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Mainstreaming Alternatives in Veterinary Medical Education: Resource Development and Curricular Reform

Lynette A. Hart ■ Mary W. Wood ■ Hsin-Yi Weng

ABSTRACT

Veterinary medical educators are charged with preparing students to enter practice in veterinary medicine during a four-year, intensive, professional education program. This requires giving students in laboratory training that involves dead, anesthetized, or conscious animals, so that they become proficient in the expected range of veterinary knowledge, skills, and abilities. Undeniably, experience with animals is essential to prepare students for a profession in which animals comprise the total domain. However, the consumptive use of animals for teaching students, especially in laboratories, is increasingly subject to regulatory requirements, while also being scrutinized by animal protection groups, and has become a common focus of contention among veterinary students. Not surprisingly, the use of animals in teaching has sharply declined over the past few decades, as new teaching resources and methods, involving less consumptive use of animals, have been incorporated. This change in veterinary medical education has occurred on such a wide scale, in almost all veterinary schools and colleges, that the educational approach can serve as a model for further developments within the veterinary educational community and, indeed, for animal-related material in secondary schools and undergraduate higher education. This article highlights examples of the leadership provided by veterinary educators in developing alternative teaching resources and methods, while maintaining the high level of proficiency expected from traditional educational approaches.

INTRODUCTION

Teaching methods in both veterinary and human medicine have co-evolved, epitomized historically by the use of cadavers and even fresh tissue. Dissections of animal and human cadavers and surgeries were performed in “theaters”; even in those early times, controversy surrounded these practices, as was the case with Vesalius in Bologna in 1540.¹ The early demonstrations led to a flow of new discoveries about mammalian anatomy and physiology and the concept of the teaching laboratory evolved. The undergraduate biology laboratory often featured animals, whether live or cadavers, that were used for students to gain familiarity with the anatomy and physiology of whole animals. In the present, the use of animals at levels ranging from high school classes to veterinary instruction is controversial.

In this wave of controversy, veterinary faculty and administrators are seldom credited with being committed to developing effective curricular methods that permit a reduction in the consumptive use of animals. We present in this article a sample of the substantial effort within the field of veterinary medical education during the past three decades to replace many of the interventive uses of animals with resources and methods that are equally effective in imparting the essential knowledge, skills, and abilities.

While early dissections provided opportunities for anatomical research, the use of animals in teaching laboratories currently differs from that in research in that their use is oriented not towards discovery but rather to the transfer of established information to a new group of students. This teaching context has consistently inspired faculty members to find better methods of teaching veterinary students anatomy, physiology, and surgical skills. Over the

past 30 years, a broad-based effort conducted at many veterinary schools has led to improvements in instructional methods, reducing the use of live animals or cadavers, while conserving a high-quality learning environment for each new wave of veterinary students.

Animals used for education and training comprise a small proportion of all animals used in research, teaching, and testing. In 1999, the estimated use for teaching and training in higher education in Europe was approximately 1% of the total.² The proportion of the total in the European Union for all teaching in 2002 was estimated at 3%.³ However, regulation concerning animal use pertains to even the small number of animals used in teaching as well as to those used in research, and animal use in the United States must conform to the terms of the USDA Animal Welfare Act, which requires searching for alternatives.⁴ This requirement became more formalized in policies 11 and 12.^{5,6} Thus, in the United States, those using animals in teaching are required to submit an animal-use protocol, describing the procedures and including the results of a bibliographic search.

As mentioned, unlike early scholars who studied animals, today’s teachers do not expect to make new discoveries during these laboratories. Yet, while the relevant knowledge is already widely disseminated in books and other media, each student must be provided with efficient ways to learn the material in a short period of time. Knowledge of the body’s structure as it appears in cats, dogs, horses, and birds, as also in other animals, and experience with physiological responses are required of veterinary students, who also must perfect basic skills in animal handling, venipuncture, placing catheters, intubation, and giving injections before they can move on to more sophisticated

procedures. Categories for the uses of animals for educational purposes have been set out by Morton:⁷ as cadavers for dissection or examination of preserved specimens, under terminal anesthesia, with recovery from anesthesia, in observational studies, and in demonstrations of known facts. In a slow process over decades, practices such as performing multiple surgical procedures over one or more successive weeks on the same live animal have been replaced.

Precise estimates are not readily available of the numbers of colleges and schools of veterinary medicine that were using live animals, but the number of medical schools that had entirely discontinued live-animal use increased steadily between 1982 and 1993, and in 1994, medical schools reported that live animals were used at 62% of the schools, typically in physiology laboratories.⁸ This number had decreased to one third of medical schools by 2001.^{9,10} The reported reasons for discontinuing live-animal use were the expense of live-animal labs and changes in the curriculum. Student debates on the use of dog labs, student petitions for non-participation, verbal protests by students, and demonstrations during World Animal Week were among the incidents of harassment, protest, or legal actions relating to the use of live animals in laboratories.⁸

While the general topic of animal use in education has not been a major focus of ongoing professional discussion among educators, outstanding reviews have been provided.¹¹⁻¹⁸ One focus of these papers is that dissection remains a prevalent practice in education at the secondary school level.¹⁶ A comprehensive database of teaching resources is offered by NORINA, the Norwegian Reference Centre for Laboratory Animal Science and Alternatives; detailed information can be accessed on about 4,000 items of software, models, posters, and other teaching resources; some are available at the associated library.¹⁹ InterNICHE, the International Network for Humane Education, outlines the use of alternative teaching methods by disseminating information, loaning out resources, and publishing an informative book.²⁰

The number of animals used in instructing veterinary students at more than 30 North American veterinary schools is tiny compared with the number of dissections performed in high schools, yet it is a matter of remaining concern. A large number of veterinary students enter the profession because of their great love of animals. In recent years, many students have found themselves deeply conflicted when facing some of the laboratory procedures required in the veterinary curricula. Differences of opinion on the value of these procedures sometimes have created schisms among students. Simultaneously, external criticism has been directed at veterinary schools by people commenting that the profession should be more protective of animals. Conjectures have been put forward as to problems that impede the introduction of alternatives, including that some teachers are resistant to change, alternatives require the investment of time and money, information is not widely disseminated, and the quality of material available varies.¹⁴

LEADERSHIP FROM VETERINARY SCHOOLS

Administrative support has been essential for sustaining the effort over the past three decades to modernize the

methods of providing adequate training and experience to students without slipping in the intellectual preparation of the students to enter the veterinary profession. At many veterinary schools, interdisciplinary teams of faculty and technicians have mobilized their abilities toward enhancing teaching. For those whose regular work involves contact with anatomical specimens on a daily basis, the possible toxicity of formaldehyde has led to some replacement of conventional specimens. Over time, the aggregate of new resources, combined with other curricular changes, has systematically reduced the use of animals for veterinary education.²¹ The net effect over the past three decades has been an impressive team effort, sweeping across the veterinary schools and colleges of North America and beyond. Some highlights of this curricular revolution in animal use are summarized in Table 1,²²⁻⁸³ revealing that faculty and staff at more than 20 veterinary schools have contributed to the increasing use of alternatives in teaching.

Some veterinary schools had specific objectives in their efforts, with an interdisciplinary team taking on a particular topic. For example, Washington State University developed curricula with special courses to teach psychomotor surgical skills.⁸¹ Tufts University publicized ending the consumptive use of animals and then went on to develop new methods.⁴⁶ The University of Illinois created artificial organs for surgical use and interfaced its evolving curricular changes with pedagogical inquiry and the assessment of essential learning and skills.⁶⁷⁻⁷⁶ These developments have had limited funding: About one fourth of the articles mentioned having some support; about half of the sources of support were from on-campus and half from off-campus. Despite meager financial support, a widespread, sustained effort has been conducted throughout the veterinary community.

Beginning in 1975, the University of California, Davis, began supporting the creation of alternative curricular materials for the replacement of animals.⁵¹ This effort grew into establishing a talented software and technological team that produced an ongoing array of instructional materials, including plastinated organs and other models and molds, interactive software such as a CD-ROM on the virtual heart, and videotapes. Some of these curricular materials are available to the public as products for purchase, including 16 compact discs, 95 videocassettes, and models of the canine head and foreleg for teaching vascular access techniques.⁵⁴

The process of converting the veterinary curricula over to less interventive uses of animals has been gradual. Most campuses have had both advocates and detractors of this process as it has continued unfolding, yielding a well-considered outcome, with the input of new teaching resources and methods from most veterinary schools.

RESOURCES DEVELOPED BY VETERINARY FACULTY

We review, in this section, some contributions of faculty to the enhanced teaching of anatomy, physiology, psychomotor skills, and surgery, offering a sampling of those in the veterinary academic community who have assisted the process of curricular reform. Modifying the comprehensive veterinary curricula so as to develop new teaching resources as alternatives wherever indicated is a significant and complex project. The production and distribution of high-quality videotapes and software^{19,30,36,54} help veterinary

Table 1: Sample contributions of veterinary schools and colleges to teaching alternatives

Auburn University: videodisc of heart sounds and physiology laboratories ²²⁻²³
Colorado State University: freeze-dried specimens, cadaver and survival surgeries ²⁴⁻²⁹
Iowa State University: new technology developments for veterinary curricula ³⁰
Kansas State University: new technique for preparing histology slides in gross anatomy ³¹
Louisiana State University: alternatives in neuroanatomy; survey on animals in surgery ^{32, 33}
Michigan State University: prosection; mentoring by students; instructional media ³⁴⁻³⁶
Mississippi State University: portable mockup for milking machine instruction ³⁷
North Carolina State University: plastic bone fixation; video of respiration patterns ³⁸⁻⁴¹
Ohio State University: simulator for surgical skills; mentoring in ambulatory practice ⁴²⁻⁴⁴
Purdue University: prosection approaches for gross anatomy ⁴⁵
Tufts University: alternative surgical program; cadavers from clients; euthanasia videos ⁴⁶⁻⁴⁹
Uniformed Services University of the Health Sciences: preparing anatomy specimens ⁵⁰
University of California, Davis: videocassettes, software, models for surgery ⁵¹⁻⁵⁵
University of Edinburgh: computer alternatives in physiology and pharmacology ⁵⁶
University of Florida: use of human patient simulator ⁵⁷
University of Georgia: heart sounds; videodiscs; electronic cardiac imaging ⁵⁸⁻⁶²
University of Glasgow: bovine rectal palpation simulator ⁶³
University of Guelph: dog abdominal model; radiology for teaching anatomy ^{64, 65}
University of Illinois: heart sounds; surgical training models; assessment; expectations ⁶⁶⁻⁷⁶
University of Prince Edward Island: simple alternatives for laboratory animal care ⁷⁷
University of Tennessee: assessment of surgical training; use of plastinated specimens ^{78, 79}
Virginia Tech University: survey of surgical curricula at veterinary schools ⁸⁰
Washington State University: psychomotor skills laboratory; image data base ^{81, 82}

schools continue to deliver authoritative instruction, despite the sharp reduction in the interventive use of animals, even at a time when there is a growing shortage of qualified gross anatomy teachers.⁸³

The topics and references listed in Table 2 provide some indication of the complexity of the changes that have been implemented. Reading these research reports reveals the step-by-step process that veterinary schools have followed in revising course outlines and methods and curricula. Many authors place their work in a historic context, describing the evolution of their own curricular methods as they put forward a new method or evaluate a new method in comparison with an older one. In this regard, the work reported by the interdisciplinary team headed by Greenfield⁶⁷⁻⁷² and Johnson⁷³⁻⁷⁶ is particularly instructive in laying out their evolving curricular strategies, revealing their thought processes when identifying pedagogical requirements, and obtaining evaluations by students and veterinarians, while also creating new resources and methods of teaching. Similarly, another team headed by Bauer²⁶⁻²⁸ explains that they conducted multiple survival surgeries until 1990, ended survival surgeries in 1991, and then shifted to spay/neuter surgeries of animals from humane societies to meet both budgetary and social demands.

Teaching Anatomy

A highly publicized use of animals in teaching is for courses in anatomy. The first article appearing in the *Journal of Veterinary Medical Education* in 1974 advocated using freeze-dried specimens.²⁴ Using prosections in teaching gross anatomy was suggested later that same year: The paper explained that, by combining the use of prosections and freshly killed material of animals, they had totally discontinued dissecting embalmed material, adopting an improved method that also was more time-efficient.³⁴ Later, at Purdue University in 1990, some dissections were replaced with student-prepared prosections, a technique that proved more efficient.⁴⁵ In an assessment of the effectiveness of using the prosections, students' errors were similar whether they performed the dissections or studied the prosections done by others.

Teaching Physiology

The development of alternatives to the use of live animals in laboratories allows efficient repetition of previous laboratories and data collection at any time desired by the users and avoids the lengthy preparation for the laboratory and possible mishaps in the procedure. Students can easily learn heart and respiratory patterns and repeat portions that they need to review as needed.^{22, 41, 58, 66}

Teaching Psychomotor Skills, Techniques, and Diagnosis

Teaching students procedures involving large animals poses a particular challenge, due to concerns for student safety if the animals object to repeated use in demonstrations. Creating a virtual cow that provides force-feedback during rectal palpation, despite the cow's lacking a rectum, feces, or peristalsis, offers a useful introduction to this skill.⁶³ An earlier approach had mounted a bovine cadaver in a standing position, replacing a live cow for learning these techniques.³⁹

Students need to get accustomed to working with an array of surgical tools, while coordinating with another person in a small working area. They can prepare for these psychomotor challenges by practicing the internal fixation of fractures with plastic bone models.^{38, 75} Washington State

Table 2: Categories of alternatives in various teaching procedures

Anatomy: acquire, preserve, and present specimens (traditionally with cadavers)

Acquisition of specimens by client donation of dogs and cats rather than shelter animals⁴⁸

Prosection approaches for comparative gross anatomy^{34,45}

New histology technique for teaching of gross and microscopic anatomy³¹

Plastination for reusable specimens⁷⁹

Freeze-drying for preserving specimens that are easily handled²⁴

Radiology for imaging in gross anatomy⁶⁵

Development of neuroanatomy in veterinary medical education³²

Physiology (traditionally with anesthetized live animals)

Heart sounds on videodisc, simulator, and computer^{22,58,66}

Physiology, pharmacology alternatives on computer⁵⁶

Physiology via videodisc²³

Breathing patterns on enhanced video clips⁴¹

Psychomotor Skills, Techniques, and Diagnosis (traditionally with cadavers or live anesthetized or conscious animals)

Bone fractures and pathological conditions treated using plastic bones^{38,75}

Motor skills with computer-assisted instruction and other models^{60,73,81}

Soft tissue models used and assessed in surgical curriculum^{68,69}

Mentoring, supervision in operative surgery provided by fourth year students³⁵

Attitudes of students, expectations by veterinarians for surgical proficiency^{69,71,72,76}

Milking in a portable mock-up for instruction³⁷

Full-service rotation in ambulatory practice to teach large-animal medicine⁴⁴

Human model simulator to teach students of veterinary medicine⁵⁷

DASIE model as an abdominal surrogate for teaching surgical techniques⁶⁴

Bovine cadaver standing and simulator for teaching rectal palpation^{39,63}

Simple techniques for training in laboratory animal care and use⁷⁷

Pathology diagnosis via videodisc⁵⁹

Cardiac, endoscopic images interpreted via electronic transmission, and evaluation^{61,62}

Surgery and Euthanasia (traditionally with anesthetized animals)

Videocassette to deliver surgical techniques⁵¹

Cadavers compared with live animals, models, computers in teaching surgery²⁵⁻²⁷

Survival spay/neuter surgery of shelter animals versus terminal surgery in teaching²⁸

Hemostasis model for teaching surgical skills, compared with splenectomy on live dogs²⁹

Alternative biological model utilizing human cadavers as a vascular model⁸⁴

Video and simulator for instruction of basic surgical skills and hollow organ closure^{42,43}

Abdominal surrogate of a dog for teaching surgical technique⁶⁴

Resources and use: assessing live animals, cadavers, models, computers for surgery^{26-28,48}

Emergency procedures in an alternative model⁴⁰

Operating room as a venue for teaching surgery⁷⁴

Euthanasia as taught by videotape and other alternative methods⁴⁹

Assessment of alternative medical and surgical laboratory program⁴⁷

University pioneered methods of training surgically related psychomotor skills and offering summer courses to interested students.⁸¹ Students learn such basic skills as how to suture, perform a venipuncture, insert an intravenous catheter, and identify bones by palpation.

Teaching Surgery and Euthanasia

Shmarak's⁵¹ presentation in 1975 of the videocassette as a prime delivery system for teaching surgery launched a method of instruction that was offered with 24-hour access, funded by the Dean's Office for curricular development, and that led to a continuing program of teaching-resource development at the University of California, Davis.^{54,55}

DASIE, the Dog Abdominal Surrogate for Instructional Exercises, created by Dr. David Holmberg, proved to be a fine model for teaching abdominal draping, aseptic technique, and tissue handling.⁶⁴ Since then, additional models have been developed for the leg and head.⁵⁴

In an inventory of methods used for teaching veterinary surgery, Bauer²⁶ reported a survey in 1993 of the use of live animals, cadavers, inanimate models, and other methods to teach veterinary surgery. Assessing veterinary practitioners' expectations of new veterinary graduates with regard to skills in small-animal surgical procedures has been useful, showing that ovariectomy, castration, declawing, dental prophylaxis, abscess treatment, tooth extraction, lumpectomy, and cystotomy are among the most common procedures.⁷⁶

The challenge of integrating new models into an existing curriculum includes dealing with students who feel cheated at losing contact with animals and finding other ways to offer experience in live-animal surgery.⁶⁸ Adding a neutering program evolves as nonsurvival surgical laboratories are phasing out. Using cadavers and soft tissue models provides additional opportunities for learning.⁶⁷

An essential complement to ending terminal surgeries has been increasing the mentoring provided by faculty members, residents, and more advanced students. Students are typically given more exposure to the surgical and clinical environments, with closer supervision. Clinical responsibilities begin earlier than in the past; for example, in first year at the University of California, Davis. Some programs are coordinated with clinical efforts for the animals of humane societies.

DISCUSSION AND CONCLUSIONS

The teaching of biology has relentlessly evolved to focus on cellular and genetic biology; yet students still need an orientation in gross anatomy that is unfortunately being phased out in campus after campus. While exposure to animals and animal tissue is most essential for students in veterinary schools, it is within the veterinary context that faculty have led the way in scaling back terminal procedures while still offering top-quality instruction.

As mentioned, the opportunity to spread the improved methods to undergraduate and secondary education has not been developed to any great extent. Regrettably, most campuses have discontinued offering comparative anatomy courses to undergraduates. As an example of what can be provided for the undergraduate program in biology, at the

University of California, Davis, a course in Comparative Vertebrate Organology using alternatives, presents functional anatomy of the major organ systems in fish, birds, and mammals, from the cellular to the gross level. Engaging laboratories focus on each of the organ systems, offering three-dozen gross anatomy laboratory stations, which are available for a full day each week. The laboratories present reusable materials, combining an array of preserved specimens, dissections, microscopic slides, and diagrammatic presentations. Much more can be done to spread these resources and methods to pre-college education.^{85,86}

Veterinary school curricula continue to evolve today and show considerable convergence in offering survival surgeries on shelter animals to teach basic surgical skills, focusing on the common surgical procedures, and offering clinical experience throughout the years of veterinary school. The emphasis on animal welfare that is a typical characteristic of veterinary medical education has gathered momentum throughout the profession, as evidenced by its growing role within the American Veterinary Medical Association.

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