Perspectives on Curriculum Needs in Laboratory-Animal Medicine

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ABSTRACT
Both the United States and Canada have projected shortages of qualified laboratory-animal veterinarians within the next 10 years. This gap is occurring because of retirement, increased regulatory requirements for research animal oversight, and insufficient numbers of veterinarians entering this field. One of the primary means of increasing student interest in nontraditional practice areas, such as laboratory animal medicine, is to ensure that they have appropriate exposure to the topic during their basic clinical training. We outline a recommended curriculum for laboratory animal medicine for North American veterinary medical colleges, which provides strategies for integrating comparative medicine material into the curriculum, incorporates flexibility for a range of delivery methods, and suggests potential resources that may be used to develop this material.

Key words: laboratory-animal medicine, comparative medicine, training, veterinary curriculum

INTRODUCTION
Concern for an inadequate supply of trained specialists in the field of laboratory animal medicine has existed for many years. Although a study in 1997 suggested a reasonable supply of laboratory animal veterinarians through the year 2005, actual experience has shown a growing shortage of trained individuals entering the field. In both the United States and Canada, the available data suggest a continuing shortage of laboratory animal veterinarians over the next 10 years. Membership statistics tabulated annually by the American College of Laboratory Animal Medicine (ACLAM) indicate that there are 688 actively employed college diplomates, the majority of whom are working in the United States. Of these, approximately 45% have recently indicated that they intend to retire within the next 10 years (ACLAM, unpublished data, 2008). In Canada, there are approximately 220 veterinarians working within laboratory animal medicine, with approximately 40% eligible for retirement within the next 10 years (Canadian Council on Animal Care and the Canadian Association of Laboratory Animal Medicine [CALAM], unpublished data, 2007). These figures suggest an urgent need to attract more veterinary professionals into this field, a key method for retaining veterinary students.

This critical shortage has been recognized by the National Academies in the United States and by the American Association of Veterinary Medical Colleges (AAVMC), with both organizations resolving to increase awareness and training opportunities for veterinarians in this field. The importance of specialists in laboratory animal medicine to the advancement of biomedical research in North America should not be underestimated. In 2007, both the American Medical Association and the American Veterinary Medical Association (AVMA) resolved to enhance collaboration between human and veterinary scientists to fully realize the potential of comparative medicine to benefit human and animal health.

Veterinarians and veterinary students need to be aware of opportunities to select laboratory animal medicine as a potential career path. In North America, organizations such as ACLAM, the American Society of Laboratory Animal Practitioners (ASLAP), the Association of Primate Veterinarians (APV), and CALAM provide education and information about laboratory animal medicine to veterinary students and veterinarians to promote the field. Internationally, the International Association of Colleges of Laboratory Animal Medicine has recently been formed and is also committed to this endeavor. Outreach to veterinary students is a fundamental mission of both ASLAP and CALAM. As a major initiative of the 2005 strategic plan, active outreach programs continue to be a focus of effort for ACLAM. Although these efforts may have been helpful, the shortage has not been resolved.

Mechanisms of financial support for specialized training in laboratory animal medicine have diminished with changes over the past decade in US federal funding opportunities, including redirection of funds by the National Center for Research Resources for research training in lieu of focused clinical training for veterinary biomedical support roles. Guaranteed federal stipend support has never existed for laboratory animal veterinary trainees in Canada. Consequently, the number of training positions being offered and filled annually has not increased in proportion to the need for laboratory animal specialists (see Figure 1).

The shortage of veterinarians in laboratory animal medicine and other biomedical research fields in the United States has been explored in detail in a study sponsored by the National Research Council of the National Academies, which was summarized in their 2004 publication National Need and Priorities for Veterinarians in Biomedical Research. This report recommends that veterinary students become acquainted within veterinary schools with the full range of practice areas, including laboratory animal medicine, and recommended changes in veterinary curricula to this end.
Veterinarians providing care to laboratory animals include individuals both with and without formal specialized training (i.e., residency, diploma, and degree programs). Board certification by ACLAM, a recognized specialty board within the AVMA, documents knowledge of the diseases, care, and use of a wide variety of laboratory animal species. Credentials required for ACLAM board examination eligibility can be gained without formal training for individuals with at least six years of relevant experience, or following completion of an ACLAM-recognized training program. Regardless of the route veterinarians take to enter the field of laboratory animal medicine, they must be aware of its existence within veterinary medicine to be able to consider it as a tenable career pathway.

Because more extensive and effective measures are needed to increase the number of veterinarians entering laboratory animal medicine, a working group composed of the current authors was appointed by ACLAM at the request of the AAVMC to evaluate the current curriculum content in laboratory animal medicine in North American veterinary schools, and to make curricular recommendations based on these findings. The working group surveyed the 32 veterinary colleges in the United States and Canada for laboratory animal medicine curriculum content, representing the first such effort since Leathers and Bustad recommended curricular exposure of veterinary students to laboratory animal medicine in 1978. Using the results and comments arising from this survey, a formal planning process was undertaken to develop a recommended curriculum for laboratory animal medicine.

GENERAL CURRICULUM DESIGN CONSIDERATIONS AND PLANNING
A curriculum guide is a structured document that articulates a clear philosophy, objectives, and learning experiences that make up the specific educational program.

Figure 1: Monthly average of new positions advertised in laboratory animal medicine in the United States and Canada. 2001–2007. Data were primarily collected from advertisements in the ACLAM and CALAM newsletters.

Guides should allow for flexibility and encourage experimentation and innovations, promote interdisciplinary approaches when appropriate, suggest methods of assessing achievement of program objectives, and provide a means for ongoing review and improvement. Rarely is a curriculum guide free from criticism; however, acceptance is easier when the curriculum has been developed to be straightforward, with examples and suggested resources, and is linked to faculty evaluation goals and professional development.

In preparing this guide, the working group followed the basic components inherent in an effective curriculum development process. These included the following:

- planning, including addressing key issues and trends in specific laboratory animal medicine content that need to be delivered to students.
- articulating and developing a laboratory animal medicine educational philosophy for veterinary student education, defining goals for the four-year program, developing specific objectives for these goals, identifying resource materials to assist with program implementation, and developing and identifying potential assessment items and instruments to measure student progress.

The final two steps of curriculum development, which consist of implementation and evaluation, have yet to be completed.

As part of the initial planning process, the working group first considered a number of key issues and trends related to laboratory animal medicine that needed to be explored for the development of a curriculum guide. These included the following:

- estimating the demographics of current laboratory animal science specialists within Canada and the United States to ascertain the need for professionals in this field.
- enumerating the numbers and types of post-graduate training programs in laboratory animal medicine in North America and numbers of trainees to determine the current pipeline for this specialty.
- surveying North American veterinary schools to determine current coverage of laboratory animal medicine within the DVM/VMD curriculum and, where appropriate, reviewing syllabi from veterinary schools both inside and outside of North America.
- summarizing employment trends in the United States and Canada over the past five years to try to project current and future needs for laboratory animal veterinarians and the adequacy of the current post-graduate training pipeline.
- identifying currently available instructional materials for laboratory animal medicine-related education (e.g., Web sites, electronic presentations, and other media forms) and the types of resources required to use them in veterinary schools.
- defining the current expectations of ACLAM and veterinary schools in terms of knowledge expected in the field for new veterinary graduates, as well as informally tabulating perceived knowledge and
The information gathered from this planning exercise is incorporated within the statements and recommendations that follow.

CURRICULUM GUIDE FOR LABORATORY ANIMAL MEDICINE

Philosophy Statement

Laboratory animal medicine supports the use of experimental animals and the associated research that is essential for progress in biomedical science and health care for humans and animals. Laboratory animal veterinarians play an essential role on behalf of society to ensure that experimental protocols maximize animal well-being and minimize pain and distress. On behalf of the research community, laboratory animal veterinarians help ensure that healthy animals are used to produce consistent and reliable research results. They also assist the research team in developing relevant models for study, and they seek refinements in animal use such that appropriate humane and scientific end points are utilized. Laboratory animal veterinarians also play a critical role in addressing and safeguarding public concern regarding animal welfare, ensuring compliance with diverse regulatory agencies, and providing the necessary clinical, research, and managerial support for the rapidly expanding use of genetically engineered animals. While alternatives are vigorously being sought to replace the use of animals in research, experimental animals will remain a critical tool in the foreseeable future for bridging molecular research through translational studies, thereby leading to improvements in health care for humans and animals. Laboratory animal veterinary specialists also contribute to the body of scholarly knowledge surrounding many facets of veterinary and human medicine by conducting independent or collaborative research in a wide variety of areas.

ACLAM recognizes that laboratory animal medicine is a post-graduate specialty. The College strongly supports broad, science-based training of veterinary students in core areas of science, medicine, surgery, pathology, and epidemiology, as this provides the solid foundation of knowledge required by all veterinarians, regardless of their area of practice. The College also believes that it is critical for all veterinary students to have exposure to the field of laboratory animal medicine within their curriculum.\(^18\)

The goals of this exposure are to introduce veterinary students to the vitally important and challenging nontraditional area of laboratory animal practice, provide information regarding pathways for pursuing specialization in laboratory animal medicine, reinforce the critical role of biomedical research for furthering advances in animal and human health, instill an awareness of the significant ethical and regulatory oversights for research involving animal subjects, and inform students about the key role of the laboratory animal veterinarian for overseeing the health and welfare of animals used in research.

Statement of Purpose

This guide for veterinary curricula has been designed to serve as a framework for presenting instructional information relevant to laboratory animal medicine to veterinary students. In writing this document, the working group has researched and considered a wide range of sources and materials, as detailed.

A draft version of the guide was sent to all ACLAM members for comment in September, 2006. Comments were incorporated in November, 2006. The final document represents a consensus plan of College members. The ACLAM Board of Directors reviewed and approved the final document in April, 2007, and the AAVMC Board of Directors approved the guide in July, 2007. A final copy was sent to the education committees of the AVMA and Canadian Veterinary Medical Association in 2007, as well as to the deans of all North American veterinary schools. Recent summaries of current North American post-graduate training opportunities in laboratory animal medicine have been reviewed elsewhere.\(^19,20\)

Recommendations have been divided into required and elective elements, in recognition of the diversity of veterinary programs, including early specialization and streaming/tracking, and the difficulty of adding more material into an ostensibly full curriculum. Where appropriate, suggestions are offered for presenting this material to students, including means of assessments. The subject topics and recommendations contained within this report will complement the material currently being taught to veterinary students and enhance post-graduate professional flexibility. The overall curriculum recommendations are summarized in Table 1, and expected core competencies in this area are summarized in Table 2. Potential teaching resources are listed in Table 3.

RECOMMENDATIONS AND OBJECTIVES

Required Curriculum Elements

Objectives Related to Laboratory Animal Medicine as an Area of Veterinary Medical Practice

- Veterinary medical graduates will be able to:
  - describe the full range of career opportunities in this field
  - be knowledgeable about post-graduate opportunities for pursuing a career in laboratory animal medicine

Exposure of veterinary students to this topic should occur within the first year of the veterinary program, preferably within the first semester, as it is consistently mentioned by educators, residents, and graduate students as being the most successful tool for engaging student interest and
awareness of this field. Exposure to the full range of practice options must occur early in the veterinary program, before students are required to declare or select areas of specialization. To engender interest and excitement about this field, the seminar should be given by an experienced laboratory animal specialist and resources should be made available by veterinary colleges to bring in a laboratory animal veterinarian for this purpose if one is not available locally.

A number of veterinary schools in the United States and Canada have already incorporated this element into freshman “career day” seminars or first-year health management courses. A minimum of one hour is recommended to cover this material adequately and to provide time for a question and answer session. This may be combined with some preliminary regulatory information to instill an awareness of the ethical oversight for animals used in teaching, research, and testing. A list of relevant local and Web resources could be given to veterinary students as part of this instruction or used to develop this teaching material (see Table 3). Specific examples of career options within the

<p>| Table 1: Summary and suggested timeframe for laboratory animal medicine curriculum guidelines |</p>
<table>
<thead>
<tr>
<th>Guideline (Minimum Duration)</th>
<th>Year of Program</th>
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<tbody>
<tr>
<td>Mandatory</td>
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<tr>
<td>Introduction to careers in laboratory animal medicine (1 hour)</td>
<td>First year</td>
</tr>
<tr>
<td>Introduction to comparative medicine (rodents, rabbits, ferrets, nonhuman primates) (≥4 hours)</td>
<td>Any</td>
</tr>
<tr>
<td>Introduction to local, state/provincial, and national regulations and legislation regarding research animal care and use (1 hour)</td>
<td>Any</td>
</tr>
<tr>
<td>Recommended</td>
<td></td>
</tr>
<tr>
<td>Research experience (4 weeks)</td>
<td>First/second year</td>
</tr>
<tr>
<td>Applied elective/externship in laboratory animal medicine (1 week)</td>
<td>Final year</td>
</tr>
<tr>
<td>Laboratory animal health management (open)</td>
<td>First/second/third year</td>
</tr>
<tr>
<td>Instructional cases involving laboratory animals integrated into other courses in DVM/VMD curriculum (n/a)</td>
<td>All</td>
</tr>
</tbody>
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<p>| Table 2: Summary of expected core competencies of North American veterinary graduates in laboratory-animal medicine |</p>
<table>
<thead>
<tr>
<th>Veterinary Medical Graduates Will Be Able To</th>
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<tbody>
<tr>
<td>Describe career opportunities in this field</td>
</tr>
<tr>
<td>Be knowledgeable about post-graduate opportunities for pursuing a career in laboratory animal medicine</td>
</tr>
<tr>
<td>Know how to handle and restrain animals safely and humanely, provide common methods of treatments, and obtain diagnostic specimens</td>
</tr>
<tr>
<td>Diagnose, clinically and at necropsy, major diseases of these species: ferrets, rabbits, rodents, and non-human primates*</td>
</tr>
<tr>
<td>Offer appropriate advice on management, treatment, and prevention of major diseases and zoonotic risks related to these species</td>
</tr>
<tr>
<td>Be able to locate specialists in the field, if consultation is needed</td>
</tr>
<tr>
<td>Describe applicable state/provincial and national regulatory oversight for research animal use</td>
</tr>
<tr>
<td>Describe local institutional oversight for animal use in teaching, research, and testing (i.e., institutional policies and animal-care committee function)</td>
</tr>
<tr>
<td>Define the role of the laboratory animal veterinarian in overseeing the care and welfare of research animals</td>
</tr>
</tbody>
</table>

*Minimum clinical knowledge of these species required for NAVLE includes:
- Rabbits: abscesses, *Cuterebra*, encephalitis, fractured lumbar spine, gastric trichobezoars, heat stroke, malocclusion, otoacariasis, pasteurellosis, pneumonia, sterilization, tularemia.
- Ferrets: adrenal tumors, canine distemper virus, estrogen toxicity, foreign body, heat stroke, insulinoma, pneumonia, splenomegaly, sterilization, urethralitis.
- Hamsters: malocclusion, proliferative ileitis, salmonellosis, trauma.
- Rats and mice: abscesses, pneumococcal and mycoplasma-associated pneumonia, tumors, wounds.
- Guinea pigs: antibiotic toxicity, bacterial enteritis, dystocia, heat stress, nutrition, pregnancy toxemia.
- Non-human primates: infection with hepatitis virus, herpes virus B (CHV-1), simian AIDS, tuberculosis.
Table 3: Summary of selected resources for laboratory animal medicine instruction within the veterinary curriculum

<table>
<thead>
<tr>
<th>Resource</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Role of the Laboratory Animal Veterinarian</strong></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.calam-acmal.org/Content/StandardsVetCare.pdf">http://www.calam-acmal.org/Content/StandardsVetCare.pdf</a></td>
<td>CALAM/ACMAL Standards of Veterinary Care—provides in-depth information regarding the responsibilities of a laboratory animal veterinarian</td>
</tr>
<tr>
<td>Guidelines for the veterinary care of laboratory animals: report of the FELASA/ECCLAM/ESLAV Joint Working Group on Veterinary Care. Lab Anim 42:1–11, 2008</td>
<td>Guidelines for the veterinary care of laboratory animals</td>
</tr>
<tr>
<td><a href="http://www.aslap.org/career.php">http://www.aslap.org/career.php</a></td>
<td>Web site summarizing details for all North American laboratory animal medicine post-graduate training programs, plus elective and externship opportunities for students</td>
</tr>
<tr>
<td><strong>Comparative Medicine/Laboratory Animal Medicine</strong></td>
<td></td>
</tr>
<tr>
<td><a href="http://owc.tufts.edu/courses/5/LectureNotes">http://owc.tufts.edu/courses/5/LectureNotes</a></td>
<td>Open courseware notes that provide an excellent resource for developing appropriate-level material for major comparative medicine species, including avian and reptile species. Students could be sent to this Web site with a list of questions to research</td>
</tr>
<tr>
<td><a href="http://www.radil.missouri.edu/info/dora/Dora.htm">http://www.radil.missouri.edu/info/dora/Dora.htm</a></td>
<td>Diseases of laboratory animals with photos</td>
</tr>
<tr>
<td><a href="http://www.geocities.com/virtualbiology/necropsy.html">http://www.geocities.com/virtualbiology/necropsy.html</a></td>
<td>A virtual mouse necropsy</td>
</tr>
<tr>
<td><a href="http://www.digires.co.uk">http://www.digires.co.uk</a></td>
<td>CDs for purchase related to laboratory animal anesthesia and analgesia, pain evaluation, and images of laboratory animals</td>
</tr>
<tr>
<td><a href="http://www.ubn.no/vivariat/mou_blood/Blood_coll_mice_.html">http://www.ubn.no/vivariat/mou_blood/Blood_coll_mice_.html</a></td>
<td>A saphenous vein blood collection tutorial</td>
</tr>
<tr>
<td><a href="http://film.oslovet.veths.no">http://film.oslovet.veths.no</a></td>
<td>Techniques demonstrated, from the Norwegian Reference Centre for Laboratory Animal Science &amp; Alternatives</td>
</tr>
<tr>
<td><a href="http://www.medipoint.com/html/animal_lancets.html">http://www.medipoint.com/html/animal_lancets.html</a></td>
<td>Facial vein bleeding in mice</td>
</tr>
<tr>
<td><a href="http://netvet.wustl.edu/pain.htm">http://netvet.wustl.edu/pain.htm</a></td>
<td>Links to resources relevant to pain</td>
</tr>
<tr>
<td><a href="http://homepages.mac.com/exoticdvm/mammal/Menu76.html">http://homepages.mac.com/exoticdvm/mammal/Menu76.html</a></td>
<td>Mammalian cases corresponding to Exotic DVM forum discussions, plus good-quality photographs of case presentations</td>
</tr>
<tr>
<td><a href="https://www.aalaslearninglibrary.org">https://www.aalaslearninglibrary.org</a></td>
<td>AALAS Learning Library, with free courses on topics such as biomethodology for mice, working safely with non-human primates, anesthesia, and analgesia</td>
</tr>
<tr>
<td><strong>Training in Basic Biomethodology for Laboratory Mice</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Ethics of Animal Use in Research, Teaching and Testing</strong></td>
<td></td>
</tr>
<tr>
<td><a href="http://www.ahwla.org.uk">http://www.ahwla.org.uk</a></td>
<td>Tutorial for assessing the health and welfare of laboratory animals</td>
</tr>
</tbody>
</table>

Continued
specialty as well as training options should be discussed to provide students with an idea of what a career in laboratory animal medicine entails.

One suggested activity or method for formative evaluation might include, before or following didactic delivery, giving students an online multiple-choice quiz related to this material and the Web sites. Suggested reading material for students to review includes the ACLAM Role Delineation Document and the CALAM Standards of Veterinary Care document (see Table 3), both of which concisely define the responsibilities of the laboratory animal veterinarian.

In addition, with respect to the practice of medicine for rodents, lagomorphs, ferrets, and non-human primates, veterinary graduates will know in theory, if not in practice, how to:

- handle and restrain animals safely and humanely,
- provide common methods of treatments, and obtain diagnostic specimens

Table 3: Continued

<table>
<thead>
<tr>
<th>Resource</th>
<th>Description</th>
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<tbody>
<tr>
<td><a href="http://caat.jhsph.edu/programs/course/login.cfm">http://caat.jhsph.edu/programs/course/login.cfm</a></td>
<td>Free online course discussing ethics of research on animals from the Johns Hopkins Center for Alternatives to Animal Testing</td>
</tr>
<tr>
<td><a href="http://ae.imcode.com">http://ae.imcode.com</a></td>
<td>Interactive tutorial discussing various animal ethics dilemmas</td>
</tr>
</tbody>
</table>

Regulatory Oversight and Institutional Guidelines

<table>
<thead>
<tr>
<th>Resource</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://www.nap.edu/catalog.php?record_id=5140#toc">http://www.nap.edu/catalog.php?record_id=5140#toc</a></td>
<td>ILAR Guide for the Care and Use of Laboratory Animals</td>
</tr>
<tr>
<td><a href="http://grants.nih.gov/grants/olaw/references/phspol.htm">http://grants.nih.gov/grants/olaw/references/phspol.htm</a></td>
<td>US Public Health Service Policy on Humane Care and Use of Laboratory Animals</td>
</tr>
<tr>
<td><a href="http://www.iacuc.org">http://www.iacuc.org</a></td>
<td>Information related to animal care committee function</td>
</tr>
<tr>
<td><a href="http://www.canlii.org">http://www.canlii.org</a></td>
<td>Search for Ontario’s Animals for Research Act</td>
</tr>
<tr>
<td><a href="http://www.ccac.ca">http://www.ccac.ca</a></td>
<td>Canadian Council on Animal Care—all Canadian guidelines pertaining to research animal care and use</td>
</tr>
</tbody>
</table>


Selected Organizations Devoted to Laboratory Animal Science

<table>
<thead>
<tr>
<th>Resource</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://www.aalas.org">http://www.aalas.org</a></td>
<td>American Association for Laboratory Animal Science (AALAS)</td>
</tr>
<tr>
<td><a href="http://www.primatevets.org">http://www.primatevets.org</a></td>
<td>Association of Primate Veterinarians (APV)</td>
</tr>
<tr>
<td><a href="http://www.aslap.org">http://www.aslap.org</a></td>
<td>American Society of Laboratory Animal Practitioners (ASLAP)</td>
</tr>
<tr>
<td><a href="http://www.aclam.org">http://www.aclam.org</a></td>
<td>American College of Laboratory Animal Medicine (ACLAM)</td>
</tr>
<tr>
<td><a href="http://www.aclad.org">http://www.aclad.org</a></td>
<td>American Committee on Laboratory Animal Diseases (ACLAD)</td>
</tr>
<tr>
<td><a href="http://www.aaalac.org">http://www.aaalac.org</a></td>
<td>Association for Assessment and Accreditation of Laboratory Animal Care International (AAALAC, Int'l)</td>
</tr>
<tr>
<td><a href="http://www.adelaide.edu.au/ANZCCART">http://www.adelaide.edu.au/ANZCCART</a></td>
<td>Australian &amp; New Zealand Council for the Care of Animals in Research and Teaching (ANZCCART)</td>
</tr>
<tr>
<td><a href="http://www.calas-acsal.org">http://www.calas-acsal.org</a></td>
<td>Canadian Association for Laboratory Animal Science (CALAS)</td>
</tr>
<tr>
<td><a href="http://www.calam-acmal.org/">http://www.calam-acmal.org/</a></td>
<td>Canadian Association for Laboratory Animal Medicine (CALAM)</td>
</tr>
<tr>
<td><a href="http://ecvam.jrc.it/index.htm">http://ecvam.jrc.it/index.htm</a></td>
<td>European Centre for the Validation of Alternative Methods (ECVAM)</td>
</tr>
<tr>
<td><a href="http://www.eslav.org">http://www.eslav.org</a></td>
<td>European Society of Laboratory Animal Veterinarians (ESLAV)</td>
</tr>
<tr>
<td><a href="http://www.felasa.eu">http://www.felasa.eu</a></td>
<td>Federation of European Laboratory Animal Science Associations (FELASA)</td>
</tr>
<tr>
<td><a href="http://dels.nas.edu/ilar">http://dels.nas.edu/ilar</a></td>
<td>Institute for Laboratory Animal Research (ILAR)</td>
</tr>
<tr>
<td><a href="http://www.iaclem.org">http://www.iaclem.org</a></td>
<td>International Association of Colleges of Laboratory Animal Medicine (IACLAM)</td>
</tr>
<tr>
<td><a href="http://www.iclas.org">http://www.iclas.org</a></td>
<td>International Council for Laboratory Animal Science (ICLAS)</td>
</tr>
<tr>
<td><a href="http://www.scaw.com">http://www.scaw.com</a></td>
<td>Scientists Center for Animal Welfare (SCAW)</td>
</tr>
</tbody>
</table>

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• diagnose, clinically and at necropsy, major diseases of these species
• offer appropriate advice on husbandry, behavior, management, treatment, and prevention of major diseases and zoonotic risks related to these species
• be able to locate specialists in the field, if consultation is needed

It is recommended that comparative medicine instruction covering these specific elements be mandatory for all veterinary students. This information is currently required for successful completion of the NAVLE, and it provides an introduction to nontraditional veterinary species, including aspects related to public health and zoonoses. The above-listed species form the core of animal populations present in most biomedical research facilities and are also being seen with increased frequency in traditional veterinary practice. Practitioners must be aware and be able to advise clients and other veterinary care workers of potential zoonotic diseases and health risks associated with these species.

The majority (87%) of veterinary schools in the United States and Canada offer some form of comparative medicine coursework (see Table 4); however, in many colleges this is elective material. Several schools incorporate medicine and diseases of laboratory animals into the small-mammal portion of the comparative medicine course or offer these as separate, standalone electives. Many educators interviewed reported a lack of resources for teaching this material and insufficient time to develop new or more complete material covering these objectives. Few schools (10%) offer hands-on opportunities within formal didactic courses to practice applied skills, such as anesthesia, with these species. This is a common complaint from recent veterinary graduates, as well as new laboratory animal medicine residents and graduate students. Because comparative medicine knowledge is required for successful completion of the NAVLE, it is recommended that a summative evaluation be administered for this didactic material by the end of year 3 of the DVM/VMD program.

Objectives Related to Regulatory Oversight of Animal Use in Teaching, Research, and Testing – Veterinary medical graduates will be able to:
• describe applicable state/provincial and national regulatory oversight for research animal use
• describe institutional oversight for animal use in teaching, research, and testing (i.e., institutional policies and animal-care committee function)
• define the role of the laboratory animal veterinarian in overseeing the care and welfare of research animals

This instruction may occur at any time within the veterinary curriculum and should be mandatory for all veterinary students. This information may be administered in modular format, via Web-based self-study material, case discussions, and scenarios that require application of regulatory knowledge; more formal, didactic seminars; or a combination of any of these. 23 A minimum of one hour should be assigned to this topic within the curriculum, to be followed by a formative or summative evaluation or activity. In addition to providing more complete curriculum coverage of veterinary-specific regulations and legislation, coverage of this subject matter will sensitize veterinary students to the rigors of animal-use oversight and public interest in research animal welfare. It is important that all veterinary practitioners practicing in community settings be aware of this information as they will be questioned by clients regarding advances in animal and human medicine made through research, as well as the humane care and use of animals in biomedical research.

Whereas the majority of medical schools in Canada and the United States provide some form of regulatory instruction specific to the use of animals in research, teaching, and testing, only five of 31 colleges responding (see Table 4) provide this as a mandatory component of the curriculum for all veterinary students. It is not uncommon for veterinary graduates to be unaware of regulations and controls governing research animal care and use. Animal welfare as a general topic also receives little direct coverage within most veterinary curricula. 24 The US Department of Agriculture has recently supported the development of an electronic educational tool for veterinary animal welfare training that should help to address this educational gap in the United States. 25 Consideration should be given to incorporating this into the curriculum and developing similar training materials for Canadian veterinary students.

Recommended Curriculum Elements

Strive to Provide a Research Experience to all Veterinary Students

Prior to Graduation – Research-based learning engages students in a different, discovery-oriented form of active learning and problem solving, and assists students in developing critical thinking and communication skills. The benefits of this experience are not specific to laboratory animal medicine and are expected to positively impact all veterinary disciplines. This is not a new recommendation as it was advocated originally in the Pew Report in 1989, but it is inconsistently applied. 26 Specific to laboratory animal medicine and the science of comparative medicine, encouraging veterinary student participation in research sensitizes students to the use of animals for this purpose. This includes issues such as the practical application of institutional and other regulatory requirements related to animal use, encouraging creativity in considering refinements and alternatives to animal use, providing insight into research-based post-graduate careers, describing the benefits that may accrue to animals and humans from this work, and, ideally, projecting a view of the laboratory animal veterinarian as an essential member of the research team.

A number of veterinary colleges have instituted formal “summer leadership” programs to encourage veterinary students to explore applied and basic science research projects, particularly following their first and second year of education. Some summer programs additionally offer weekly seminars that explore nontraditional practice areas such as laboratory animal medicine and biomedical research. Two veterinary colleges also report offering a research elective for credit to veterinary students during the regular academic year. Although many veterinary colleges offer summer research positions for students, these may not be geared specifically to veterinary students and cannot be expected to introduce veterinary students to the breadth of opportunities in the field of laboratory animal medicine.
Resources to support student employment are available at numerous campuses through an array of programs such as the Merck-Merial Summer Research Scholarship program (http://www.merckmerialscholars.com); the ACLAM, ASLAP, and APV externship programs (http://aslap.org/preceptorships.php); and T35 research scholarships offered specifically to veterinary students by the National Institutes of Health (http://grants.nih.gov/grants/guide/pa-files/PA-08-227.html); US Department of Agriculture (http://www.usda.gov/wps/portal/!ut/p/_s.7_0_A/7_0_1OB?navid=INTERN_SCHOLAR); and Canadian Food Inspection Agency (http://www.inspection.gc.ca/english/hrrh/grapro/vetinitiae.shtml). Veterinary students should be kept informed of and encouraged to take advantage of these opportunities by frequent e-mail and in-class announcements and hard-copy postings of potential opportunities.

Table 4: Summary of responses of veterinary colleges to a 2006 survey* on laboratory animal medicine content within the current curriculum. In total, 31 out of 32 North American veterinary schools responded (97%)

<table>
<thead>
<tr>
<th>Question 1: Is a Laboratory Animal Medicine Course Offered as Part of the Current Curriculum for DVM/VMD Students? If Yes, is the Course Part of the Core Curriculum or an Elective?</th>
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<tbody>
<tr>
<td>No: 11/31 (35%)</td>
</tr>
<tr>
<td>Yes: 20/31 (65%)</td>
</tr>
<tr>
<td>1 elective offered: 10</td>
</tr>
<tr>
<td>&gt;1 elective offered: 4</td>
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<tr>
<td>1 course required: 5</td>
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<tr>
<td>&gt;1 course required: 2 (one of institution indicated that only students doing a combined DVM/MSc program in laboratory animal medicine were required to take &gt;1 course in laboratory animal medicine)</td>
</tr>
</tbody>
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<tr>
<th>Question 2: Are there Laboratory Animal Medicine-Related Lectures Presented within Other Courses of the DVM/VMD Curriculum (e.g., a Rabbit Lecture Within a Required Radiology Course)?</th>
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<tbody>
<tr>
<td>No: 4/31 (13%)</td>
</tr>
<tr>
<td>Yes: 27/31 (87%)</td>
</tr>
<tr>
<td>Teaching exposure includes: career survey course, animal handling, exotic animal medicine</td>
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<tr>
<th>Question 3: Are Laboratory Animal Medicine-Related Problems Used as Cases in Problem- or Case-Based Learning Tutorials (e.g., Work-Up of a Mouse Hepatitis Virus Outbreak in a Mouse Colony as Part of a Population Medicine Course)?</th>
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<tbody>
<tr>
<td>No: 22/31 (71%)</td>
</tr>
<tr>
<td>Yes: 9/31 (29%)</td>
</tr>
<tr>
<td>Course examples include: radiology, dermatology, anatomy, epidemiology</td>
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<tr>
<th>Question 4: Are there Laboratory Animal Medicine Rotations, Electives, or Independent Study Opportunities Offered Within the Veterinary College or University?</th>
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<tbody>
<tr>
<td>No: 7/31 (23%)</td>
</tr>
<tr>
<td>Yes: 24/31 (77%)</td>
</tr>
<tr>
<td>Two respondents indicated that there were no electives available on site; however, assistance was available to help students find placements elsewhere. Most indicated that electives were available for senior students only, while three indicated that more junior students also had elective opportunities in this field</td>
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<tr>
<th>Question 5: Are there any Other Formal Training Opportunities in Laboratory Animal Medicine within Your Institution’s Current DVM/VMD Curriculum (i.e., Not Post-Graduate Programs)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>No: 29/31 (94%)</td>
</tr>
<tr>
<td>Yes: 2/31 (6%)</td>
</tr>
<tr>
<td>Both institutions responding positively indicated that they offer a combined laboratory animal medicine MSc/DVM program.</td>
</tr>
</tbody>
</table>

*The survey was conducted by e-mail and telephone between March 1 and May 31, 2006. Of the respondents, answers were provided for all but one institution by laboratory animal veterinary faculty or clinicians actively engaged in teaching within the schools. In one case, the associate dean of student affairs provided the survey responses.
summer research employment competitions and opportunities.

Provide Internal or External Experiential Opportunities for Veterinary Students to Shadow and be Mentored by Laboratory Animal Veterinarians - All colleges are strongly encouraged to develop and offer practical electives or externships in laboratory animal medicine of at least one week in duration, particularly for veterinary students in their final clinical rotation year. Experienced laboratory animal practitioners should oversee these electives. If opportunities and/or expertise are not available in-house, colleges should provide recommendations to veterinary students for these experiences to be obtained externally, ideally within a reasonable commuting distance.

The objective of these applied experiences is to introduce veterinary students to the range of issues and species typically encountered by a laboratory animal veterinarian. In addition to participating in clinical rounds, this type of experience may include discussion of surgical or anesthetic issues related to animal modeling, ethical issues related to the various research projects such as the creation of genetically engineered mice, biosafety and occupational health and safety concerns for facility personnel, and health management problems in colony animals. One-on-one or small group learning opportunities allow veterinary students to discuss concepts and issues in-depth, gain a greater appreciation for the complexities of this practice area, and instill confidence when working clinically with these species.

Provide Core or Elective Internal Didactic Opportunities to Apply Basic Veterinary Medical Concepts to Laboratory Animal Medicine-Specific Problems or Health Management Issues - Colleges are encouraged to offer formal core or elective instruction on subject matter related to laboratory animal species as part of streaming/specialization programs. The purpose of this instruction is to encourage students to explore issues and concepts that lie outside of the boundaries of traditional practice and to "plant a seed" regarding nontraditional practice areas that students may return to, at or following graduation. This might include material on non-human primate medicine, pathology of non-domestic species, herd health management as applied to laboratory species, and emerging zoonoses of laboratory animals. These modules or electives should be offered to veterinary students within the first three years of their training and should be taught by laboratory animal medicine specialists.

Incorporate Instructional Examples Involving Laboratory Animal Species More Generally into the Veterinary Medicine Curriculum - The case-based use of laboratory animal species as examples within other courses will promote awareness among veterinary students of how alike these species are to more traditional veterinary species (i.e., promote the concept of comparative medicine) and is beneficial for re-affirming algorithms and approaches to diagnostic problem-solving in a new setting (e.g., "if this were a dog or cat, how would you approach your workup?"). Occasional use of these species in other disciplines permits generalization of basic principles to new problems and species, and assists with resource management and time constraints as other veterinary faculty may provide these instructional examples. Areas in which this type of modular instruction would be particularly well suited include problem- or case-based learning sessions, anatomy, anesthesia, dermatology, ophthalmology, radiology, and clinical and anatomic pathology. Material could be provided during in-class discussions or as Web-based material for self-study.

IMPLEMENTING CURRICULUM RECOMMENDATIONS

Throughout the process of developing and articulating these recommendations, two recurrent problem areas emerged from discussions with the veterinary faculty responsible for delivering this instruction: curriculum space and resources for developing instructional materials.

With the exponential information explosion in veterinary medicine and recent availability of electronic instructional aids to supplement formal in-class delivery of course content, it has become a real and constant challenge for veterinary educators to balance delivery of an appropriate amount of information to students to ensure clinical competency while avoiding information overload. In addition, there is an increasing trend amongst veterinary colleges in the United States and Canada to permit veterinary students to select an area of practice specialty early in their training, also known as streaming or tracking, which limits the amount of time available for core instruction. For that reason, recommendations for formatting instructional delivery of laboratory animal medicine-related material have been kept to the absolute essential elements. Faculty are encouraged to be creative with electronic information technology tools for developing efficient methods of teaching, as recently reviewed by Bernardo and Malinowski.23

Resources for developing much of the material outlined above are readily available for free or for a nominal fee. A representative sample of potentially suitable materials is listed in Table 3. Some are not geared specifically to veterinary students, but could be incorporated with a suitable preamble by the instructor. Several "Introduction to Laboratory Animal Medicine" PowerPoint presentations are freely available on the ACLAM Web site (http://aclam.org/pathways/index.html) and are easily modified to suit an institution or individual. ACLAM also provides some funds to support lunchtime seminars on laboratory animal medicine at veterinary schools through its Career Pathways Committee (http://www.aclam.org/pathways/index.html). To support future veterinary education in this field, professional interest groups such as ACLAM, ASLAP, and CALAM should consider developing and making available additional presentations on topics related to the described curriculum for classroom use, to assist veterinary colleges with limited resources.

CONCLUSIONS

These curriculum guidelines for laboratory animal medicine have been developed using extensive formal and collaborative reviews to assist veterinary schools with ensuring that all North American veterinary students receive a minimum level of exposure to this vital alternative career path. The plan has been developed to provide enough flexibility for incorporation of the recommendations into the wide variety of DVM/VMD programs that are currently
operating in North America. Although minimum recommendations have been put forth, opportunities for expanding the content are strongly encouraged, particularly through the use of electives throughout all phases of the curriculum. A follow-up implementation survey is planned in the future to determine the outcome of this planning exercise and development of veterinary curricula, and to gauge the impact of implemented curricula in laboratory animal medicine on the entry of veterinary students into this specialty post-graduation.

NOTES
a Laboratory animal medicine typically refers to the study of medicine of laboratory animal species, such as mice, rats, rabbits, and non-human primates.
b In its broadest sense, comparative medicine usually refers to the study of differences and similarities between veterinary and human medicine; however, within the context of the North American veterinary curriculum, comparative medicine generally refers to the study of medicine of “other species” (e.g., fish, reptiles, amphibians, small mammals, wildlife). Both terms, laboratory animal medicine and comparative medicine, are used throughout this paper, because laboratory animal medicine is typically covered under the umbrella of comparative medicine coursework in the veterinary curriculum.

REFERENCES
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