






A survey of US and Caribbean veterinary schools reveals strengths and opportunities in antimicrobial stewardship and infection prevention and control activities

Jennifer L. Granick, DVM, PhD, DACVIM^{1*} ; Claire L. Fellman, DVM, PhD, DACVIM, DACVCP² ;
Ian M. DeStefano, DVM, DACVECC² ; Dubraska Diaz-Campos, DVM, PhD³ ; Emily Janovyak, DVM³;
Amanda L. Beaudoin, DVM, PhD, DACVPM⁴; Emma R. Bollig, MPH¹ 

¹Department of Veterinary Clinical Sciences, College of Veterinary Medicine, University of Minnesota, Saint Paul, MN

²Department of Clinical Sciences, Cummings School of Veterinary Medicine, Tufts University, North Grafton, MA

³Department of Veterinary Clinical Sciences, College of Veterinary Medicine, The Ohio State University, Columbus, OH

⁴Department of Veterinary Population Medicine, College of Veterinary Medicine, University of Minnesota, Saint Paul, MN

*Corresponding author: Dr. Granick (grani003@umn.edu)

OBJECTIVE

To understand antimicrobial stewardship (AS) and infection prevention and control (IPC) activities in veterinary schools.

METHODS

An online survey was completed by representatives from American Association of Veterinary Medical Colleges-accredited veterinary schools in the US and Caribbean prior to attending the Inaugural Small Animal Antimicrobial Stewardship Workshop for US Veterinary Schools. Responses were examined to identify patterns among AS and IPC activities and adherence to the AVMA core principles.

RESULTS

Half (12 of 24) of the surveyed schools had an AS committee and most (79% [19 of 24]) had an IPC committee. Lack of dedicated staff time was a common barrier to AS (88% [21 of 24]) and IPC (75% [18 of 24]) reported by schools both with and without AS and IPC committees. Eleven of 24 schools (46%) reported performing at least 1 activity focused on each of the AVMA's 5 core principles of AS. Although 79% (19 of 24) of schools incorporate AS into preclinical curricula, training of clinical faculty (17% [4 of 24]), veterinary technicians and support staff (21% [5 of 24]), and house officers (42% [10 of 24]) is less common, despite these individuals engaging in teaching clinical-year veterinary students.

CONCLUSIONS

Veterinary schools varied in established AS education and AS and IPC practices, though financial and human resources were a common barrier.

CLINICAL RELEVANCE

A collaborative and cohesive approach to AS and IPC among schools to create sustainable frameworks for practice improvement will help combat the global threat of antimicrobial resistance. This is a critical action for settings where future veterinarians are trained.

Keywords: antimicrobial stewardship, infection prevention and control, One Health, antimicrobial resistance, veterinary schools

Antimicrobial stewardship (AS) is a comprehensive approach aimed at optimizing the use of antimicrobial drugs to improve patient outcomes while minimizing the emergence of antimicrobial resistance (AMR) and reducing adverse effects. According to the AVMA, AS involves veterinarians taking actions

to preserve the effectiveness and availability of antimicrobial drugs while ensuring animal, public, and environmental health.¹ Antimicrobial stewardship encompasses a set of core principles delineated by the AVMA, including commitment to AS, advocating for a system of care to prevent common diseases, judicious selection and use of antimicrobial drugs, evaluation of antimicrobial drug use practices, and education and expertise building.¹ Adherence to these principles by practitioners, veterinary schools, and clinical practices will support optimal antimicrobial use (AU), mitigate AMR, and improve overall patient care.

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Veterinary schools bear responsibility for teaching best practices of AU and reinforcing those practices throughout their curricula, especially during clinical training. Challenges exist in adding more to already full curricula. Additionally, veterinary faculty are already overburdened, with 62% (29 of 47) of faculty participants in 1 study meeting criteria for burn-out.^{2,3} Siloed efforts to introduce AS and infection prevention and control (IPC) into veterinary schools are inefficient, especially in schools that are poorly resourced in terms of faculty and teaching support. Networking among veterinary schools to develop AS curricula and clinical AS and IPC programs can drive efficiency. In an effort to increase cooperation among schools, an AS workshop was held at the University of Minnesota, in collaboration with Tufts University and The Ohio State University, in August 2023.⁴

Before the workshop, a survey was sent to all those registered to attend to gather information about current AS and IPC practices and what veterinary schools are offering for professional education in these areas. The survey goals were to evaluate strengths, areas for growth, and needs in AS and IPC clinical and educational programs and to identify opportunities for collaboration among schools.

Methods

Ethics statement and recruitment

All US and Caribbean veterinary schools (n = 38), including those with an onsite teaching hospital (30), distributive model (5), both onsite and distributive model (1), or 2+2 model⁵ (2), were invited to attend an in-person workshop focused on AS and IPC in veterinary schools. Recruitment occurred from March to May 2023 and was promoted through several avenues, including the veterinary school deans list, past participants in AU studies,⁶ personal networks of collaborators, and direct emails to hospital directors and individuals at schools working in disciplines related to AMR and AU (eg, microbiology, pharmacy, public health). The authors expanded upon a survey utilized for a veterinary teaching hospital AU study to include questions about the AVMA core principles of AS.⁶ Workshop participants were asked to complete the online survey (**Supplementary Material S1**), available from June 22 to July 14, 2024, about their institution's AS and IPC practices prior to the in-person meeting. The survey was reviewed by the University of Minnesota Institutional Review Board and categorized as not human research.

Data collection

The survey was completed by planned attendees of the workshop, with input from others at their institution with working knowledge of the veterinary teaching hospital (if present) and awareness of any AS and IPC initiatives and curricular teaching. If > 1 individual from an institution completed the survey, any discrepancies were resolved among the individuals and 1 response was recorded for each institution. Questions were grouped into 3 sections:

background information of the person(s) completing the survey and their respective school, AS and IPC program structure, and formalized activities aligning with the AVMA core principles. The survey included multiple-choice, multiple-answer, free-text, and Likert-type questions.

Survey responses were entered and managed in a secure online Research Electronic Data Capture database.⁷ Data from each school could only be viewed by the submitting institution and the University of Minnesota researchers. No identifiable client, pet, or prescriber data were collected. Analyses were performed with SAS (version 9.4; SAS Institute Inc). Data are summarized as frequencies (n) and percentages (%).

Results

Participants from 24 of 38 veterinary schools (63%), all with onsite teaching hospitals, registered to attend the workshop. All (24 of 24) completed the preworkshop survey. Individuals or teams who completed the survey included veterinarians (n = 11), microbiologists (7), pharmacists and pharmacologists (7), infection preventionists (6), administrators (3), epidemiologists (2), and 1 veterinary technician.

Antimicrobial stewardship committees

Half (12 of 24) of the veterinary schools reported having an AS committee. Among schools without an AS committee (50% [12 of 24]), most (75% [9 of 12]) expressed interest in establishing one, 2 had no interest, and 1 was unsure. All members of existing AS committees were volunteers for most (67% [8 of 12]), while memberships were assigned for 2 committees, and 2 AS committees had a combination of volunteers and assigned members. All committees included small animal veterinarians, and many included large animal veterinarians, pharmacists or pharmacologists, and veterinary microbiologists, while less than half included veterinary technicians and hospital leadership (**Table 1**). Frequency of AS committee meetings ranged from every 2 weeks to quarterly, although some responded that they have no set frequency of meetings but rather assemble on an as-needed basis.

The most common barrier to establishing or maintaining an AS committee, reported by schools both with (100% [12 of 12]) and without (75% [9 of 12]) an AS committee, was lack of staff time (88% [21 of 24]; **Table 2**). Lack of dedicated financial resources was also a challenge expressed by most respondents (71% [17 of 24]). For those without AS programs, lack of formal commitment or interest from hospital leadership and uncertainty of how to initiate an AS committee were recognized obstacles.

The majority of schools (63% [15 of 24]) had no dedicated faculty or staff effort allocation for AS or IPC programs. Two schools had dedicated faculty or staff time for both IPC and AS activities, and no schools had time dedicated solely to AS activities.

Infection prevention and control committees

A large number of schools (79% [19 of 24]) reported having IPC committees, and for 5 of 19 (26%) the IPC and AS committees were combined. For most (47% [9 of 19]), membership on IPC committees was voluntary, while for 4 committees membership was assigned and for 6 committees members were a combination of assigned and volunteer. Like

Table 1—Composition of antimicrobial stewardship (AS) and infection prevention and control (IPC) committees.

Role	No. (%) represented in AS committee n = 12	No. (%) represented in IPC committee n = 19
Small animal veterinarian	12 (100)	17 (89)
Large animal veterinarian	10 (83)	16 (84)
Pharmacist	10 (83)	9 (47)
Pharmacologist	3 (25)	2 (11)
Veterinary microbiologist	8 (67)	14 (74)
Microbiology technician	3 (25)	4 (33)
Infection preventionist	7 (58)	9 (47)
Veterinary technician	5 (42)	13 (68)
Veterinary assistant	2 (17)	4 (21)
Veterinary public health faculty/staff	5 (42)	10 (53)
Hospital director	4 (33)	13 (68)
Practice manager	1 (8)	5 (26)
Office administrator/receptionist	3 (25)	5 (26)
Veterinary students	2 (17)	3 (16)
Central supply personnel	1 (8)	1 (5)
Facilities staff	1 (8)	1 (5)
Nursing director	0 (0)	1 (5)
Safety and compliance officer	0 (0)	1 (5)
Caretaker supervisor	0 (0)	1 (5)
Large animal barn manager	0 (0)	1 (5)

Table 2—Major barriers to establishing or maintaining AS committees.

Response	No. (%) yes AS committee n = 12	No. (%) no AS committee n = 12	Total (%) n = 24
Lack of staff time dedicated to AS activities	12 (100)	9 (75)	21 (88)
Lack of dedicated resources (eg, money) to AS activities	8 (67)	9 (75)	17 (71)
Lack of formal commitment or interest from hospital leadership	3 (25)	8 (67)	11 (46)
Lack of training regarding AS practices and initiatives	4 (33)	5 (42)	9 (38)
Lack of awareness of the importance of an AS committee	4 (33)	4 (33)	8 (33)
Lack of formal commitment or interest from hospital staff	3 (25)	4 (33)	7 (29)
Uncertainty of how to initiate establishment of an AS committee	0 (0)	7 (58)	7 (29)
Other	0 (0)	1 (8)	1 (4)
None	0 (0)	0 (0)	0 (0)
Unsure	0 (0)	1 (8)	1 (4)

Table 3—Major barriers to establishing or maintaining IPC committees.

Response	No. (%) yes IPC committee n = 19	No. (%) no IPC committee n = 3	No. (%) unsure IPC committee n = 2	Total (%) n = 24
Lack of staff time dedicated to infection prevention activities	15 (79)	2 (67)	1 (50)	18 (75)
Lack of dedicated resources (eg, money) to infection prevention activities	10 (53)	0 (0)	0 (0)	10 (42)
Lack of faculty or staff with infection prevention expertise	6 (32)	0 (0)	1 (50)	7 (29)
Lack of formal commitment or interest from hospital leadership	4 (21)	1 (33)	1 (50)	6 (25)
Lack of formal commitment or interest from hospital staff	5 (26)	0 (0)	0 (0)	5 (21)
Lack of awareness of the importance of infection prevention	3 (16)	0 (0)	1 (50)	4 (17)
Uncertainty of how to run an infection control program	3 (16)	0 (0)	1 (50)	4 (17)
Other	0 (0)	1 (33)	0 (0)	1 (4)
None	1 (5)	0 (0)	0 (0)	1 (4)

AS committees, most IPC committees included small and large animal veterinarians and veterinary microbiologists, and many more IPC committees than AS committees included veterinary technicians and hospital directors (Table 1). Frequency of IPC committee meetings ranged from weekly to every few years, with 74% (14 of 19) convening at least quarterly. Of the 3 schools that did not have an IPC committee and the 2 that were unsure of having an IPC committee, 2 had an interest in establishing an IPC committee and 3 were unsure of an interest in establishing an IPC committee.

Similar barriers were identified for both AS and IPC committees. The most common barrier to establishing or maintaining an IPC committee was a lack of staff time dedicated to IPC activities (Table 3), which was true of 79% (15 of 19) of those with IPC committees. Only 7 schools had dedicated faculty or staff time solely for IPC activities. Although less of a barrier than with AS committees, the need for dedicated financial resources was cited as a challenge for some IPC committees (42% [10 of 24]), as was lack of interest from hospital leadership (25% [6 of 24]) and staff (21% [5 of 24]). Faculty or staff with infection prevention expertise was listed as an unmet need for 29% (7 of 24). Only 1 school cited that they experienced no barriers to IPC, and 1 reported having an IPC program for over 20 years.

Interprofessional engagement

Two-thirds (16 of 24) of schools indicated that they had opportunities for engagement with other health disciplines working on AMR, IPC, or AS. The most common cross-professional activity cited was collaborative research (38% [6 of 16]), followed by

collaboration with local or state health departments or federal agencies (eg, CDC; 31% [5 of 16]). Two schools engaged with human health AS committees, 2 had opportunities for continuing education with human health professionals, 2 engaged with One Health activities and programs, and 1 collaborated with a human health IPC committee.

The AVMA antimicrobial stewardship core principle activities

Eleven of the 24 veterinary schools (46%) reported performing at least 1 activity focused on each of the AVMA's 5 core principles of AS (**Supplementary Table S1**). Only 1 school reported no activities related to any of the core principles. A majority of schools (71% [17 of 24]) were found to be actively involved in at least 1 core principle 1 activity, which focuses on commitment to AS. The most common activities—forming an AS committee and identifying an AS champion—were reported by half of the schools (12 of 24), although only a minority (13% [3 of 24]) reported institutional support for these endeavors. Most schools (88% [21 of 24]) were engaged in at least 1 core principle 2 activity—advocating for a system of care to prevent common diseases—many of which perform multiple activities (83% [20 of 24]), including client education regarding the importance of preventative care and implementation of infection prevention and control plans. Core principle 3, focused on judicious use of antimicrobial drugs, was also an area of active involvement by schools (88% [21 of 24]). Activities supporting core principle 3 included providing available AU consultations with specialists (67% [16 of 24]), using clinical guidelines for responsible AU (58% [14 of 24]), and promoting alternative care to reduce the need for systemic antimicrobials when appropriate (58% [14 of 24]). Gaps included a lack of workflow interventions to curb unnecessary AU prescribing, with only 3 schools adopting such measures despite their recognized impact in human healthcare. Eighteen schools (75%) were engaged in at least 1 core principle 4 activity, evaluating antimicrobial drug use practices; engaging veterinary diagnostic laboratories to provide antibiograms and document AMR trends was the most common activity. Most schools (71% [17 of 24]) were involved in at least 1 core principle 5 activity regarding educating and building expertise, most commonly including providing information to clients about proper medication disposal and offering AS continuing education for hospital personnel.

Specific survey questions delved deeper into AS training activities and client education. Most schools incorporated AS concepts into the preclinical curriculum (79% [19 of 24]) via dedicated lectures (92% [22 of 24]) or entire courses (17% [4 of 24]). However, training of clinical faculty (17% [4 of 24]), veterinary technicians and support staff (21% [5 of 24]), and house officers (42% [10 of 24]) was less common, despite these individuals serving a critical role in teaching clinical-year veterinary students. Over half of schools (54% [13 of 24]) were not providing any form of client education on AS. Some schools did provide information to clients

about antimicrobial alternatives (33% [8 of 24]), fact sheets about antimicrobials and AMR (25% [6 of 24]), and disease prevention protocols for common conditions (25% [6 of 24]).

Discussion

The survey revealed successes and opportunities regarding AS and IPC among US and Caribbean veterinary schools. Of participating schools, half already had functioning AS programs and nearly 80% had IPC programs. However, there was variability in the number of activities in which each was actively engaged. Resources, both financial and human (eg, dedicated staff and faculty time), were the biggest obstacles for implementation and maintenance of AS and IPC programs in veterinary schools. This concern was expressed by schools both with established programs and without programs. Given these challenges, opportunities exist for cross-institutional collaboration that will provide a pathway for those without AS and IPC programs to start them and those with programs to advance them. In addition to a collaborative approach among veterinary schools, there is a need for institutions to identify means to allow dedicated staff time and provide greater financial support to AS and IPC programs.

While 46% (11 of 24) of schools reported performing at least 1 activity focused on each of the AVMA's 5 core principles of AS, there were activities schools expressed no intention of pursuing. A third of schools did not intend to identify an AS champion or publicize their AS commitment to staff, veterinarians, clients, or partners. Antimicrobial stewardship champions fill a critical role in AS programs by garnering support within an institution, identifying needed resources, and bringing awareness to AS program activities.⁸ Ideally, AS champions have some authority within a hospital or clinic.⁸ Top-down support of AS programs and implementation of AS activities contributes to clinician uptake of prescribing guidelines.⁹ Public announcement of intentions—in this case, to use antimicrobials more judiciously—is thought to create external motivation to actually achieve that behavior.^{10,11}

A quarter of schools reported no activities related to core principle 4, evaluate antimicrobial drug use practices, and a third of schools did not intend to review appropriateness of prescribing for priority conditions. Reluctance to discuss prescribing with individual clinicians or during AS committee meetings may be due to the value placed on prescriber autonomy and the pervasive belief that antimicrobials provide possible benefit and limited harm.¹² However, cultural change driven by AS committees with buy-in from clinicians can create a similar type of "cultural inertia," as in 1 study,¹² where adoption of evidence-based practice was enhanced by the need of prescribers to adhere to institutional norms, which subsequently affected the acceptability and feasibility of implementing change.

Failure or hesitance to review AU and appropriateness may also stem from the perceived time and

resources required to accomplish this objective.¹³ Veterinarians use a variety of medical record systems, including diverse electronic medical record platforms and paper record systems. Veterinary medical records systems lack standardized vocabularies for coding diagnoses, procedures, diagnostic tests, and prescriptions, and there are no widely available resources or programs to extract and report AU data from these heterogeneous systems. Nevertheless, the value of such efforts is documented in 1 study¹⁴ in which routine antimicrobial reporting combined with educational interventions reduced prescribing of highest-priority critically important antimicrobials. Another study¹⁵ evaluated the ability to use natural language processing to compare AU to guideline recommendations. As technology advances, these capabilities will hopefully become more available to veterinary practitioners. Until then, other methods, such as evaluating total pharmacy sales or antimicrobial purchasing records^{16,17} and using point-prevalence surveys,^{6,18} offer manageable approaches to these challenges. Point-prevalence surveys involve collecting data from a limited time frame (eg, 1 clinic day) and can facilitate both individual hospital comparisons over time and summary reports of regional antimicrobial prescribing by different hospital types.^{6,18,19} Increasing awareness of the different options for measuring and reporting AU, including those possible without extensive information technology infrastructure, is critical to engage more hospitals in efforts to benchmark, monitor, and report AU.

Education and building of expertise around AS is the focus of core principle 5. Approximately a third of schools actively educated pet owners about AMR and potential harms of AU, and just over a third provided education on AS to hospital personnel. There is a clear need for educational resources targeting different populations, including pet owners, students, house officers in advanced training programs (ie, interns, residents), faculty and staff veterinarians, and veterinary technicians and veterinary assistants. Several studies describe a lack of knowledge and confidence regarding AU topics among graduating veterinarians.^{20,21} Additionally, disconnection between lecture-based teaching in the preclinical years and clinical teaching is common.²⁰ Lack of faculty, house officer, and staff training in AS may undermine efforts in preclinical AS education.²² Reinforcement of AS concepts is often inconsistent in veterinary students' clinical experiences and therefore unlikely to be an ingrained part of their clinical practice once graduated. Antimicrobial prescribing by newly graduated veterinarians is influenced by senior colleagues and practice hierarchy.^{23,24} Thoughtful design of AS curricula, including meaningful repetition and reinforcement of pharmacology and AS concepts throughout preclinical and clinical education, is needed to instill sufficient confidence upon graduation to impact appropriate prescribing. Collaboration among veterinary schools can help decrease the workload required to provide educational resources and training for students, trainees, staff, and clinicians, as well as client resources.

There were several limitations of this study that should be considered. As all survey participants were from veterinary schools with an onsite teaching hospital, the study lacked representation from those with a 2+2 or distributive model. While participants were asked to consult those with expertise within their institution, it cannot be ensured that responses were not biased toward the opinion of the individual completing the survey. The AVMA core principles of AS are subject to interpretation by each institution. Survey responses regarding actions taken for each core principle might represent different implementation approaches. Additionally, there was no opportunity for free-text responses soliciting explanations for multiple-choice selections, which precluded understanding of why an institution may not be pursuing a particular activity.

The findings of this survey highlight both areas of strength and areas for improvement in veterinary education institutions' efforts toward AS. Clear barriers for AS and IPC best practices and AS education are the lack of human and financial resources. The varied experience and expertise among schools can be leveraged through collaboration to support common needs. The veterinary profession should advocate for including AS and IPC education in veterinary curricula, particularly during clinical years. This will ensure that future veterinarians are well-equipped with the necessary knowledge and skills to implement these crucial programs effectively. Despite having individuals interested in implementing AS and IPC programs at each school, significant progress will be difficult to achieve without the support of organizational leaders and sufficient financial resources, at minimum. Progress in human healthcare has been largely driven by federal requirements for AS and IPC programs in hospitals and inclusion of these topics in facility accreditation standards.^{25,26}

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ORCID

J. L. Granick  <https://orcid.org/0000-0001-8330-3848>
C. L. Fellman  <https://orcid.org/0000-0003-4799-3372>
I. M. DeStefano  <https://orcid.org/0000-0002-3634-9971>
D. Diaz-Campos  <https://orcid.org/0000-0001-6749-4218>
E. R. Bollig  <https://orcid.org/0000-0002-5997-3208>

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Supplementary Materials

Supplementary materials are posted online at the journal website: avmajournals.avma.org.