into private clinical practice. AVMA reports that 2005 graduates entering small animal-exclusive practice earn a mean of $53,796 whereas those entering advanced study earn $25,100.\textsuperscript{117} Every year, the report lists government salaries as 'unknown' perhaps because there are so few respondents. Until April 2006, the federal government paid veterinarians with no experience at a GS-9 level ($38,175) whereas physicians were paid at GS-12 ($55,360). Since then, the Office of Personnel Management has revised the qualification standards for veterinary medical officers, reclassifying them at GS-11 level ($46,189).\textsuperscript{118}

According the KPMG study, “veterinary medicine is more adversely affected by increased student debt than other graduate degrees... because increases in veterinarians’ incomes have not kept pace with increases in their student debt... Therefore, we believe that it is probably more appropriate to characterize veterinarians’ debt problem as not purely a debt problem but as an income problem.”\textsuperscript{119} This is a well-recognized problem in veterinary medicine, and the profession must increase starting incomes, including post-graduate training.\textsuperscript{120} Some see the dual degree model as a partial solution to both income and competency shortcomings\textsuperscript{121,122,123} and many dual-degrees can be completed in the four years required for just a DVM degree.\textsuperscript{124}

\textsuperscript{114} King
\textsuperscript{115} Baker
\textsuperscript{116} LaBranche
\textsuperscript{117} AVMA, 2008
\textsuperscript{118} Office of Personnel Management
\textsuperscript{119} Brown J, Silverman J
\textsuperscript{120} Baker
\textsuperscript{121} King
\textsuperscript{122} Blackwell
\textsuperscript{123} Held
\textsuperscript{124} NRC Committee on Assessing the Nation’s Framework for Addressing Animal Diseases
Again, the profession must do a better job at promoting its work, and the value of the DVM credential. Government agencies such as CDC must start paying veterinarians comparable wages to human physicians when managing the same public health responsibilities.

**Conclusion**

Recent studies in the economic, educational, and market trends of veterinary medicine agree that there are increasing but unmet needs in veterinary public health. Both a cause and effect of this trend is a lack of adequate presence of public health in the current training of veterinarians. Because students are largely unaware of their potential contributions to public health, they undervalue their training in comparative medicine and population medicine. Major efforts are needed in terms of recruitment, DVM training, and promotion of the profession to meet current demand for competent public health practitioners with a background in animal health.

Leadership is needed in this area, where much discussion has resulted in few effective solutions and no major increases in resources. There are many opinions and critics but too few effective strategies to bring about change. Leadership in veterinary education must not only focus on outputs such as papers and meetings, but outcomes such as DVM graduates who have better appreciation and awareness of their potential interface with public health. Leaders in veterinary education must engage the overall profession and gain the attention of other national leaders in veterinary lobbying groups, specialty colleges, industry, public health, and others who have not recognized the importance of the interface between public health and veterinary medicine. Setting curricular guidelines, such as those from AAVMC, is ineffective if not coupled with issues the schools and their curriculum committees will take seriously, such as funding, licensing, and AVMA veterinary school accreditation. Importantly, the profession as a whole must make a commitment to public health. Changes at these critical points in the education and practice of veterinary medicine may reverberate to alter licensing and continuing education.
structures, as well as building staffing and facility infrastructures and partnerships. However  
difficult it will be to change established educational structures, without change, the profession  
will falter in its responsibility to protect and promote public health.

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