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Distribution and abundance of *Eimeria* species in commercial turkey flocks across Canada

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E d i t o r i a l  É d i t o r i a l

Veterinary telemedicine
Télémédecine vétérinaire

“T elemedicine can be broadly defined as the use of telecommunications technologies to provide medical information and services” (1). Modern telemedicine applications originate with the transfer of electrocardiograms in Europe at the beginning of the 20th century. Not long after, consultations by radio were used to assist patients on ships and in remote places. In North America, a wave of programs including transmission of radiographic images began in the 1950s. NASA’s need to have the capacity to remotely provide medical assistance to astronauts spurred developments in the USA. Later, telemedicine was seen as a partial answer to shortages of family doctors and specialists, especially in remote areas. Telemedicine is also seen as providing efficient and convenient access for busy working people.

As newer technology is developed, the cost of the technology goes down, but pressure on hospital infrastructure continues to increase, as does the prevalence of chronic medical conditions, thereby making telemedicine increasing more attractive for providers and patients. A system that started as a simple transfer of images has blossomed into a complex array of technologies that form electronic medical networks to provide remotely assisted surgery, diagnostic or therapeutic consultations, case management and education.

In Canada, a number of private companies provide access to telemedicine for humans. Typically, clients pay a consultation fee, or purchase a subscription. One company CEO noted that over half of the diagnoses that are made do not require in-person hands-on access and suggested that telemedicine is a partial answer to the problem of long wait times, as well as a time-saver for some patients (2). You pay for rapid and convenient access to a doctor who can provide advice, order prescriptions, and treat certain conditions (3). One advertisement promises instant connection to a doctor from your phone, tablet, or computer at any time. The patient opens the app, describes her/his symptoms and requests to see a doctor. You are connected to a doctor, with the telephone call between medical professional and patient.

Veterinary telemedicine
Télémédecine vétérinaire

« L a télémédecine se définit largement comme le recours aux technologies de télécommunication pour fournir des renseignements et des services médicaux» (1). Les applications de la télémédecine moderne trouvent leur origine dans le transfert des électrocardiogrammes en Europe au début du 20e siècle. Peu de temps après, des consultations par radio ont été utilisées pour porter assistance aux patients à bord des navires ou dans des endroits éloignés. En Amérique du Nord, une vague de programmes, dont la transmission d’images radiographiques, s’est amorcée dans les années 1950. D’autre part, les besoins de la NASA pour fournir une capacité d’assistance médicale à distance aux astronautes ont suscité des progrès aux États-Unis. Plus tard, la télémédecine a été perçue comme une réponse partielle aux pénuries de médecins de famille et de spécialistes, particulièrement en région éloignée. La télémédecine est aussi perçue comme un moyen efficace et pratique d’accéder aux soins pour les travailleurs à court de temps.

Le développement de la nouvelle technologie permet de réduire graduellement son coût tandis que la pression sur l’infrastructure hospitalière et la prévalence des affections médicales chroniques continuent d’augmenter et, en conséquence, la télémédecine devient de plus en plus attrayante pour les prestataires de soins et les patients. Un système qui a commencé comme un simple transfert d’images s’est épanoui en un éventail complexe de technologies qui forment des réseaux médicaux électroniques afin de fournir de la chirurgie assistée, un diagnostic ou des consultations thérapeutiques, une gestion des cas et de l’éducation à distance.

Au Canada, plusieurs compagnies privées fournissent l’accès à la télémédecine pour les humains. Habituellement, les clients paient des frais de consultation ou achètent un abonnement. Un PDG d’entreprise a signalé que plus de la moitié des diagnostics posés n’existent pas un accès en personne et a suggéré que la télémédecine représente une solution partielle au problème des
whom you consult by text, audio, or video. The doctor can make a diagnosis and, if necessary, provide prescriptions.

Veterinary telemedicine is following along the same path as human telemedicine but has challenges associated with the inability of patients to describe their ailment. Regulatory bodies such as the College of Veterinarians of Ontario (CVO) have been quick to lay out the framework within which veterinarians can engage in this form of veterinary practice. The CVO regulations support developments in telemedicine for animals, but insist on a veterinarian-client-patient relationship (VCPR). In many cases a physical examination is considered essential for a proper diagnosis and drugs cannot be prescribed based on telemedicine alone.

There are now several opportunities for clients to access telehealth services for their pets in Canada and the US. Ontario Veterinary TeleHealth Services started in 2016 and claims to be the first in this field in Canada. Led by Dr. Garth Graham in Guelph, Ontario, this company has established digital communication platforms that allow veterinarians to connect with pet owners to provide consultation on health issues. The business started as a simple one in which pet owners could call a 1-800 number and reach Dr. Graham who would listen to the owner’s description and offer advice (4).

Healthy Pets started more recently but garnered considerable publicity through an episode of the television show Dragon’s Den, on which Emma Harris, CEO of the company, received a $500 000 boost from Arlene Dickinson’s venture capital fund (5). Healthy Pets has a video platform and a network of veterinarians who are able to assess clinical signs and offer advice but are not permitted to diagnose or prescribe. Pet owners may opt for single 15-minute sessions or they may pay a monthly subscription. Veterinarians in the network pay $50/month and earn $20 per consultation. The value of the service is that it guides clients to the appropriate level of intervention and does so in a convenient and inexpensive manner.

Healthy Pets is similar to US companies, such as Whisker Docs, which offers a 24/7 pet helpline via phone, e-mail, or live chat. They charge $39.99 for a call-in or live chat and $4.99 for e-mail. Annual subscription is $129.99; monthly subscription is $16.99. An interesting expansion involves an arrangement with Embrace Pet Insurance, whereby pet owners with this company’s insurance have free access to Whisker Docs services.

Telemedicine for farm animals is somewhat different. Some rural farm animal practices are using smartphones and iPads in combination with Facetime and Skype to gather and share patient information in order to get a head start on decision-making and to provide assistance to inexperienced colleagues in activities such as surgery. Also, researchers are investigating systems to monitor farm animal health at a distance. Challenges include cost-effectiveness, robustness and accuracy of equipment, effectiveness in predicting health status, and information security.

There appears to be a bright future for telemedicine for animals. It expands access to veterinary health care, provides an inexpensive triage service, provides payment for veterinary consultation, and is particularly effective in situations such as follow-up after an office or hospital visit or for inspection of surgical sites or mobility.
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La télémédecine pour les animaux semble vouée à un brillant avenir, car elle permet d’élargir l’accès aux soins vétérinaires, fournit un service de triage économique, offre une rémunération pour la consultation vétérinaire et est particulièrement efficace dans des situations comme un suivi après une visite au cabinet ou à la clinique ou pour l’inspection des sites chirurgicaux ou la mobilité.

Carlton Gyles

Opinions expressed in this column are those of the Editor.
Ethical question of the month — February 2019

When a pet shows signs of severe distress outside of regular business hours, clients are directed to an emergency clinic. It is common practice in such cases for the emergency clinic to request a down-payment or guarantee of payment for the initial examination and treatment. Emergency care can be very costly and some owners request the emergency clinic do whatever necessary to save their pet without appreciating the costs involved and without the ability to pay. Animals in severe distress have been refused admission at emergency clinics if the clients are unable to provide proof that they can afford the emergency work. Is refusing to treat an animal in severe distress compatible with the Canadian Veterinary Oath to relieve animal suffering? How should practitioners balance their business and professional responsibilities?

Les réponses au cas présenté sont les bienvenues. Veuillez limiter votre réponse à environ 50 mots et nous la faire parvenir par la poste avec vos nom et adresse à l’adresse suivante : Ethical Choices, a/s du Dr Tim Blackwell, 6486, E. Garafraxa, T ownline, Belwood (Ontario) N0B 1J0; téléphone : (519) 846-3413; fax : (519) 846-8178; e-mail : tim.e.blackwell@gmail.com

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Ethical question of the month — November 2018

Your beef cattle clients know from experience that foot-rot responds well to antibiotic treatment. Recently, your clients have begun to treat their cattle with foot-rot using a dart gun. Producers find this approach time efficient compared with moving affected animals into a chute or treatment pen. You are aware of published research demonstrating that dart guns are not as effective as the standard syringe injection procedure when dose and injection site are compared (1,2). You prescribe and dispense medication with clear instructions regarding dose and injection technique while aware that your clients are using dart guns to treat their animals. New antibiotic prescription rules in Canada place a greater responsibility on you than previously to ensure appropriate antibiotic use in livestock. Should you continue to dispense antibiotics to your beef cattle clients, fully aware that these drugs will be used in an extra-label manner that you do not recommend?

References

Question de déontologie du mois — Novembre 2018

Vos clients éleveurs de bovins de boucherie savent d’expérience que la fièvre aphteuse répond bien au traitement antibactérien. Récemment, vos clients ont commencé à traiter leurs bovins atteints de piétin à l’aide d’un fusil à injection. Les éleveurs trouvent que cette approche est rapide et ils la préfèrent au déplacement des animaux affectés dans un couloir de contention ou un enclos de traitement. Vous êtes au courant que des études de recherche ont démontré que les fusils à injection ne sont pas aussi efficaces que les injections de seringue lorsque l’on compare la dose et le site d’injection (1, 2). Vous prescrivez et distribuez des médicaments en donnant des directives claires concernant la dose et la technique d’injection, tout en sachant que vos clients utilisent des fusils à injection pour traiter leurs animaux. Les nouvelles règles de prescription des antibiotiques au Canada vous imposent maintenant une responsabilité accrue afin d’assurer une utilisation appropriée des antibiotiques chez le bétail. Devriez-vous continuer à distribuer des antibiotiques à vos clients qui sont éleveurs de bovins de boucherie en sachant que ces médicaments seront utilisés d’une manière en dérogation des directives de l’étiquette que vous ne recommandez pas?

Renvois

An ethicist’s commentary on dart gun used to deliver antibiotics for foot-rot

Foot-rot is an extremely painful bacterial infection in cattle which, aside from resulting in extremely severe pain, can also cause loss of appetite, decreased weight gain, decreased milk production, great restriction on mobility, and refusal of bulls to mount. In fact, so painful and devastating is this disease that the drug used for pain control for foot-rot is the only FDA approved analgesic for cattle. Treatment of choice is antibiotic therapy delivered by injection. The disease can also easily spread to other animals in the herd.

In an effort to make delivery of antibiotics more efficient, some cattlemen utilize a dart gun, with darts containing the antibiotic. There is limited data on the effectiveness of this approach, but it is clearly less time-consuming than injecting each animal. Research results of dart use are inconclusive. Whereas some studies say that the proper use of darts is not very much different from injection, another study showed that 4 out of 15 darts failed to deliver the antibiotic to the area designated appropriate by the BQA (Beef Quality Assurance) for antibiotic injection (1). Failure of the dart can result in insufficient amounts of antibiotics delivered; injection into inappropriate tissue (intramuscular rather than subcutaneous); and food safety issues arising from accumulation of drugs in the incorrect locus.

To put it simply, use of a dart gun can result in failure of treatment and risk to animals and consumers. Using the dart gun as a “quick fix” is therefore bad husbandry and bad management. As John Maday, chief editor for Bovine Veterinarian and a good friend of the beef industry, wrote use of darts should be restricted to situations of necessity, not convenience (2). What then, should the role of the veterinarian be with regard to the practice of darting to save time? As the case presentation illustrates, the veterinarian provides explicit directions for proper use when dispensing antibiotics, even though he or she may be aware that some clients will utilize dart guns. Not only is it morally questionable to ignore improper use, it is extremely
imprudent. For one thing, if darting creates a food safety issue or an animal health issue, the veterinarian can end up being sued on the grounds that he or she knowingly permitted misuse.

Furthermore, and equally important, the credibility of the veterinary profession is at stake here. If journalists begin pro-suing on the grounds that he or she knowingly permitted misuse or an animal health issue, the veterinarian can end up being imprudent. For one thing, if darting creates a food safety issue and to the status in society of the veterinarian himself or herself. cattle business, to the societal respect for veterinary medicine, with the veterinarian's instructions. In this document, I would to sign a document promising to use the drug in accordance more labor-intensive injection technique, I would ask the client client plans to dart the animals rather than using the proper but veterinarian dispensing antibiotics for foot-rot, suspecting that the professional autonomy.

by government of veterinary practice with correlative loss of cattle and of people. And this in turn can lead to greater control bespeaking lack of veterinarian concern for the well-being of development of antibiotic resistance. Such cases can be seen as bespeaking lack of treatment concern for the well-being of cattle and of people. And this in turn can lead to greater control bespeaking lack of veterinarian concern for the well-being of human health, but also to the public image of the cattle business, to the societal respect for veterinary medicine, and to the status in society of the veterinarian himself or herself.

I would also remind my clients how far darting has moved from the pride cattlemen take in providing good care for their animals. To evidence my point, I would tell them about the statue that stands in front of the agriculture building at Colorado State University. Entitled “20% chance of flurries,” it depicts an elderly rancher on horseback carrying a lost calf home across the saddle in the middle of a snowstorm. Realistically rendered, even showing his windblown duster and white snow-drifts, it eloquently bespeaks the rancher ethic, with the cattlem man risking his life to bring home the baby animal. Clearly, his motivation is not financial. In an age where society demands good husbandry, the extra time spent avoiding shortcuts is more than justified by this unique image of the cattlem an’s ethic.

Bernard E. Rollin, PhD

Reference


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Articles from the January 2019 issue of CJVR that might be of interest to practitioners include:

Evaluation of effects of radiation therapy combined with either pamidronate or zoledronate on canine osteosarcoma cells on page 3

Changes in antimicrobial susceptibility profiles of Mycoplasma bovis over time on page 34

Peripartum metabolic profiles in a Holstein dairy herd with alarm level prevalence of subclinical ketosis detected in early lactation on page 50

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1. A 3-year-old cat is presented with an acute onset of unilateral exophthalmos and pain on opening the mouth. Which of the following is/are recommended diagnostic tests?
   A. Orbital ultrasound
   B. CT scan
   C. Dental examination and dental radiographs
   D. A and B
   E. A, B, and C

2. Cyanosis of the mucous membranes indicates which of the following?
   1. A high level of CO₂
   2. A problem with oxygen delivery
   3. A hemoglobin oxygen saturation of less than 75%
   4. An oxygen flow rate of 2 to 3 mL/kg/min
      A. 1 is correct.
      B. 1 and 2 are correct.
      C. 2 and 3 are correct.
      D. 2, 3, and 4 are correct.

3. A 6-month-old Labrador retriever presents for exercise intolerance. On physical examination, it has a systolic right heart murmur and normal femoral pulse quality. An electrocardiogram is performed, and the QRS complex is splintered. The most likely congenital heart defect is which of the following?
   A. Pulmonic stenosis
   B. PDA
   C. Ventricular septal defect
   D. Subaortic stenosis
   E. Tricuspid valve dysplasia

1. Un chat âgé de 3 ans présente un début soudain d’exophthalmie unilatérale et de douleur à l’ouverture de la gueule. Laquelle (lesquelles) des épreuves de diagnostic suivantes est (sont) recommandée (es)?
   A. échographie orbitaire;
   B. scanogramme;
   C. examen et radiographies des dents;
   D. A et B;
   E. A, B et C.

2. La cyanose des muqueuses indique lequel (lesquels) des problèmes suivants?
   1. Un taux élevé de CO₂.
   2. Un problème de distribution d’oxygène.
   3. Une saturation de l’hémoglobine en oxygène de moins de 75 %.
   4. Un débit d’oxygène de 2 à 3 ml/kg/min.
      A. 1 est correct;
      B. 1 et 2 sont corrects;
      C. 2 et 3 sont corrects;
      D. 2, 3 et 4 sont corrects.

3. Un Labrador retriever âgé de 6 mois présente de l’intolérance à l’effort. À l’examen physique, le chien montre un souffle cardiaque droit systolique et un pouls fémoral normal. On réalise un électrocardiogramme et le complexe QRS est dentelé. Lequel des défauts cardiaques congénitaux suivants est le plus probable?
   A. sténose pulmonaire;
   B. persistance du canal artériel;
   C. communication interventriculaire;
   D. sténose subaortique;
   E. dysplasie de la valve tricuspine.
As you begin considering your options for selling your pet hospital business, it's important to find a partner aligned with your values, respectful of the individuality of what you've built, and equipped to grow your business, while your team and culture remain intact.

Ask around to find out which buyers have the best reputation for caring for pets and the people who love them. Is it the right culture fit for your team?

Because selling your pet hospital is such a personal decision, you'll want to understand what types of options are available, and to what level they can tailor the terms to meet your needs.

Ask if the buyer can:
• Make all cash offers with no finance contingency
• Offer Joint Venture partnerships for growth and flexibility
• Buy the real estate outright or lease from you

Are there flexible deal structures?

As you contemplate transitioning your business, you'll want to know every aspect is covered. Seek out a partner with a dedicated team seasoned in marketing (including digital advertising and social media strategy), web development and hosting, client satisfaction surveys, IT, HR, accounting, taxes, legal and more.

How comprehensive are the support services?

Questions to ask as you enter discussions with potential partners.

What's your vision for the future of your business?

We're confident that we can care for and grow your practice like no one else. We'd be more than happy to talk through your questions. You can reach us at: 888.767.7755 | NVA.COM | ACQUISITIONS@NVA.COM
What’s your vision for the future of your business?

3 Questions to ask as you enter discussions with potential partners.

NO. 01 Is it the right culture fit for your team?

As you begin considering your options for selling your pet hospital business, it’s important to find a partner aligned with your values, respectful of the individuality of what you’ve built, and equipped to grow your business, while your team and culture remain intact.

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NO. 02 Are there flexible deal structures?

Because selling your pet hospital is such a personal decision, you’ll want to understand what types of options are available, and to what level they can tailor the terms to meet your needs.

ASK IF THE BUYER CAN:
- Make all cash offers with no finance contingency
- Offer Joint Venture partnerships for growth and flexibility
- Buy the real estate outright or lease from you

NO. 03 How comprehensive are the support services?

As you contemplate transitioning your business, you’ll want to know every aspect is covered. Seek out a partner with a dedicated team seasoned in marketing (including digital advertising and social media strategy), web development and hosting, client satisfaction surveys, IT, HR, accounting, taxes, legal and more.
4. A 3-year-old male dachshund is presented for hair loss. Examination reveals complete hair loss affecting the entire ventrum. The skin in this area is completely normal in appearance the dog is not pruritic. What is the most appropriate diagnostic test to confirm the presumed diagnosis?
A. Skin scrapings
B. Serum allergy testing
C. Intradermal allergy testing
D. Skin biopsy
E. Elimination diet trial

5. Manure should be spread on fields when which of the following is true?
A. Snow covers them.
B. Rain is forecast.
C. Crops are maturing.
D. Tillage will occur.
E. The farm is Cryptosporidia-free.

(See p. 192 for answers./Voir les réponses à la page 192.)
Council Update

The Canadian Veterinary Medical Association (CVMA) Council met to evaluate the work that the CVMA delivered in 2018 and to approve the 2019 program plans and budget. Council also made policy decisions. One of the 2018 highlights was the record achieved in CVMA membership of 7399! In addition to that, the CVMA comprises 7851 affiliated RVTTC veterinary technicians.

As of January 2019, CVMA Council consists of the following members, representing provincial veterinary medical associations, veterinary colleges, veterinary students and veterinary technicians:

- Dr. Terri Chotowetz, president
- Dr. Troye McPherson, immediate past-president
- Dr. Melanie Hicks, president-elect (New Brunswick)
- Dr. Enid Stiles, vice-president (Quebec)
- Dr. Louis Kwantes, executive member (Alberta)
- Dr. Barry Stemshorn, treasurer (Ex officio)
- Mr. Jost am Rhyn, CEO (Ex officio)
- Dr. Christiane Armstrong (British Columbia)
- Dr. Tracy Fisher (Saskatchewan)
- Dr. Christopher Bell (Manitoba)
- Dr. Timothy Arthur (Ontario)
- Dr. Trevor Lawson (Nova Scotia)
- Dr. Erin MacDonald (Prince Edward Island)
- Ms. Kate Rundle, SCVMA president
- Ms. Lois Ridgway, RVT (RVTTC) (Ex officio)

Mise à jour du Conseil

Le Conseil de l’Association canadienne des médecins vétérinaires (ACMV) s’est réuni afin d’évaluer le travail que l’ACMV a réalisé en 2018 et d’approuver les plans de programme et le budget de 2019. Le Conseil a aussi pris des décisions sur les politiques. L’un des faits saillants de l’année 2018 a été le nombre record de 7399 membres inscrits à l’ACMV! De plus, l’ACMV comporte un effectif de 7851 techniciens vétérinaires affiliés de TTVAC.

En janvier 2019, le Conseil de l’ACMV se composait des membres suivants, représentant les associations provinciales de médecins vétérinaires, les écoles de médecine vétérinaire, les étudiants en médecine vétérinaire et les techniciens vétérinaires :

- Dr. Terri Chotowetz, présidente
- Dr. Troye McPherson, présidente sortante
- Dr. Melanie Hicks, présidente désignée (Nouveau-Brunswick)
- Dr. Enid Stiles, vice-présidente (Québec)
- Dr. Louis Kwantes, membre de l’exécutif (Alberta)
- Dr. Barry Stemshorn, trésorier (membre d’office)
- Mr. Jost am Rhyn, CEO (membre d’office)
- Dr. Christiane Armstrong (Colombie-Britannique)
- Dr. Tracy Fisher (Saskatchewan)
- Dr. Christopher Bell (Manitoba)
- Dr. Timothy Arthur (Ontario)
- Dr. Trevor Lawson (Nouvelle-Écosse)
- Dr. Erin MacDonald (Île-du-Prince-Édouard)
- Ms. Kate Rundle, présidente des ÉACMV
- Ms. Lois Ridgway, TVA (TTVAC) (membre d’office)
Strategic Planning: The CVMA conducted 2 focus groups with participants of the CVMA’s 2018 Emerging Leaders Program. Here are just a few findings from these insightful workshops:

**Overall satisfaction:**
- Focus group veterinarians love their work with animals, and, for the most part, with clients. Challenges mentioned were work-life balance, business owners, colleagues and staff.
- Work-life balance is an issue for almost all focus group veterinarians, specifically the struggles with exhaustion and “decision fatigue” that affects their personal lives.
- Possibly the greatest challenge the groups face are difficulties with employers and management; there was also some concerns about business decisions and quality of care.

**Expectations versus reality:**
- Most veterinarians in the groups enjoyed the medical practice side of their careers. On the other hand, most were not prepared for the workplace culture, communications and the management challenges.
- Participants noted that their medical education didn’t include training in managing clients, particularly the clients’ financial concerns.
- Clients were an early challenge for many veterinarians, specifically the ability to balance their care for the animals with the demands of clients, as well as clients who simply cannot afford the cost of appropriate care.

In 2019, the CVMA will focus, in particular, on a) communication challenges of recent graduate veterinarians with clients and the staff team, and b) on-boarding (on-the-job training) needs in practice.

To learn more about CVMA members and the potential needs of members, the CVMA will conduct quantitative and qualitative surveys in 2019. This will provide valuable information for the March 2019 Strategic Planning meeting involving CVMA Council, Committee Chairs and management staff.

**Animal Welfare Committee (AWC)**

In 2019, the AWC will review Position Statements on euthanasia, pest control, and tail docking in sheep. The AWC will also develop new Position Statements on animal welfare and co-sheltering, and service animals. A draft code of practice on Small Mammal Pets will be developed as well as a review and revision of the Cattery Code.

On the advocacy front, the Committee will follow up on the implementation of proposed amendments to the federal transportation regulations. The CVMA will also continue to support Bill C-84 — An Act to amend the Criminal Code (bestiality and animal fighting).

The CVMA will maintain and strengthen representation on the National Farm Animal Care Council (NFACC) Code development; the National Farm Animal Health and Welfare Council; the National Companion Animal Coalition; and the Canadian Violence Link Coalition.

**Communications/education**

In 2019, the CVMA will realign web resources that focus on animal abuse; demonstrate the impact of CVMA’s Position

Planification stratégique : L’ACMV a tenu deux groupes de discussion avec les participants à l’édition 2018 du Programme des futurs leaders de l’ACMV. Voici quelques-unes des constatations de ces ateliers intéressants :

**Satisfaction générale :**
- Les médecins vétérinaires du groupe de discussion adoraient leur travail auprès des animaux et, pour la plupart, avec les clients. Parmi les défis mentionnés, citons la conciliation travail-famille, être propriétaire d’entreprise, les collègues et les employés.
- La conciliation travail-famille représente un enjeu pour presque tous les médecins vétérinaires du groupe de discussion, particulièrement les difficultés liées à l’épousement et à la « fatigue décisionnelle » qui affectent leur vie personnelle.
- Les difficultés avec les employeurs et la direction représentent probablement le plus grand défi que doivent relever les personnes au sein des groupes. Il existe aussi certaines préoccupations au niveau des décisions d’affaires et de la qualité des soins.

**Attentes et réalité :**
- La plupart des médecins vétérinaires des groupes adoraient le côté de la pratique médicale de leur carrière. Par contre, la plupart n’étaient pas préparés pour la culture en milieu de travail, les communications et les défis liés à la gestion.
- Les participants ont signalé que leur formation vétérinaire n’incluait pas une formation sur la gestion de la clientèle, particulièrement les préoccupations financières des clients.
- Les clients ont représenté l’un des premiers défis pour beaucoup de médecins vétérinaires, particulièrement la capacité de concilier les soins pour les animaux et les exigences des clients ainsi que les clients qui n’avaient simplement pas les moyens de se payer les soins appropriés.

En 2019, l’ACMV se concentrera en particulier sur a) les défis liés à la communication des médecins vétérinaires récemment diplômés avec les clients et les membres de l’équipe et b) les besoins de formation « sur le tas » (en cours d’emploi) au sein des établissements vétérinaires.


**Comité sur le bien-être animal (CBA)**

En 2019, le CBA examinera les énoncés de position sur l’euthanasie, le contrôle des animaux nuisibles et l’amputation de la queue des moutons. Le CBA élaborera aussi de nouveaux énoncés de position sur le bien-être animal et l’hébergement conjoint ainsi que sur les animaux d’assistance. De plus, l’ébauche d’un code de pratiques pour les petits mammifères de compagnie sera rééditée et on procédera aussi à l’examen et à la révision du Code de pratiques à l’intention des chahuteries.

Quant aux activités de défense des intérêts, le comité effectuera un suivi sur la mise en œuvre des modifications proposées aux règlements fédéraux sur le transport. L’ACMV continuera aussi d’appuyer le projet de loi C-84 — Loi modifiant le Code criminel (bestialité et combat d’animaux).
Statements; feature animal welfare articles in The CVJ; engage students in animal welfare issues, and develop a Pain Management Framework and action plan including tools for practitioners and the public.

National Issues Committee (NIC)
With regard to antimicrobial use (AMU), in 2019, the CVMA will achieve the following:

- Fine tune new online antimicrobial prudent use guidelines; add aquaculture and equine.
- Pilot antimicrobial use surveillance with a limited group of food animal practitioners.
- Increase awareness and transfer knowledge and best practices on antimicrobial stewardship with veterinarians and public.
- Consider and promote alternatives to AMU.

In the area of cannabinoid products and in pets, the CVMA will monitor the impact of legalization of cannabis on veterinarians and patients and provide pertinent information to members, and continue dialogue with Health Canada (HC).

Position Statements
In 2019, the CVMA will develop a new Position Statement on service animals; renew a Position Statement on Antimicrobial Use in Animals (previously rescinded with introduction of HC rule changes); review Surgical Procedures Position Statement; review Telemedicine Position Statement; and coordinate CVMA Global Forum on Telemedicine Position Statement during the 2019 Convention.

Lyme disease
In 2019, the CVMA will again roll out National Tick Awareness Month; and build and maintain linkages between the CVMA and medical and public health entities (Canadian Medical Association, Public Health Agency of Canada, Health Canada).

OIE country assessment
The CVMA will represent the interests of Canadian veterinarians and engage in the action plan resulting from this assessment.

Ownership and selection of pets
The CVMA will keep this public section of the CVMA website pertinent.

Representations
The CVMA is represented on the Canadian Animal Health Products Regulatory Advisory Committee (CAHPRAC); the CAHPRAC Subcommittee on Communications; Health Canada’s Veterinary Natural Health Products Expert Advisory Committee; the Zoo-technical Products working group; the Centre for Emerging and Zoonotic Disease Integrated Intelligence and Response (CEZD IIR), the Canadian Animal Health Surveillance System (CAHSS), and the National Companion Animal Coalition.

Dr. Jaspinder Komal, vice-president, Science Branch, Canadian Food Inspection Agency (CFIA), Chief Veterinary Officer and Canada’s delegate to the World Organisation for Animal Health (OIE), met with Council to discuss veterinary

L’ACMV poursuivra et renforcera sa représentation dans le cadre de l’élaboration des codes du Conseil national pour les soins aux animaux d’élevage (CNSAE); le Conseil national sur la santé et le bien-être des animaux d’élevage et la Canadian Violence Link Coalition.

Communication et formation
En 2019, l’ACMV réalisera ses ressources Web qui portent sur la violence envers les animaux, démontrera l’impact des énoncés de position de l’ACMV, publiera des articles sur le bien-être animal dans La RV; invitera la participation des étudiants à l’égard des enjeux liés au bien-être animal et élaborera un cadre stratégique et un plan d’action pour la gestion de la douleur qui comprendra notamment des outils pour les praticiens et le public.

Comité sur les enjeux nationaux (CEN)
En ce qui concerne l’utilisation des antimicrobiens en 2019, l’ACMV atteindra les objectifs suivants :

- Elle participera aux tables rondes concernant l’élaboration du Plan d’action fédéral pour le Cadre pancanadien sur la résistance aux antimicrobiens.
- Elle peaufinera les nouvelles lignes directrices en ligne sur l’utilisation prudente des antimicrobiens et ajouterait l’aquaculture et les équidés.
- Elle pilotera la surveillance de l’utilisation des antimicrobiens avec un groupe limité de praticiens des animaux destinés à l’alimentation.
- Elle rehaussera la sensibilisation et effectuera un transfert des connaissances et des meilleures pratiques sur l’antibio-gouvernance aux médecins vétérinaires et au public.
- Elle considérera et fera la promotion des solutions de remplacement à l’utilisation des antimicrobiens.

Dans le domaine des produits cannabinoïdes chez les animaux de compagnie, l’ACMV surveillera l’impact de la légalisation du cannabis sur les médecins vétérinaires et les patients et elle communiquera des renseignements pertinents aux membres et poursuivra le dialogue avec Santé Canada (SC).

Énoncés de position
En 2019, l’ACMV élaborera un nouvel énoncé de position sur les animaux d’assistance, elle révisera un énoncé de position sur l’utilisation des antimicrobiens chez les animaux (déjà éliminé en raison de l’introduction de nouveaux règlements par SC), elle révisera l’énoncé de position sur les interventions chirurgicales, elle révisera l’énoncé de position sur la télémédecine et elle coordonnera le Forum mondial de l’ACMV qui se penchera sur l’énoncé de position de la télémédecine durant le congrès 2019.

Maladie de Lyme
En 2019, l’ACMV présentera de nouveau le Mois national de la sensibilisation aux tiques et établira et maintiendra des liens entre l’ACMV et les entités médicales et les organismes de santé publique (Association médicale canadienne, Agence de la santé publique du Canada, Santé Canada).

Évaluation nationale de l’OIE
L’ACMV représentera les intérêts des médecins vétérinaires canadiens et participera à un plan d’action découlant de cette évaluation.
capacity in the public sector, the new federal policy on veterinary oversight of antimicrobials, and how the CVMA can assist with the implications on feed mills. Dr. Komal also informed Council about the process for the federal government’s action plan following the OIE Performance of Veterinary Service Evaluation of Canada and discussed the involvement of the CVMA in this process.

Dr. Mary-Jane Ireland, director general, Veterinary Drugs Directorate (VDD), and Dr. Manisha Mehrotra, director, Human Safety Division, VDD, joined Council for a presentation and discussions on the status of the AMU regulatory and policy changes, as well as on cannabis and opioid use.

**Dog breeding**

Council approved the following revised Position Statement:

“The Canadian Veterinary Medical Association (CVMA) supports the breeding of dogs only when it is undertaken by those who are committed to providing a high level of care for their dogs and to supporting their dogs’ physical and psychological well-being.

“Likewise, the CVMA only supports the breeding of dogs by those who strive to produce offspring that are predisposed to a good quality of life. A good quality of life is one in which dogs normally experience a state of physical, psychological, and social well-being, without disease or chronic illness.

“The CVMA opposes the selective breeding of dogs resulting in changes in body form, function, coat color, or temperament, that are potentially detrimental to the quality of life of the resulting progeny.”

**Co-sheltering standards**

Council approved the development of a new Position Statement on Animal Care in Emergency Co-sheltering.

**Small Mammal Code of Practice**

Council approved the development of a Code of Practice for Small Mammal Pets that, by its structure, will mirror the recently developed Kennel and Cattery Codes of Practice.

**Continuous monitoring of antimicrobials**

Council approved a joint American Veterinary Medical Association-CVMA- Federation of Veterinarians of Europe Position Statement on Continuous Monitoring of Antimicrobial Use and Antimicrobial Resistance. The full text is posted on the CVMA’s website under the Policy & Advocacy tab, International Relations section.

**Shortage of veterinarians**

The CVMA has heard anecdotally from many veterinary practices across Canada that they have a difficult time finding veterinarians to fill positions. However, the CVMA has no work-force study data at this time to confirm the information. We can attest that the classified ads in *The Canadian Veterinary Journal* are at an all-time high. The CVMA will monitor the situation and consider whether to conduct a workforce study.

**Possession et choix d’un animal de compagnie**

L’ACVM mettra à jour cette section publique du site Web de l’ACVM.

**Représentations**

L’ACVM est représentée au sein du Comité consultatif canadien sur la réglementation des produits de santé animale (CCCRPSA), du sous-comité du CCCRPSA sur les communications, du comité consultatif d’experts sur produits de santé naturels vétérinaires, du groupe de travail sur les produits zootechniques, du Centre pour des renseignements et une intervention intégrés sur les maladies émergentes et zoonotiques (CEZDIIR), du système canadien de surveillance de la santé animale (SCSSA) et de la Coalition nationale sur les animaux de compagnie.

Le D’ Jaspinder Komal, vice-président, Science, à l’Agence canadienne d’inspection des aliments (ACIA), médecin vétérinaire en chef et délégué du Canada auprès de l’Organisation mondiale de la santé animale (OIE), a rencontré le Conseil afin de discuter de la capacité vétérinaire dans le secteur public, de la nouvelle politique fédérale sur la surveillance vétérinaire des antimicrobiens et de la façon dont l’ACVM peut porter assistance en lien avec les usines de fabrication des aliments pour animaux. Le D’ Komal a aussi informé le Conseil à propos du processus pour le plan d’action du gouvernement fédéral après l’évaluation de la performance des services vétérinaires au Canada par l’OIE et il a discuté de la participation de l’ACVM dans ce processus.

Le D’ Mary-Jane Ireland, directrice générale, Direction des médicaments vétérinaires (DMV), et la D’ Manisha Mehrotra, directrice, Division de l’innocuité pour les humains, se sont jointes au Conseil pour une présentation et des discussions sur la situation en lien avec les modifications aux règlements et aux politiques ainsi que sur l’usage du cannabis et des opioïdes.

**Élevage des chiens**

Le Conseil a approuvé l’énoncé de position révisé suivant :

“L’Association canadienne des médecins vétérinaires (ACVM) appuie l’élevage des chiens seulement lorsque l’élevage est entrepris par des personnes qui se sont engagées à fournir un niveau élevé de soins à leurs chiens et à assurer leur bien-être physique et psychologique.

De plus, l’ACVM appuie seulement l’élevage des chiens par ceux qui travaillent en vue de produire une progéniture qui est prédisposée à une bonne qualité de vie. Une bonne qualité de vie est une vie au cours de laquelle les chiens jouissent d’un bien-être physique, psychologique et social sans être atteints de maladies ni d’affections chroniques.

L’ACVM s’oppose à l’accouplement sélectif des chiens qui provoque des changements de la fonction et de la conformation physique, de la couleur du pelage ou du tempérament lorsqu’ils sont néfastes pour la santé ou la qualité de vie de la descendance.”

**Normes pour l’hébergement conjoint**

Le Conseil a approuvé l’élaboration d’un nouvel énoncé de position sur les soins aux animaux lors de l’hébergement conjoint d’urgence.
CVMA Veterinary Technician Program Accreditation

SCVMA Symposium
The Symposium of the Students of the CVMA, which took place on January 18 and 19, 2019, was hosted by the Faculté de médecine vétérinaire de l’Université de Montréal in St. Hyacinthe, Quebec. At press time, 259 students had signed up for this popular annual event.

Student Leadership Workshop
The Students of the CVMA hosted the latest Workshop at the Western College of Veterinary Medicine on November 17, 2018. This Workshop was facilitated by Dr. Rick DeBowes. All participating students of this 1-day course received a Student Leadership Workshop Certificate.

CVMA Convention 2021
Council approved that Calgary be the host city for the 2021 Convention, which is scheduled to take place from July 9–12.

2019 CVMA-WSAVA Conference
This is an opportunity for the CVMA to bring the veterinary world to Canada. The World Small Animal Veterinary Association (of which the CVMA is a member) and the CVMA are hosting this joint Congress from July 16 to 19, 2019 in Toronto, Ontario. On July 16, 2019, as part of this event, the CVMA will be hosting a Global Summit on “The Gold Standard of Animal Welfare — Positive and Negative Impact on Animals and Veterinarians.” This Summit will be chaired by CVMA’s president-elect, Dr. Melanie Hicks. The CVMA will also host a Global Issues Forum on Telehealth and Animal Welfare, which will be chaired by Dr. Serge Chalhoub, member of the CVMA’s National Issues Committee.

(by Jost am Rhyn, CEO, CVMA)

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Code de pratiques pour les petits mammifères
Le Conseil a approuvé la rédaction d’un Code de pratiques pour les petits mammifères de compagnie dont le format s’apparentera aux Codes de pratiques recommandées pour les chéniels et les chatteries récemment publiés.

Surveillance continue des antimicrobiens
Le Conseil a approuvé un énoncé de position conjoint de l’American Veterinary Medical Association-ACMV-Fédération des vétérinaires d’Europe sur la surveillance continue de l’utilisation des antimicrobiens et l’antibiorésistance. La version intégrale est affichée sur le site Web de l’ACMV sous l’onglet Politiques et défense des intérêts, dans la section des Relations internationales.

Pénurie de médecins vétérinaires
L’ACMV a entendu des anecdotes de nombreux établissements vétérinaires au Canada mentionnant qu’ils ont de la difficulté à trouver des médecins vétérinaires pour combler les postes. L’ACMV ne possède pas actuellement de données provenant d’études sur la main-d’œuvre afin de confirmer ces renseignements, mais nous pouvons cependant confirmer le nombre de petites annonces publiées dans La Revue vétérinaire canadienne se situe à un niveau record. L’ACMV surveillera la situation et décidera s’il vaut la peine de réaliser une étude sur la main-d’œuvre.

Agrément des programmes de techniques vétérinaires par l’ACMV
Le Conseil a approuvé l’agrément du programme de technologie en santé animale d’Olds College à Olds, en Alberta; le programme de technologie vétérinaire du Maritime Business College à Sackville, en Nouvelle-Écosse; et le programme de technologie en santé animale de Lakeland College à Vermilion, en Alberta.

Symposium des ÉACMV
Le Symposium des Étudiants de l’ACMV s’est déroulé les 18 et 19 janvier 2019 à la Faculté de médecine vétérinaire de l’Université de Montréal à Saint-Hyacinthe, au Québec. Au moment de mettre sous presse, 259 étudiants étaient inscrits à ce populaire événement annuel.

Atelier de leadership étudiant
Les Étudiants de l’ACMV ont tenu la plus récente édition de cet atelier le 17 novembre 2018 au Western College of Veterinary Medicine. Cet atelier a été animé par le Dr Rick DeBowes. Tous les étudiants qui ont participé à ce cours d’une journée ont reçu un certificat de l’Atelier de leadership étudiant.

Congrès 2021 de l’ACMV
Le Conseil a approuvé la ville de Calgary afin d’accueillir le congrès 2021, qui se déroulera du 9 au 12 juillet.

Congrès 2019 de l’ACMV-WSAVA
C’est l’occasion pour l’ACMV d’inviter le monde vétérinaire au Canada. La World Small Animal Veterinary Association (dont l’ACMV est membre) et l’ACMV organiseront ce congrès conjoint du 16 au 19 juillet 2019 à Toronto, en Ontario. Le 16 juillet 2019, dans le cadre de cet événement, l’ACMV organisera un Sommet mondial sur «La norme d’excellence en matière de bien-être animal — impact positif et négatif sur les animaux et les médecins vétérinaires». Ce Sommet sera présidé par la présidente désignée de l’ACMV, la Docteure Melanie Hicks. L’ACMV organiserait aussi un Forum sur les enjeux mondiaux qui portera sur la télésanté et le bien-être animal et sera présidé par le Dr Serge Chalhoub, membre du Comité sur les enjeux nationaux de l’ACMV.

(par Jost am Rhyn, PDG, ACMV)
Meet some of Canada’s Future Veterinary Leaders!

The CVMA Student Leadership Award, instituted in 1966, consists of a plaque and a monetary award presented annually to a 3rd-year veterinary student at each of the Canadian veterinary colleges. The recipient is selected by classmates on the basis of leadership and achievement in student affairs. One International CVMA Student Leadership Award recipient is also presented annually to a student studying at one of the CVMA’s international student affiliate schools and is chosen by the CVMA Awards Selection Committee and the Students of the CVMA (SCVMA) Committee senior representatives.

Below are the 2018 CVMA Student Leadership Award recipients:

Katya Melnick, now a 4-year student at the Western College of Veterinary Medicine (WCVM), grew up near the water with cats and a few backyard laying hens in Pinawa, Manitoba. Katya has a passion for water and downhill skiing, as well as recently becoming excited about mountain biking. After completing her degree in Animal Agriculture at the University of Manitoba, Katya was accepted into WCVM. She is currently serving as the Class of 2019 president and enjoys being a student liaison between her class and the college administration. After Katya graduates, she hopes to practice small animal general medicine and is excited to be one of the recipients of the CVMA Student Leadership Award!

Rae-Leigh Pederzolli, a 3rd-year student at the University of Calgary — Faculty of Veterinary Medicine (UCVM), was born and raised on a commercial cow calf operation in Medicine Hat, Alberta. She spent her childhood helping at her home operation and competing in rodeo arena barrel racing, steer riding, and trick riding. Rae-Leigh completed a Bachelor of Science degree with honors majoring in Animal Science in 2014 as well as a Master of Science degree in 2016 with Dr. Gregory Penner, an associate professor and Centennial Enhancement Chair in Nutritional Physiology, both at the University of Saskatchewan. She evaluated the barrier function of the gastrointestinal tract in Holstein steers when exposed to low feed intake and acute ruminal acidosis. Rae-Leigh was selected for the Cattlemen’s Young Leaders Program in 2014 and was mentored by Kajal Devani, member service team leader at the Canadian Angus Association and she was a member at large for the Young Cattlemen’s Council under the Canadian Cattlemen’s Association for the 2015–2016 year. Rae-Leigh was also fortunate to be selected as a student delegate for both the Canadian and American International Livestock Congress, as well as the International Livestock Forum. During the two first years at the UCVM, Rae-Leigh has also been president of the promotion 2020 of the UCVM and she is currently president of the Club of the safety of the animals of elevage, which includes the post of delegate junior of the UCVM at the American Association of Bovine Practitioners. In the last 2 years, she has been part of the evaluation committee, she travels and enjoys the underwater and marine, as well as the training in parcours and equestrian. At the end of her course,

Rencontrez quelques-uns des futurs leaders vétérinaires du Canada!

Le Prix de leadership étudiant de l’ACMV, qui a été établi en 1966, se compose d’une plaque et d’une bourse et est décerné annuellement à un étudiant en médecine vétérinaire de troisième année à chacune des écoles de médecine vétérinaire canadiennes. Le récipiendaire est choisi par ses camarades de classe en fonction de son leadership et de ses réalisations dans les affaires étudiantes. Un Prix de leadership étudiant de l’ACMV est aussi présenté annuellement à un étudiant inscrit à l’une des écoles de médecine vétérinaire affiliées et est choisi par le Jury de sélection de l’ACMV et les représentants sénior du Comité des Étudiants de l’ACMV (ÉACMV).

Voici les récipiendaies de l’édition 2018 du Prix de leadership étudiant de l’ACMV :

Katya Melnick, maintenant étudiante de quatrième année au Western College of Veterinary Medicine (WCVM), a grandi sur l’eau avec des chats et quelques poules à Pinawa, au Manitoba. Katya se passionne pour le ski nautique et le ski alpin et elle s’est récemment éprise du vélo de montagne. Après avoir terminé son diplôme en agriculture animale à l’Université du Manitoba, Katya a été acceptée au WCVM. Elle occupe actuellement le poste de présidente de la promotion 2019 et elle aime être agente de liaison étudiante entre sa promotion et l’administration universitaire. Après la fin de ses études, Katya espère exercer en médecine générale des petits animaux et elle est très excitée d’être l’une des récipiendaies du Prix de leadership étudiant de l’ACMV !

Rae-Leigh Pederzolli, étudiante de troisième année à la Faculté de médecine vétérinaire de l’Université de Calgary (UCVM), est née et a grandi dans une exploitation commerciale de naissage-elevage à Medicine Hat, en Alberta. Elle a passé son enfance à travailler à l’exploitation familiale et à participer à des courses de barils, à des courses de bouvillons et à des parcours d’acrobaties dans les rodéos. Rae-Leigh a obtenu son baccalauréat en sciences avec spécialisation en sciences animales en 2014 ainsi qu’une maîtrise en sciences en 2016 auprès du D’ Gregory Penner, professeur agrégé et titulaire de la chaire Centennial en physiologie nutritionnelle, tous deux à l’Université de la Saskatchewan. Son projet a évalué la fonction barrière de l’appareil gastro-intestinal chez les bouvillons Holstein lorsqu’ils sont exposés à un faible apport alimentaire et à une acidose ruminale aiguë. Rae-Leigh a été choisie pour le Programme des jeunes leaders de la Canadian Cattlemen’s Association en 2014 et a été mentoree par Kajal Devani, leader de l’équipe de service aux membres à la Canadian Angus Association et elle a été membre à titre individuel du Conseil des jeunes de la Canadian Cattlemen’s Association pour l’année 2015–2016. Rae-Leigh a aussi été fortunée d’être choisie comme déléguée étudiante pour les congrès International Livestock Congress tenus aux États-Unis et au Canada ainsi que lors de l’International Livestock Forum. Pendant les deux premières années à l’UCVM, Rae-Leigh a été présidente de la promotion 2020 de l’UCVM et elle est actuellement présidente du Club de la santé des animaux d’élevage, ce qui inclut le poste de délégué junior de l’UCVM auprès de l’American Association of Bovine Practitioners. En dehors des études, elle aime voyager et faire de la plongée sous-marine, de l’entraînement en parcours et de l’équitation. À la fin de son cours,
Livestock Forum. For the first 2 years at UCVM, Rae-Leigh served as UCVM’s Class of 2020 president and she is currently the Production Animal Health Club president, which includes being the UCVM junior delegate for the American Association of Bovine Practitioners. Outside of academics, she enjoys traveling, scuba diving, crossfit, and horseback riding. After graduation, Rae-Leigh’s main focus is to practice large animal medicine in her rural community while still being actively involved at her home operation.

Jolene Vermeulen, now a 4th-year student at the Atlantic Veterinary College (AVC), grew up on Nova Scotia’s southern shore. Jolene completed her Bachelor of Science degree at the Nova Scotia Agricultural College in Truro, Nova Scotia, majoring in Animal Science and her Master of Science degree in Animal Behavior and Welfare at the University of Guelph. During all her post-secondary education, Jolene’s passion for large animals continued to grow. In 2014, Jolene bought a dairy farm with her husband in Princeport, Nova Scotia where they milk 60 Holsteins. The year after purchasing the farm, Jolene was accepted to AVC where she has continued to develop her large animal knowledge. Jolene’s hope is that after graduation she will be able to practice large animal medicine in the Maritimes and have the opportunity to educate other young farmers.

Rachel Gauvin, now a 4th-year veterinary student at la Faculté de médecine vétérinaire (FMV) de l’Université de Montréal, has always been involved in her college. During her first 2 years pursuing her doctoralate in veterinary medicine, Rachel was her Class of 2020 student representative and for the last 2 years, she served as the External Affairs coordinator for the Association des étudiants en médecine vétérinaire du Québec (AEMVQ). Rachel was also one of the coordinators in charge of FMV’s small animal shelter for a year, and has taken an active part in many of her college’s projects and committees including the Politics Committee, the Student Well-Being Committee, the Committee for the Reform of FMV’s DVM Program, and the Young Women’s Veterinary Association. Rachel is also proud of how she pushed for, and initiated, a change in the way the integrational activities for new students were done at FMV. Rachel helped make the activities more inclusive and respectful and she also encouraged the entire student body to adopt a healthier mindset when organizing them.

Eastman Welsford, now a 4th-year student at the Ontario Veterinary College (OVC), took every opportunity to get involved at OVC from the moment he walked through the doors. Eastman served as co-president of his class and feels fortunate for the opportunity to work alongside faculty and motivated students. Born in Montreal, Quebec and raised in Rae-Leigh désire exercer la médecine des grands animaux dans sa collectivité rurale tout en demeurant active au sein de l’exploitation familiale.


Rachel Gauvin, maintenant étudiante en médecine vétérinaire de quatrième année à la Faculté de médecine vétérinaire (FMV) de l’Université de Montréal, a toujours participé activement aux activités de son école. Durant ses deux premières années au programme de doctorat en médecine vétérinaire, Rachel a été représentante étudiante de la promotion 2020 et, pendant les deux dernières années, elle a occupé le poste de coordonnatrice des affaires externes pour l’Association des étudiants en médecine vétérinaire du Québec (AEMVQ). Rachel a aussi été coordonnatrice responsable du refuge pour petits animaux de la FMV pendant un an et elle a participé activement aux nombreux projets et comités de la faculté, dont le Comité des politiques, le Comité du bien-être des étudiants, le Comité pour la réforme du programme de D.M.V. de la FMV et l’Association des jeunes femmes médecins vétérinaires. Rachel est aussi fière de la façon dont elle a fait la promotion et mis en œuvre des changements liés aux activités d’intégration des nouveaux étudiants à la FMV. Rachel a contribué à rendre les activités plus inclusives et respectueuses et elle a aussi encouragé tous les étudiants à adopter un état d’esprit plus sain lors de l’organisation de ces activités.

Eastman Welsford, maintenant étudiant de quatrième année à l’Ontario Veterinary College (OVC), a profité de toutes les occasions pour s’impliquer à l’OVC dès le moment où il a franchi le seuil de la porte. Eastman a occupé le poste de coprésident de sa promotion et il s’estime fortuné d’avoir l’occasion de travailler aux côtés des professeurs et d’étudiants motivés. Né à Montréal, au Québec, Eastman a grandi à Oakville, en Ontario, et les animaux ont toujours fait partie de sa vie. Le chien familial était son premier meilleur ami et la maison comptait presque toujours un animal de compagnie. Il était clair qu’Eastman était destiné à une carrière auprès des animaux après avoir grandi aux côtés de poissons, de lézards, de chiens, d’oiseaux et d’un furet et avoir passé les fins de semaine dans des écuries. Avant d’être accepté à l’OVC, Eastman a obtenu un baccalauréat en arts et en sciences à l’Université McGill avec une majeure en biologie et en anthropologie. Pendant ce temps, Eastman a développé un vif intérêt pour l’agriculture, après avoir travaillé à la ferme laitière du Campus Macdonald. Il croit que la combinaison des arts et des sciences est importante en médecine vétérinaire, car ces deux domaines réunissent les
Oakville, Ontario, animals were always in the picture for Eastman. The family dog was his first best friend and the house was almost never without pets. It was clear Eastman was destined for a career with animals after growing up with pet fish, lizards, dogs, birds and a ferret and spending weekends at riding stables. Before being accepted to OVC, Eastman completed a Bachelor of Arts and Science at McGill University majoring in Biology and Anthropology. It’s during this time Eastman developed a keen interest in agriculture, having worked on the Macdonald Campus dairy farm. He believes the combination of arts and science is important in veterinary medicine, bringing together applied sciences in biology and medicine with the importance of communicating effectively with clients and working as part of a healthcare team. Eastman is looking forward to working in large animal practice after graduation and hopes to complete a one-year internship.

Born and raised in Toronto, Ontario, Matthew Barnes is now a 4th-year Canadian veterinary student studying abroad at the University of Glasgow — School of Veterinary Medicine in Scotland. While pursuing his undergraduate degree, Matthew volunteered in many organizations, including being a Queen’s University Blood Team Committee member; organizing campus blood donation clinics, volunteering for the Helen Tufts Child Outreach Program; mentoring disadvantaged children in Kingston, Ontario, being a teaching assistant and a human anatomy course laboratory instructor. In Matthew’s 1st year of veterinary school, he continued his involvement in school clubs and societies.

With approachability and strong communications skills, Matthew delivered a speech to his new peers, and was elected as the Class of 2020 student representative, representing class members’ interests and concerns at staff and student government meetings, and selected as the “Big Vet Wee Vet” student mentorship program coordinator, matching 1st-year students with senior students who help them transition to life in Glasgow and foster friendships.

Matthew is also the VetPrep student representative, a North American Veterinary Licensing Exam (NAVLE) test preparation company. Matthew was selected, in part, because for 4 summers he worked for Prep101, a test preparation company teaching prospective medical students. Matthew was selected, in part, because for 4 summers he worked for Prep101, a test preparation company teaching prospective medical students university level organic chemistry in preparation to write their Medical College Admissions Test (MCAT).

Matthew is also a member of the Glasgow University Mountaineering Club, the Zoological Society, the Pathology Club, the Clinical Club, the university boxing club and, of course, the University of Glasgow CVMA Chapter (affectionately dubbed the “Canada Club”).

On the road to becoming a veterinarian, Matthew received invaluable support from family, professors and mentors that helped form Matthew’s professional goals: teaching others, continuously learning, pushing the profession forward and promoting animal welfare. After graduation, Matthew intends to achieve his goals by pursuing board certification in Internal Medicine so he can teach and transfer his knowledge to future veterinarians in Canada, while practicing compassionate veterinary medicine.
Spotlight on an Emerging Leader Program Participant

Evy van Nobelen

I graduated from the University of Utrecht, the Netherlands in 2013. I moved to live and work as a small animal veterinarian in Canada right after graduation. I love traveling, knitting, and urban sketching.

Before attending the Emerging Leader Program (ELP), I felt disillusioned about veterinary medicine. Getting blackmailed emotionally by clients and team members, lacking mentorship from the start, case competitions, and toxic work environments had finally affected my well-being. At the same time, I lost my admiration for my veterinary role model who used to inspire me. I decided to observe veterinarians and their teams during small local workshops and in their clinics through shadowing. Sadly, I discovered there is a lot of competition and fear out there, both between clinics and within clinics between various positions. A few veterinarians I met were candid about their reluctance in providing mentorship, sharing their skills and knowledge. They seem to fear that they would lose their niche and income. I became cynical and disappointed in the veterinary community I knew.

Thankfully ELP came in the nick of time. Dr. Rick DeBowes is a very motivating speaker.

We were given tasks and pieces of puzzles, which required teamwork in order to solve them. They were great lessons in communication and human behavior. The exercises showed me what a healthy team is and how it performs. The key is respect, good communication between each team member and a good leader. During the sessions, we also discussed what leadership is about and which characteristics of an effective leader are crucial for the team’s performance. Dr. DeBowes pointed out that good leaders are made and not born. Having the prerogative to lead does not mean one is automatically a good leader. Being a leader does not mean that one only gives directions to others, but one also needs to be able to inspire people to think outside the box and give the team accountability. A good leader appreciates and acknowledges the contribution of each team member. Leadership is a skill that can be learned through training and needs to be practiced.

As veterinarians, we are all leaders; we lead our team and it is important to also lead ourselves through practicing self-awareness and self-management. With regard to self-leadership, Dr. DeBowes taught us that having core values and sticking to self-leadership is a skill that can be learned through training and needs to be practiced.

Pleins feux sur une participante au Programme des futurs leaders

Evy van Nobelen


Avant d’assister au Programme des futurs leaders (PFL), je me sentais désillusionnée face à la médecine vétérinaire. Je me sentais prise au piège émotionnel par les clients et les membres de l’équipe, je n’avais pas eu de mentorat et les compétitions entre collègues et des environnements toxiques au travail avaient finalement affecté mon bien-être. En même temps, j’avais perdu mon admiration pour le rôle de vétérinaire qui m’inspirait auparavant. J’ai décidé d’observer les vétérinaires et leurs équipes durant des petits ateliers locaux et dans leurs cliniques lors d’une activité de jumelage. Malheureusement, j’ai découvert qu’il y avait beaucoup de compétition et de peur, tant entre les cliniques et au sein des cliniques entre les divers postes. Quelques vétérinaires que j’ai rencontrés ont été francs à propos de leur réticence à m’offrir du mentorat, afin de partager leurs compétences et connaissances. Ils semblaient craindre de perdre leur clientèle et leur revenu. J’éprouvais du cynisme et de la déception envers les collectivités vétérinaires que je connaissais.

Fort heureusement, le PFL est arrivé juste à temps. Le Dr Rick DeBowes est un conférencier très motivant.

On nous a donné des tâches et des morceaux de casse-tête et il fallait travailler en équipe pour les terminer. Il s’agissait d’excellentes leçons en communication et en comportement humain. Les exercices m’ont montré une équipe saine et comment elle effectue son travail. Il faut qu’il y ait du respect, une bonne communication entre les membres de l’équipe et un bon leader. Durant les ateliers, nous avons aussi discuté ce en quoi consiste un bon leadership et les caractéristiques qui sont cruciales pour un leader efficace afin d’assurer le bon fonctionnement de l’équipe. Le Dr DeBowes a signalé que les bons leaders sont formés et ne sont pas nés comme tels. La responsabilité du leadership ne signifie pas automatiquement que nous sommes un bon leader. Le leadership ne signifie pas seulement la communication de directives aux autres, car il faut aussi être capable d’inspirer les gens à sortir des sentiers battus et de responsabiliser l’équipe. Un bon leader apprécie et reconnaît les contributions de chaque membre de l’équipe. Le leadership est une compétence qui peut s’apprendre par de la formation et que l’on doit exercer.

À titre de médecins vétérinaires, nous sommes tous des leaders. Nous dirigeons notre équipe et il est important aussi de nous comporter en leaders en étant conscients de notre comportement et le gérant de façon appropriée. En ce qui concerne le leadership en soi, le Dr DeBowes nous a enseigné qu’il fallait avoir des valeurs fondamentales et les respecter en milieu de travail afin de nous aider à créer des limites et à nous épanouir. Mes valeurs fondamentales me définissent moi et mon milieu choisi. Le Dr DeBowes nous a aussi encouragés à garder l’esprit ouvert, à rechercher des possibilités et à prendre des risques afin de nous améliorer. Il a expliqué que notre état d’esprit a un impact sur notre pensée et nos
to them in the workplace will help us to create boundaries and find fulfillment. My core values define me and my chosen environment. Dr. DeBowes also encouraged us to keep an open mind, look for possibilities, and take risks in order to grow. He explained that our mindset impacts our thinking and action. As most people fear change, our own beliefs can limit possibilities. I took his advice to heart and took the risk. Now, I have found fulfillment in a healthier work environment.

The ELP 2018 in Vancouver provided an amazing experience and knowledge on leadership. It has renewed my enthusiasm, motivation, and aspirations as a veterinarian. In my opinion, veterinarians of all levels and also practice managers should participate in leadership training to help them build a productive, healthy, and sustainable workplace.

Obituary

Dr. Tom Hulland

Family, colleagues, and friends will miss Dr. Thomas (Tom) Hulland, who passed away on October 15, 2018. He will be missed not only because he was an exceptional academic and internationally respected pathologist but also because he was a gentle, thoughtful man who earned the admiration of students, staff and faculty colleagues.

Tom was a 1954 DVM graduate of the Ontario Veterinary College (OVC) who later earned a Veterinary Surgery diploma from the OVC and a PhD in pathology from the University of Edinburgh, Scotland. He was a diplomate of the American College of Veterinary Pathology (ACVP) and became president of the ACVP in 1973. He was an exceptional teacher and research advisor who cared about his students and always took the time to explain pathology. His leadership at the OVC included roles of chair of the Department of Pathology, associate dean, Academic (for 12 years), and acting dean. He was chair of several college and university committees and task forces. He was sought after for these roles because of his caring for the institution, his fairmindedness, and his outstanding capacity to listen and be genuinely interested in what each person had to say.

Tom served the profession beyond the University of Guelph. He was president of the Canadian Veterinary Medical Association (CVMA) in 1971–1972 and a member of the CVMA Council for several years. He was a Fellow of the Royal Society of Medicine, London, England. In 2002 he was honored as OVC Distinguished Alumnus in recognition of his unselfish devotion to his students and his outstanding life-long contributions to his profession and university.

Tom is survived by Eleanore, his wife of 62 years, 4 children, and 8 grandchildren. A Celebration of Life took place at the University of Guelph Arboretum Center, Guelph on Saturday, December 1st.

Carlton Gyles
RVTTC Announces New Affiliate Membership of World Small Animal Veterinary Association

On September 24, 2018, at the World Small Animal Veterinary Association (WSAVA) General Assembly in Singapore, the Registered Veterinary Technologists and Technicians of Canada (RVTTC) was accepted as a new affiliate member of the WSAVA Global Veterinary Community.

“The WSAVA is excited to welcome the RVTTC as an affiliate member and as such, all of their members to the WSAVA Global Veterinary Community,” says Dr. Walt Ingwersen, WSAVA immediate past-president. “Our strategic plan recognizes the value of all companion animal team members in achieving the WSAVA Vision and Mission, of which veterinary technicians are integral members. We look forward to further involvement from the RVTTC in both collaborative continuing education delivery, as well as active members in our guideline groups”.

Nationally, the RVTTC and the Canadian Veterinary Medical Association (CVMA) work closely together on a variety of committees including CVMA Council, CVMA Animal Welfare Committee, CVMA AHT/VT Program Accreditation Committee, and the CVMA Professional Development Committee. Together, they honor the Memorandum of Understanding (signed in 2014) by working in harmony to support and advance veterinary medicine in Canada.

“The CVMA is thrilled to have helped bring Canadian registered veterinary technologists and technicians into the global veterinary health discussion,” says Dr. Terri Chotowetz, CVMA president. “Recognizing the RVTTC as an affiliate member of WSAVA will strengthen the relationship Canada has with the global veterinary community and undoubtedly contribute to the advancement of veterinary medicine worldwide.”

Internationally, 2016 marked the RVTTC becoming the 1st veterinary technician association to join the World Veterinary Association. As small animal medicine is a significant area of expertise within the registered veterinary technician and technologist (RVTs) membership, the RVTTC wished to expand its global connections to share this expertise, while providing an opportunity for RVTs to engage within the WSAVA global veterinary community. As an affiliate member of WSAVA it will be mutually beneficial to share the RVT voice while actively contributing within the WSAVA committees.

The RVTTC Board of Directors wishes to thank Dr. Jim Berry for presenting the application on its behalf.

The Registered Veterinary Technologists and Technicians of Canada (RVTTC) is a not-for-profit national organization uniting Canadian veterinary technician and technologist associations. Founded in 1989 as the Canadian Association of Animal Health Technologists and Technicians (CAAHIT), RVTTC is tasked with promoting the veterinary technology profession, establishing and maintaining national standards of membership, and is a resource regarding national and international issues.

TTVAC announces a new affiliation membership to the World Small Animal Veterinary Association

Le 24 septembre 2018, à l’Assemblée générale de la World Small Animal Veterinary Association (WSAVA) tenue à Singapore, Technologues et techniciens vétérinaires agréés du Canada (TTVAC) a été accepté à titre de nouveau membre affilié de la collectivité vétérinaire mondiale de la WSAVA.

«La WSAVA est excitée d’accueillir TTVAC à titre de membre affilié et, à ce titre, tous ses membres au sein de la collectivité vétérinaire mondiale de la WSAVA», dit le Dr Walt Ingwersen, président sortant de la WSAVA. «Notre plan stratégique reconnaît la valeur des membres de l’équipe des animaux de compagnie pour la réalisation de la vision et de la mission de la WSAVA, dont les techniciens vétérinaires font partie intégrante. Nous nous réjouissons à la pensée de la participation accrue de TTVAC à la formation continue concertée et en tant que membres actifs au sein des groupes des lignes directrices.»


«L’ACVM est ravie d’avoir contribué à l’intégration des technologues et des techniciens vétérinaires agréés canadiens dans la discussion sur la santé vétérinaire mondiale», dit la Dr* Terri Chotowetz, présidente de l’ACVM. «La reconnaissance de TTVAC en tant que membre affilié de la WSAVA renforcera la relation qu’a le Canada avec la collectivité vétérinaire mondiale et contribuera assurément à l’avancement de la médecine vétérinaire à l’échelle mondiale.»

À l’échelle internationale, en 2016, TTVAC est devenu la première association de techniciens vétérinaires à se joindre à l’Association mondiale vétérinaire. Vu que la médecine des petits animaux représente un domaine d’expertise important au sein de l’effectif des techniciens et des technologies vétérinaires agréés (TVA), TTVAC désirait élargir ses relations mondiales afin de communiquer son expertise tout en offrant des occasions aux TVA de participer au sein de la collectivité vétérinaire mondiale de la WSAVA. À titre de membre affilié de la WSAVA, il sera mutuellement bénéfique de partager la voix des TVA tout en contribuant activement aux comités de la WSAVA.

Le conseil d’administration de TTVAC désire remercier le Dr* Jim Berry qui a présenté la demande en son nom.

Technologues et techniciens vétérinaires agréés du Canada (TTVAC) est une organisation nationale sans but lucratif qui unit les associations de techniciens et de technologies vétérinaires canadiens. Fondé en 1989 sous le nom d’Association canadienne des technologues et techniciens en santé animale (ACTTSA), TTVAC a pour mission de promouvoir la profession de technologue vétérinaire, d’établir et de maintenir les normes nationales d’adhésion et est une ressource à l’égard des enjeux nationaux et internationaux.
**Taking it Online**

*New online platform supports Canada’s veterinarians in overseeing responsible use of veterinary antimicrobials*

The Canadian Veterinary Medical Association (CVMA), with the input of key stakeholders, has created a new online platform for Canada’s veterinarians to support decision-making on appropriate and responsible use of antimicrobials in animals.

The CVMA Guidelines for Veterinary Antimicrobial Use is an electronic searchable interface with filtering capabilities for quicker access to information on antimicrobial use. It also allows for more frequent updating of information and the addition of new resources, and it is accessible from a variety of devices (e.g., laptop, tablet, smartphone).

“As veterinarians, we oversee the appropriate and responsible use of antimicrobials in animals, thereby helping minimize the emergence and spread of antimicrobial resistance; a threat in Canada and around the world,” says CVMA president Dr. Terri Chotowetz. “The new online platform of veterinary guidelines for antimicrobial use allows our profession to support Canada’s overarching strategy on antimicrobial resistance and use.”

The updated format replaces the CVMA’s original print-only guidelines from 2008. The scope of the original guidelines (4 species groups: beef, dairy, poultry, and swine) was expanded to include small ruminants and companion animals (canine, feline). Recommendations on antimicrobial use were developed and tested by key subject matter experts and their supporting teams, representing 6 veterinary species groups.

Development of the updated veterinary guidelines for antimicrobial use was supported during 2017 and 2018 by funding from Agriculture and Agri-Food Canada’s AgriAssurance Program, and the Canadian Food Inspection Agency.

All licensed veterinarians in Canada will be granted full access to content on the new information platform hosted on the CVMA website (www.canadianveterinarians.net/AMU-UAM) until April 1, 2019, when only active CVMA members will have full access.

The new online platform is intended to host documentation and information to be reviewed and updated regularly to ensure it represents the latest in guidance and science-based knowledge. Future platform development will include integrated links to other key resources, veterinary guidelines for additional animal species, information on alternatives to antimicrobial use. The guidelines will be available in both official languages.
The work by the CVMA will help Canada's commitment to conserve the effectiveness of antimicrobials now and into the future, in animals and humans, as described in *Tackling Antimicrobial Resistance and Antimicrobial Use: A Pan-Canadian Framework for Action*.

You may not have the time, facilities, or experience to write scientific articles for review by experts. But you have interesting and valuable experiences that are worth sharing. We encourage you to share by submitting articles to Practitioners’ Corner, *The Canadian Veterinary Journal*. Simply e-mail your article to Ms. Heather Broughton (hbroughton@cvma-acmv.org). We will edit to ensure the format is correct then we will publish your article in *The CVJ*. 

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The Pan-Canadian Approach to Wildlife Health

Craig Stephen

Wildlife diseases and their effects are expected to increase with climate change, urbanization, and increased natural resource development (1). Growing demands for cumulative effects management are creating new expectations to measure, monitor, and maintain wildlife population health (2). A new approach is needed to: i) harmonize capacity across Canada; ii) more efficiently use shared platforms, infrastructure, and expertise; and iii) bolster the ability to quickly detect emerging threats while promoting new partnerships to anticipate problems and sustain healthy populations in advance of harm. The current approach to wildlife health problems is often reactive and follows a “disease-by-disease” sequence. As a consequence, problems are rarely addressed in their early stages and response options may be few. There is a need for greater focus on early warning, prevention, and preparedness, which will depend on improved knowledge of risks, better surveillance for early warning, improved coordination, and integrated response capability. In the Spring of 2018, all federal, provincial, and territorial Ministers responsible for biodiversity and conservation approved a new Pan-Canadian Approach to Wildlife Health. The Approach presents a vision for wildlife health to protect the socioeconomic, cultural, and ecological value of healthy wildlife. The Canadian Wildlife Health Cooperative has championed this modernization of wildlife health over the past 4 years, working closely with government and non-governmental partners to advocate for an approach to effectively respond to up-and-coming threats to conservation, public health, and economies from climate change, emerging diseases, globalization and changes to organizational capacities.

The Approach addresses 4 challenges. First, is the challenge of crossing boundaries. Unlike public health and domestic animal health, which are the mandates of specific government agencies with direct budget allocations, wildlife health falls across multiple agencies at several levels of government. Problems at human-animal-environmental interfaces require an all-of-government approach, but the gulf between departmental and jurisdictional mandates seems exceptionally wide for wildlife health. While federal, provincial, and territorial governments implement a wide variety of wildlife health programs within their mandates, many wildlife health issues fall across multiple departments and levels of government. The success of past collaborations (e.g., avian influenza, white nose syndrome of bats) is driving demand for more regular and systematic mechanisms to share capacity and information across programs and personnel. For this reason, partnerships and coordinated networks of expertise are essential for achieving the goals of the Pan-Canadian Approach. The Approach outlines an innovative public management model with the flexibility to deliver and integrate roles across Ministries, governments, and private sectors.

The second challenge arises from our rapidly changing social and environmental conditions. With changing landscapes and climates, and global transport of humans and goods, new avenues are being created for the movement of pathogens and pollutants into and within the Canadian environment. These changes are creating new risks for conservation, public health, and economic activities. Wildlife health continues to be a “canary in the coal mine” that helps us to identify environmental threats in advance of human illness, ecological effects, or economic impacts. Demands for wildlife health services and expertise are growing beyond current capacity because of the needs for assurances for trading partners, the expectation to manage for uncertainty, and the increase in emerging diseases threatening public health, conservation, and agriculture.

Thirdly, we are challenged in providing assurances throughout the second biggest country in the world that human activities are not negatively affecting wildlife health, or that wildlife health is not a risk. Efforts and investment vary throughout the country and few formal mechanisms exist to share and make best use of wildlife health observations. Canada must be able to make credible and verifiable wildlife health claims to meet its international and national obligations. The World Organisation for Animal Health (OIE) and World Health Organization (WHO), for example, both require that Canada maintain capabilities that can immediately detect and respond to unusual or unforeseen events that may become a significant human or animal health threat. The Convention on Biological Diversity and the Rio Declaration on Environment and Development similarly require that signatories be able to identify and monitor circumstances likely to adversely impact conservation and sustainable use of biological diversity. Canada’s Constitution affirms the rights of First Nations, Métis, and Inuit peoples to hunt, fish, and consume wild foods. The implementation of the Pan-Canadian Approach to Wildlife Health contributes to the fiduciary obligations owed to First Nations, Métis, and Inuit peoples and provides a strong response to our international obligations.

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The fourth challenge is our increasing reliance on ad hoc programs without sustainable or predictable resource. This situation is creating a deficit that is diminishing services and capabilities which, in turn, threatens the ability to anticipate emerging needs, provide nationally representative situational awareness, allow for prevention and preparedness, harmonize an equitable program across Canada, and plan beyond an annual cycle.

The 4 strategic goals of the Approach are to: i) strengthen Canada’s capacity to identify and reduce wild animal health threats and determinants that put conservation, public health, and cultural or economic opportunities at risk; ii) develop, implement, and assess programs and policies intended to sustain healthy wild animals and the positive contributions they make to Canada by reducing disparities and differences in capacity and information across the country; iii) encourage strategies that improve anticipation of wildlife health policy and practice needs in the face of rapidly changing social and environmental conditions; and iv) improve efficiency and effectiveness of public services by working together towards the goal of sustainable wildlife health.

The approach focuses on 4 pillars of activity to achieve its goals. The first is health intelligence: the process of generating, collecting, and analyzing a variety of information to foster collaboration and consultation through innovation in surveillance, information exchange, research, and response. Health intelligence activities will link information to document the wildlife health situation in Canada, including signals of emerging risks and changes in vulnerability. This will be achieved, in part, by working towards equitable access to diagnostic and investigatory capacity to track wildlife health trends and assess their significance and by developing coordinated analytical capacity to interpret and communicate health intelligence outputs.

The second pillar develops and supports coordinated and responsible management of expertise and capacity across Canada, providing independent advice, and helping achieve policy goals through wildlife health stewardship. A national secretariat will be responsible for planning and managing capacities and functions needed to provide a national perspective on wildlife health, regularly assemble a pan-Canadian perspective of the state of wildlife health and ensure timely sharing of policy-relevant knowledge arising from the network.

Innovation is the third pillar of the Approach. Wildlife health innovation involves research and knowledge transfer that lead to new public policy and practices to forecast ways to prevent adverse wildlife health outcomes and sustain confidence and access to the services wildlife provide Canadians. The fourth pillar promotes openness, transparency, and integrity through integrated governance to facilitate effective collaboration and promotes performance orientation in program delivery. A recently created forum for leadership, strategy, policy development and inter-jurisdictional cooperation will help translate wildlife health policy goals and social expectations into positive health outcomes.

The Pan-Canadian Approach to Wildlife Health will ensure fair and secure marketplace access and public use of natural resources, collectively worth billions of dollars to the Canadian economy. The resulting wildlife health intelligence network will strive to: i) be nationally representative; ii) identify needs for adaptive management of endemic problems; iii) provide early warning of emerging threats; iv) detect infectious, non-infectious, or environmental threats; and v) support a sentinel system to monitor environmental safety. The improved situational awareness will help identify, triage, and prioritize threats across Canada to support risk prioritization and evidence-based risk management across public health, conservation, agriculture, natural resource management, and other economic and social sectors. The Approach ensures no single agency bears the full burden of a national program and that investment of any one agency is leveraged by the capacity, infrastructure, and expertise secured through the total investment of all partners. A health protection focus supports more cost-effective and proactive responses against threats compared to investing only in reactions to problems after they emerge.

Canada’s approach to wildlife health is internationally well-respected, serving as a model for many other countries. The essential structures and arrangements necessary to implement the Pan-Canadian Approach to Wildlife Health are in place; however, they require coordination, resources, and dedicated leadership. Environmental and Climate Change Canada is leading the government’s charge to implement the Approach. It is supported by the advice and cooperation of a committee of federal, provincial, territorial, First Nations, Inuit, and academic and non-governmental partners. This committee will help identify 5-year priorities for action and create the business case to secure the funds needed to see that the goals of the Approach are fully realized. The Pan-Canadian Approach builds on the foundations created by the Canadian Wildlife Health Cooperative by sustaining and supplementing core stewardships and health intelligence capacities and creates new opportunities to expand the network of skills and expertise to meet modern demands for a national wildlife health program. Interacting with knowledge users, knowledge producers, partners in Canada and abroad will allow for more effective mobilization of information to decision-makers. By networking wildlife health expertise and knowledge found in existing provincial, territorial, federal, and academic partners, a more resilient, better informed, and better prepared network will be created.

References
Review Article  Compte rendu

What is the evidence that bovine coronavirus is a biologically significant respiratory pathogen in cattle?

John Ellis

Abstract — Coronaviruses, including bovine coronavirus (BCoV), are etiologically associated with enteric and respiratory disease across a wide range of mammalian and avian species. The role of BCoV in calfhood diarrhea is well-established, but its role in the bovine respiratory disease complex (BRDC) has been controversial. This review re-examines the evidence that BCoV is a significant pathogen in the BRDC.

Résumé — Quelle est la preuve que le coronavirus bovin est un agent pathogène biologiquement important chez le bétail? Les coronavirus, y compris les coronavirus bovins (BCoV), sont étiologiquement associés à des maladies entériques et respiratoires chez un vaste éventail d’espèces mammifères et aviaires. Le rôle du BCoV dans la diarrhée des veaux est bien établi, mais son rôle dans le complexe de la maladie respiratoire bovine est controversé. Cet examen se penche de nouveau sur les preuves indiquant que le BCoV est un agent pathogène important pour le complexe de la maladie respiratoire bovine.

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Introduction

Bovine coronavirus (BCoV) belongs to a family of microbes that is etiologically associated with enteric and respiratory disease across a wide range of mammalian and avian species (1). The role of BCoV in calfhood diarrhea is well-established, and it continues to be a problem in calf-rearing operations (1). The role of BCoV in the bovine respiratory disease complex (BRDC) has been controversial, and, if anything, the recent increased application of molecular diagnostics to BRDC cases has further muddied the waters. Over the years since its discovery there have been several reviews on BCoV, including some focusing on “respiratory” BCoV (2–5). Beyond the biological precedents linking coronaviruses to respiratory diseases, recent information concerning BCoV is reviewed herein, and the evidence that implicates BCoV in the BRDC is re-addressed.

A brief history of bovine coronavirus

Exemplifying Pasteur’s aphorism, “Chance only favors the prepared mind,” BCoV was accidently discovered by Mebus et al (6) at the University of Nebraska in 1972. These authors were conducting efficacy studies on a vaccine for the then newly discovered bovine reovirus-like virus (rotavirus) and astutely observed that while the vaccine was apparently effective in reducing diarrhea due to the rotavirus, there were several herds in which vaccinated calves developed diarrhea later than expected with rotavirus, and their feces were free of that microbe. Mebus et al (6) observed a corona-like virus in diarrheic feces and conducted transmission experiments in gnotobiotic calves. They then cultured the virus, determined which cell types would support growth, attenuated the virus, and performed initial protection experiments (7). In the next decade BCoV was recognized as a common cause of calfhood diarrhea (8). In 1982 Thomas et al (9) working in England in a search for new microorganisms in calf pneumonia first implicated BCoV as a respiratory pathogen by inoculating material from nasopharyngeal swabs and lung washes from calves with naturally occurring respiratory disease into gnotobiotic calves. Coronaviruses were then observed using electron microscopy in respiratory samples and supernatants from organ cultures that were inoculated with respiratory samples from the experimentally infected calves (9). The studies by Thomas et al (9) also provided the first indication that the 2 BCoVs associated with enteric and respiratory disease were the same, or at least belonged to the same serotype, by noting that serum raised against enteric isolates of BCoV immunoagglutinated the “respiratory” BCoV. Shortly thereafter, workers in the same laboratory extended investigations of the relatedness of BCoVs in 1985, and demonstrated immunity to heterologous infection and cross-neutralization of BCoVs by porcine antisera to enteric and respiratory isolates (10). Subsequently, numerous investigators have confirmed, using various techniques, that enteric and
Coronaviruses are spherical to pleomorphic enveloped RNA viruses (1–5). They have distinctive club-shaped 20-nm peplomers or "spikes" protruding uniformly, circumferentially from the envelope. Some coronaviruses, including BCoV, have a secondary fringe of smaller 5-nm spikes (1–5). In electron micrographs the overall appearance of the viral particles was reminiscent of the solar corona to virologists, hence the name “corona” (12). The lipid-containing envelope makes these viruses susceptible to conventional disinfectants and the extra-corporal environment (1). The larger spike is a heterodimeric glycoprotein comprising 2 subunits, S1 and S2 (1,2,5). This spike protein has several important biological features: it interacts with sialic acid-containing receptors on the target cell membrane, probably largely determining tissue tropism and species specificity of different coronaviruses; it is involved in fusing infected cells; it contains, mostly conformational, epitopes that are the major targets for antibody responses and less well-characterized cell-mediated immune responses; and it is the major site of immunologically important antigenic variation amongst BCoV isolates, which likely contributes to vaccines working, or not (1,2,5). The smaller spike is a second envelope glycoprotein, which is also a heterodimer comprising a host membrane (class I) protein and a hemagglutinin-esterase (HE). This spike also interacts with cellular receptors and contains epitopes that are targets for neutralizing antibodies (1,2,5). There are 3 other structural proteins; 2 transmembrane proteins: M and E, that assist in viral assembly, and an internal N or nuclear protein that is associated with the genome to form a helical nucleocapsid. The amino acid structure of N protein is relatively conserved amongst BCoV isolates and is therefore targeted in diagnostic testing such as polymerase chain reactions (PCRs) (1,2,5). Less glamorous, but no less biologically significant, is a group of 4 to 8 (depending on the particular coronavirus) nonstructural "accessory" proteins. These proteins have been best characterized in the emergent bat coronaviruses, notably SARS virus, but have not been thoroughly examined in BCoV. Nevertheless, a major function of these proteins is to inhibit innate (interferon) responses (1,13). Inter-isolate differences in this immunosuppressive function could contribute to differences in virulence amongst BCoV isolates (13); time will tell.

Coronaviruses are in the Order Nidovirales (from the Latin nidus, nest), which refers to their complex replicative scheme, involving “nests” of subgenomic RNAs (1). Essentially, this involves 3 major steps. First, part of the +stranded RNA genome acts as messenger RNA for the synthesis of an RNA-dependent RNA polymerase. Then, this enzyme guides cellular machinery in the cytoplasm of the infected cell to transcribe a full length negative (complementary) RNA from which a new copy of the +strand genome is transcribed. The RNA polymerase also directs the transcription of a set, or “nests” of subgenomic messenger RNAs from the complementary RNA strand, which the cell uses to translate individual viral proteins (1). Molecular details aside, this highly error-prone replicative scheme, together with the possibility of recombination between isolates, results in high mutability, making BCoV and other coronaviruses rapidly moving targets.

Historically, coronaviruses were divided into 3 groups based on genetic and serologic properties: Group 1 included feline infectious peritonitis virus and transmissible gastroenteritis virus, and lacked the hemaglutinin-esterase (HE); Group 2 included BCoV and the human "cold" virus, HCoV-043, and had the HE; and Group 3 included avian viruses, notably infectious bronchitis virus (2,5). More recently, the relative ease and low cost of sequencing, together with the discovery of more coronaviruses, have complicated the taxonomy of coronaviruses (1). These viruses are currently divided into 4 genera based on the partial nucleotide sequences of the RNA-dependent RNA polymerase: alpha, beta (contains 4 subgroups A to D), gamma, and delta, with BCoV in the beta A grouping, with its close relationship to the human (and canine) "respiratory" coronaviruses preserved. Genotyping of BCoV isolates is in its infancy (14). However, despite the confusion more cladistics analyses may bring, it is likely that the current bottom line will not change; BCoV exists as a quasispecies with 1 serotype, but with significant variation, including antigenic spectrum, tropism, and virulence, amongst isolates that does not necessarily relate to their clinical origin (enteric versus respiratory) (1,5).

Circumstantial evidence that BCoV is a respiratory pathogen

Associations with ex vivo and postmortem sampling

As indicated in the first report implicating BCoV as a respiratory pathogen in the early 1980s (9), the presence of a microbe in nasal secretions and other respiratory samples has long been taken as evidence of pathogenicity/causality in BRD cases. Historically, detection was accomplished using electron microscopy and/or virus isolation. Isolation of BCoV in cell culture can be problematic because, as first reported in the seminal studies (7), it is fastidious, especially in the case of field isolates (15,16). The latter usually preferentially grow in primary or very low passage cell cultures, and, for some undetermined reason, in the human rectal adenocarcinoma cell line, HRT-18 (17), which is the cell of choice in most diagnostic settings when culture of BCoV is attempted (1). Currently, as throughout veterinary diagnostic medicine, reverse transcriptase (RT)-PCR-based methods (18–25), and most recently metagenomic analysis (26) have largely supplanted culture in identifying BCoV in clinical samples. The increased sensitivity, however, could lead to false positives with regard to biological significance in the likely case that a certain threshold of viral growth is necessary to cause clinical disease. Attesting to this caveat emptor, as is the case with many (all?) endemic pathogens in host populations, BCoV has been identified in respiratory samples from healthy (16,21,26–28) as well as sick cattle (16,18–25). In the latter case, BCoV shedding has been documented in the absence of other recognized, or tested for, respiratory pathogens (27,28), and, more frequently as an apparent co-conspirator with other
respiratory pathogens in clinical specimens (18,22,27–31). Even if it is not consistent with Evans’s postulates (29) the presence of BCoV in the nasal secretions of healthy cattle is not exculpatory of pathogenicity; however, it does make the indictment of BCoV as a significant respiratory pathogen, based on presence alone, more tenuous. Simply because a microbe is present in a sick animal does not necessarily mean it is a pathogen. Quantitative PCR (qPCR) has been used experimentally in a small number of calves to correlate amount of nasal shedding with transmissibility (32). No direct link was found, but this study suffered the confounding variable of developing immunity (32). Beyond Evans postulates (29), more data correlating BCoV load with disease would be an obvious theoretical and practical advancement to more definitively establish the conditions of causality with regard to the detection of BCoV in clinical samples.

**Associations with immune responses to BCoV**

Like a fingerprint at the scene of a crime, traditionally and currently, post-disease seroconversion is often used as evidence of causality. From its initial discovery and indictment in respiratory disease to the present day, numerous serological studies have implicated BCoV; but not without reasonable doubt (28,31,33–37). Conversely, an association between an immune response to BCoV, *a priori* to exposure/challenge, and disease-sparing has also been taken as circumstantial evidence of causality. Several epidemiologic studies have reported that high antibody titers to BCoV, most likely resulting from exposure prior to weaning, can have a respiratory disease-sparing effect. Cattle with high antibody titers on entry to a feedlot or other situations of exposure are less likely than those with low antibody titers to develop the BRDC and/or require treatment (28,31,34,38–40). In addition, in the 1 and only prospective study that examined the effect of (intranasal) vaccination for BCoV it was reported that vaccination before entry to the feedlot and/or antibody titers > 20 were associated with decreased risk of treatment for BRDC; whereas vaccination on arrival was associated with increased risk (41). However, in the absence of specific etiologic diagnosis, preferably visualization of BCoV in lesions, these data may indicate an association and not a causal relationship. The data do not rule out that calves with a broad range of immunological experience may have less BRD simply because they also have antibody and other immune responses to the pathogen(s) which is the true cause of the observed disease; bovine respiratory syncytial virus (BRSV), for instance. Moreover, at the individual calf level, data are conflicting as to the predictive value of BCoV antibody titers regarding which calves require treatment for BRDC after entry to a feedlot (25,28,34).

**Physical evidence that BCoV is a respiratory pathogen**

In contrast to the relative plethora of circumstantial evidence in the form of epidemiologic data and routine diagnostic testing of clinical specimens that are often used to indict BCoV as a respiratory pathogen, there is a dearth of physical evidence of its criminality in that organ system. Quite simply, there are very few images demonstrating BCoV in lesions in the respiratory tract in naturally or experimentally infected cattle in the peer-reviewed literature or textbooks, which would arguably constitute a “smoking gun” of direct evidence, at least for pathologists. From the standpoint of naturally occurring disease, this could be due, at least in part, to the timing of sampling. Cattle that die of respiratory disease often present little physical (immunohistochemical) evidence of viral infection in affected organs simply because the acutely infecting respiratory viruses have come and gone by the time an animal succumbs to secondary, more readily demonstrable, bacterial infections (5,42). In the last decade, 1 investigation of outbreaks of acute respiratory disease in intensively reared beef calves showed a series of good quality gross and histological lesions. These included tracheal petechiation together with mucopurulent discharge and bronchointerstitial pneumonia with intra-bronchial syncytial cells in an affected airway that could have been compatible with BCoV infection (43). Bovine coronavirus RNA was detected by qRT-PCR in 2 of 15 lesional lungs tested; however, unfortunately, there was no apparent attempt to directly associate BCoV with the histological lesions.

From the perspective of attempting to demonstrate Koch’s postulates by experimentally reproducing disease, convincing evidence convicting BCoV in a causal relationship with respiratory disease is scant. Four studies reported a failure to produce clinical respiratory disease using various BCoV-containing inocula (10,44–46). The first was a complicated cross-protection study and used feces from diarrheic calves administered orally or material from nasopharyngeal swabs administered intranasally and intratracheally as inoculum. Bovine coronavirus-positive epithelial cells were demonstrable in nasal turbinates and/or tracheas of 11 of 12 infected calves; however, there was no associated inflammation reported or evident in pictures of immunohistochemically stained tissues (10). No BCoV was similarly identified in lungs of any calf. In a second study, 18 (3- to 50-day-old) gnotobiotic calves and 7 (25- to 63-day-old) colostrum-deprived calves were inoculated intranasally, orally, or by both routes with a suspension of BCoV-containing intestinal contents that had been derived from the 5th passage of similar material in gnotobiotic calves and was “bacteriologically sterile” (44). All the calves developed diarrhea by 2 to 4 d after infection, but none had clinical signs of respiratory disease. Bovine coronavirus-infected nasal and/or tracheal epithelial cells were detected in 16 of the 18 calves, and in the “lung tissue” (impression smears) of 4/18 calves by immunofluorescent staining. Two of the latter calves had “focal interstitial pneumonias”; however, assessment of histological changes was not performed, or at least not presented. In the third study, 5 (1- to 10-day-old) colostrum-deprived calves and 2 (5- to 27-day-old) gnotobiotic calves were administered either 40 mL of a HRT-18 cultured (passage level and dose not given) “respiratory” strain (BC930), or “a winter dysentery strain” or “a calf diarrhea strain,” “oronasally” (passage levels and doses not given) (45). All calves developed diarrhea of variable severity and duration. No calves developed signs of respiratory disease, and aside from monitoring nasal (and fecal) shedding of BCoV, there was no examination of any tissues from the respiratory tract to determine sites of infection. Arguably the most convincing experimental physical evidence of
the pathogenicity of BCoV in the respiratory tract was obtained with a winter dysentery isolate of the virus, the Korean strain “KWD3” that had been passaged 6 times in HRT-18 cells (46). Six 2- to 4-day-old colostrum-deprived (CD) Holstein calves were inoculated orally with 40 mL of HRT-18 cell culture supernatant containing 1.5 × 10^8 focus (plaque) forming units/mL; 1 CD calf was mock infected with 40 mL of uninfected HRT-18 cell culture supernatant, and 1 CD calf received 40 mL of inactivated infected HRT-18 supernatant. All of the infected calves developed diarrhea and elevated body temperatures; the mock infected controls did not. Despite the report of no clinical signs of respiratory disease in the infected calves, there were significant lesions described throughout the respiratory tract, including infection and necrosis of epithelia in the nasal turbinates, trachea, bronchioles, and pulmonary parenchyma. There was associated interstitial pneumonia and hyperplasia of type II pneumocytes, and BCoV antigens were demonstrated immunohistochemically in the cytoplasm of degenerate epithelial cells. Unfortunately, these changes were illustrated in figures of only moderate quality, somewhat limiting interpretation. Although the authors did not exclude the possibility of some inhalation of the inocula during administration, they made the point of discussing a probable role for viremia, including cell-free and infection of cells of monocyte macrophage lineage, resulting from transmucosal transmission in the pathogenesis of respiratory infection.

Two studies reported reproduction of some level of respiratory disease (47–49). In the first published attempt to produce respiratory disease with BCoV, 7 (<7-day-old) calves, 5 CD, 2 colostrum fed, were infected with a tracheal-organ culture supernatant containing BCoV (derived from a field case) as inoculum (47). Mild signs of respiratory disease, including cough and nasal discharge, as well as diarrhea, were produced. A few scattered areas of atelectasis were observed in lungs of 3 calves; changes in tracheas and nasal turbinates were not reported. Bovine coronavirus positive cells were visualized by immunofluorescence in the lungs of 2 calves, but no histological examination of respiratory organs was reported. However, this was the result of a draconian, unnatural challenge method involving both intranasal and transtracheal inoculation of 10 mL of supernatant given twice daily for 4 consecutive days. In another study published as 2 brief communications (48,49), 5-day-old CD Holstein calves were infected orally with different doses of an attenuated BCoV (2 calves; Mebus strain; 41 passages in vitro) or a ”virulent pneumoenteric strain,” the “Minnesota strain” in the form of suspended filtered fecal material containing BCoV from a field case (3 calves). All 3 calves that received the field isolate developed diarrhea; 2 had “pneumonia,” including respiratory distress, and 1 of these died. The investigators reported fluorescence using BCoV conjugates [but not with conjugates for bovine respiratory syncytial virus (BRSV), bovine parainfluenza virus-3 (BPIV-3), or bovine herpes virus-1 (BHV-1)] of variable intensity in lung sections and “disrupted nasal cells.” There were no images of lesions or immunological staining.

Some degree of diarrhea resulted during the attempts to reproduce respiratory disease with inocula containing BCoV, even when “respiratory” isolates were used and some respiratory disease was observed. Ironically, this unintended outcome provides some of the best evidence of the still-debated idea that the BCoVs that cause enteric and respiratory disease in cattle are essentially the same (5). Excluding the possibility that BCoV is not a significant respiratory pathogen, it is not known why respiratory disease caused by BCoV has been so difficult to reproduce. It could involve strain differences, host factors, or environmental co-factors to name a few, but it may be as conceptually and practically simple as how the BCoV inoculum is propagated. As demonstrated in the first paper reporting the in vitro culturing of BCoV nearly 50 y ago (7), and confirmed subsequently (2,5), upon repeated passage in cell culture, BCoV isolates become more promiscuous in their ability to grow in a broader range of cell types, and in higher passage cell cultures. This could simply reflect the de facto selection of variants within the quasispecies that are more flexible in their growth requirements. Again, the seminal studies indicated that this “adaptation to culture” is associated with attenuation (7); good for vaccine development, not so good for producing inocula to study pathogenesis. Still, the details as to how, and to what extent this promiscuity concerning target cell permissivity to infection in vitro is associated with changes in pathogenicity and/or virulence in vivo remains to be more fully examined. It has been more than a decade since there has been a publication related to the experimental reproduction of respiratory disease with BCoV in calves.

In conclusion, the answer to the rhetorical question that is the title of this review ultimately turns on one’s definition of “biologically significant.” Certainly, from the standpoint of pulmonary infection and pathology, in contrast to, for example, BRSV (50), available evidence indicates that BCoV has been associated with neither substantial infection of the lower airways or pulmonary parenchyma, nor substantial pulmonary pathology. In this it is different from the avian infectious bronchitis virus (IBV), the prototype virus of the Coronaviridae (12); severe respiratory disease and pulmonary (airway) pathology can be sequel to infection with virulent strains of that virus (1,12). With regard to the trachea, BCoV infection has been associated with mild clinical signs consistent with tracheal disease, and BCoV infection has been documented immunohistochemically in situ in that organ. However, this infection has apparently not been associated with the severe clinical tracheitis and extensive necrotizing, so-called “stove-pipe” lesions, typical of many cases of bovine herpesvirus-1 infection (50) or IBV (1). Examination of the nasal turbinates and sinuses is generally not a common practice in cases of bovine respiratory disease outside academia. BCoV has been identified, in situ, in those parts of the upper respiratory tract, which is consistent with the “cold-like” signs that are associated with BCoV infection in cattle, as well as in humans infected with another prototypical coronavirus responsible for the “common cold” (12).

Although it is certainly cliché to discuss the synergy between various pathogens in the development of the BRDC, it is probably in the case of mixed infections, generally the rule, that BCoV achieves significance as a respiratory pathogen. Certainly, infection and some level of damage to epithelium and resultant
inflammation, relatively innocuous in itself (witness the common cold), could and often probably does serve as a preamble to “secondary infections.” Indeed, the first study implicating BCoV as a respiratory pathogen (10) provided evidence of this probable necessity and alluded to the problem of reproducing disease with a monoculture of BCoV (or other recognized respiratory pathogens), proving that Koch’s postulates are a limited way of thinking about a syndromic, etiologically complicated, disease. This difficulty in reproducing dramatic respiratory disease, or at least something that can be measured beyond shedding of virus, with BCoV (alone) is also an impediment to having a BCoV vaccine with a label claim for respiratory disease from a regulatory perspective. In the context of this apparent constraint of disease production, it is both interesting and inconsistent that vaccines for the 2 recognized paramyxoviral respiratory pathogens of cattle, BRSV and bovine parainfluenza virus-3 (BPIV-3), were in the case of BRSV (51), and are in the case of BPIV-3 (52), licensed on the basis, essentially, of reduced virus shedding (of the viruses) alone, with no requirement for case of BPIV-3 (52), licensed on the basis, essentially, of reduced virus-3 (BPIV-3), were in the case of BRSV (51), and are in the regulatory pathogens of cattle, BRSV and bovine parainfluenza respiratory viruses as field and vaccine strains. Vaccine 2016;34:378–388.


Article

Distribution and abundance of *Eimeria* species in commercial turkey flocks across Canada

Rachel K. Imai, John R. Barta

Abstract — Diversity and regional abundance of *Eimeria* species infecting Canadian commercial turkey flocks are largely unknown. To address this paucity of data regarding coccidiosis and its distribution in Canada, fecal samples from turkey flocks (N = 39) representing 27 commercial farms [ON (n = 20), SK (n = 2), BC (n = 3), AB (n = 1), NS (n = 1)] were screened for coccidia. Identification of all *Eimeria* species present in each sample was accomplished using a nested-polymerase chain reaction (PCR) assay targeting the mitochondrial cytochrome *C* oxidase subunit I gene. Most samples (33/39) were *Eimeria*-positive with 6 *Eimeria* species identified by the nested-PCR assay (1 to 6 species/sample, average 3.2); 4 samples (4/39, > 10% of samples) contained all 6 species. *Eimeria* species were common and distributed widely in Canadian commercial turkey flocks. Turkeys reared using in-feed medication or live vaccination for coccidiosis control had similar *Eimeria* species diversity within individual flocks. These preliminary observations highlight that coccidiosis remains a concern for Canadian turkey producers.

Résumé — Distribution et abondance d’espèces d’*Eimeria* infectant des troupeaux de dindes commerciaux à travers le Canada. La diversité et l’abondance régionale d’espèces d’*Eimeria* infectants des troupeaux de dindes commerciaux canadiens sont pour la plupart inconnues. Pour adresser cette pénurie de données concernant les coccidies et leurs distributions au Canada, des échantillons fécaux provenant de 39 troupeaux de dindes, représentants 27 fermes commerciales [ON (n = 20), SK (n = 2), BC (n = 3), AB (n = 1), NS (n = 1)] étaient ciblés pour la coccidie. L’identification de toutes les espèces d’*Eimeria* trouvées dans chaque échantillon était accomplie en utilisant une PCR nichée pour cibler la sous-unité I mitochondriale du cytochrome *C* oxydase. La plupart des échantillons (33/39) était positif pour l’*Eimeria* avec six espèces d’*Eimeria* identifiées par la PCR nichée (1 à 6 espèces/échantillon, moyenne 3,2); quatre échantillons (4/39, > 10% d’échantillons) contenaient toutes les six espèces. Les espèces d’*Eimeria* sont communes et sont largement distribuées dans les troupeaux de dindes commerciaux canadiens. Les dindes élevées en utilisant des anticoccidiens en additifs alimentaire ou vaccinées avec des vaccins vivants pour la coccidie avaient une diversité d’espèces d’*Eimeria* similaire entre les troupeaux individuels. Ces observations préliminaires indiquent que la coccidie demeure toujours une préoccupation pour les éleveurs de dindons.

(Traduit par Alex Léveillé et Lisa Gordon)

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Introduction

There are 6 well-described *Eimeria* spp. that have been characterized through molecular genotyping methods; additional *Eimeria* spp. from turkeys have been named but their taxonomic validity remains uncertain. The *Eimeria* spp. widely accepted to be valid are: *E. adenoeides*, *E. dispersa*, *E. gallopavonis*, *E. innocua*, *E. meleagritis*, and *E. meleagridis*. Few species are believed to cause clinical coccidiosis in turkeys and information on the degree of pathogenicity for certain species is lacking (1,2). Although over 183 million kg of meat turkeys are produced annually in Canada (3), information on the distribution and identities of *Eimeria* spp. infecting turkeys in Canada has not been examined systematically. Identifying species of *Eimeria* based on morphological features alone has been shown to be unreliable because of the significant overlap in shapes and sizes of oocysts (4,5). Chapman (6) highlighted the importance of combining phenotypic characteristics as outlined by Joyner (7), such as site of development, characteristic lesions, cross-immunity, and pathogenicity, with molecular methods including DNA extraction and polymerase chain reaction (PCR) (8). Understanding the distribution and diversity of *Eimeria* spp. within Canadian turkey operations is essential for making rational decisions regarding the economic and health importance of...
these parasites and the need for their inclusion in live coccidiosis vaccines for use in turkeys.

In the present study, field samples were solicited from geographically distant locations across Canada in order to determine the number of oocysts shed in commercial turkey flocks. The diversity of *Eimeria* spp. parasites found in positive samples was further characterized using a modification of a species-specific, nested PCR assay (8).

**Materials and methods**

**Obtaining samples and detecting *Eimeria* oocysts**

A detailed letter was sent to turkey farmers across Canada requesting turkey fecal samples. Farmers were sent specific instructions outlining how the fecal samples were to be collected as well as all required collection materials and packaging for shipment to the University of Guelph. The samples were collected from the top of the litter and the freshest of droppings were to be collected. The samples were mixed with a 1:50 diluted bleach solution (provided) and sent overnight (at room temperature). Upon arrival samples were stored at 4°C until processing. Each participating farmer was asked to identify the coccidiosis control program being used (either live vaccination or in-feed anticoccidial medication) for each submitted sample; no further information regarding anticoccidial use or management was requested or obtained.

Initial detection of oocysts was made using light microscopy directly from the sample. If negative, 5 g of the original sample was mixed to homogeneity with saturated NaCl (aqueous) to a total volume of 50 mL; an aliquot of the homogenate was loaded into a McMaster counting chamber. The chamber was examined for the presence/absence of oocysts and recorded as oocyst-positive or oocyst-negative. No further processing was done on oocyst-negative samples with the exception of 2 samples that were included in the DNA extraction procedure outlined below as oocyst-negative control DNA.

Oocyst-positive fecal samples were processed for sporulation by mixing 30 g fecal sample with approximately 60 mL 2.5% potassium dichromate (w/v aqueous) and passing the homogenate through a sieve with 1 mm² openings. The filtrate (< 100 mL) was transferred to a 250-mL Erlenmeyer flask capped with aluminum foil perforated to permit air exchange and then placed on a rotary platform shaker operating at 100 rpm at room temperature for 5 d to permit sporulation of viable oocysts. Following sporulation, the filtrate of sporulated/unsporulated oocysts mixed with fine fecal debris were held at 4°C until DNA isolation. Upon arrival samples were stored at 4°C until DNA extraction.

**DNA extraction**

The DNA was extracted from all oocyst-positive samples following crude filtration and sporulation. Briefly, post-sporulation oocysts and fecal debris suspended in 2.5% potassium dichromate (w/v aqueous) were collected by centrifugation (1500 × g for 10 min). The supernatant was decanted from the pelleted oocysts and debris; a 2× volume of 0.9% saline (0.9% NaCl, w/v aqueous) was added to the pelleted material and mixed to homogeneity. The resulting washed, sporulated oocysts mixed with fine fecal debris were held at 4°C until DNA isolation.

The DNA was isolated using DNAzol (Life Technologies, Burlington, Ontario) following the manufacturer’s instructions modified by the addition of 0.5 mm glass beads (Ferro Micro beads; Cataphote Division, Jackson, Mississippi, USA) to improve oocyst disruption as described previously (8). A sample (~1.5 mL) of the washed, sporulated oocysts mixed with fine fecal debris was pelleted by centrifugation (12000 × g for 2 min). After decanting and discarding the supernatant, 100 μL DNAzol reagent was added to the pellet and mixed, and approximately 0.3 g of 0.5 mm glass beads was added until a few dry beads were at the surface of the sample. This lysis mixture was processed in a horizontal bead beater fitted with a rack holder for 1.5 mL centrifuge tubes (Mickle Disintegrator I; Mickle Laboratory Engineering, Gomshall, Surrey, UK) for 60 s. Oocyst breakage was confirmed microscopically, and additional rounds of disruption were used until most of the oocysts had been lysed. Once sufficient oocyst breakage was confirmed microscopically, an additional 900 μL of DNAzol was added to the sample plus beads and the entire tube rotated at room temperature for at least 1 h and up to 14 h (overnight) to ensure complete disruption of the sample. After this process, the sample was centrifuged at 13 000 × g for 15 min at 4°C; the supernatant was transferred to a new 1.5 mL centrifuge tube to remove insoluble debris and glass beads; the remainder of the DNAzol extraction procedure was completed as described by the manufacturer. At the conclusion of the isolation protocol, the pelleted DNA was dissolved in 100 μL of EB Buffer provided in the QIAquick PCR purification kit (QIAGEN, Venlo, The Netherlands). Half (50 μL) of each sample was further purified using QIAquick column purification following the manufacturer’s instructions. The DNA concentration was estimated spectrophotometrically both before and after column purification using a NanoDrop 2000 instrument (NanoDrop, Wilmington, Delaware, USA).

**Nested PCR assay for *Eimeria* species identification**

**Primary PCR.** A PCR-based assay based on Hafeez et al (8) was used to identify the various *Eimeria* spp. in each DNA sample. A nested PCR approach was taken to improve the sensitivity of this PCR-based assay for low abundance *Eimeria* spp. present in a mixed sample. In the first round of PCR, genus-specific primers (COI_UNI_199F — 5'TATGATYTT CTTTAGTAGTATGCCC-3'; mRNA20_UNI_R — 5'GTAG GATTTCCAGGTCAA-3') that amplify a 1272 base pair (bp) fragment spanning the region from nucleotide 199 of the COI coding region to 27 nucleotides (nt) past its end were used. This covers nearly the complete cytochrome *C* oxidase subunit I region of the mitochondrial genomes of all *Eimeria* spp. Each primary PCR tube contained 500 nM of each primer, 50 mM MgCl₂, 1 mM dNTPs, 1× PCR buffer and 0.4 U Platinum *Taq* polymerase (Life Technologies). For the primary PCR, samples were run at 95°C for 180 s, followed by 35 cycles of denaturation at 94°C for 30 s, annealing at 58°C for 30 s and extension at 72°C for 75 s, followed by a final extension at 72°C for 5 min. Using a portion from each tube, PCR products
were electrophoresed on a 1.5% agarose submarine gel in Tris-Acetate-EDTA (TAE) buffer (40 mM Tris, 20 mM acetic acid, 1 mM EDTA) at ~95 V for ~30 min. The resulting gel was stained with ethidium bromide and the product size was estimated by comparison with a 1-Kb Plus DNA Ladder (Bio Basic, Mississauga, Ontario) visualized using UV transillumination. If a primary amplicon was not visualized, a second PCR run was completed on the sample using an annealing temperature of 54°C instead of 58°C.

After electrophoresis, the intensity of each positive band was compared to the 1500 bp band of the DNA ladder to estimate amplicon abundance. If the band was estimated at ≤ 250 ng, a 1:100 dilution of the primary PCR tube contents was made using nuclease-free water; if the band was estimated to be > 250 ng, a 1:1000 dilution was made using nuclease-free water. A 2.5-µL aliquot of the appropriately diluted primary reaction solution was then used as template for each subsequent species-specific PCR reaction.

**Secondary PCR.** The species-specific PCR-based assay using diluted primary PCR amplicons (as described) as templates was completed as described by Hafeez et al (8) with minor modifications to the annealing conditions for each primer pair (Table 1).

### Animals

Turkey poult (hens) used to propagate some field samples were received as a donation from Hendrix Genetics Hybrid Turkeys (Kitchener, Ontario). All studies were performed in the CAF (Central Animal Facilities) Isolation Unit at the University of Guelph, Guelph, Ontario, in compliance with the Canadian Council on Animal Care’s “Guide to the Care and Use of Experimental Animals,” 2nd edition (2017; www.ccac.ca). All experiments were approved by the University of Guelph’s Animal Care Committee in compliance with all institutional and national guidelines. All birds were provided feed and water ad libitum.

### Propagation for samples negative on PCR assay

If an oocyst-positive sample tested negative in the primary PCR assay, oocysts in the sample were propagated through birds to provide fresh oocysts for characterization. Coccidia-free turkey poult (2 to 3 per cage) were inoculated with a small number of oocysts (< 2000 per bird) suspended in 1 mL 0.9% saline from a single PCR-negative sample via oral gavage. Inoculations via oral gavage were accomplished using a 1-mL Luer Slip tuberculin syringe without a needle or feeding tube fitted. Oocysts collected from such propagations were sporulated, isolated, and had DNA extracted as previously described. The DNAs isolated from such propagated samples were then used as templates for primary PCR in the same manner as DNA isolated directly from a field sample. Samples that were propagated in vivo before species-specific PCR were designated “PS” (i.e., Passaged Sample) whereas oocysts isolated directly from a submitted sample were designated “S” (i.e., Sample).

### Results

#### Sample locations

A total of 39 fecal samples representing unique flocks or barns located on 27 farms were obtained from farmers who collected and sent samples to the laboratory from various locations across Canada (Table 2). Of the 27 farms, 20 farms were from numerous locations across Ontario, 2 farms were from Saskatchewan (Farms 17 and 27), 3 farms were from British Columbia (Farms 11, 12, 13), 1 farm was from Alberta (Farm 18), and 1 from Nova Scotia (Farm 14). Live coccidiosis vaccination was being used in almost half of the sampled flocks (18 samples) and anticoccidial medications were being used in the remaining flocks (21 samples).

#### Geographic distribution and diversity of *Eimeria* species

Oocysts of various *Eimeria* spp. were detected microscopically in 33 of 39 samples (85% prevalence) and oocyst-positive samples were recorded in samples from all provinces.

Primary and subsequent secondary nested PCR assays were performed on oocyst-positive samples as outlined in Table 2. Of the 33 oocyst-positive samples, 26 samples were positive following the primary PCR reaction and the primary product could be used for secondary nested species-specific PCR reactions.

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**Table 1.** PCR annealing temperatures used with the *Eimeria* species-specific PCR primers.

<table>
<thead>
<tr>
<th>Species</th>
<th>Primer name</th>
<th>Annealing temperature of Hafeez et al (8)</th>
<th>Revised annealing temperature</th>
<th>Amplicon size (base pairs)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Eimeria adenooides</em></td>
<td>E.ad.CO1_427F, E.ad.CO1_1186R</td>
<td>62°C</td>
<td>64°C</td>
<td>713</td>
</tr>
<tr>
<td><em>Eimeria dispersa</em></td>
<td>E.disp.CO1_577F, E.disp.CO1_1028R</td>
<td>55°C</td>
<td>59°C</td>
<td>451</td>
</tr>
<tr>
<td><em>Eimeria gallopavonis</em></td>
<td>E.gal.CO1_292F, E.gal.CO1_1153R</td>
<td>62°C</td>
<td>60°C</td>
<td>861</td>
</tr>
<tr>
<td><em>Eimeria meleagris</em></td>
<td>E.md.CO1_431F, E.md.CO1_1443R</td>
<td>58°C</td>
<td>55°C</td>
<td>1012</td>
</tr>
<tr>
<td><em>Eimeria meleagridis</em></td>
<td>E.mel.CO1_474F, E.mel.CO1_1028R</td>
<td>52°C</td>
<td>62°C</td>
<td>554</td>
</tr>
<tr>
<td><em>Eimeria innocua</em></td>
<td>E.inn.CO1_396F, E.inn.CO1_604R</td>
<td>50°C</td>
<td>59°C</td>
<td>209</td>
</tr>
</tbody>
</table>
There was considerable diversity in the number and specific species detected in the samples using the nested PCR assay; 1 to 6 different *Eimeria* spp. were detected in oocyst-positive samples. One location from Ontario had all known *Eimeria* spp. in turkeys (i.e., *E. adenoeides*, *E. dispersa*, *E. gallopavonis*, *E. innocua*, *E. meleagridis*, and *E. meleagrimitis*) present in each of 4 submitted samples. The 1 positive sample received from 1 farm in Nova Scotia contained *E. adenoeides*, *E. meleagridis*, and *E. meleagrimitis*. The 1 sample received from the single sampled farm in Alberta contained only *E. adenoeides*. Of the 2 samples from 2 farms in Saskatchewan, only 1 sample was positive and it contained *E. meleagrimitis*. Of the 3 samples from 3 different farms in British Columbia, 2 samples contained 3 or 4 *Eimeria* spp. each representing 5 unique *Eimeria* spp.; only *E. dispersa* was not detected in the BC samples.

Overall, the species diversity (Table 3) of *Eimeria* present in samples coming from flocks using live coccidiosis vaccination (14 PCR-positive samples with 3.6 species/sample) was higher than the species diversity found in samples from medicated flocks (12 PCR-positive samples with 2.8 species/sample). However, exclusion of the 2 *Eimeria* spp. expected to be present in all flocks administered the live coccidiosis vaccine (i.e., *E. adenoeides* and *E. meleagrimitis*) resulted in remarkably similar mean parasite species diversity in vaccinated and medicated flocks at 2.4 and 2.8 *Eimeria* species/sample, respectively.

**Discussion**

Prior to the present study, the diversity of *Eimeria* spp. infecting turkeys on Canadian commercial farms was largely unknown because suitable fecal sampling and analyses from various Farms were not available. The current study demonstrated a high species diversity of *Eimeria* species in flocks of turkeys, especially when using live coccidiosis vaccine. This finding suggests that further investigation is needed to determine the optimal vaccine strategy to control coccidiosis in turkeys. Overall, the results of this study highlight the importance of ongoing surveillance and research to better understand and manage coccidiosis in the poultry industry.
geographic locales had not been attempted systematically. With few exceptions (9), there was a paucity of information regarding *Eimeria* spp. on farms in Canada. Furthermore, the available data were based universally on morphological diagnoses. Molecular and biological data (2,5,8,10–14) have become available for turkey *Eimeria* species only recently, permitting detailed studies that were previously challenging to undertake because of the difficulty in differentiating these parasites in field samples (1).

The preliminary prevalence data obtained in this study suggest that the 6 generally recognized *Eimeria* spp. capable of infecting turkeys are distributed widely within Canadian commercial turkey flocks. At least some *Eimeria* spp. are common, abundant, and widespread in these flocks. The composition and diversity of parasites in individual samples varied widely and, despite the relative paucity of samples from outside of Ontario in the survey, a diverse parasite fauna was found across the country. Previous reports based on morphological identification of *Eimeria* spp. from the USA (15–17) and the UK (18,19) had suggested that *Eimeria* spp. of turkeys were common and distributed widely in commercial turkey flocks. Direct comparisons between previous studies and the present work are complicated by the limitations of such morphological identifications (5). Nonetheless, the 85% (33/39) prevalence of the highly pathogenic parasite, *E. meleagris* in US samples detected by Edgar (16) was remarkably similar to the 88% prevalence (23/26) of the same parasite in the present study.

Most samples (85%) herein had detectable oocysts and the number of detectable *Eimeria* spp. in the positive samples ranged from 1 to 6 with an average of 3.2 species/sample detected among all PCR-positive samples. Flocks that were vaccinated had more species diversity (average of 3.6 *Eimeria* species/sample) compared to samples from medicated flocks but this greater species diversity was largely the result of including the vaccine constituents found in Immucox-T in the species count. The species diversity was essentially identical after correcting for the species found in the vaccine. Generally, oocyst-positive samples obtained from vaccinated and medicated flocks that were successfully amplified using the nested PCR assay had 2 to 3 *Eimeria* spp. present.

The diversity of *Eimeria* spp. circulating in Canadian commercial turkey flocks was remarkably similar to the prevalence and diversity of *Eimeria* spp. found in hunter-harvested wild turkeys in Ontario. As in the commercial flocks, most of the sampled hunter-harvested wild turkeys were infected (77% *Eimeria* oocyst-positive, *n* = 107) (20). Earlier investigations using morphometric data to differentiate parasites (9,21–23) had shown that *Eimeria* spp. were common and relatively diverse in wild turkeys in the southern USA; more recently, MacDonald et al (20) used molecular methods similar to those used in the present work to demonstrate that *Eimeria* spp. were common and diverse in Ontario wild turkeys. Interestingly, 4 of the 6 species found within commercial flocks in the present study (i.e., all except *E. dispersa* and *E. innocua*) were also found in wild turkeys in Ontario, Canada, with an average of 2.6 *Eimeria* species per oocyst-positive bird. In the present study, the 26 oocyst-positive samples that were PCR positive had similar species diversity (2.8 and 2.4 species/samples for medicated and vaccinated flocks, respectively) to the hunter-harvested wild turkeys even though additional *Eimeria* spp. were detected in the commercial flocks. It is probable that all *Eimeria* spp. would be detected in both wild and domestic turkeys across their distributions in Canada given sufficient sampling effort; it is likely that any geographic restriction of particular *Eimeria* spp. (e.g., *E. dispersa* found only in Ontario samples) reflects the limited sampling more than restricted geographic range.

With similar prevalence and diversity of *Eimeria* spp., wild turkeys may be potential reservoirs for *Eimeria* spp. infecting commercial poultry; there is no physiological or other impediment against *Eimeria* spp. that infect commercial turkeys infecting wild turkeys or *vice versa* (1,20). Commercial turkey farms are widespread across Canada and may be in close association with wild turkey habitats that may provide opportunity for transfer of pathogens from wild to domestic flocks and *vice versa*. The opportunity for such cross infections in Canada was negligible until the reintroduction of wild turkeys during the 1980’s.

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**Table 3.** Summary of oocyst positive samples from each province, *Eimeria* species found in each province, number of samples from vaccinated and medicated flocks and average species diversity per province.

<table>
<thead>
<tr>
<th>Location</th>
<th>Occyst positive</th>
<th>PCR positive</th>
<th>AD</th>
<th>DISP</th>
<th>GALL</th>
<th>INN</th>
<th>MD</th>
<th>MEL</th>
<th>Average species diversity (species/sample)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td>3.6</td>
</tr>
<tr>
<td>BC</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3.5</td>
</tr>
<tr>
<td>NS</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>ON</td>
<td>27</td>
<td>21</td>
<td>10</td>
<td>8</td>
<td>15</td>
<td>6</td>
<td>13</td>
<td>19</td>
<td>3.4</td>
</tr>
<tr>
<td>SK</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2.8</td>
</tr>
<tr>
<td>All of Canada</td>
<td>33</td>
<td>26</td>
<td>13</td>
<td>8</td>
<td>16</td>
<td>7</td>
<td>16</td>
<td>23</td>
<td>3.2</td>
</tr>
</tbody>
</table>

* Immucox-T contains *Eimeria adenoides* and *Eimeria meleagridis*.

**Summary of PCR positive samples**

<table>
<thead>
<tr>
<th>Location</th>
<th>Occyst positive</th>
<th>PCR positive</th>
<th>Average species diversity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaccinated flocks (Immucox-T)</td>
<td>1</td>
<td>1</td>
<td>3.6</td>
</tr>
<tr>
<td>Vaccinated flocks (excluding Immucox-T constituents)*</td>
<td>14</td>
<td></td>
<td>2.4</td>
</tr>
<tr>
<td>Medicated flocks (Anticoxidials)</td>
<td>12</td>
<td></td>
<td>2.8</td>
</tr>
</tbody>
</table>

* Immucox-T contains *Eimeria adenoides* and *Eimeria meleagridis*.

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was undertaken to reverse the extirpation (local extinction) of *Meleagris gallopavo* during the early 20th century through widespread hunting and loss of habitat. In 1984, captive-bred wild turkeys from the United States were released to initiate their re-establishment (24); that has resulted in a flourishing wild turkey population in Canada (Eastern and Western) (25). Wild turkeys have been shown to shed *Eimeria* spp. oocysts into the environment in Ontario (20) and these parasites may be carried into commercial operations. *Eimeria* spp. apparently overwinter within infected wild turkeys or within the environment suggesting that they may have adapted to the harsh local climatic conditions. Such hardy parasites may be important reservoirs of infection for turkey barns that are typically “all-in-all-out” operations; brooder barns, in particular, are typically cleaned thoroughly between each flock (26). Conversely, commercial turkey operations must compost, dispose of, or spread their manure depending on the farm’s nutrient management plan. This spreading of manure into the environment may provide a source of *Eimeria* spp. for wild turkeys and an alternate way that commercial turkeys could be infecting wild populations. With this potential cycle of infection between wild and domestic animals and increased potential of spreading infection within the higher stocking density of commercial farms, eliminating *Eimeria* spp. from commercial or wild populations seems challenging. As a result, preventing this condition may be the best option to reduce the economic burden on the industry. Although many *Eimeria* spp. of turkeys are considered only mildly pathogenic (1,2,10) there may be more numerous pathogenic species than previously assumed (i.e., not only *E. adenoeides* and *E. meleagrimitis*). The diversity of species identified across Canada begs the question as to whether or not the existing Immucox-T vaccine can protect against all pathogenic *Eimeria* spp. present in a turkey flock. A recent well-controlled in vivo cross-species challenge study (27) confirmed that no significant adaptive cross-immunity was detected among any of the 6 *Eimeria* species found in turkeys despite robust protection against homologous challenge. However, some limited, non-specific protection against all other *Eimeria* spp. that infect turkeys. The present study identified common *Eimeria* spp. found on a limited number of commercial farms in Canada sampled in a consistent manner and analyzed using newly available molecular diagnostic methods (8) for determining the prevalence of the various *Eimeria* spp. However, further research is needed to gain a more detailed understanding of the geographic and seasonal distribution of *Eimeria* spp. in more regions of Canada. Establishing the diversity and distribution of the various *Eimeria* spp. in Canadian commercial flocks may be useful for managing the use of the single licensed live coccidiosis vaccine currently registered for use in turkey (Immucox-T containing *E. adenoeides* and *E. meleagrimitis*), as well as prophylactic anticoccidial use.

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Comparison of carbon dioxide laser versus bipolar vessel device for staphylectomy for the treatment of brachycephalic obstructive airway syndrome

Meghan S. Kirsch, Daniel Spector, Sarah R. Kalafut, George E. Moore, Renee McDougall

Abstract — Carbon dioxide (CO\textsubscript{2}) laser and bipolar vessel sealing device (BSD) are industry standards for soft palate resection. No studies exist to directly compare these 2 techniques in a clinical setting. The purpose of this study was to describe and compare clinical outcomes for dogs that underwent CO\textsubscript{2} laser versus BSD staphylectomy.

Medical records of brachycephalic dogs that underwent CO\textsubscript{2} laser (Group-L) or BSD staphylectomies (Group-B) between September 2013 and September 2017 were reviewed retrospectively. Of 60 dogs that met the inclusion criteria, 26 dogs (43\%) were designated Group-L and 34 (57\%) Group-B. Techniques did not differ in procedure or anesthetic time ($P = 0.52$ and $P = 0.19$, respectively) or major complication rates [intraoperative ($P = 1.00$), post-operative ($P = 0.72$), short-term ($P = 1.00$), and long-term ($P = 0.68$)]. This study suggests that patient outcomes are similar for dogs undergoing staphylectomy performed by CO\textsubscript{2} laser and BSD.

Introduction

Enlarged soft palate (ESP) is a common abnormality among dogs with brachycephalic syndrome (BS); a syndrome which is composed of primary and secondary components. The primary components of stenotic nares, elongated soft palate, and hypoplastic trachea often lead to secondary components of everted laryngeal sacculae or tonsils, tonsillar enlargement, as well as laryngeal collapse and edema due to increased airway pressure (1–4). Brachycephalic syndrome is commonly diagnosed in breeds such as the English bulldog, pug, Boston terrier, and Cavalier King Charles spaniel (2,3). Treatment for BS is primarily surgical and performed to decrease airway resistance and prevent the development of a secondary BS component (3,5).

Described surgical techniques include wedge resection of the ala nasi, staphylectomy, partial tonsillectomy and ventriculectomy, and more advanced techniques such as folded flap palatoplasty, nasal vestibuloplasty, and laser-assisted turbinectomy.
(5–7). Staphylectomy to correct an ESP has traditionally been performed by sharp excision followed by primary closure by suturing (5,8). Complications associated with this procedure include pharyngeal edema, dyspnea, nasal regurgitation, aspiration pneumonia, airway obstruction, and the need for temporary or permanent tracheostomy (9,10). Alternative procedures for ES have been described in an effort to reduce the incidence of postoperative complications and include the use of carbon dioxide (CO₂) and diode lasers, and electrosurgical devices such as monopolar and bipolar cautery, bipolar vessel sealing devices, and ultrasonic energy systems (11–16).

Two of the most frequently used modalities are the CO₂ laser and bipolar vessel sealing device (BSD) (5,10). There are fundamental differences in the ways CO₂ laser and BSD generate thermal energy. The CO₂ laser works by producing focused infrared light (wavelength: 10 600 nm) that is highly absorbed by water resulting in ablation and vaporization of the tissues (11,13). The LigaSure (Covidien Energy-Based Devices, Boulder, Colorado, USA) is a commonly used bipolar vessel sealing device that uses electrothermal energy to denature collagen and elastin in blood vessel walls and seal the vessels (7,17). This device automatically adjusts the current and output voltage according to tissue impedance. To the authors’ knowledge, only 1 study has compared CO₂ laser and BSD techniques for staphylectomy in dogs (7). Neither technique resulted in significant complications in a small number of normocephalic dogs; however, postoperative evaluation was limited to 96 h (7). Several studies investigating CO₂ laser and BSD techniques have reported faster procedure times and decreased hemorrhage, swelling, and postoperative pain compared to sharp dissection (2,6,7,14). However, studies comparing clinical outcome are lacking. The purpose of the study herein was to compare clinical outcomes following staphylectomy using CO₂ laser and BSD techniques in brachycephalic dogs with elongated soft palate. We hypothesized that there would be no difference in short- or long-term complications between the 2 procedures.

Materials and methods

Medical records from the Animal Medical Center from September 2013 to September 2017 were reviewed to identify dogs that underwent staphylectomy with CO₂ laser or BSD. Dogs with complete medical records and documented upper airway examination findings consistent with an ESP were included in the study. Information retrieved from the medical records included signalment, presenting complaint, clinical signs, preoperative thoracic radiographic findings, nasal and upper airway examination findings including presence and grade of laryngeal collapse, perioperative protocol, surgical methods, and outcome at follow-up appointments. Concurrent medical conditions and surgical procedures were also recorded. Dogs were excluded from the study if they had concurrent upper airway disease unrelated to BS such as laryngeal paralysis, tracheal collapse or epiglottic retroversion, had previous upper airway surgery, or if they had a concurrent illness that would significantly impact prognosis. Primary changes associated with BS included stenotic nares and elongated soft palate. A hypoplastic trachea, though independent of BS anatomic conditions, was included as a primary component as commonly described in the literature. Secondary changes included eversion of the laryngeal sacculae (grade I laryngeal collapse), moderate to severe laryngeal collapse (grades II and III laryngeal collapse), enlarged tonsils, and palate or laryngeal edema (18).

Dogs were categorized based on method of staphylectomy into 2 groups; Group-L and Group-B. Group-L dogs had the palate resected by use of a CO₂ laser as described by Clark and Sinibaldi (11). Group-B dogs had the palate resected using a BSD in a technique similar to that described by Brdecka et al (7). However, different from the technique used in that study, the dogs in Group-B underwent the procedure in sternal recumbency and the elongated soft palate was excised to the level of the caudal aspect of the tonsillar crypts. The BSD used in our study, LigaSure Small Jaw (LSJ; Covidien Energy-Based Devices) had the ability to seal and transect the tissue simultaneously, and therefore the additional step of transecting the tissue with Metzenbaum scissors as previously described (7) was not required. The device (LSJ), had the benefit of a small, curved jaw, minimal thermal spread, and a low temperature profile (17). The total and median numbers of airway procedures in addition to staphylectomy were recorded, and included wedge resection alaplasty, laryngeal saccullectomy, tonsillectomy, and procedures unrelated to the airway. Due to the retrospective nature of the study, procedure times for the staphylectomy alone were not available for comparison, and instead, a composite of all multilevel BAS surgical procedures and total anesthesia times were used as a surrogate measurement.

Intra-operative and post-operative complications following anesthesia for staphylectomy surgery were evaluated and compared between the 2 treatment groups. Complications were defined as intra-operative if they occurred from the time of sedation for upper airway examination, inclusive of the surgical procedure, to the time of extubation. Postoperative complications occurred from the time of extubation to discharge from the hospital. Short-term follow-up information was retrieved from medical records from re-examination visits 2 wk following surgery and any additional visits documented before 14 d after discharge. Long-term follow-up information was recorded as the last documented examination. Complications were further divided into major and minor complications with major complications necessitating surgical treatment (tracheostomy, revision surgery), prolonged hospitalization (aspiration pneumonia, non-cardiac pulmonary edema, hypoxia, respiratory crisis, and reintubation), or resulting in death or euthanasia. Minor complications included cough, stertor, nasal discharge, incisional infection, and regurgitation. The number of complications as well as type were compared between groups.

Statistical analysis

Numerical data were assessed for normality by the Shapiro-Wilk test. Normally distributed data in independent groups were compared using Student’s t-test, and nonparametric data of 2 groups were compared with the Wilcoxon rank sum test. Summary statistics for parametric data are presented as mean ± standard deviation (SD), and for nonparametric data are presented as median (range). Proportions of categorical data were
compared using the Chi-squared test of independence, unless expected frequencies were < 5 in which case Fisher’s exact test was used. Odds ratios (ORs) with 95% confidence intervals (CI) were calculated from 2 × 2 contingency tables. A P-value < 0.05 was considered statistically significant.

**Results**

A review of the medical records identified 69 dogs that underwent staphylectomy between the study period and September 2017. Nine dogs were excluded from the study as they had additional upper airway procedures unrelated to the primary BAS under the same anesthesia including tracheal stent placement, temporary epiglottopy and upper airway endoscopy due to bronchopneumonia. Of the 60 dogs that met the inclusion criteria, 26 dogs (43%) comprised Group-L and 34 dogs (57%) comprised Group-B. Breeds represented included French bulldog (31/60, 52%), English bulldog (19/60, 32%), pug (8/60, 13%), bulldog mix (1/60, 2%), and shih tsu (1/60, 2%). The average age at the time of surgery was 4.3 y (range: 0.4 to 10.8 y). There was equal distribution of males and females: castrated males (n = 20), intact males (n = 10), spayed females (n = 23), and intact females (n = 7). Median body weight (BW) was 11.4 kg (range: 5.1 to 31.1 kg). There was no significant difference between Group-L and Group-B in breeds represented, mean age at the time of surgery, gender, or median body weight (P = 0.13).

Nineteen dogs (32%) were presented for elective surgery, and at the time of presentation had no to mild stertor. Twenty-six dogs (43%) were presented for elective surgery (not currently in respiratory crisis) with a history of moderate to severe clinical signs (dyspnea, exercise intolerance, collapse, cyanosis, hyperthermia). Nine dogs (15%) were presented in acute respiratory crisis and 6 dogs (10%) were hospitalized for other reasons not attributed to the upper airway but had an acute respiratory crisis necessitating upper airway surgery for extubation. Nineteen dogs (32%) had a history of chronic vomiting and regurgitation and 9 dogs (15%) had a history of aspiration pneumonia. There were no statistically significant differences between groups concerning presenting complaint, history of vomiting or regurgitation, or incidence of aspiration pneumonia (P = 0.67).

Preoperative thoracic radiography was performed for 57 (95%) of the dogs. Five (9%) dogs were diagnosed with aspiration pneumonia and 7 (12%) dogs had radiographic evidence of hiatal hernia. Radiographs were also evaluated by a Board-certified radiologist for the presence of a hypoplastic trachea. There was no significant difference between the groups in preoperative aspiration pneumonia (P = 0.07) or hiatal hernia (P = 1.00).

Of the 60 dogs, the median number of primary components for BAS was 2 (range: 1 to 3) with ESP noted in all dogs, stenotic nares in 50 dogs (83%) and hypoplastic trachea in 7 dogs (12%). The median number of secondary components of BAS was 1 (range: 0 to 4). Secondary components included everted laryngeal sacculles in 53 dogs (88%), moderate to severe laryngeal collapse in 11 dogs (18%), enlarged tonsils in 7 dogs (12%), and palate or laryngeal edema in 9 dogs (15%). There was no significant difference between the groups in median number of primary or secondary (P = 0.14) components of BAS.

All dogs received perioperative gastrointestinal protectants (proton pump inhibitor) and an anti-emetic. Forty-eight dogs (80%) received 1 or more doses of dexamethasone (DexaJet SP; Biomeda-MTC Animal Health, Cambridge, Ontario), median dose: 0.1 mg/kg BW, range: 0.01 to 0.5 mg/kg BW, during the peri-operative period for the prophylactic treatment of upper airway inflammation. There was no significant difference between the groups (P = 0.33). Fifty-five (92%) dogs underwent multilevel surgery to address additional components of BAS including wedge resection alaplasty in 46 (77%), laryngeal saccullectomy in 47 (78%), and tonsillectomy in 8 dogs (13%). The median number of upper airway BS-related surgeries for both groups was 3 (range: 1 to 4); however, in total Group-L underwent significantly more multilevel surgical procedures than Group-B (P = 0.01). Additional procedures unrelated to the respiratory tract performed under the same anesthetic event were recorded in 23 dogs (38%), and included laparoscopic ovariotomy, open ovariohysterectomy, prescrotal castration, epiplasty, hiatal hernia repair, upper gastrointestinal endoscopy and biopsies, subcutaneous mass removal, combined laparoscopic ovarioectomy and renal biopsy, tail amputation, head and bulla computed tomography, tracheobronchoscopy, and pacemaker placement. There was no statistical significance between the groups in terms of additional procedures unrelated to the upper airway (P = 0.10).

For Group-L, the median procedure time was 32.5 min (range: 10 to 80 min) and anesthesia time was 67.5 min (35 to 295 min). For Group-B, the median procedure time was 27.5 min (range: 10 to 60 min) and anesthesia time was 58.5 min (range: 20 to 210 min). There was no significant difference in procedure or anesthesia time between the groups (P = 0.52 and P = 0.19, respectively). The median length of hospitalization was 2 d (range: 1 to 11 d) with no significant difference between the groups (P = 0.67). The final cost of surgery and hospitalization was not significantly different between the groups (P = 0.01) with a median of $3131 US$ (range: $850 to $19 640 US$) for Group-B and $3475 US$ (range: $1430 to $11 645 US$) for Group-L.

The overall major complication rate was 14/60 (23%) including 5 dogs (5/26, 19%) from Group-L and 9 dogs (9/34, 26%) from Group-B. There was no significant difference between the groups in major or minor complications in the intraoperative period (P = 0.68). No significant difference was demonstrated between the groups in major complications necessitating additional surgical interventions (P = 1.00), prolonged hospitalization (P = 0.51), or resultant death or euthanasia (P = 0.22). Patients that underwent major complications throughout the study period are further described in Tables 1 and 2.

The entire population was further assessed for variables associated with the development of major complications. Two preoperative variables were associated with an increased risk of major complications: English bulldog breed [odds ratio (OR): 5.83; 95% confidence interval (CI): 1.3 to 26.1; P = 0.03] and the development of respiratory distress following hospitalization for a concurrent disease process (OR: 8.8; 95% CI: 1.4 to 54.9; P = 0.02). There was no significant difference between Group-L and Group-B.
and Group-B in preoperative variables associated with major complications ($P < 0.13$) (Table 3). The overall mortality rate for the study was $6/60$ (10%) with all cases of death/euthanasia occurring within the post-operative and long-term periods. Two major complications were negatively associated with an increased risk of death/euthanasia throughout the study period; aspiration pneumonia (OR: 17; 95% CI: 2.3 to 123.02; $P = 0.01$) and placement of a temporary tracheostomy (OR: 26.5; 95% CI: 1.9 to 359.2; $P = 0.02$). Of the 3 dogs that underwent placement of a temporary tracheostomy tube, all 3 had aspiration pneumonia and 2 subsequently died or were euthanized. There was no difference between Group-L and Group-B in complications associated with death/euthanasia ($P < 0.17$) (Table 4). Though not associated with an increased risk of death/euthanasia, revision surgery was performed in $3/60$ (5%) dogs including 2 from Group-L and 1 from Group-B. Two of the revision surgeries were performed secondary to a respiratory crisis and the third case of revision surgery was performed secondary to owner reported exercise intolerance in the short-term period. There was no significant difference between the groups in the performance of revision surgery ($P = 0.57$).

**Discussion**

The results of this study indicate that the clinical outcome and procedure time for staphylectomy in dogs are similar between CO$_2$ laser and the LigaSure. To the authors’ knowledge this is the first study to provide a direct clinical comparison between CO$_2$ laser and BSD-assisted staphylectomy in a population of brachycephalic dogs. While the results demonstrate no statistical difference between the 2 groups in total procedure times and anesthesia times ($P = 0.52$ and $P = 19$, respectively), there were more multilevel surgical procedures performed in Group-L ($P = 0.01$) even with the exclusion of patients that received staphylectomy alone ($P = 0.01$). It may be inferred that surgeries in Group-L were faster, given a greater total number of multilevel procedures and similar total procedure and anesthesia times; however, further prospective studies are necessary for a direct comparison. Surgical times for staphylectomy performed by CO$_2$ laser in the literature have been variable. Davidson et al (19) reported a mean staphylectomy procedure time of 309 s (range: 210 to 450 s). Dunie-Merigot (12) reported surgical times of 510 s when combined staphylectomy and extended palatoplasty techniques were used in brachycephalic dogs with upper airway obstructive syndrome. Brdecka et al (7) reported shorter surgical times for staphylectomy performed by a bipolar sealing device (mean 67.5 +/- 14.1 s, range: 45 to 90 s) compared with the CO$_2$ laser (mean: 174.5 +/- 76.5 s, range: 90 to 313 s) in normal dogs. The medical records used for the current study reported only total surgical time and did not differentiate between individual procedure times in multilevel surgeries.

The second goal of the current study was to compare the 2 procedures in terms of complication rates. The intraoperative, post-operative, short-term, and long-term complication rates were similar between the 2 groups. While Group-B had more major complications at each time point, the difference was not significant. During the intraoperative period, Group-L had no major complications. Group-B had a single patient that became hypoxemic during surgery and required reintubation and

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**Table 1.** Patient variables and major complications for Group-L.
Table 2. Patient variables and major complications for Group-B.

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BAS — Brachycephalic airway syndrome; NCPE — Noncardiogenic pulmonary edema.
n/a — Not available.
placement of a temporary tracheostomy tube in the post-operative period. Of the 10 patients that experienced major complications during the postoperative period, 3 were from Group-L (3/26, 12%) and 7 from Group-B (7/34, 21%). In further comparing complications between the groups, 1 patient from Group-L (1/26, 4%) and 2 patients from Group-B (2/30, 7%) experienced major short-term complications. Long-term complications occurred in 2 patients from Group-L (2/26, 8%) and 3 from Group-B (3/30, 10%). Mortality rates follow a similar trend as postoperative rates were lower for Group-L (0/26, 0%) compared with Group-B (4/34, 12%), although these differences were not significant.

The ideal procedure for staphylectomy would provide consistent hemostasis with minimal local inflammation, edema, and complications. The current study failed to demonstrate superiority when comparing the CO₂ laser with LigaSure and it appears that each method should be evaluated for its potential advantage and disadvantages specific to the patient, surgeon, and facility.

Post-operative dyspnea can occur in up to 20% of patients following upper airway surgery that is related to pharyngeal and laryngeal inflammation and edema, which can further contribute to airway resistance. In comparing the CO₂ laser with LigaSure there is no clear advantage of one modality over the other in post-operative inflammation evaluated histologically in one study. In the current study, severe post-operative dyspnea (reported as hypoxia) occurred in 9 patients, and of these patients, 4 ultimately died or were euthanized. Our study failed to demonstrate a statistically significant difference between the groups in terms of post-operative complications.

Another possible contributing factor to the perioperative complication rate is the high rate of aspiration pneumonia in the study (6/60, 10%). In a study by Ree et al (9), both perioperative metoclopramide use (OR: 16; P = 0.0172) and postoperative radiographic evidence of pneumonia reported in 5% of dogs (OR: 49.99; P = 0.0059) were associated with development of major complications (euthanasia/death and need for temporary tracheostomy tube placement). At our institution, metoclopramide has been routinely administered in the perioperative period. The current study showed, similarly, that patients which developed aspiration pneumonia alone (OR: 17; P = 0.0103) or in addition to placement of a temporary tracheostomy tube (OR: 26.5; P = 0.0243) were at much greater risk for mortality. Lorinson et al (20) also reported aspiration pneumonia as a significant risk factor for the development of major complications in the postoperative period. In that study, postoperative aspiration pneumonia was reported in 11% of dogs with the overall mortality rate associated with aspiration pneumonia being 6.25%; however, in bulldogs aspiration pneumonia appeared to be more severe with a 12.5% mortality rate (20). In our study, English bulldogs were significantly more likely than any other brachycephalic breed to develop a major complication (OR: 5.83; P = 0.03). Brachycephalic breeds have increased negative intrathoracic pressure as a result of increased respiratory effort which predisposes them to gastroesophageal reflux and subsequently aspiration pneumonia (6,20,21).

Limitations of the current study include those associated with retrospective studies including a lack of standardization in the amount of soft palate resected and anatomic landmarks used for staphylectomy. The goal of staphylectomy is to shorten the soft palate by resection of the caudal portion to prevent obstruction to the rima glottidis during inspiration. A reported complication of excessive staphylectomy is pharyngonasal regurgitation secondary to over-shortening the soft palate. Future studies should be conducted to determine if there are differences between ease of use and precision in performing staphylectomy with the CO₂ laser versus LigaSure. In addition, staphylectomy is used to shorten the soft palate but does not address underlying soft palate hyperplasia that may contribute to the upper airway obstruction. A recent study determined a correlation between the thickness of the soft palate and severity of brachycephalic obstructive clinical signs. This study also demonstrated that the soft palate of French bulldogs is significantly thicker than that of pugs (6).

The current study showed similar outcomes and safety for CO₂ laser and BSD-assisted staphylectomy. Both procedures were equally effective in speed of the procedure, minimal intra-operative complications and favorable clinical outcomes.
References


Animal Health Information Sources

Below is a list of several links to Canadian sources of information on animal health and disease. Our goal is to provide current information while not duplicating existing efforts. We hope that this contact information will be of assistance to veterinarians across the country.

1. Canadian Animal Health Coalition (CAHC/CCSA) newsletter
   http://service.meltwaternews.com/mnnews-ws/resources/pastnewsletter/latestHtml?n=MTUwNTUz&r=MTUyNzQz
2. Alberta Animal Health Source (ABVMA) site:
   http://www.albertaanimalhealthsource.ca/
3. Animal Health Laboratory — University of Guelph
   http://www.guelphlabservices.com/ahl/
   http://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/animal-health/animal-health-centre/newsletter
5. Prairie Diagnostic Services Inc. (Animal Health Perspectives newsletter)
   http://pdsc.ca/
7. University of PEI — Diagnostic Services (Newsletter)
   http://www.upei.ca/avc/diagnostic-services/newsletters

Shannon H. Wainberg, Brigitte A. Brisson, Stephanie N. Reabel, Jennifer Hay, Galina Hayes, Cindy L. Shmon, Kim Murphy, William Sears

Abstract — The objectives of this retrospective case series study were to describe a group of 66 dogs with lung lobe torsion (LLT) and to investigate the incidence of complications and risk factors for mortality and overall outcome in this population. Sixty-six dogs with LLT from 3 independent academic institutions were investigated. Information on signalment, history, clinical findings, and interventions was obtained. Associations with mortality outcome were examined via logistic regression. Dogs with a depressed mentation at presentation were 21 times more likely to die than dogs with normal mentation ($P = 0.008$, 95% confidence interval (CI) = 1.949 to 579.904). The overall odds of mortality were increased by 18% for each unit change in Acute Patient Physiologic and Laboratory Evaluation (APPLEfast) score ($P = 0.04$, 95% CI = 0.998 to 1.44). No other clinical abnormalities correlated with outcome.

Résumé — Évaluation des facteurs de risque pour la mortalité chez les chiens souffrant d’une torsion du lobe pulmonaire : étude rétrospective de 66 chiens (2000–2015). Les objectifs de cette étude rétrospective d’une série de cas consistaient à décrire un groupe de 66 chiens ayant une torsion du lobe pulmonaire (TLP) et d’investiguer l’incidence de complications et les facteurs de risque pour la mortalité et les résultats généraux chez cette population. Soixante-six chiens atteints de TLP provenant de trois établissements universitaires indépendants ont été étudiés. Des données ont été obtenues sur le signalement, les résultats cliniques et les interventions. Les associations avec les résultats de mortalité ont été examinées via la régression logistique. Il était 21 fois plus probable que les chiens ayant un état mental déprimé à la présentation meurent que les chiens ayant un état mental normal ($P = 0.008$, intervalle de confiance [IC] de 95% = de 1.949 à 579.904). Les probabilités globales de mortalité augmentaient de 18% pour chaque unité de changement selon la note Acute Patient Physiologic and Laboratory Evaluation (APPLEfast) ($P = 0.04$, IC de 95% = de 0.998 à 1.44). Aucune autre anomalie clinique n’offrait de corrélation avec les résultats.


Introduction

Lung lobe torsion (LLT) is a rare life-threatening condition that results from the rotation of a lung lobe along its longitudinal axis with twisting of the bronchovascular pedicle at the hilus, causing pulmonary arterial and venous obstruction, thrombosis, and necrosis of the lung lobe (1). Lung lobe torsion is typically an acute condition of dogs that can be fatal without surgical intervention. Pathophysiology is typically described as spontaneous or secondary to underlying thoracic disease or trauma. Diagnosis is most commonly made based on the detection of dyspnea or tachypnea and evidence of pleural effusion with pulmonary consolidation and twisted/truncated bronchi on radiographs. In many cases a more definitive diagnosis can be made based on the results of a thoracic ultrasound examination, computed tomography (CT), or bronchoscopy (2–5), but some cases cannot be confirmed without surgery or necropsy.
Various large and small breed dogs have been reported to develop LLT. Previous studies have found Afghan hounds and pug breeds overrepresented (2,6,7), with Afghan hounds being 133 times more likely to develop LLT than other large breed dogs (6), and male pugs being prone to spontaneous torsion of the left cranial lung lobe (7). Few studies have reported on LLT and the largest study to date included only 22 dogs (6). This study found an overall fair to guarded prognosis with only 68% (n = 15) of dogs surviving to discharge and 33% (n = 5) of these 15 dogs dying of thoracic-related disease within the study period (6). This study was mostly descriptive and to the authors’ knowledge, no risk factors other than breed predisposition were studied or identified against patient outcome. More recent studies found the overall prognosis for LLT to be good to excellent with survival rates to discharge ranging from 86% to 100%; however, these studies included small numbers of dogs and focused on 1 specific breed: notably pugs (7,8). This discrepancy in patient outcome and lack in information on predisposing patient factors prompted this study.

The Acute Patient Physiologic and Laboratory Evaluation (APPLEfast) model is a scoring system for illness severity based on several clinical variables that predict mortality risk and help to provide an objective basis for risk stratification (9–11). Lung lobe torsion does not currently have a diagnosis-specific scoring system and so this diagnosis-independent model was chosen to provide a level of objective standardization among patients’ groups and to determine if the APPLEfast model could be applied to a group of patients with LLT to predict probability of death.

The main objectives of this study were to describe a large group of dogs with LLT and to investigate the incidence of complications and risk factors for mortality and overall outcome in this population.

Materials and methods

Inclusion criteria

Medical records of all dogs with LLT examined at the Ontario Veterinary College (OVC), Western College of Veterinary Medicine (WCVM), and Cornell University College of Veterinary Medicine from January 2000 to 2015 were reviewed. Cases were included if a complete medical record (history, clinical signs, imaging, and surgical report, including outcome) was available and if LLT was confirmed at the time of surgery, or necropsy for dogs that were euthanized. Long-term follow-up was obtained when recorded in the medical record.

Data collection

Data retrieved from medical records included age, gender, breed, history, clinical signs, complete blood (cell) count (CBC) and serum biochemistry, pleural fluid cytology, APPLEfast parameters if available (mentation at admission, lactate, glucose, platelets, albumin), diagnostic modalities and results, surgical procedures performed, lung lobe(s) affected, histopathology results, necropsy reports, pleural fluid and/or lung bacterial culture and susceptibility, duration of hospitalization, anesthesia and surgery times, intra- and post-operative complications, and outcome (euthanasia, death, or discharge).

Mentation

Medical records were evaluated and patient mentation at admission was ranked as bright, alert, responsive (BAR), quiet, alert, and responsive (QAR), and depressed (dull, depressed, laterally recumbent, or non-responsive).

APPLEfast score calculation

The APPLEfast score is used to stratify illness severity and risk of mortality in hospitalized animals (8). A number is assigned to each parameter collected from the medical record (mentation at admission, lactate, glucose, platelets, albumin) based on the degree of abnormality, previously established by logistic regression model construction of 598 critically ill dogs, and the sum of these numbers is referred to as the APPLEfast score. For this purpose, separate mentation scores were assigned using the previously published scoring system: 0 = normal; 1 = able to stand unassisted, responsive but dull; 2 = can stand when assisted, responsive but dull; 3 = unable to stand, responsive; and 4 = unable to stand, unresponsive (9). Mentation status was collected at admission before sedation or administration of analgesic, while the lowest abnormal parameter within 24 h of admission and before surgery was collected for all values other than lactate. When available, the highest abnormal parameter within 24 h of admission and prior to surgery was collected for lactate. Each numerical increment or reduction in APPLEfast score is referred to as a unit. Total scores were calculated based on procedures described by Hayes et al (9) (Figure 1).

Statistical analyses

Statistical analysis was done using a commercial software (SAS/STAT 9.4; SAS Institute, Cary, North Carolina, USA) and descriptive statistics were calculated for many data. Data were assessed for normality and means +/- SD were reported where data were normal, and medians (range) were reported where data were not normal. Differences between means were assessed using Student’s t-test. Fischer’s exact Chi-squared test was used to compare breed prevalence in the study to hospital populations. Differences between medians were assessed using the Mann-Whitney test. Survival data were calculated on dogs that underwent surgery. Dogs euthanized prior to planned surgery were not included in the outcome analysis as a clear reason for euthanasia could not be determined from the records. This was done to prevent confounding variables affecting the statistical analysis since it was unclear whether this decision was due to patient variables (poor condition or prognosis) or non-patient variables (financial, not wanting surgery). Dogs euthanized during or after surgery were included in outcome analyses as euthanasia was elected due to poor clinical progression in all cases. Survival was related to the APPLEfast score via logistic regression. Odds ratios and 95% CIs were calculated for prevalence data. A P-value ≤ 0.05 was considered significant.

Outcome

Outcome was divided into death or discharge. Death was classified as preoperative, intraoperative, or postoperative and cause of death (cardiopulmonary arrest or euthanasia) was recorded. Reason for euthanasia was recorded when possible.
Dogs discharged were further categorized as being alive or dead at the time of follow-up. If dogs had died, further classification into disease and non-disease related death was made. All postoperative complications were recorded. If the complication developed post-discharge, it was considered a long-term complication.

Results

Sixty-six cases of LLT met the criteria for inclusion in the study (OVC = 33, WCVM = 22, and Cornell University College of Veterinary Medicine = 11). Mean age was 5.85 y +/- 3.239 (range: 0.25 to 12.6 y). Fifty-five dogs were purebred, representing 28 breeds, the major ones being 21 pugs, 3 Afghan hounds, 3 Labrador retrievers, 2 borzois, 2 golden retrievers, 2 shih-tzus. The remaining 11 (17%) were mixed-breed. Median weight was 13 kg (range: 1.13 to 60 kg, mean = 19.57 kg). Thirty-five (53%) dogs were small breed (< 15 kg). Twenty-one (60%) small breed dogs were pugs, which were significantly overrepresented (P = 0.001) compared with the hospital population. There was no significant difference in outcome based on breed or dog weight in this study (P = 0.31).

Clinical abnormalities

Clinical signs at presentation included dyspnea (n = 28, 42%), anorexia (n = 53, 80%), cough (n = 28, 42%), lethargy (n = 57, 86%), and vomiting (n = 6, 9%). Median duration of clinical signs before presentation at the teaching hospital was 5 d (range: 1 to 22 d, mean = 7.7 d). Four dogs (6%) had a reported history of trauma. Abnormal physical examination findings included dull cardiopulmonary auscultation (n = 60, 91%), tachypnea (n = 40, 61%), pyrexia (n = 19, 29%) and a depressed mentation (n = 11, 17%). One dog with a depressed mentation was euthanized before planned surgery (no clear reason was noted in the medical record) and was therefore omitted from analysis. Of the remaining 10 dogs, 3 died before surgery or immediately after surgery from cardiopulmonary arrest and 5 were successfully discharged. The remaining 2 dogs were euthanized after surgery and before discharge due to clinical deterioration associated with a chylothorax (n = 1) and pneumothorax (1). There was an association between abnormal mentation (depressed versus normal) and disease-related euthanasia or death (Figure 2). Dogs with a depressed mentation were 21 times more likely to die than dogs with a normal mentation (P = 0.008; 95% CI = 1.95 to 579.90). No other clinical abnormalities were associated with outcome.

Clinicalopathologic findings

A CBC and biochemistry profile performed within 24 h of admission was available for 59 of 66 dogs. Abnormalities included neutrophilia (n = 50), anemia (n = 30), hypoalbuminemia (n = 28), elevated alkaline phosphatase (n = 22), bilirubinemia (n = 16), hyperglycemia (n = 10), hypercholesterolemia (10), elevated alanine aminotransferase (n = 7), thrombocytopenia (n = 4), and hemorrhage (n = 1). Hyperlactatemia was not evaluated in previous studies and lactate concentration was found to be elevated (> 2 mmol/L) in 35% of cases before surgery. High lactate was not associated with death (P = 0.06; OR = 8.34; 95% CI = 0.92 to 229.59).

Pleural fluid was obtained before surgery by thoracocentesis in 37 dogs. Examination of the pleural fluid revealed non-degenerate neutrophils, mild to moderate hemorrhage with macrophages, lymphocytes, and small reactive mesothelial cells in 36 dogs. Chylothorax was diagnosed in 6 dogs based on triacylglyceride levels. Cytology inconsistent with a LLT was noted in 1 dog in which coccoid bacteria and large hyperplastic mesothelial cells were identified. Pleural fluid and/or lung samples from 31 dogs were submitted for culture, and 2 had bacterial growth; organisms identified were Streptococcus canis and Staphylococcus pseudintermedius.

APPLE$_\text{fast}$

APPLE$_\text{fast}$ was performed for all dogs for which required data were available, but several patients did not have a recorded lactate value. Mentation was available in 66 of 66 dogs, while lactate was available in only 37 of 66 dogs. As such, a total of 37 APPLE$_\text{fast}$ scores were calculated in this study (Table 1). Three cases were excluded from analysis as cause for euthanasia could not be determined, resulting in a total of 34 APPLE$_\text{fast}$ scores. Median APPLE$_\text{fast}$ score was 20 (range = 12 to 34; mean = 21.5). Overall, the odds of disease related death increased by 18% for each unit increase in APPLE$_\text{fast}$ score (P = 0.04; 95% CI = 1.03 to 1.44) (Figure 3).

Diagnostic imaging

Thoracic radiographs were taken in all dogs. Radiographs revealed pleural effusion in 54 dogs and were considered diagnostic for LLT according to the imaging reports in 16 (24%) dogs. Ultrasound was performed in 28 dogs and was considered diagnostic for LLT in 5 (18%) dogs. Computed tomography (CT) scan was performed in 17 dogs and was considered...
diagnostic for LLT in 13 (76%) dogs. Six dogs had all 3 imaging modalities performed prior to surgery. Bronchoscopy was performed in 12 dogs and was considered diagnostic in 6 (50%).

**Treatment**

Seven (10.6%) dogs died (n = 2) or were euthanized (n = 5) before surgery due to poor prognosis, poor condition, and/or financial reasons. The remaining 59 (89.4%) dogs were treated surgically. Surgical approach for these dogs included an intercostal thoracotomy (n = 56, 84.9%) or median sternotomy (n = 3, 4.5%). Lung lobectomy was performed with a thoracoabdominal (TA) stapler (n = 44), ligatures (n = 4), hand sewn (n = 4), TA stapler and ligatures (n = 5), and TA stapler and hand sewn (n = 2). The lobes affected and removed at the time of surgery included the left cranial lung lobe (n = 30), the right middle lung lobe (n = 22), the right cranial lung lobe (n = 4), and the left caudal lung lobe (n = 3). Pugs more frequently had the left cranial lung lobe affected (n = 18, 90%) compared to the right middle lung lobe (n = 2, 10%). Median anesthesia time for diagnostic and surgical procedures, including other surgical procedures such as thoracic duct ligation and diaphragmatic hernia repair where required, was 180 min (range: 75 to 570 min) and median surgery time was 90 min (range: 45 to 480 min).

**Histology**

Lung lobes from 57 dogs were submitted for histopathology. Findings, including hemorrhage, thrombosis, and necrosis, were consistent with LLT in 56 dogs. No histological diagnosis was recorded in the remaining report, but medical records including the surgery report and discharge statement confirmed the diagnosis of LLT.

**Outcome**

Of the 59 (89.4%) dogs that underwent treatment following diagnosis, 8 (13.6%) died during surgery (n = 3) or after surgery (5). Of these, 3 dogs suffered cardiopulmonary arrest and 5 were euthanized at the owner’s request due to complications or secondary to other thoracic disease (chylothorax = 2, pneumothorax = 1, bronchoalveolar carcinoma = 1, sepsis due to pyothorax = 1) resulting in a perceived poor prognosis.

Postoperative complications occurred before discharge in 14/59 (24%) dogs. These included chylothorax (n = 3, 21%), pneumothorax (n = 6, 43%), and non-chylos pleural effusion (n = 4, 29%). Chylos effusion was diagnosed based on a high triglyceride ratio between the thoracic effusion and serum. One dog with persistent severe hypotension presumably caused by a septic pyothorax failed to recover from anesthesia and was euthanized at the owner’s request due to a poor prognosis. Patients were excluded from outcome calculations if any complications were identified before surgery or if complications developed after discharge.

Of the 6 dogs with preoperative chylothorax, 1 was euthanized before planned surgery and 2 were euthanized after surgery because of a perceived poor prognosis. One dog that had persistent chylothorax after surgery underwent thoracic duct ligation 8 d later and was successfully discharged. One dog had no evidence of persistent chylothorax immediately after surgery, but it recurred 2 wk later. This dog was not treated and was clinically normal at the time of follow-up 3 mo later. One dog underwent thoracic duct ligation at the time of surgery and was discharged without recurrence.

Three dogs without a previous diagnosis of chylothorax developed it after surgery. Two developed chylothorax immediately.

![Figure 2. Outcome of dogs (n = 60) based on mentation at time of presentation (P = 0.003)](image-url)
One dog underwent thoracotomy for a second lung lobe torsion by thoracocentesis 3 y after LLT and was discharged well at follow-up 2 y later. The other dog was diagnosed with LLT recurrence (charge from the hospital and included chylothorax (and was diagnosed on postmortem histopathology with granulomatous lung involvement). One resolved 10 d after diagnosis without further surgery. The dogs were suspected to have had a right middle lung lobe torsion that could have been addressed medically or surgically. The dogs were lost to follow-up.

Four dogs developed non-chylochory thoracic effusion after surgery. One resolved 10 d after diagnosis without further treatment. Two dogs were euthanized due to failure to respond to treatment and 1 was managed for 2 mo until it was lost to follow-up. One dog underwent cardiac arrest 1 mo after surgery and was diagnosed on postmortem histopathology with granulomatous empyema.

Long-term complications developed in 5 dogs following discharge from the hospital and included chylothorax (n = 2) and LLT recurrence (n = 3). One dog developed chylothorax 5 mo after surgery, underwent no further treatment, and was doing well at follow-up 2 y later. The other dog was diagnosed with chylothorax by thoracoscopy 3 y after LLT and was discharged without any report of recurrence in 10 y after thoracoscopy. One dog underwent thoracotomy for a second lung lobe torsion (left cranial) 6 mo following right cranial lung lobectomy. Two dogs had radiographs suspicious for recurrent LLT 8 wk and 6 mo after surgery, but were euthanized due to a perceived poor prognosis associated with the need for a second surgery. A postmortem examination was not permitted in either case. Both dogs were suspected to have had a right middle lung lobe torsion following a previous left cranial lung lobectomy.

Fifty-one of the 59 dogs (86%) dogs survived until discharge, 10 of which were alive at the time of data collection and 15 of which had died from causes unrelated to LLT. Of the 8 dogs that did not survive to discharge, 5 were euthanized for reasons that could have been addressed medically or surgically. The remaining cases (n = 26) were lost to follow-up.

### Discussion

Overall outcome of LLT with timely and appropriate surgical treatment was found to be very good in this study. Eighty-six percent of dogs that underwent treatment in this study were discharged. Clinicopathologic findings reported herein were consistent with previous reports (6–8,12–14,17), none of which individually were associated with patient outcome. Mentation status was found to have a significant association with outcome in this study, whereby dogs with a depressed mentation were 21 times more likely to die or be euthanized for poor doing than dogs that had normal mentation ($P = 0.004; 95\% CI = 1.95$ to $579.90$) (Figure 2). Although mentation is a subjective measure...
in veterinary medicine, the \( \text{APPLE}_{\text{fast}} \) model provided more objective criteria, including ability to ambulate and respond to the surrounding environment, to help eliminate clinician variability in assessment of this non-numerical parameter.

The \( \text{APPLE}_{\text{fast}} \) model is a scoring system that predicts the probability of death based on a combination of clinical findings that have been previously identified as factors associated with survival prediction index (9–12). The \( \text{APPLE}_{\text{fast}} \) can provide the researcher with an objective illness severity measure (9). Only 37 \( \text{APPLE}_{\text{fast}} \) scores were obtained for dogs in this study because several dogs did not have a recorded lactate level. Most of the missing lactate data was from one institution in which lactate levels were unfortunately not included in the paper record during the study period. The absence of this data is therefore less likely to have been related to the severity of illness and is less likely to have biased the results.

Our results revealed that the odds of mortality were increased by 18% for each unit change in \( \text{APPLE}_{\text{fast}} \) score (\( P = 0.04, 95\% \) CI = 1.03 to 1.44) (Figure 2). Dogs with an elevated lactate concentration (> 2 mmol/L) tended to die more frequently (Table 1); however, this difference was not significant (\( P = 0.06 \)), likely due to lack of power resulting in a type II error. None of the other variables studied were associated with outcome.

Thoracic radiographs revealed pleural effusion in most of the dogs (83%) but were only considered to be diagnostic for LLT in 30%. Thoracic CT resulted in the greatest frequency of a positive diagnosis for LLT (76%) but was not used as much as ultrasound due to its less frequent availability, relatively higher cost, and need for sedation or general anesthesia. Compared to previous studies (6), ultrasound was not often considered diagnostic for LLT in this study (5/28 cases). This can be attributed to selection criteria whereby a definitive diagnosis of LLT recorded in the radiology report was required in this study to confirm an LLT. Despite the lack of formal diagnosis obtained using these imaging modalities, many dogs had surgery following radiographs and ultrasound with a suspicion for LLT.

Therefore, although CT was more useful in obtaining a definitive diagnosis of lung lobe torsion in this study (13/17 cases), combined thoracic radiographs and ultrasound provided sufficient information to warrant thoracic exploration with definitive diagnosis obtained at the time of surgery.

Pleural fluid or samples from the affected lung lobes were obtained and submitted for culture in 31 dogs. Only 6% of the submitted cultures were positive for bacterial growth. This is markedly different from a previous study in which 60% of cultures submitted yielded bacterial growth (6). These differences may be attributed to a different study population, differences in duration of torsion, or variation in sample collection or culture techniques. Although the exact pathophysiology of LLT is not understood, this study supports that underlying infection is not a common risk factor for the development of LLT.

Pugs, which have been previously identified as a predisposed breed (7,8,15), were significantly overrepresented as a small breed in this study. Previous studies have identified an association between breed and the torsed lobe, with the right middle lung lobe most commonly affected in large breed dogs (16), and the left cranial lung lobe more commonly affected in pugs (7,8,15). This was also true in the current study. However, breed or dog size (large versus small) had no association with outcome in this study (\( P = 0.31 \)).

Four dogs (6%) in this study had a history of thoracic trauma and 14 had identified concurrent thoracic disease (chylothorax = 6, spontaneous pneumothorax, and aspiration pneumonia = 2 each, traumatic pneumothorax bronchoalveolar carcinoma, pyothorax, and smoke inhalation = 1 each). The remaining 47 (71%) cases were classified as spontaneous LLT because no histologic evidence of underlying disease was present. These percentages are similar to previously reported cases of spontaneous lung lobe torsion (6,7).

Acute or persistent chylothorax has been identified as a common concurrent thoracic condition with LLT (6,14). Although several causes have been identified including neoplasia, trauma, and heart disease, in many cases chylothorax is considered idiopathic (18). In the present study, 3 cases not documented to have chylothorax before surgery developed chylothorax after surgery. In these cases, it is possible that the pleural effusion was not consistent with chylous effusion pre-surgery and led to an incorrect diagnosis due to the LLT confounding the cytologic characteristics of the pleural effusion. It is difficult to assess whether LLT caused disruption to the thoracic duct resulting in chylothorax, or vice versa without knowing whether chylothorax was in fact present pre-surgery. Of 9 cases with chylothorax in this study, 8 had surgery for lung lobectomy. Chylothorax resolved in 30% of dogs and thoracic duct ligation was only performed in 25% (2 of 8 dogs). The remaining 4 dog owners elected no further treatment and no recurrence of chylothorax was reported. Previous literature found an association between chylothorax and outcome; however, more recent studies, including the present study, have found this not to be true (6). One must, however, consider that some dogs with chylothorax were euthanized due to non-patient factors (financial, emotional) and therefore an actual overall outcome is unknown. No significant correlation was found between trauma, previous thoracic...
surgery, concurrent thoracic conditions, and overall patient outcome in this study.

Limitations of this study are related to its retrospective nature in that clinical data collected (specifically lactate levels), imaging interpretation, surgeon technique, postoperative management, and follow-up were not uniform among institutions. Multiple institutions were involved in this study in order to obtain a larger sample size, which resulted in greater variability in methods of diagnosis, treatment, and management of cases. Despite including 3 times more cases than the largest previously published report, lack of power to detect associations between other risk factors and outcome was likely a limitation given so few dogs had a negative (death or complication) outcome after surgery in this study which limits the precision of estimation of effect and could be misleading. This is supported by the wide confidence intervals reported for the odds ratios in this study.

To date, no study has reported on a large number of dogs with LLT. This study confirmed the ability of the APPLEfast score, which is a diagnosis-independent illness severity score, to predict outcome in this population when required data were available in the medical record. The APPLEfast score is currently meant for assessment of populations and is not considered an accurate predictor of individual cases. This study also identified depressed mentation as a risk factor for poor outcome in dogs with LLT; however, caution should be exercised regarding the use of this parameter to guide prognosis and client decision-making in clinical practice since depression can be subjective, and may be affected by factors other than LLT itself.

References
Case Report  Rapport de cas

Transient distal renal tubular acidosis in a dog with gastric-dilatation-volvulus

Carlos Torrente, Carla Molina, Luis Bosch, Cristina Costa-Farré

Abstract – A case of distal renal tubular acidosis occurring as a transient complication in a 13-year-old female greyhound dog with gastric-dilatation-volvulus was diagnosed. The acute renal ischemia and inflammatory condition associated with this syndrome could be considered the main underlying mechanisms responsible for the acute, severe, and complicating renal tubular dysfunction.

Résumé – Acidose tubulaire rénale distale transitoire chez un chien atteint de volvulus et de dilatation gastrique. Un cas d'acidose rénale distale se manifestant comme une complication transitoire chez une chienne Lévrier anglais âgée de 13 ans atteinte de dilatation gastrique-volvulus a été diagnostiqué. L'ischémie rénale aiguë et l'affection inflammatoire associées à ce syndrome pourrait être considérées comme les principaux mécanismes sous-jacents responsables de la dysfonction tubulaire rénale grave et complexe.

Renal tubular acidosis refers to an unusual group of kidney disorders characterized by the presence of normal anion gap hyperchloremic metabolic acidosis associated with reduced bicarbonate reabsorption in the renal proximal tubule or failure of the renal distal tubule to synthesize new bicarbonate in the absence of substantial renal insufficiency (1–4). Distal renal tubular acidosis (DRTA) can be a transient or permanent disorder and can occur either as a primary disease (congenital DRTA) or as a complication (acquired DRTA) of other diseases, both of renal and non-renal origin. Acquired DRTA has been described infrequently in the veterinary literature, mainly in association with some drugs and nephrotoxins, infectious diseases, autoimmune disorders, chronic hypocalcemic conditions, and neoplastic disorders (1,5–8).

The diagnostic criteria and clinical management of transient but severe DRTA in a geriatric dog presenting with a gastric-dilatation-volvulus syndrome (GDV) is described. The authors hypothesize about the underlying mechanisms responsible for this disorder.

Case description

A 13-year-old, spayed female, 23-kg greyhound dog was presented to the Fundació Hospital Clínic Veterinari-UAB for evaluation of acute abdominal distention and non-productive retching. The clinical history included a previous diagnosis of hypothyroidism under treatment with levothyroxine.

Physical examination revealed dull mentation, tachypnea (60 breaths/min) with increased respiratory effort, congested and dry mucous membranes, capillary refill time < 2 s, tachycardia (176 beats/min), left side apical systolic heart murmur (grade 3/6), synchronous and bounding pulses, body temperature of 39.2°C, painful abdomen, and tympanic abdominal distention. On admission, a mean arterial blood pressure (MAP) of 136 mmHg was obtained by oscillometric method (Vet20; B. Braun Medical S.A., Barcelona, Spain) and the electrocardiogram (ECG) showed ventricular tachycardia without hemodynamic consequences. Initial blood tests revealed a packed cell volume (PCV) of 65% [reference range (RR): 37% to 55%], total plasma protein concentration of 72 g/L (RR: 52 to 82 g/L), plasma glucose concentration of 8.32 mmol/L (RR: 3.89 to 7.94 mmol/L), and plasma lactate of 4.7 mmol/L (RR: ≤ 2.0 mmol/L). Emergency treatment upon admission included flow-by oxygen at 4 to 5 L/min, percutaneous gastrocentesis, and intravenous fluid therapy with an isotonic crystalloid solution; a bolus of Lactated Ringer's solution (B. Braun Medical S.A.), 20 mL/kg body weight (BW) was initially administered in 15 min, followed by a fluid rate of 10 mL/kg BW per hour. It should be noted that in spite of the moderate hyperlactatemia, use of this solution is not contraindicated in patients with type A hyperlactatemia (tissue hypoperfusion). At the normal dosages, use of this balanced...
replacement solution is not associated with an increase in blood lactate concentration if clearance mechanisms are not impaired (i.e., liver failure, lymphoma).

Pain control was achieved by administration of a bolus of fentanyl (Fentanest; Kern Pharma S.A., Madrid, Spain), 5 µg/kg BW, IV, and lidocaine (Lidocaína; B. Braun Medical S.A.), 2 mg/kg BW, IV, followed by a constant rate infusion (CRI) of both drugs (5 µg/kg BW per hour and 60 µg/kg BW per min, respectively). Treatment with cefazolin (Cefazolin; Laboratorios Normon SA, Madrid, Spain), 25 mg/kg BW, IV, was also initiated before surgery. Cefazolin was added to the pre-operative treatment plan following the surgical protocols of the FHCV-UAB for gastrointestinal surgery, in patients at risk for splanchnic hypoperfusion and gastrointestinal compromise.

Throughout the emergency stabilization period, monitoring was carried out by continuous ECG, pulse-oximetry, non-invasive oscillometric blood pressure measurements and body temperature measurements. Blood samples were obtained for complete blood (cell) count (CBC), serum biochemistry, and electrolyte and coagulation profiles. Results of the blood analysis revealed a leukogram showing slight neutrophilia (12.45 × 10³/µL; RR: 2.95 to 11.64 × 10³/µL), marginal eosinopenia (0.05 × 10³/µL; RR: 0.06 to 1.23 × 10³/µL) and mild lymphopenia (0.83 × 10³/µL; RR: 1.05 to 5.1 × 10³/µL). Serum biochemistry showed mild hyperglycemia (8.32 mmol/L; RR: 3.89 to 7.94 mmol/L) and elevated alanine-aminotransferase (287 U/L; RR: 10 to 125 U/L). After stabilization, abdominal X-rays were taken and confirmed the final diagnosis of gastric dilatation volvulus (GDV).

The dog was premedicated with methadone (Semfortan; Laboratorios Esteve, Barcelona, Spain), 0.4 mg/kg BW, IM, and midazolam (Midazolam; Normon EFG, Madrid, Spain), 0.25 mg/kg BW, IV. No induction agent was necessary, and the patient was endotracheally intubated and connected to an anesthetic circuit. Intermittent mandatory positive-pressure ventilation with 100% oxygen was provided. Anesthesia was maintained using a CRI of a combination of fentanyl and lidocaine (5 µg/kg BW per hour and 60 µg/kg BW per minute, respectively), plus isoflurane (IsoFlo, Laboratorios Esteve). Intravenous fluid therapy was continued, using the same crystalloid solution given on admission, at a rate of 10 to 20 mL/kg BW per hour depending on the patient’s blood pressure.

During anesthesia the patient was monitored by continuous ECG, invasive blood pressure, pulse-oximetry, end-tidal carbon dioxide (ETCO₂), and body temperature. All parameters were recorded in the anesthesia flowsheet every 10 min throughout the anesthetic procedure. Exploratory laparotomy and gastrectomy were performed routinely. After 20 min of the surgical procedure, a sudden episode of hypotension secondary to a sustained supraventricular tachycardia (190 to 220 beats/min) was detected. A single dose of esmolol (Brevibloc; Baxter SA, Lessines, Belgium), 0.05 mg/kg BW, IV, was administered with a positive response and normal sinus rhythm and arterial blood pressure were re-established during the rest of the procedure. The patient recovered uneventfully from anesthesia.

Postoperative therapy included intravenous balanced isotonic crystalloid solution (Lactated Ringer’s solution; B. Braun Medical S.A.) supplemented with potassium chloride (potassium chloride 2 M; B. Braun Medical S.A.), 30 mEq/L, to provide rehydration (5%) and maintenance needs. Dehydration percentage was estimated based on dry mucous membranes and slightly increased body temperature. Additionally, broad-spectrum antibiotics including cefazolin (Cefazolin; Laboratorios Normon SA), 25 mg/kg BW, IV, q8h, and enrofloxacin (Enrofloxacin; Bayer AG), 10 mg/kg BW, IV, q24h; oxygen therapy by nasal prongs; omeprazole (Omeprazol; Laboratorios Cinfa SA, Pamplona, Spain), 1 mg/kg BW, IV, q12h; maropitant (Cerenia; Zoetis-España, Madrid, Spain), 1 mg/kg BW, IV, q24h, and levothryoxine (Leventa; Merck Sharp & Dohme Animal Health SL, Salamanca, Spain), 20 µg/kg BW, PO, q12h, were also started. Fentanyl and lidocaine CRI were continued after surgery, plus methadone as needed (0.2 to 0.4 mg/kg BW, SQ, q6h) for pain control. Packed cell volume, plasma concentration of total proteins, and glucose and lactate concentrations were recorded every 4 to 6 h during the first 24 h after surgery; body weight, hydration status, perfusion and respiratory parameters were also monitored 1, 2, and 4 times per day, respectively. An indwelling urinary catheter connected to a closed collection system was also placed immediately after surgery to monitor urinary output. Assessment of urinary specific gravity and urinary sediment was performed every 48 h during hospitalization. Early enteral nutritional support was initiated by placing a nasogastric feeding tube.

Despite the initial positive recovery over the first 24 h, progressive mental depression, anorexia, non-ambulatory weakness, and polyuria/polydipsia were observed throughout the following 48 to 72 h. On the third day, blood samples were submitted for analysis, including a CBC, complete biochemical profile, and venous blood gas analysis. Urinalysis, thoracic radiographs and abdominal ultrasound were also performed. Laboratory abnormalities revealed a moderate hypernatremia, severe hyperchloremia, and metabolic acidosis (Table 1). Analysis of urine obtained by cystocentesis revealed isosthenuria (USG: 1.010), a pH of 7.0, ketonuria (2 +), bilirubinuria (2 +) and proteinuria (2 +), with an inactive urinary sediment and increased urine protein/creatinine (UPC) ratio (0.9; reference value: < 0.5). The urinary anion gap (UAG) was also abnormal (UAG 29.8; RR: −10 to +10 mEq/L). Thoracic radiographs and abdominal ultrasound did not show abnormalities.

Results of the laboratory tests confirmed a severe hyperchloremic metabolic acidosis with normal anion gap (absence of unmeasured organic anions) and inappropriately alkaline urine and concomitant increased UAG and DRTA was strongly suspected. Because the patient’s blood pH was less than 7.2 (Table 1), acidosis was considered severe and at risk to cause life-threatening cardiovascular complications. Therefore, infusion of an alkalinizing HCO₃⁻ solution (sodium bicarbonate 1/6 M; B. Braun Medical S.A.) was started according to the calculated patient’s base deficit. The total amount of HCO₃⁻ to be infused was estimated based on formulas described in the veterinary literature (9). A third (43 mmol of NaHCO₃) of the total dose was administered over 30 min and venous blood gas was re-evaluated. The rest of the dose (86 mmol of NaHCO₃) was administered over 6 h at a rate of 0.6 mmol/kg BW per hour.
Immediately after infusion, the plasma $\text{HCO}_3$ concentration was within normal limits and the metabolic acidosis was almost corrected (Table 1). The urine fractional excretion (FE) of $\text{HCO}_3$ (0.34%; RR: 0.04% to 0.13%) was measured once the infusion $\text{NaHCO}_3$ was completed and the results were consistent with a diagnosis of DRTA (7).

After alkalinizing therapy, acid-base and electrolyte disturbances were corrected progressively showing normalization of the anomalies on day 4 after admission. The dog remained in the ICU for 5 more days and during that period fluid therapy was adjusted according to the daily fluid balance assessment and blood analysis (Table 1). During those days, the dog remained bright and alert, her appetite was normal, and she showed no abnormal clinical signs.

The patient was discharged 13 d after admission. Three days later, the dog was re-evaluated, and the owner reported good attitude, appetite, and normal water intake. The patient was scheduled for follow-up 1 mo later. The dog continued to have a good attitude, normal appetite, and absence of clinical signs. Re-check blood analysis did not show abnormalities (Table 1) and urinalysis performed following cystocentesis revealed persistent isosthenuria (USG: 1.018; RR: 1.015 to 1.045) and increased UPC ratio (1; reference value: < 0.5). At that time a renal diet was prescribed.

The dog was scheduled for re-evaluation monthly, but the owner decided to continue follow-up with his own veterinarian and additional information was, therefore, unavailable. However, 6 mo after discharge telephone contact was resumed, and the owner reported a good condition with no changes in attitude, appetite, body weight, or daily water consumption. Recheck blood analysis and urinalysis were offered but the owner declined.

**Discussion**

Distal renal tubular acidosis refers to a group of disorders characterized by normal anion gap hyperchloremic metabolic acidosis that occurs as a result of failure of the distal tubules to synthesize bicarbonate or acidify the urine by $\text{H}^+$ excretion, despite normal or only mildly reduced glomerular filtration rate (GFR) (1,2). Patients with DRTA show a decreased FE of $\text{HCO}_3$ and an impaired capacity to excrete $\text{H}^+$ at the distal tubule. As a result, the patient’s urine pH was > 5.5 in the presence of acidemia, characterized by a severe decrease in $\text{HCO}_3$ plasma concentration (< 10 to 12 mmol/L) (1,2,10,11). Human patients with DRTA typically show a urine FE-$\text{HCO}_3$ less than 3% after plasma $\text{HCO}_3$ has been restored with an alkalizing solution. In this dog, urine FE-$\text{HCO}_3$ was above the reference range but below the percentage previously described for this tubular disorder in dogs (7). In any case, the dog in this report met the main diagnostic criteria previously described for humans but also accepted for canine species.

Other tests have been described to confirm the diagnosis of DRTA, such as the ammonium chloride loading test (1) which is considered the gold standard in human medicine. This test consists of repeated measurements of urine pH and UAG (before and hourly), during 6 h after oral administration of $\text{NH}_4\text{Cl}$, 0.1 g/kg BW. In clinically normal dogs, the kidneys excrete excess $\text{H}^+$ in the urine, and pH should decrease to a minimum value of 5.5 at 4 h post-administration. Failure to acidify urine 6 to 8 h after $\text{NH}_4\text{Cl}$ administration confirms the diagnosis of DRTA. The UAG represents an indirect index of urinary $\text{NH}_4^+$ that under normal circumstances is positive and ranges from 20 to 90 mEq/L. Patients with normal urinary acidification capacity should be expected to produce a negative UAG following $\text{NH}_4\text{Cl}$ administration. An inappropriately positive UAG suggests the possibility of DRTA resulting in lower amounts of $\text{NH}_4^+$ and chloride in the urine. That test was not performed in our patient for several reasons: i) it is commonly associated with dysrhythmia and gastrointestinal side effects such as nausea and vomiting associated with the $\text{NH}_4\text{Cl}$ administration; ii) the test is considered unnecessary in patients with obvious hyperchloremic metabolic acidosis with inappropriately high urine pH; and iii) the test could be unsafe in patients which are already acidic, as in the dog in the present report. In these cases, a single positive UAG measurement may be sufficient to verify the diagnosis of DRTA, such as the case described in this report (3,10–12).

Distal renal tubular acidosis involves failure of the renal distal tubule to synthesize new bicarbonate and to acidify the urine due to impaired secretion of the $\text{H}^+$ load in the collecting
ducts. However, bicarbonate production failure may be due to: i) disabled voltage-dependent sodium reabsorption mechanism, with $\text{H}^+$ and $\text{K}^+$ retained inside the tubular cell causing metabolic acidosis and hyperkalemia; ii) a dysfunctional $\text{H}^+$-ATPase pump mechanism, which impairs active secretion of $\text{H}^+$ out of the cell but enhances losses of $\text{K}^+$ into the tubular lumen because of increased electronegativity, triggering metabolic acidosis and hypokalemia; and iii) abnormal increased membrane permeability of distal tubular cells, which facilitates the exchange of $\text{H}^+$ into the cell and potassium into the tubular lumen, also causing metabolic acidosis and concurrent hypokalemia in the affected patient (1,2,4,6). In the absence of abnormalities in plasma levels of potassium, to better characterize distal tubular dysfunction as either a defect in the $\text{H}^+$-ATPase or voltage-dependent mechanism in patients with metabolic acidosis, a furosemide response test could be performed (5,7). This test assumes that furosemide increases distal tubular sodium delivery and enhances urine acidification by stimulation of $\text{Na}^+/\text{H}^+$ exchangers. In the present case, that test was not performed due to the dog’s clinical condition and the risks associated with furosemide administration in a dehydrated, polyuric, and polydipsic patient.

Although the present case fulfilled the main diagnostic criteria, other differential diagnoses such as urinary tract infection with urease-producing microorganisms or severe diarrhea had to be excluded before confirmation of a DRTA diagnosis. Based on the clinical history, symptoms, results of urinary sediment and culture, both diseases were ruled out. Underlying advanced chronic kidney disease was also excluded because of the absence of azotemia, hypertension, or evidence of chronic renal changes on abdominal ultrasound. Although patients with advanced stages of kidney disease frequently show acid-base disturbances and those metabolic disorders are commonly associated with normal anion gap metabolic acidosis too, this is not a common clinical finding in early stages of kidney disease in which capability of excretion of the $\text{H}^+$ load is often preserved (1,5,10,13).

Isosthenuria was detected in our patient, 72 h after surgery. It should be noted that isosthenuria may be difficult to interpret in patients receiving intravenous fluid support. Therefore, it could be difficult to link that finding to an acute kidney injury instead of a previous asymptomatic chronic kidney disorder. Considering the patient’s age and other analytical findings, such as persistently increased UPC ratio during the first month of follow-up, an early stage of chronic kidney disease was strongly suspected. Although urinalysis on admission could have detected such abnormality, in the authors’ opinion information from that analysis would not have prevented the sudden and unexpected kidney injury and/or modified clinical management over the clinical course. Similarly, analytical determination of plasma or urinary biomarkers in early chronic kidney disease, such as symmetric dimethylarginine (SDMA) or neutrophil gelatinase-associated lipocalin (NGAL) could be considered. However, taking into consideration availability of these tests on an emergency basis and clinical findings obtained by the diagnostic work-up performed on the patient, additional information offered by these tests would not have modified the clinical management during the ICU stay nor the initial follow-up.

In humans, common causes of acquired DRTA are autoimmune disorders (i.e., systemic lupus erythematosus), nephrotoxins, pyelonephritis, chronic kidney disease from any cause, disorder in calcium metabolism (i.e., primary hyperparathyroidism), and marked volume depletion (3,10,11). Similarly, in animals, acquired DRTA has been associated with drugs and nephrotoxins (i.e., amphotericin B, tetracycline, heavy metal toxicity, zonisamide), pyelonephritis, immune-mediated hemolytic anemia, leptospirosis, multiple myeloma, and chronic hypocalcemic conditions (1,5,7,8). However, in the present case, no specific cause of DRTA could be found despite a complete analytical, acid-base, imaging, and relevant diagnostic work-up.

Gastric-dilatation-volvulus syndrome is a common condition, associated with high morbidity and potential mortality in emergency patients, that may result in a systemic inflammatory response and potentially multiple organ dysfunction syndrome (MODS). Organ dysfunction documented as part of MODS in canine species may include the heart, lung, gastrointestinal tract, hemostatic system, and kidney (14). Acute kidney injury (AKI) has been reported in dogs as a common (8%) complication associated with GDV. Predisposing factors include: sustained poor perfusion, exposure to endotoxins, thromboembolic events, and ischemic-reperfusion injury (IRI) itself (15). In human medicine, several reports document that despite the causal event, AKI is characterized by a lower capacity to decrease urinary pH in the presence of systemic acidosis, which is intensified by the acute decrease in functioning nephrons. In veterinary medicine, there is only 1 experimental study in dogs that evaluated the impaired renal acidification capacity of the kidney following an acute ischemic event. This study demonstrated that acute renal ischemia in dogs could be associated with a tubular defect in $\text{H}^+$ ion secretion, predominantly in the distal tubules (16). Considering these arguments and the fact that during the recovery phase, the re-establishment of the urine acid excretion capacity can be prolonged much more than the normalization of the GFR, both mechanisms could explain the clinical and laboratory findings in the reported case. Finally, according to the exclusion of other potential causes of DRTA and because of the well-known pathogenesis of GDV, the authors hypothesize that the associated intravascular volume depletion, distributive shock and the IRI syndrome could have generated an acute and reversible kidney injury affecting the renal tubules resulting in the development of a transient but severe DRTA.

In canines, DRTA can be asymptomatic or symptomatic. In symptomatic patients, most clinical signs are associated with the acidic state itself and include lethargy, anorexia, nausea, vomiting, weight loss, muscle weakness, and neurologic signs such as paralysis (1). In humans, polyuria and polydipsia are mainly associated with enhanced kaliuresis and calcium reabsorption. Although urinary FE of these electrolytes was not measured, and the dog did not show hypokalemia, both mechanisms in addition to the increased natriuresis associated with the disease could explain findings such as polyuria/polydipsia in the dog herein. In the authors’ opinion, the early supplementation of intravenous fluids with potassium chloride could have masked the hypokalemic nephropathy frequently associated with this tubular disorder.
In humans, chronic or prolonged DRTA may induce persistent metabolic acidosis that can lead to osteomalacia, urolithiasis, bone demineralization, and nephrocalcinosis, which may evolve into chronic renal failure (11). According to the acute onset, short period of disease process, and limited follow-up those signs could not be identified in the present case.

Treatment for DRTA is directed at identifying the underlying disease process and providing adequate alkali base to balance H+ production (2,13). In veterinary medicine, the recommended initial dose is 1.0 to 1.5 mEq/kg BW per day of sodium bicarbonate in divided doses, but higher doses (up to 4 mEq/kg BW per day) may be required to maintain normal pH (1,2). In this patient, an initial dose of 1.8 mEq/kg was administered. Due to the persistence of metabolic acidosis, a dose of 3.7 mEq/kg BW was administered to correct acid/base balance. The total dose of 5.5 mEq/kg BW per day is still considered moderate and compatible with a diagnosis of DRTA (1). Repeated evaluations after bicarbonate administration revealed resolution of the acidosis and alkali administration was discontinued.

Prognostic information about DRTA in canine species has not been reported in the veterinary literature. Human medicine reports describe a worse prognosis for DRTA compared to proximal RTA. This is due to the risk of complications such as urolithiasis and bone demineralization (1). In our patient, the tubular disorder appeared to have been transient in nature, a phenomenon that is rarely seen in human or veterinary medicine (17,18).

In the authors’ opinion, although DRTA is an uncommon disorder in veterinary patients, its incidence may be underestimated in the critical care setting. Despite a potential transient nature, this disorder might be associated with increased morbidity and mortality in affected individuals. Rapid detection of biochemical and electrolyte changes associated with DRTA in patients at risk of acute kidney injury and a careful correction of the associated acid-base and electrolyte disturbances should improve significantly the management of these critically ill patients.

References
Case Report  

Rapport de cas

Use of slide scrape lysates for polymerase chain reaction confirmation of disseminated *Mycobacterium avium* infection in a cat

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**Abstract** — Disseminated mycobacteriosis in a 3-year-old domestic medium-haired cat was diagnosed on lymph node cytology. Slide scrape lysates from the cytology submission were used to confirm *Mycobacterium avium* by polymerase chain reaction (PCR) and sequencing and proved a simple technique that could be a valuable tool in veterinary diagnostics and research.

**Résumé** — Utilisation d’un lysat de grattage de lame pour la confirmation par amplification en chaîne par la polymérase d’une infection disséminée à *Mycobacterium avium* chez un chat. Une mycobactériose disséminée chez un chat domestique à poil moyen âgé de 3 ans a été diagnostiquée à l’aide d’une cytologie des ganglions lymphatiques. La soumission d’un lysat de grattage d’une lame provenant de la soumission de cytologie a été utilisé pour confirmer *Mycobacterium avium* par amplification en chaîne par la (PCR) et séquençage et elle s’est avérée une technique simple qui pourrait être un outil utile dans les diagnostics et la recherche vétérinaires.

(Traduit par Isabelle Vallières)

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**Case description**

A 3-year-old domestic medium-haired cat was presented for lack of appetite, weight loss, significant lethargy, hiding, and increased shedding of the hair coat. The patient had been treated 3 wk earlier for bilateral keratitis, and the ocular abnormalities had completely resolved.

On physical examination the patient was pyrexic, had generalized lymphadenopathy, appeared unkempt, and had hair loss around the ears and on the left forelimb. A complete blood (cell) count (CBC) and serum chemistry were performed using automated bench top analyzers (VetScan HM5 and VS2; Abaxis, Union City, California, USA). There was a mild leukopenia \[5.32 \times 10^9/L; \text{reference interval (RI):} 5.50 \text{ to } 19.50 \times 10^9/L\] characterized by a mild lymphopenia \[1.08 \times 10^9/L; \text{RI:} 1.50 \text{ to } 7.00 \times 10^9/L\] likely as part of a cortisol response. While the analyzer detected a mild to moderate thrombocytopenia \[91.00 \times 10^9/L; \text{RI:} 300.00 \text{ to } 800.00 \times 10^9/L\], a blood smear was not evaluated to rule out platelet clumping as a likely cause. Abnormalities on serum chemistry were limited to a mild hypoalbuminemia \[(20.0 \text{ g/L;} \text{RI:} 22.0 \text{ to } 44.0 \text{ g/L})\] which was likely due to a negative acute phase response, but losses or malabsorption could not be ruled out with the available data; and mild decrease in blood urea nitrogen \[(2.86 \text{ mmol/L; } \text{RI:} 3.57 \text{ to } 10.71 \text{ mmol/L})\] which could have resulted from decreased protein intake. A SNAP FeLV/FIV combo test (IDEXX Laboratories, Westbrook, Maine, USA) was negative.

Fine-needle aspirates of the right and left submandibular, prescapular, and popliteal lymph nodes were carried out and submitted to Prairie Diagnostic Services, Saskatoon, Saskatchewan, for cytological evaluation (Figure 1). The slides were stained with modified Wright-Giemsa stain (Fisher Scientific, Pittsburgh, Pennsylvania, USA) and coverslipped. All aspirates were similar in appearance, with a heterogeneous population of lymphocytes variably effaced by a moderate to marked increase in macrophages and a mild increase in non-degenerate neutrophils. On some slides the macrophages were arranged in sheets, and in all samples the macrophages were laden with negatively staining rods. These rods were also numerous in the dense basophilic background. Based on the characteristic cytological appearance, and involvement of numerous lymph nodes, disseminated mycobacteriosis was diagnosed, and *Mycobacterium avium* was suspected.

At this point the patient was lost to follow-up, excluding the possibility of additional sampling for polymerase chain reaction (PCR) confirmation. However, as numerous cytology smears had been submitted, DNA isolation for PCR was attempted on slide scrape lysates (SSL). Coverslips were removed via immersion in xylene and material was scraped from 2 slides into separate Eppendorf tubes using single-edged razor blades. Each tube had 500 µL lysis buffer containing 500 mM Tris-HCl, 100 mM NaCl, and 10% sodium dodecyl sulfate. Proteinase K (5 µL of
a 10 mg/mL stock solution) was added, the samples were heated overnight at 56°C, DNA was extracted with phenol-chloroform and precipitated with ethanol. Pellets were resuspended in 50 µL Tris-EDTA buffer.

Before PCR, adequate DNA concentration (50 to 1000 ng) was confirmed for each sample using a spectrophotometer (NanoDrop spectrophotometer; Thermo Fisher Scientific, Wilmington, Delaware, USA). Polymerase chain reaction amplification using 16S rRNA universal primers (16S For 5’TGT CCT GGC TCA G3’ and 16S Rev 5’TGA TTA CCG CGG CKG CTG3’) was performed in a 50-µL PCR reaction which included 100 ng of DNA, 0.20 mM dNTP, 2.5 mM MgCl₂, 1 × PCR Buffer, 0.4 µM of each primer and 2 units of Taq DNA polymerase. The following conditions were used to amplify the DNA: 30 s at 94°C, 60 s at 57°C, and 60 s at 72°C for 30 cycles. The no-template control sample was negative, whereas a band of the expected size (500 bp) was produced in the patient samples. This amplified DNA was purified using a commercial kit (EZ-10 Spin Column PCR Purification kit; Bio Basic, Markham, Ontario), pooled, and submitted for sequencing at Macrogen, Seoul, Korea. Sequence analysis, using Staden Package programs Pregap4 and Gap4 (1), confirmed a 100% sequence identity between the patient sample and GenBank accession numbers LT558822.1, LC020093.1, JN899580.1, HM056092.1, GU142929.1, NR 117219.1, GQ184167.1 (Mycobacterium avium) partial 16s rRNA gene, strains: Marseille, JCM 15429, E6, IEC14, M214, ATCC 25291 and M88, respectively), and NR 102855 (Mycobacterium avium 104 strain 104 16S ribosomal RNA, complete sequence) over a 501-bp region of high quality sequence.

Polymerase chain reaction for feline leukemia virus (FeLV) was also performed using the SSL, as previously described (2), and a faint band was produced in the patient sample but was considered equivocal with respect to the expected 166 bp size. As a positive status could not be confidently confirmed visually, further amplification was performed, and DNA was purified and submitted for sequencing at Macrogen, as described. However, confirmation of the FeLV status on sequencing was not possible due to insufficient material, and the diagnosis remained equivocal.

**Discussion**

*Mycobacterium avium* complex refers to a group of closely related, ubiquitous, saprophytic, slow growing strains of mycobacteria (3). It is divided into 2 main species *M. avium* and *M. intracellulare*, with *M. avium* being subdivided into 4 subspecies (*avium, hominissuis, paratuberculosis,* and *silvaticum*). Feces from birds infected with *Mycobacterium avium* complex (MAC) contain large numbers of bacilli (3). Infection of dogs and cats occurs from ingestion of infected meat or contact with infected soil or with fomites contaminated by poultry carcasses or feces (3). Among the opportunistic mycobacteria in animals, MAC organisms are the most likely to produce bacteremia and multiple-organ disseminated disease (3).

Despite the widespread environmental distribution of this organism, to the authors’ knowledge, there have only been 26 reports of disseminated disease in cats (4–16). As in the current case, most of these cats were young, but up to 13 y of age has been reported (5,14). There is a marked overrepresentation of Siamese and Abyssinian cats in the literature, suggesting the possibility of underlying familial immune defects (8,14). Feline leukemia virus and FIV are alternate causes of immunosuppression in feline patients. The patient of the current report was a domestic medium-haired cat with no known Siamese or Abyssinian influence. The status of FeLV/FIV was negative on initial testing test sensitivity is 98.6% and 93.5% for FeLV and FIV, respectively, and specificity 98.2% and 100%, respectively (IDEXX Laboratories). Of the previous 26 reports of disseminated disease, 24 cats were tested for FeLV antigen and 21 for FIV antibody. Except for 1 indeterminate IHC FeLV result (12), all cats were negative on initial FeLV/FIV testing (5–8,10,11,13–16). In 2 cases, follow-up FeLV testing was performed: real-time polymerase chain reaction on a mesenteric lymph node biopsy in an 18-month-old cat, which was negative (16), and immunofluorescent antibody testing of bone marrow in a 4-year-old cat, which was positive (11). Although discrepant results between FeLV antigen testing and PCR are more likely in cats ≥ 7 y old, follow-up PCR on lymph node SSL was performed in the current case to rule out latent FeLV infection (2). Previous studies suggest that latent infections can involve a minor subset of nodal lymphocytes as well as bone marrow (2,17). If FeLV was truly present in the current case, the minor subset of lymphocytes that contain the virus may have been diluted by the inflammatory infiltrate and abundant intracellular organisms in the sample, resulting in the faint suspicious band, but insufficient material for sequencing. In the report by Rivière et al (16), follow-up molecular testing for latent FeLV infection was performed on mesenteric lymph node described on histopathology to contain a granulomatous and severely necrotic inflammatory reaction. While the FeLV status may have truly been negative in that case, it may be that bone

![Figure 1](Image) Fine-needle aspirate of the right submandibular lymph node showing numerous negatively staining rods within macrophages as well as in the background. Modified Wright’s stain.
marrow would be a more appropriate sample, not only because it more consistently harbors latent infection, but also because the composition of the lymph node can be dramatically altered in cases of disseminated mycobacteriosis.

As in the current case, clinical signs of mycobacteriosis are typically non-specific with weight loss and ill thrift being common, but can reflect specific organ involvement (3,14). Slow progression of this disease is typical, with signs being present in some cases for weeks to months before diagnosis (14). In the current case, it is unclear if the recent keratitis was related to the mycobacteriosis, but the more systemic signs developed over the following 3 wk. Diagnosis can be challenging because of the non-specific presentation of these patients, and mycobacterial infections should therefore be included in the differential diagnoses for wasting, multisystemic, or otherwise nonspecific disease in young cats (7).

Presumptive diagnosis often results from visualization of negative staining or acid-fast, uniform slender rods on cytology or histopathology samples; however, visualization within neutrophils and monocytes in peripheral blood has also provided evidence of disseminated disease (8,11,12). Definitive diagnosis has historically required culture, which can take several weeks, but as PCR becomes more accessible, it offers a faster method to confirm the diagnosis and identify the species of Mycobacterium present. More recently, targeting specific gene sequences or using species and subspecies-specific PCR assays have allowed efficient discrimination of subspecies within the MAC complex, which cannot be achieved with 16S rRNA sequencing alone (18,19). Previous reports of disseminated mycobacteriosis in cats have typically identified the mycobacterial organism to the level of species (M. avium). Further investigation into subspecies would have been ideal but was not pursued in the current case due to financial restrictions. Although transmission of MAC from pets to humans has not been reported, animal infections should be regarded as potentially zoonotic, particularly for immunocompromised individuals (8). The clinical relevance of the MAC in humans has been amplified in recent decades with the increasing population of immunocompromised individuals resulting from longer life expectancy, immunosuppressive chemotherapy, and the AIDS pandemic (19,20). Discriminating among closely related, yet pathogenetically diverse, members of the MAC would further our understanding of the epidemiology of these pathogens and the potential sources of infection (19).

The ability to perform PCR on material harvested from a cytology preparation was integral to confirming mycobacteriosis in the current case in which additional samples were not available for routine PCR or culture. An advantage of PCR in its use on archived cytologic samples is the extremely small amount of material required. While fresh samples are preferred for PCR analysis, recent studies have demonstrated that there is no statistically significant difference in the ability to amplify DNA between fresh and archival cytology specimens (21). Specifically, when evaluating samples for amplification through primers directed to the housekeeping gene glyceraldehyde phosphate dehydrogenase (GAPDH) of human origin, 85% of SSL samples showed a positive reaction, compared to 91% of the fresh samples (21). In addition, there was no statistically significant difference found in the yield of amplifiable DNA when different sample types were compared between SSLs and fresh samples (21). Similarly, cytoclogic samples were amenable to RT-PCR as long as the target gene fragment was restricted to 150 bp or less, and neither staining nor prolonged storage up to 15 y had major negative effects (22).

The use of SSL for PCR has rarely been described in the literature (21–23). Preparation of SSLs varies somewhat between reports, with some destaining archival slides and others washing in ethanol or adding digestion buffer to the slide before removal of the cytologic material with a razor blade (21–23). In the current report, after removal of the coverslip, no special preparation was performed before scraping the slide. The procedure was no more technically demanding than a routine PCR and yielded a 501 bp high quality sequence. Without the ability to perform PCR on SSL in the current case, it would not have been possible to definitively confirm disseminated Mycobacterium avium infection in this cat. This case provides a good example of the use of SSL for PCR diagnosis in a clinical case. While mycobacteriosis and FeLV were the focus of our investigation, the same sample retrieval technique could be used for PCR diagnosis of countless other diseases. Use of SSL for PCR could play an important role in veterinary pathology where fresh tissue is unavailable, as in the current case, in which morphologic review may help focus molecular diagnostics on certain areas or populations on a slide, or for retrospective studies.

References


Case Report  
Feline infectious peritonitis in a cat presented because of papular skin lesions

Tony Redford, Ahmad N. Al-Dissi

Abstract — A 19-week-old neutered male domestic shorthair cat was examined because of multiple raised pruritic skin lesions along the dorsal head and back. Histopathology of biopsies of the lesions detected nodular pyogranulomatous dermatitis with vasculitis and necrosis, leading to a suspicion of feline infectious peritonitis (FIP). Postmortem examination revealed gross lesions consistent with FIP. Histopathologic lesions and positive immunohistochemical staining for feline coronavirus in multiple tissues, including the skin, confirmed the diagnosis of FIP. The current case was similar to previous cases, except for the initial presentation with cutaneous lesions and no other clinical signs, which had not been reported previously.

Résumé — Péritonite infectieuse féline chez un chat présenté pour des lésions cutanées papuleuses. Un chat domestique commun mâle stérilisé âgé de 19 semaines a été examiné en raison de multiples lésions cutanées prurigineuses épaisses le long de la tête dorsale et du dos. L'histopathologie des biopsies des lésions a détecté une dermatite pyogranulomateuse nodulaire avec vasculite et nécrose, ce qui a soulevé des soupçons de péritonite infectieuse féline (PIF). L'examen post mortem a révélé des lésions macroscopiques conformes à la PIF. Les lésions histopathologiques et la coloration immunohistochimique positive pour le coronavirus félin dans plusieurs tissus, y compris la peau, ont confirmé le diagnostic de PIF. Le cas actuel est semblable aux cas antérieurs, sauf pour la présentation initiale avec des lésions cutanées et aucun autre signe clinique, ce qui n'avait pas été signalé précédemment.

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Introduction

Feline infectious peritonitis (FIP) is a chronic disease of cats that is caused by a mutated form of feline coronavirus (FCoV) (1). This disease is characterized by gross lesions that may include pyogranulomas in multiple organs, polyserositis, and high protein cavitary effusions. Histologic lesions include pyogranulomatous inflammation and vasculitis in affected organs (2–4). Presence of FIP virus in lesions suggestive of FIP is often confirmed through immunohistochemistry (5).

Although FIP is a relatively common disease that has been reported since the 1950's, cutaneous lesions associated with this disease are rare (2,5–11). Clinical and gross skin lesions have included papular nodules, pitting edema, or skin fragility with papular nodules being the most common (5 of 7 reported cases) (5,7,8,11). All cats with papular lesions displayed multisystemic signs of FIP suggesting that these skin lesions appear later in the course of the disease.

In this report, we describe a unique case of FIP in which papular skin lesions were the cause for the cat’s initial presentation to the referring veterinarian and were found before other multisystemic signs of infection were identified.

Case description

A 19-week-old neutered male domestic shorthair cat was first presented to its veterinarian on August 15, 2015, for multiple raised pruritic skin lesions along the dorsal head and back. The cat was febrile at this time, so therapy was initiated with cephalaxin and diphenhydramine. The cat was again presented 5 d later with poor appetite and spreading of the skin lesions, and treatment was modified to consist of prednisone and methylprednisolone acetate. Biopsies were taken and submitted to the dermatopathology service of Prairie Diagnostic Services (PDS) at the Western College of Veterinary Medicine (WCVM), Saskatoon, Saskatchewan. Histopathology revealed nodular pyogranulomatous dermatitis with vasculitis and necrosis, and there was a strong suspicion of FIP. The cat’s health continued to decline, with progression to seizures. Euthanasia was performed on August 24, 2015 and the cat was received for necropsy at PDS a day later.
The cat was in good body condition and there were multiple 3- to 5-mm diameter skin nodules along the dorsal surface of the head and neck, as well as the lateral aspects of the cranial thorax, similar to those described in the clinical history (Figure 1A).

The abdomen, thorax, and pericardium contained abundant viscous serofibrinous effusions. The lungs, liver, and kidney contained multiple white nodules ranging from 3 to 7 mm in diameter. Multiple mesenteric lymph nodes were enlarged and firm. There were no other significant findings on gross examination. A variety of tissues were fixed in 10% buffered formalin, routinely processed and stained with hematoxylin and eosin (H&E) for histopathology.

Histologically, the liver, lungs, kidneys, and mesenteric lymph nodes featured multifocal to coalescing areas of pyogranulomatous inflammation composed of lymphocytes, plasma cells, macrophages, and neutrophils that were often surrounding and infiltrating the wall of veins (phlebitis). Many larger foci had a central core of necrosis. Similar inflammatory cells often infiltrated the wall of veins in the meninges and extended into the meninges and, occasionally, the neuropil. Histologic examination of the eye revealed pyogranulomatous inflammation and phlebitis in the periocular tissue, as well as pyogranulomatous optic neuritis. Sections of the skin also featured multiple vessels with walls infiltrated by mixed inflammatory cells and surrounding large pale areas of dermal necrosis characterized by loss of collagen fibers and replacement with karyorrhectic and necrotic debris and surrounded by low numbers of lymphocytes, plasma cells and macrophages (Figure 1B).

Microscopic sections of the duodenum, jejunum, ileum, and colon featured multifocal crypt necrosis and mild lymphoplasmacytic infiltrates within the lamina propria.

Immunohistochemical staining for intracellular feline coronavirus N protein (FIPV3-70, 1:500; Custom Monoclonals, West Sacramento, California, USA) was performed and showed positive staining within the cytoplasm of macrophages in the lung, kidney, skin, and brain (Figure 1C).

Immunohistochemistry of the colon, ileum, and spleen for feline parvovirus and feline leukemia virus yielded negative results. A cause of the crypt necrosis was not determined. Feline infectious peritonitis with associated cutaneous lesions was diagnosed in this cat based on gross and histologic lesions along with immunohistochemistry results.

**Discussion**

This report presents a case of systemic feline coronavirus infection in a cat causing cutaneous lesions along with classic lesions of feline infectious peritonitis (FIP). While FIP is a common disease in domestic cats, cutaneous lesions associated with this disease are rare; there have only been 7 previous reports (2,5–9,11). The most common cutaneous manifestation is formation of papular nodules, as observed in the current case, but there are also single reports of swollen limbs with pitting edema and development of skin fragility syndrome in separate cases related to FIP virus infection (2,5–9,11). The current case is of particular interest because the cutaneous lesions were the primary reason for initial presentation, while all other cases, save for the case of pitting edema, were presented because of other systemic signs.

Examination of previous reports of FIP cases with skin involvement revealed interesting patterns that fit with many of the findings in the current case (Table 1). Younger animals seemed to be at higher risk for cutaneous lesions, as 4 of the 7 previous cases were less than 3 y old and the cat in the current case was only 19 wk old. There was no gender predilection, as 3 of the cats in previous cases were intact males, 3 were spayed females, 1 was of unspecified gender, and the cat in the current case was a neutered male. Domestic shorthair (4/7 previous and the current case) and sphinx cats (2/7 previous cases) were overrepresented in FIP cases with cutaneous lesions, but conclusions cannot be drawn based on the low number of cases. Finally, all cases included some gross evidence of granuloma formation.

Despite the variety of gross manifestations of cutaneous disease in previous reports, histologically, all cats in the 7 reported
affected tissues (2, 5–9, 11). It appears that histologic examining for FCoV antigen in macrophages in the dermis and other within the dermis. All cases also showed positive immunostaining.

Table 1. Data summary of feline infectious peritonitis cases with cutaneous involvement.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Breed</th>
<th>Signalment</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>(7)</td>
<td>DSH</td>
<td>Male intact</td>
<td>Adult</td>
</tr>
<tr>
<td>(9)</td>
<td>Sphinx</td>
<td>Male intact</td>
<td>1 y</td>
</tr>
<tr>
<td>(2)</td>
<td>DSH</td>
<td>Not specified</td>
<td>1 y</td>
</tr>
<tr>
<td>(11)</td>
<td>DSH</td>
<td>Female spayed</td>
<td>6 y</td>
</tr>
<tr>
<td>(6)</td>
<td>DSH</td>
<td>Male intact</td>
<td>7 m</td>
</tr>
<tr>
<td>(5)</td>
<td>Sphinx</td>
<td>Female spayed</td>
<td>2 y</td>
</tr>
<tr>
<td>(8)</td>
<td>DSH</td>
<td>Female spayed</td>
<td>13.5 y</td>
</tr>
<tr>
<td>Current case</td>
<td>DSH</td>
<td>Male neutered</td>
<td>5 mo</td>
</tr>
</tbody>
</table>

DSH — Domestic shorthair.

cases had similar pyogranulomatous vasculitis and necrosis within the dermis. All cases also showed positive immunostaining for FCoV antigen in macrophages in the dermis and other affected tissues (2, 5–9, 11). It appears that histologic examining of skin lesions related to FIP yields consistent findings and should raise suspicion for FIP, with IHC needed for definitive diagnosis.

There has yet to be an explanation for the development of cutaneous lesions in few cases of FIP with absence in most cases. The reason may be host-specific; one proposed explanation is the selectiveness of endothelial cell reactivity to systemic cytokines. There may be individual variability in the cellular adhesion molecules and integrins expressed on endothelial cells of different tissues and on leukocytes (2). Alternatively, tissue specificity may be related to viral variability. While this has not been investigated thoroughly, the gene for the surface glycoprotein S of feline coronavirus differs between non-mutated coronavirus and the mutated FIP virus and may also take part in determining the tissues to which virus particles may disseminate (12, 13).

Regardless of the mechanism of tissue specificity of FIP viral infection, cutaneous lesions do occur occasionally. The reason for rarity of dermal involvement needs further exploration, and pathologists should keep FIP on their differential diagnosis list when considering biopsies from cats with skin lesions. (CV)

References

Bilateral phacoemulsification and intraocular lens implantation in a young African lion (Panthera leo)

Marta Viñas, Nunzio D’Anna, Adolfo Guandalini, Michele Capasso, Maurizio Nocerino, Alessandra Guerriero, John Sapienza

Abstract — An 18-month-old intact female lioness (Panthera leo) was referred to the Clinica Veterinaria Roma Sud for evaluation of bilateral cataracts. Phacoemulsification and implantation of +30 diopter intraocular lens (IOL) were performed bilaterally. Seven years after surgery, the IOL remained centrally positioned and the patient had normal activity.

Résumé — Phaco-émulsification bilatérale et implantation d’une lentille intra-oculaire chez une jeune lionne africaine (Panthera leo). Une lionne entière âgée de 18 mois (Panthera leo) a été dirigée à la Clinica Veterinaria Roma Sud pour l’évaluation de cataractes bilatérale. La phaco-émulsification et l’implantation de lentilles intra-oculaires dioptriques +30 (LID) ont été réalisées bilatéralement. Sept années après la chirurgie, les LID sont demeurées en position centrale et la patiente s’adonnait à des activités normales.

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Cataract is defined as any opacity of the lens or its capsule (1). In young animals, cataract formation may result from nutritional imbalance, congenital malformation, trauma, genetic factors, or as a sequel to other ocular diseases such as uveitis or retinal degeneration. Congenital cataracts have been described in Persian, Birman, and Himalayan kittens, and a 3-month-old clouded leopard (2–4). In 1 study, milk replacement was the cause of cataracts, suggesting that the milk replacer used may have contained inadequate levels of arginine (5). Low levels of dietary histidine have also been implicated in the pathogenesis of cataract formation in kittens (6). Primary and inherited cataracts are rare in domestic cats. Most feline cataracts are secondary and are commonly due to uveitis (2–4).

Cataracts are common in zoo animals (7–13). An inherited basis was proposed in a 3-month-old clouded leopard with bilateral cataract, as nutritional etiology was unlikely (2). In 2003, one lioness was diagnosed with cataracts; hence all lions from the same group intended for the breeding program underwent complete ophthalmic examinations. A diagnosis of cataracts was made in 5 of these lions. Subsequently in 2010, candidate genes were evaluated for their potential role in cataract formation in these Angolan lions. The study concluded that the 14 candidate genes investigated were not involved in the cataracts observed (14).

Encephalitozoon cuniculi has been described as a causative agent of cataract and uveitis in cats (15) and has also been identified as a cause of cataract in a snow leopard (11).

Phacoemulsification with intraocular lens implantation is routine surgical treatment for cataracts in dogs and cats. A few reports have described treatment of cataracts in exotic animals including a clouded leopard (Neofelis nebulosa) without intraocular lens implantation (2,7,8,12,13). The objective of the report herein was to describe, for the first time, bilateral phacoemulsification with intraocular implantation of lenses specifically manufactured for an African lion in order to achieve emmetropia.

Case description

An 18-month-old, 96-kg intact female lioness (Panthera leo) was referred to the Clinica Veterinaria Roma Sud with a history of aggressive behavior since birth and visual dysfunction. The lioness came from a circus in France. She was weaned from her mother at the age of 5 mo. Her diet had been based on chicken, rabbit, and beef supplemented with taurine 5 mg twice a week.

The general examination performed by the referral veterinarian revealed bilateral cataracts. Results of hematology, biochemistry, and electrolyte analyses were within normal limits (16). Serological tests for feline leukemia virus (FeLV), feline immune deficiency virus (FIV), and feline coronavirus (FCoV) were negative.

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Ten days after initial presentation, the lioness was sedated intramuscularly using a blowpipe with medetomidine (Domitor; Elanco, Eli Lilly, FI, Italia), 30 μg/kg body weight (BW), ketamine (Ketavet 100; Intervet Production, Aprilia, LT, Italy), 2 mg/kg BW, and butorphanol (Dolorex; MSD-Animal Health Italia, Segrate, MI, Italy), 0.1 mg/kg BW. Examination by a Board-certified ophthalmologist included slit-lamp biomicroscopy, applanation tonometry (TonoPen Vet; Mentor, Norwell, Massachusetts, USA) and indirect ophthalmoscopy (Omega 2000; Heine, Herrsching, Germany). Bilaterally dazzle reflex was present; direct, and consensual pupillary light reflexes were present but incomplete. Slit-lamp biomicroscopy showed a late-immature cataract in the right eye and an early-immature cataract in the left eye (Figures 1a, b). Mild lens induced uveitis was present in the right eye, evidenced by a slight miosis. No signs of uveitis were present in the left eye. Intraocular pressure (IOP) readings after instillation of oxybuprocaine chloride 0.4% (Novesina; Novertis, Origgio, VA, Italy) were 20 mmHg OD and 25 mmHg OS. The IOP in both eyes was within normal limits (normal range: 23.9 to 24.1 mmHg) (17). A bilateral examination of the posterior segment was performed 10 min after topical application of tropicamide 1% (Visumidriatic; Visufarma S.p.A. RM, Italy). The examination, although limited, was unremarkable but showed mild resistance to complete dilatation of the right eye.

Physical examination was unremarkable. Phacoemulsification with intraocular lens implantation was discussed and recommended. In order to achieve emmetropic vision, the lens power was calculated using Retzlaff’s formula (Figure 2). A and B mode ultrasounds and keratometry were performed.

B-mode ultrasound (MyLab, Esaote Pie Medical, Italy) revealed normal posterior segments in both eyes, and lenses that were 8.6 mm thick and 22 mm in diameter. The A-mode ultrasound (BioLine; Optikon 2000, RM, Italy) showed that the axial length was 27.92 mm (±1.41 mm) OD and 28.31 mm (±1.02 mm) OS, and the preoperative anterior chamber depth (ACD) was 5.76 mm (±1.89 mm) OD and 7.36 mm (±1.41 mm) OS. Keratometry (Keratron Piccolo; Optikon 2000, RM, Italy), using the Retzlaff theoretical formula, represented by K, revealed a corneal curvature of 26.8 D (±0.96 SD OD and 28.48 D (±0.65 SD OS) (Figure 3). The postoperative ACD (PACD) was calculated as the distance between the corneal epithelium and the center of the lens (equal to the preoperative ACD plus half lens thickness). Using mean axial length, K-value and estimated PACD, an IOL dioptic strength of 30.08 D for the left and 32.69 D for the right eye.
was calculated. An IOL with a diopter power of 30 D was manufactured for both eyes.

**Surgical procedure**

The lioness was sedated with medetomidine (Domitor; Elanco), 30 μg/kg BW, ketamine (Ketavet 100; Intervet), 2 mg/kg BW, and butorphanol (Dolorex; MSD-Animal Health), 0.1 mg/kg BW. Anesthesia was induced with propofol (Vetofol; Esteve, MI, Italy), 1 mg/kg BW, followed by endotracheal intubation, and maintained with isoflurane (IsoFlo; Esteve) and oxygen. Meloxicam (Metacam; Boehringer, S.p.A, MI, Italy), 10 mg, and ceftriazone (Rocefin; Roche, MI, Italy), 2 g, were administered systemically before surgery.

Both eyes received 4 cycles of topical dexamethasone 0.2% (Luxazone; Allergan S.p.A. RM, Italy), ofloxacin 0.3% (Exocin; Allergan) and tropicamide 0.5% with phenylephrine 20 min apart. Electroretinography (ERG) (HMsERG, RetVetCorp, Columbia, Missouri, USA) in both dim light and dark adaptation was performed before surgery. The ERG showed apparent normal A and B wave amplitudes when compared to other cats’ recordings in our database. After 20 min of dark adaptation ERG was recorded with light intensities of 10 millilumen/m² (mcd.s/m²); 3000 mcd.s/m²; 10 000 mcd.s/m². For photopic ERG study, there was a 10 min light adaptation. Electroretinography was recorded at 3 cd (32) std/cone bk 30 cd (Figure 4).

The lioness was positioned in dorsal recumbency. The ocular surface was prepared with povidone iodine solution, diluted with saline 1:50, and the eyelids were prepared with a dilution of 1:10 of the same povidine iodine (18). Rocuronium (Rocuronio; Fresenius Kabi, VE, Italy), 0.3 mg/kg BW, a neuromuscular blocking agent, was injected intravenously. The lioness was ventilated with a standard animal ventilator. The left eye was operated on first. As the pupil failed to dilate fully, the cornea was irrigated with 1.0 mL of diluted epinephrine 1:10 000 (A.I.C; Teva Italia, MI, Italy). Mydriasis improved allowing us to perform the surgery. A 2-step corneal incision using a microsurgical blade n.64 (Swann-Morton, Sheffield, UK) and a keratome with a blade width of 2.8 mm (Surgical Specialties Corporation, Tijuana, Mexico) was made 1 mm from the limbal margin at the 1 o’clock position. A second incision of 1.0 mm width was made at the 10 o’clock position as a side-port incision. The anterior chamber was filled with hyaluronic acid (Viscoelastic 1.8% I-MED Animal Health, Dollard-des-Ormeaux, Quebec). A 9-mm anterior capsulotomy was made with a 25-gauge 1-inch needle and Vannas scissors. A continuous tear curvilinear capsulorrhexis (CCC) was carried out using Utrata forceps.

Phacoemulsification of the nucleus was conducted with a 30° phacoemulsification needle (Pulsar; Optikon 2000, RM, Italy). Total phacoemulsification time was 4 min and 42 s. The ultrasonic power used was 80%. The remaining cortical debris was aspirated with a 0.5-mm irrigation/aspiration (I/A) tip.

![Figure 3. Keratometry revealed a corneal curvature of 26.8 D +/- 1.96 SD in the OD and 28.48 D +/- 6.55 SD in the OS.](image-url)
The posterior capsule was vacuum-polished. An enlargement of the corneal incision up to 5 mm was made in order to introduce the lens into the capsular bag. A +30.0 diopter acrylic foldable lens with a 22-mm diameter haptic was placed (S&V Technologies; AG Acrivet, Hennigsdorf, Germany). The viscoelastic was removed by irrigation/aspiration. The wound was closed routinely with a 9-0 Polyglactin 910 suture in a simple interrupted pattern (Vicryl; Ethicon, Johnson & Johnson, St. Stevens-Woluwe, BXL, Belgium). A subconjunctival injection of triamcinolone (Kenacort; Bristol-Myers Squibb S.r.l, Italy), 20 mg, was performed. At that point, the lion became unstable and for safety reasons the surgery of the second eye was postponed. The recovery was uneventful.

After the surgery, the left eye was treated with topical antibiotic ofloxacin 0.3% (Exocin; Allergan RM, Italy) 4 times daily for 15 d. Systemic antibiotic, ceftriazone (Rocefin; Roche), 2 g, q24h, for 14 d and meloxicam (Metacam; Boehringer), 0.1 mg/kg BW, q24h for 5 d were given. The patient was moved to a 2 m² cage to apply topical medication, which was prepared in a 1-mL syringe. The needle of the syringe was manually broken off and the content was sprayed into the eye.

One week after surgery, the lioness was sedated and anesthetized following the same protocol as previously described for performing the surgery on the right eye. The left eye showed an extrusion of one of the haptics. Under general anesthesia, both eyes were prepared following the same protocol. The corneal wound incision of the left eye was opened and the anterior chamber was filled with hyaluronic acid (Viscoelastic 1.8%, I-MED Animal Health). After the haptic was trimmed, the lens was consecutively reinserted into the capsular bag. The corneal incision was sutured as previously described.

A conventional one-handed phacoemulsification was performed on the right eye. The rest of the procedure was similar to that described for the previously operated left eye. Time for
the phacoemulsification was 2 min and 52 s. In order to avoid the complication encountered with the left eye, shortening of the haptics (about 1 mm each side) was performed before the insertion.

This eye received 20 mg of triamcinolone as a subconjunctival injection. The anesthesia and recovery were uneventful. The postoperative treatment was the same as described for the right eye.

One week later, the lioness was sedated with the previously described drugs. A complete ophthalmic examination was performed including slit-lamp biomicroscopy, tonometry, indirect ophthalmoscopy, and fluorescein staining. The only abnormal finding was moderate intraocular inflammation, presenting as a grade 2 aqueous flare. Triamcinolone injection (20 mg) was repeated in both eyes.

Eight weeks after the second surgery, the patient was sedated as previously described. Both eyes appeared quiet with no active intraocular inflammation clinically detectable (Figures 5a, b). Without dilatation, retinoscopy (Heine Beta 200 Ophthalmoscope; Heine Ophthalmic Instruments, Herrsching, Germany) performed at this time revealed both eyes to be within 1.5 D of emmetropia.

The last complete ophthalmological evaluation was done 7 y after surgery. No signs of ocular discomfort or active intraocular inflammation were seen. The lioness showed quiet, normotensive eyes with good vision (Figures 6a, b).

**Discussion**

There are several reports of surgical removal of cataracts in exotic species (2,7,8,10,13). Intracapsular lens extraction has been performed previously in an African lion with anterior lens luxation (19). This case report presents a successful phacoemulsification with intraocular lens implantation in an African lion. Systemic, metabolic, or infectious diseases were not detected by hematology or serology, and clinical signs were not consistent with a systemic cause. *Encephalitozoon cuniculi* infection cannot be ruled out, as a test for its presence was not performed.

The patient came from a circus in France, but further information about the parents’ origin was not available. With the frequent movement of animals in a circus environment, a relationship with a group of Angolan lions in Germany cannot be totally excluded. Congenital cataracts have been described in Persian, Birman, and Himalayan kittens (3). Taking into consideration that the lioness had exhibited aggressive behavior since birth, a congenital etiology would be most likely. Surgical removal associated with post-operative medical therapy is the gold standard treatment of cataracts. If surgery is not performed, the patient must be monitored and if necessary treated medically for complications such as lens-induced uveitis (LIU), secondary glaucoma, retinal detachment, and lens luxation (3). Surgical intervention of cataracts in exotic animals may be required if limited vision becomes an obstacle to normal function (12). Phacoemulsification with intraocular lens implantation was appropriate in this case.

A diopter lens power measurement was performed in order to achieve the most correct IOL for emmetropic vision. The proper lens power was determined to be +30.0 diopters, as derived from the Retzlaff equation. At the time of the second surgery, the left eye showed an extrusion from the capsular bag of one of the haptics. The intraocular lens was too big for the capsular bag, and 1 haptic was then trimmed and reinserted into the capsular bag. The amplitude and intensity of ERG were considered to be adequate for surgical intervention, compared to those from domestic cats in our database. In small animal conditions.
practice, all the patients that underwent a planned cataract surgery usually receive pre-surgical treatment. The goals are to reduce intraocular inflammation using topical anti-inflammatory drugs and to minimize ocular microbial flora with broad-spectrum bactericidal topical antibiotics, started at least 12 to 24 h before surgery, and longer if LIU is present (3,20,21). Due to the extremely aggressive behavior of the patient, topical therapy before surgery could not be considered; therefore, it was reduced to just 4 cycles of treatment before surgery.

Bilateral phacoemulsification in dogs and cats is usually performed in a single surgery, as this has the advantage of restoring sight in both eyes with a single anesthetic episode as well as reducing the convalescent period, lowering overall cost when compared with 2 unilateral surgeries, and providing a higher percentage of patients which can regain vision from 1 or both eyes (22). In our case, due to the unstable anesthesia, we postponed the surgery in the second eye.

Small animal patients that undergo phacoemulsification receive intensive post-operative treatment with topical and systemic antibiotic and anti-inflammatory drugs, Elizabethan collar, and IOP measurements every 2 h for the first 12 h. In the present case, the treatment was reduced to topical application of ofloxacin 0.3% 4 times a day for 14 d. As sedation was required for examination, 2 postoperative evaluations were performed at 2 and 8 wk after the second surgery.

Complications following cataract surgery include corneal endothelial decompensation, uveitis, hyphema, fibrin formation, glaucoma, and retinal detachment. Moderate uveitis was observed in our patient during the first 2 wk post-surgery, gradually resolving over 8 wk. Transitory ocular hypertension occurs in 22.9% to 50% of canine cases within 72 h following cataract surgery (3,23–25).

A study on African lions (Panthera leo) compared the effect on IOP using 2 different protocols for sedation. The use of IM xylazine (1 mg/kg BW), atropine (0.02 mg/kg BW), and ketamine (10 mg/kg BW) or IM ketamine (20 mg/kg BW) followed by IV ketamine (5 mg/kg BW) and diazepam (0.5 mg/kg BW), showed an insignificant effect on IOP (26).

‘To the authors’ knowledge, there are no studies in veterinary medicine documenting the effects on IOP using a medetomidine, ketamine, and butorphanol combination via the IM route. A low IOP value secondary to the sedation cannot be completely ruled out.

In the last examination, all ophthalmic findings were within normal limits, and the patient showed correct visual behavior and clinical appearance. Good vision was achieved after surgery, as retinoscopy revealed both eyes being within 1.5 D of emmetropia and there was a dramatic improvement in the lioness behavior.

The data presented in this case report support the premise that +30 D IOL was an appropriate choice following lens extraction in this African lion. The haptics of the lens needed to be shortened, as the IOL was too long for this patient. Manual error during the measurement of the lens dimensions by ocular ultrasound was the most likely reason. Fortunately, shortening of the haptic was sufficient to provide excellent centration of the IOL.

To the authors’ knowledge, this is first case report of a bilateral phacoemulsification followed by intraocular lens implantation using a +30 D IOL in an African lion. A good clinical outcome is reported up to 7 y post-surgery.

Acknowledgments

We gratefully acknowledge Mrs. Ingeborg Fromberg from An-Vision, Mr. Andrea Francia and Mr. Roberto Federici from OPTIKON 2000, and Dr. Marco Russo, ultrasonographer, for their technical support. They all helped to produce the appropriate IOLs. Thanks to Mr. Daniel Berquini, who gave hospitality to the lioness in his private zoo “Zoo delle Star” in Aprilia, Latina, Italy.

References


Answers to Quiz Corner
Les réponses du test éclair

1. E) All are recommended diagnostic tests.
   E) Ce sont toutes des épreuves de diagnostic recommandées.

2. C) The CO₂ level does not cause cyanosis. Cyanosis is due to desaturated hemoglobin, which may occur with low oxygen delivery and oxygen saturations less than 90%. A hemoglobin saturation level of 75% is similar to venous blood and will be cyanotic. An oxygen flow rate of 2 to 3 mg/kg/min (4–6 mL/kg/min) is considered to be the metabolic requirement for oxygen and will not cause cyanosis.
   C) Le taux de CO₂ ne cause pas de cyanose. La cyanose est due à l’hémoglobine insaturée qui peut avoir lieu avec une distribution d’oxygène basse et une saturation en oxygène de moins de 90 %. Un taux de saturation d’hémoglobine de 75 % est semblable au sang veineux et sera cyanosé. Un débit d’oxygène de 2 à 3 mg/kg/min (4 à 6 ml/kg/min) est considéré comme étant le besoin métabolique en oxygène et ne causera pas de cyanose.

3. E) A systolic right heart murmur and splintered QRS complexes are consistent with tricuspid valve dysplasia. Labrador retrievers are predisposed to tricuspid valve dysplasia.
   E) Un souffle du cœur droit systolique et des complexes QRS dentelés sont compatibles avec la dysplasie de la valve tricuspine. Le Labrador est prédisposé à la dysplasie tricuspine.

4. D) Pattern baldness is diagnosed by ruling out endocrinopathies and with skin biopsy. It is a nonpruritic condition; the other choices are diagnostic tests for pruritic conditions.

5. D) Manure discharge on snow or when rain is forecast is irresponsible because of the potential run-off into waterways. Risk of run-off can be avoided if tillage occurs soon after manure application. Application when plants are maturing would have little nutritive value. It is not currently possible to eradicate Cryptosporidia from dairy farms, but if the previous precautions are taken, risk of zoonosis is reduced to safe levels.
   D) L’épandage de fumier sur la neige ou lors de prévision de pluie est irresponsable à cause de l’écoulement potentiel dans les cours d’eau. Les risques d’écoulement peuvent être évités si les travaux des champs ont lieu tôt après l’épandage du fumier. L’application de fumier lorsque les cultures sont en croissance aura peu de valeur nutritive. Il n’est pas actuellement possible d’éradiquer Cryptosporidia des fermes laitières, mais si des précautions sont prises, les risques de zoonose sont réduits à des niveaux sécuritaires.
Plasma transfusions in horses with typhlocolitis/colitis

Luis G. Arroyo, William Sears, Diego E. Gomez

Abstract – The outcome of treatment of horses with plasma for typhlocolitis/colitis at the Ontario Veterinary College–Health Sciences Centre was evaluated. Horses with typhlocolitis/colitis that received a plasma transfusion had higher odds of dying than did non-transfused horses. The clinical usefulness of transfusing plasma to hospitalized hypoproteinemic horses is questioned.

Résumé – Transfusions de plasma chez les chevaux atteints de typhlocolite/colite. Les résultats du traitement des chevaux à l’aide de plasma pour la typhlocolite/colite au Health Sciences Centre de l’Ontario Veterinary College ont été évalués. Les chevaux atteints de typhlocolite/colite qui avaient reçu une transfusion de plasma présentaient une probabilité accrue de décès par rapport aux chevaux qui n’avaient pas reçu une transfusion. L’utilité clinique de la transfusion de plasma aux chevaux hypoprotéinémiques hospitalisés est remise en question.

In contrast to horses, humans most commonly receive plasma transfusions to provide coagulation factors for the prevention or treatment of bleeding disorders (4). However, even within a narrow scope of use, a lack of evidence-based medicine demonstrating any clinical benefit for such practice has generated heated discussion between protagonists and antagonists in human medicine (5). The use of plasma in equine patients has not undergone similar scrutiny. As a result, the authors of this study have questioned the clinical usefulness of transfusing plasma to hypoproteinemic horses hospitalized at our institution. In recent years, some clinicians have discontinued this practice in cases of typhlocolitis/colitis. These are the cases that typically present with hypoproteinemia. The objective of this retrospective study was to compare the clinical outcome, defined as survival to discharge, of horses with typhlocolitis/colitis that received plasma transfusion during their hospitalization at our institution, with those that did not.

The medical records of adult horses (≥ 1 y old) with a final diagnosis of typhlocolitis or colitis admitted to our institution between January 2000 and April 2011 were reviewed. Final diagnosis was achieved through a combination of some or all of the following: physical examination including presence of diarrhea, rectal palpation, nasogastric intubation, ultrasound examination, abdominocentesis, and necropsy. Case information retrieved for the analysis included signalment, total plasma protein (TPP) as measured by quantitative chemistry analysis, and whether plasma was administered or not. The plasma product administered was categorized as home harvest (blood collected from horses of the teaching herd), commercial, or unknown (origin of the plasma transfused not recorded). Outcome was recorded as survival to discharge from the hospital or not (euthanasia or death).

Data were statistically analyzed using a standard Fisher’s exact test to calculate the conditional maximal likelihood of the odds ratio (OR) of euthanasia/dying following not receiving plasma.
as opposed to receiving plasma. The exact Sterne confidence intervals (CI) on the OR were computed.

For horses that were transfused, TPP concentration (g/L) before and after (12 to 24 h) transfusion was recorded, and the change in TPP was calculated.

The total volume of plasma administered to horses that survived and to those that did not were compared using a Wilcoxon signed-rank test. To determine whether the type of plasma administered had any effect on outcome, a Chi-squared analysis was carried out to compare the use of home harvest and commercial plasma between horses that survived and those that did not survive.

A total of 465 horses met the inclusion criteria for the typhlocolitis/colitis cases during the study period. All horses had diarrhea, which was either present at the time of admission (n = 317) or became evident while in hospital (n = 148). There were 238 male and 227 female horses.

The ages ranged from 1 to 23.5 y, with a median of 12.1 y. The most common breeds represented were Thoroughbreds (n = 149), Standardbreds (n = 117), Quarter Horses (n = 47), mixed breed (n = 39), Warmblood breeds (n = 12), ponies (n = 10), Miniature horses (n = 7), and the remaining horses (n = 84), which included other breeds such as Friesian, Belgian, Haflinger, Andalusian, Tennessee Walker, and Hanoverian.

A total of 189 horses with typhlocolitis/colitis received plasma transfusion while 276 did not. Out of 189 transfused horses, 118 (62%) survived to discharge and 71 (38%) died or were euthanized during hospitalization. Out of 276 non-transfused horses, 206 (75%) survived and 70 (25%) died or were euthanized during hospitalization. Horses with typhlocolitis/colitis that received plasma transfusion had higher odds (OR: 1.77; 95% CI: 1.17 to 2.65; P = 0.001). The TPP of non-surviving horses after transfusion was not significantly different compared with the TPP before transfusion (before: 45 g/L; range: 15 to 86 g/L, and after: 46 g/L; range: 18 to 80 g/L; P = 0.647).

This study aimed to compare the clinical outcome, defined as survival to discharge, of horses with typhlocolitis/colitis that received plasma transfusion during hospitalization at our institution, with those that did not. Our results suggest that the administration of a plasma transfusion has a minimal association with survival. In fact, horses with typhlocolitis/colitis that received a plasma transfusion were 1.77 times more likely to die than horses that did not receive a plasma transfusion. The retrospective nature of the data collection means that a bias may exist whereby the more severely affected horses received plasma, and the severity of their disease made them more likely to die. However, notwithstanding this limitation, the data do not reveal a negative association with the lack of use of plasma. Moreover, based on recent publications, it can be argued that patients with a low TPP are not necessarily the ones most severely affected, because TPP alone has been shown to lack any prognostic value in horses presenting with acute colitis (6).

The median TPP of surviving and non-surviving horses before transfusion was consistent with hypoproteinemia. However, the range of TPP values before transfusion was wide in both groups of horses, which raises the question of whether some of the horses received plasma for reasons other than hypoproteinemia (e.g., coagulation, nutritional support, or to provide anti-endotoxin antibodies). The question of indication for plasma administration is fundamental and a cornerstone of this study. As mentioned, the rationale for the use of plasma is not evidence-based. The precise reason as to why it was administered was frequently not stated in the medical record, and therefore could not be included in the data analysis.

In the opinion of the authors, administration of plasma for coagulation was unlikely to be the rationale for treatment in this study: the efficacy of plasma transfusion in horses with identified, or suspected, coagulation abnormalities has not been proven in clinical experimental settings. Furthermore, the authors believe that the provision of anti-endotoxin antibodies was unlikely to be the reason for administration of plasma: most horses in the study received the home harvest plasma, which was obtained from horses not immunized to produce hyperimmune plasma. The practice of producing home harvest plasma was discontinued part way through the period from which the cases in this study were drawn, most likely explaining the use of commercial plasma in the remaining horses. Our results reveal that neither the type nor volume of plasma administered had any association with outcome.

Our results demonstrated a minimal increase (4 g/L) in TPP following transfusion in surviving (n = 115) horses, and a reduction (~1.5 g/L) in non-surviving (n = 64) horses. While it is tempting to make a statistical comparison of TPP among horses that survived and horses that did not survive, before and after plasma transfusion, the necessary information on the hydration status of each horse was not available through the records, rendering such comparison insignificant.
Nevertheless, the minimal increase in TPP, or lack thereof, in non-surviving and surviving horses is an interesting finding because it is comparable to findings in horses with hypoalbuminemia, in which the total plasma levels of albumin usually only increase slightly or not at all, following plasma transfusion (7). Furthermore, even when an increase in TTP has occurred after transfusion, the TPP levels tend to decrease to pre-transfusion levels within 24 h of the transfusion (7).

This observation is not unexpected if the amount of plasma usually administered and fate of the product after transfusion are considered. For example, in a 450-kg adult horse, with severe acute diarrhea, a TPP of 36 g/L, and a serum albumin concentration of 18 g/L, the calculated total intravascular albumin content would be 810 g [blood volume of 100 mL/kg body weight (BW) \( \times \) 450 kg = 45 L]. Transfusion of 5 L of commercial plasma with a TPP of 62 g/L and an albumin content of 38 g/L would contribute 190 g of albumin (5 L \( \times \) 38 g/L). Assuming that the transfused proteins remain in the intravascular space, and the blood volume increases by 5 L, the albumin concentration will increase from 18 g/L to 20 g/L. However, in disease states, the normal constant exchange rate of plasma constituents, such as albumin, between the intra- and extravascular compartments (trans-capillary escape rate), is increased, lowering the albumin concentration in plasma at a faster rate (8). In albumin therapy in humans, approximately 10% of the infused albumin leaves the intravascular space within 2 h, and by 2 d as much as 75% is distributed into the extravascular space (9). This distribution process can occur more rapidly if there is disruption of endothelial integrity, as occurs in colitis, leading to a significant increase in the rate of capillary albumin leakage (10,11). It is therefore possible that the increase in TPP following administration of plasma in surviving horses in this study is a reflection of a healthier state of the cecum and colon, and importantly in these horses the TPP may have increased even without a plasma transfusion.

The association between low COP in horses, and clinical outcome is not known. In humans, a relationship between death and COP could not be established in hypoproteinemic patients, and the association between serum albumin and COP in critically ill patients was found to be insignificant (12). In horses, Bellezzo et al (10) reported a discrete increase (from 11 to 13 mmHg) in the oncotic pressure after synthetic colloid administration in hypoproteinemic horses suffering from naturally occurring gastrointestinal disease. Atherton et al (11) treated colitis in horses with hyperimmunized plasma, control (regular) plasma, or no plasma. They reported that the mean values for duration of diarrhea (± standard error) were 41 ± 10 h, 119 ± 56 h, and 72 ± 25 h for the hyperimmune plasma, normal plasma, and control groups, respectively, but none of the treatments influenced the overall survival rate. Diarrhea resolved in 70% to 90% of the horses within 72 h regardless of the treatment group. The use of plasma as a source of colloidal support in horses, therefore, has a questionable impact. Large volumes may be required if plasma is used as a source of albumin. For example, approximately 25 mL/kg BW (12 L per 500 kg BW) is required to increase serum albumin by 5 g/L. It may be difficult, therefore, to justify its use with seemingly little evidence of an impact, the potential limitations of donor availability, and the economic constraints with such a large volume required.

In recent years, horses that were presented to our institution with conditions such as colitis, with TPP levels as low as 20 g/L [reference range (RR): 57 to 75 g/L], and albumin levels as low as 7 g/L (RR: 30 to 37 g/L) have been managed by addressing their primary disease and providing supportive care, without including plasma transfusions. Clinical signs traditionally associated with severe hypoproteinemia such as edema have not been observed or were only mild and transient, and considered clinically not significant. However, the change in clinical decision-making regarding the use of plasma transfusion by the authors of this study requires scientific scrutiny and further interventional studies are necessary to validate this clinical rational.

In summary, the results of this study reveal that the administration of plasma to horses with typhlocolitis/colitis did not improve the survival rate when compared to horses that did not receive a plasma transfusion. The lack of any negative association of forgoing the administration of plasma highlights the need for
inquiry of current plasma transfusion recommendations, and for targeted research. The need for evidence-based medicine to support plasma transfusion is irrefutable. To provide high quality evidence supporting whether plasma has a positive effect on outcome in horses with typhlocolitis/colitis, a randomized blinded prospective multicenter clinical study would need to be conducted (13).

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References
Congenital hydrocephalus in a Belgian draft horse associated with a nonsense mutation in B3GALNT2

David Scott Kolb, Claudia Klein

Abstract — Congenital hydrocephalus has been reported for a number of horse breeds, and for Friesian horses this condition has been associated with a nonsense mutation of B3GALNT2. We report the first case of congenital hydrocephalus associated with the said mutation in a Belgian draft horse. Genetic testing and consideration of the testing results in breeding programs are warranted.

Résumé — Hydrocéphalie congénitale chez un cheval de trait Belge associée à une mutation non-sens de B3GALNT2. L ’hydrocéphalie congénitale a été signalée pour plusieurs races de chevaux et, pour les chevaux Frisons, cette affection a été associée à une mutation non-sens de B3GALNT2. Nous signalons le premier cas d’hydrocéphalie congénitale associée à cette mutation chez un cheval de trait Belge. Les tests génétiques et la considération des résultats des tests sont justifiés dans le cadre des programmes d’élevage.

Congenital hydrocephalus (CH) is a birth defect characterized by the accumulation of cerebrospinal fluid in the ventricles of the brain, which results in a marked increase in cranial cavity volume (1). While CH in horses is not a common occurrence, 0.6 foals per 1000 births are estimated to be affected (2); it does result in the abortion or stillbirth of affected foals and can be a cause of dystocia. Congenital hydrocephalus has been reported for a number of horse breeds including the American Quarter Horse (3), American Miniature Horse (4), Friesian horse (1), Standardbred (5), Hanoverian Warmblood (6), and Thoroughbred (7). In Friesian horses, CH has an autosomal recessive mode of inheritance which is associated with a nonsense mutation in the B3GALNT2 gene (8). Interestingly, the same nonsense mutation of the B3GALNT2 gene has been reported in a human patient with muscular dystrophy suffering from hydrocephalus (9). Eight of 83 (9.6%) randomly selected Friesian stallions in Mexico were heterozygous for the nonsense mutation of the B3GALNT2 gene (10), while 8 of 60 (13.3%) Friesian stallions, and 139 of 805 (17.3%) Friesian broodmares screened in the Netherlands were carriers of the mutated allele (8).

We report here the first case of congenital hydrocephalus associated with the aforementioned mutation of B3GALNT2 in a Belgian draft horse. In the fall of 2016, a Belgian draft mare aborted a fetus during the 7th month of gestation. Upon visual inspection, the fetus had an enlarged and abnormally shaped skull (Figure 1). The dam’s daughter, which had been bred to the same stallion, also aborted a fetus with hydrocephalus during the third trimester around day 300 of gestation. Samples, including those of the dam and sire, were submitted to a commercial laboratory to determine the presence and zygosity of the B3GALNT2 nonsense mutation (Animal Genetics, Tallahassee, Florida, USA). Both parents were revealed to be carriers, i.e., heterozygous, for the mutation. Following the Mendelian laws of inheritance, the mating of heterozygous carriers results in a 25%
chance of obtaining a foal that is homozygous for the mutation and will be affected by hydrocephalus (Figure 2).

The seemingly high prevalence rate for heterozygosity in the Friesian horse population of greater than 10% (8) is likely attributable to the high inbreeding rate which was computed to be 1.5% using pedigree data (11), and exceeds the limit of 1% as recommended by the Food and Agriculture Organization (FAO) (12). Inbreeding data are not available for the Belgian draft breed, but given that it is a small population, a higher than average inbreeding rate can be expected.

The identification of the nonsense mutation of B3GALNT2 in a breed other than the Friesian horse emphasizes the importance of genetic testing in cases of CH and the consideration of results for future matings. Ideally, only individuals not carrying the mutated allele should be paired. Realizing that this is not always practical, it is strongly recommended to have only one of the parents be a heterozygous carrier for the mutated allele to avoid the risk of CH in the resulting offspring. Should the mating of 2 heterozygous carriers be pursued, preimplantation genetic testing is a viable solution to manage the risk of CH in the resulting foal. Following breeding, the blastocyst is recovered and a trophectoderm biopsy is obtained after which the embryo is cryopreserved. Following genetic testing of the biopsied material confirming the absence of the B3GALNT2 mutation, the cryopreserved embryo can be transferred to a recipient mare (13,14).

References

Student Paper Communication étudiante

Equine sinonasal anaplastic sarcoma infected with multi-drug resistant *Escherichia coli*  
Alexandra Warren

Abstract – A 5-year-old Hanoverian horse was presented for a palpable and visible mass over the frontal and maxillary sinuses. Following endoscopy and radiography surgical excision was attempted. The horse was euthanized during surgery and samples of the mass were identified as malignant anaplastic sarcoma, a seldom reported sinonasal tumor in equids.

Résumé – Sarcome anaplasique naso-sinusien équin infecté par *Escherichia coli* multirésistant aux antibiotiques. Un cheval Hanovrien âgé de 5 ans a été présenté pour une masse palpable et visible sur les sinus frontal et maxillaire. Après une endoscopie et la radiographie, une excision chirurgicale a été tentée. Le cheval a été euthanasié durant la chirurgie et des échantillons de la masse ont été identifiés comme un sarcome anaplasique malin, une tumeur naso-sinusienne rarement signalée chez les équidés.

Sinonasal tumors in horses are rare and generally present as maxillary sinus cysts, progressive ethmoid hematomas, or inflammatory nasal polyps (1,2). Neoplasms are most commonly found in the caudal maxillary sinus, unlike in humans, in whom tumors are more likely to develop in the nasal passages (2). In equids, neoplasms usually present as squamous cell carcinomas (1); adenocarcinoma, osteomas, dental tumors, fibrosarcomas, and hemangiosarcomas are also found (1,3). One case report details an anaplastic sarcoma in the right caudal maxillary sinus of a 10-year-old horse (3). Anaplastic neoplasms are solid masses of undifferentiated cells that are commonly round or pleomorphic epithelial cells, making them most commonly carcinomas.

Communication between the paranasal sinuses, nasal passages, and nasopharynx allows for easy spread of tumor cells throughout the region by invasion or expansion (1). Tumors most commonly develop in the caudal maxillary sinus from which neoplastic cells are able to pass into the frontoconchal sinus through the frontomaxillary opening (1,4) and invade the rostral maxillary sinus by eroding the maxillary septum (1,4). The rostral maxillary sinus is divided into lateral and medial compartments by the infraorbital canal; from the medial portion a neoplasm could invade the ventroconchal sinus, which communicates with the dorsoconchal sinus, through the conchoamaxillary opening (4). The rostral maxillary sinus also communicates with the middle meatus *via* the nasomaxillary opening which allows neoplasms to expand into the nasopharynx (4). The close anatomic location of the nasal cavity and paranasal sinus to vital structures, such as the meninges, great vessels, and skull base, results in sinonasal tumors having a poor prognosis (5).

Growth of a tumor puts pressure on the surrounding tissues and blood vessels, resulting in increased rate of bone resorption, while surrounding unaffected areas with intact blood vessels lay down excessive new bone, causing facial swelling (1). In expansile growth, thinner bones, such as the concha and ethmoids, are destroyed as the tumor expands into them, while more flexible tissues, such as cartilage, are distorted (1). With invasive growth there is increased pressure on tissues as the tumor cells invade between layers of calcaneous bone (1). This allows for further spread of the neoplasia into regions such as the cribriform plate and orbit. The neoplasm can also occlude the blood and lymphatic vessels which exacerbates swelling of the head (1).

Metastasis of sinonasal tumors is infrequently reported (1,6,7) but can occur to local lymph nodes and other areas of the head (1,3). Clinical signs of sinonasal neoplasia are similar to those of non-neoplastic tumors, trauma, and infectious lesions (6). Nasal and ocular discharge, facial deformities and swelling, mastication problems, and neurologic signs have all been reported (1,3,6). Treatment is difficult because diagnosis often occurs in the late stages of disease (2).

Case description

A 5-year-old Hanoverian mare was presented with a 3-week history of facial swelling and the owners had noticed blood on the stall walls. The horse appeared normal before presentation. The referring veterinarian had treated the horse with IM ceftiofur
and penicillin G. Radiographs showed fluid in the frontal and right caudal maxillary sinuses. Nasal discharge began on the left side and progressed to bilateral discharge. A week before referral the horse was started on 2 g of phenylbutazone once a day. The horse was being treated with omeprazole before initial presentation to the referring veterinarian.

On examination, the horse had persistent left-sided mucopurulent nasal discharge and the left frontoconchal and caudal maxillary sinuses were swollen. External palpation found the swelling to be firm and boney. Percussion of the left maxillary and frontal sinuses was dull. Epiphora was observed in the left eye. There was swelling in the mid-neck near the trachea, attributed to the IM injections of ceftiofur.

The horse was sedated for upper airway endoscopy using xylazine (Rompun; Bayer Animal Health, Mississauga, Ontario), 0.3 mg/kg body weight (BW), IV, and butorphanol (Torbugesic; Merial Canada, Baie d’Urfé, Québec), 0.01 mg/kg BW, IV. Endoscopy showed occlusion of the left nasomaxillary opening and mucopurulent discharge with hemorrhagic mucous membranes. The region’s normal anatomy was distorted, including the left dorsal meatus and conchae. The right side of the nasomaxillary opening was within normal limits as well as both guttural pouches, larynx, epiglottis, and dorsal pharynx.

Radiographs of the skull were taken (Figure 1). The left lateral view showed fluid lines in the rostral and caudal maxillary sinus and the dorsoconchal and frontoconchal sinuses, along with a mass of soft tissue with rounded margins in what was assumed to be the left frontoconchal and central maxillary sinuses. The nasal septum was deviated to the right in the ventral-dorsal view; an area of soft tissue or fluid opacity was observed on the left.

The coronal view showed boney deformities in the left frontal sinus and a soft tissue mass in the left caudal maxillary sinus. The tooth roots were within normal limits. Based on the initial examination a differential list included neoplasia, paranasal sinus cyst, or an ethmoid hematoma. The owner elected a sinus lavage and surgery to explore the sinus to determine the cause of the mass. The horse was admitted to hospital for surgery.

A standing sedated exploratory surgery was attempted, but the mare became fractious. It was decided that general anesthesia would be safer and less stressful for the horse and surgical team. The horse was in the hospital for 8 d before surgery under general anesthesia. During this time the horse was given a basic examination and treated with flunixin meglumine (Banamine; Intervet Canada, Kirkland, Quebec), 1 mg/kg BW, IV, and trimethoprim and sulfadiazine (TMS) (Tribrissen; Intervet Canada), 3.2 mg/kg BW trimethoprim and 16 mg/kg BW sulfadiazine, IV, q24h. The mare’s heart and respiration rates remained within normal limits for the first 5 d of hospitalization. At 8 am on day 5 the mare had copious white, frothy nasal discharge from the right nostril and increased swelling of the head and neck. The following day her heart rate was elevated at 60 beats/min (bpm), swelling was still present, ventral edema was noted, and she was having difficulty eating and drinking. The morning of surgery the mare’s heart rate was 48 bpm and her respiration rate was 20 breaths/min. She was still having difficulty eating and there was some nasal discharge.

A frontoconchal sinusotomy flap procedure was performed. The horse was anesthetized with romifidine hydrochloride (Sedivet; Boehringer Ingelheim, Burlington, Ontario), 0.05 mg/kg BW, IV, butorphanol (Torbugesic; Merial Canada),
leading to clinical signs (2,5,6,8–10). As reported by Dixon et
of disease, once the tumor has infiltrated surrounding tissues,
Sinonasal tumors are most often diagnosed in the late stages
non-neoplastic tumors, making definitive diagnosis difficult.
clinical signs that are similar to those caused by neoplastic and
head and neck neoplasms are sarcomas (5). This neoplasm has
Anaplastic sarcomas of the sinonasal region are rare in equids
and other species (1–3,5,7). In horses only about 1% of all
was multi-drug resistant, susceptible to amikacin
was very early on (2). In advanced cases, like this
infections be successful it would not have
the neoplasm would have left the nasopharynx communicating
involvement, whereas CT does. Had CT been done on this mare
a bone flap. The flap was elevated using blunt dissection
a range of clinical signs from anesthetic to euthanasia
would have been able to expand into all the affected structures.
During surgery involvement of the sphenopalatine sinus was not
did not appear to cross the nasal septum into the right side of
had surgery been taken initially, it is likely that surgery
a necropsy was not performed. Samples of the mass were
had treatment with amikacin and enrofloxacin, intermediate resistant to gentamicin, and
Bacterial culture from a swab of the sinus mass revealed
the presence of *Esherichia coli* as the predominant microbe.
*Staphylococcus* and *Streptococcus* species were also identified.
The *E. coli* was multi-drug resistant, susceptible to amikacin
and enrofloxacin, intermediate resistant to gentamicin, and
resistant to all other antimicrobials tested.

**Discussion**

Anaplastic sarcomas of the sinonasal region are rare in equids
and other species (1–3,5,7). In horses only about 1% of all
head and neck neoplasms are sarcomas (5). This neoplasm has
clinical signs that are similar to those caused by neoplastic and
non-neoplastic tumors, making definitive diagnosis difficult.
Sinonasal tumors are most often diagnosed in the late stages
of disease, once the tumor has infiltrated surrounding tissues,
leading to clinical signs (2,5,6,8–10). As reported by Dixon et al
(11), even after clinical signs are present 75% of patients with
 sinonasal tumors are initially treated with antibiotics. Nasal
and ocular discharge and facial deformities are common clinical
signs of sinonasal tumors (1,3,5), as are mastication problems
(6). These clinical signs, however, are also all associated with
traumatic or infectious lesions which are more common than benign neoplasia (6,8).

In the present case the horse had an infection with multi-drug
resistant *E. coli*, *Streptococcus* spp., and *Staphylococcus* spp. The
referring veterinarian initially treated the horse with cefotiofur
and penicillin, which were ineffective. Considering the resistance
reported, these antimicrobials would not have been effective in
controlling the *E. coli* infection. The bacterial infection was most
likely secondary to the anaplastic sarcoma and had treatment of
this secondary infection been successful it would not have
resolved the clinical signs attributed to the growing neoplasm.

The neoplasm was present in the ventroconchal, dorsoconchal,
frontoconchal, and left caudal and rostral maxillary sinuses
and extended into the nasopharynx. Sinonasal tumors most
commonly originate in the caudal maxillary sinus (1); this
is also seen in humans with sinonasal sarcomas (5). In the present
case the mass most likely developed in the caudal maxillary
sinus or the ventroconchal sinus. From either location the mass
would have been able to expand into all the affected structures.
During surgery involvement of the sphenopalatine sinus was not
detected, but this sinus could not be fully assessed. The mass
did not appear to cross the nasal septum into the right side of
the head, but this could not be confirmed.

Radiographs and endoscopy were used to identify the mass
in the sinuses; however, the definitive diagnosis was reached fol-
lowing surgery, histopathology, and cytology. Another option for
diagnosis was using the endoscope to biopsy the mass for pathol-
ogy before surgery. This would have provided the definitive diag-
osis of an anaplastic sarcoma and secondary bacterial infection.
Had this approach been taken initially, it is likely that surgery
would have still been performed to try to excise the sarcoma.
Radiographs are currently the most common form of imaging
used to diagnosis sinonasal tumors; however, radiographs do
not provide as much information on location and extent of
the lesion as computed tomography (CT) (6,8). The use of CT can
improve surgical treatment of sinonasal tumors as better surgic-
al plans can be devised (6,8) to obtain good excisional margins
(2). However, good margins are difficult to obtain unless the
neoplasm is caught very early on (2). In advanced cases, like this
one in which the sarcoma spread extensively, surgical treatment
yields poor outcomes (6,8,9). Computed tomography can be
used to diagnose these more extensive lesions, such as cribriform
plate erosion, invasion of the cranium, and aggressive osteolysis,
before surgery or other forms of treatment (8). Cissell et al (8)
also reported that radiographs do not allow for assessment of
the retrobulbar region, sphenopalatine sinus, or intracranial
involvement, whereas CT does. Had CT been done on this mare
the outcome, euthanasia, would likely be the same as removing
the sarcoma would have left the nasopharynx communicating
with the sinuses.

In humans it is more common to use radiotherapy rather than
surgery as treatment for sinonasal tumors (2). Combinations of
surgery, radiation, and chemotherapy had the most success in
reducing the rate of recurrence and increasing survival time in
humans (5,9). In dogs, radiation has been found to be more
effective than surgical excision, whereas surgical excision fol-
lowing radiotherapy yields similar survival times compared to
using only radiotherapy to treat sinonasal neoplasia (10); there is
evidence that this holds true for horses (9). Radiotherapy is
not a prevalent treatment in horses, but there is a growing
number of facilities offering radiotherapy (2). It is likely
that radiotherapy would be more successful than surgical excision
in treating sinonasal tumors in horses (2,10). However, had
the sarcoma been treated with radiotherapy and/or complete
surgical excision or any other multimodal form of treatment, a
fistula would have been made connecting the ventral conchal
sinus to the nasopharynx, allowing for passage of food and other
ingesta into the sinuses which could then pass into the airways.
Euthanasia, therefore, was the only viable option at this stage
of the disease.

The present case is similar to the one other report of equine
sinonasal anaplastic sarcoma (3). Clinical signs included facial
swelling, unilateral nasal and ocular discharge, exophthalmos,
blindness, lateral headshaking, facial pruritis, and self mutilation
of the face (3). Endoscopy showed a distention of the right max-
illary sinus and the mass was identified in the caudal maxillary
sinus. Surgery was preformed to excise the mass, which extended
from the caudal maxillary, ventrochonchal, and sphenopalatine
sinuses. The horse was euthanized a few days after surgery
due to increased neurologic signs. At necropsy, sclerosis and
necrosis of the sinus walls, and loss of the bone separating the
optic and trigeminal nerves at the optic chiasm were discovered.
Histopathology showed plump spindle cells with pale ovoid
nuclei such that the mass was deemed an anaplastic sarcoma. In
the present case there were no neurologic signs, and the sarcoma
did not infiltrate the optic chiasm or any other cranial nerves.

In the one other reported case of anaplastic sarcoma in the
sinonasal region, the mare also had a secondary infection with
E. coli that had a high level of antibiotic resistance. Both cases
highlight the difficulty in treating sarcomas of the sinonasal
region in horses.

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Too much of a good thing

Myrna Milani

When former veterinary college classmates Drs. Casale and Marchetti run into each other at a veterinary conference, they immediately agree to have dinner together to catch up. During that meal they discover that they both had become practice owners and that their practice philosophies were quite similar.

“But there’s one aspect of my philosophy that I felt so sure about when I became a practice owner that I’m not nearly so sure about now,” Dr. Casale says thoughtfully during a lull in the conversation. “I believed everyone in the practice always should put concern for the animals first and said this to every new employee. I’d worked in a practice where this wasn’t the case and it was awful. But something that happened last year reminded me of the gap between conversation and communication.”

On one hand, it did not surprise Dr. Marchetti that Dr. Casale changed her mind because a recurrent theme as they updated each other about their activities was how many of their ideas had changed over the years. On the other hand, he remembered how passionately she felt as a student about eventually owning a practice in which every staff member would love animals and every animal and client would know this. Although he knew that his more practical as well as reserved food animal clients valued his and his staff’s competence more highly than public displays of their inner feelings, he could see the benefits of such a positive-emotion-based orientation in a companion animal practice such as Dr. Casale’s. Naturally he asked her what caused her to rethink her orientation.

“It began when Josie, one of the young women who does kennel work, discovered a large, scruffy-looking dog lurking behind the clinic when she arrived for work one day,” Dr. Casale began to describe the event that changed more than her practice philosophy. “The dog was highly aggressive, but also very thin and she felt confident that all he needed was food and love.”

At that time, Dr. Casale saw no reason to question her employee’s reasoning. Within a matter of hours, the dog would accept treats from Josie and even allowed her to lure him into the clinic and into a run. Within a matter of days, the dog would allow her to pet him. However, this generated 2 consequences that almost destroyed the trust and rapport between Dr. Casale and her staff that the practitioner had worked so hard to cultivate. The more tolerant the dog became of Josie, the less tolerant he became of all other people and animals, and the more Josie became convinced that all he needed was someone who loved him as much as she did.

“Oh, course, as is often the case in these situations, that ‘someone’ wasn’t her,” Dr. Casale continued. “Josie already had a rescue who hated other dogs and only accepted a handful of people. There was no way she could keep the dog. None of the rest of the staff wanted to take the dog either. But unlike Josie, they suspected the same thing I did — that the dog most likely was a transport with strong street rather than pet dog roots that somebody dumped when he hurt someone. None of us had the time and energy, let alone the desire to take on such a canine project. I can’t tell you how many shelters and behavioral professionals I contacted, and they all said the same thing: If the dog could be helped — and that was a big if — it would take time and commitment. And one of those professionals cautioned me about liability issues related to placing a dog like that as well as having the animal in the clinic — as if I didn’t think about that every day!”

At the same time, other staff members gradually adopted 1 of 3 orientations. Josie’s closest co-workers saw saving the dog at all costs as the perfect solution. Others saw this as a laudable, but impractical solution for many reasons. A third group opted to stay out of the discussion completely. These differing orientations periodically became personal and disrupted the harmony in which the staff previously had worked.

Ultimately several circumstances brought the problem to a head. Some were practical. The dog required resources Dr. Casale and the staff needed for other patients. They could not place other animals in cages or runs near the dog because his aggressive displays stressed them. Whatever else this may have communicated to the practice’s clients, subjecting their animals to such canine harassment would not communicate

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that the practice put their patients first. And even though Josie bloomed in her role as the dog's sole caregiver, it wreaked havoc with her ability to fulfill her work-related obligations. Initially other staff members pitched in to take up the slack, but over time most grew weary of the demands Josie and her canine "soul mate" placed on them.

Although Dr. Casale had mentioned the possibility of euthanasia several times as the number of viable options regarding the dog's future decreased, no one wanted to upset the young woman who loved the dog so much. However, when the dog yanked the leash out of Josie's hand and lunged at a technician and shredded his lab coat (but fortunately did only minor damage to his arm), Dr. Casale euthanized the dog.

"What a horrible situation!" exclaimed Dr. Marchetti. "What happened next?"

"After things calmed down, I realized that, for as much as I thought I communicated well with my staff and vice versa, that wasn't true regarding this issue," replied Dr. Casale. "Superficially we all agreed that concern for the well-being of our patients should play a central role in our practice philosophy. But Josie interpreted this to mean I agreed with her love-will-conquer-all philosophy. When she discovered I didn't, she felt angry and betrayed."

Dr. Casale concluded the tale by noting she had 2 regrets regarding the incident, one about which she could do nothing and another that she could and did address. Her relationship with Josie was ruined and the practitioner eventually accepted that this was the way the young woman wanted to keep it. Fortunately, Josie agreed that she would be happier working somewhere else.

The practice owner's other regret was that she had not specifically addressed this issue in material given to prospective employees along with the employment application and reiterated it upon hiring. Instead she imparted this information informally during the job interview. In retrospect, Dr. Casale realized this denigrated the importance of the material to the employee's success.

To correct this oversight, the veterinarian composed such a document so that there could be no misunderstanding regarding: a) the value the practice placed on concern for all their patients' well-being, and b) what this entailed. She stressed that this referred to all the animals which were hospitalized and all those seen at the veterinary clinic on any given day. It also acknowledged that, although it was normal for staff members to like certain animals compared to others, this should not interfere with every team member's obligation to ensure that every animal received the same quality care.

Dr. Casale also provided more precise information regarding the reality of euthanasia in a veterinary practice. This included acknowledging that sometimes situations would arise when euthanasia constituted a caring response when the owner and veterinarian consider all the factors contributing to the animal's condition. Some of these factors may be known only to the client and the veterinarian. Clients were under no obligation to justify their choice to staff members; respect for client confidentiality obligated the veterinarian not to share such information without the consent of the client.

Other times, the veterinarian may need to euthanize unowned animals for which no suitable homes can be found due to the severity of the animal's problems and/or the threat these pose to others. These sad situations may be especially difficult for individuals prone to gravitate toward and develop stronger emotional ties with animals having such problems. The information Dr. Casale would provide to prospective employees acknowledged that such strong emotional ties can be beneficial with our own animals. However, all of those working in the veterinary practice must provide quality care for all the animals in their care, not just those who appeal to them for some reason. Once Dr. Casale completed her document, she shared it with her staff and practiced verbally communicating its key points, so she could provide the information naturally during the next potential employee interview.

Sometimes it is easy for busy practitioners to provide less information to lower level employees compared to those whose work is perceived as more important and more complex. But as this case demonstrates, failure to communicate in a meaningful way with those whose contribution may appear to be minimal may have maximum negative consequences. Moreover, these consequences may affect the entire staff plus all the animals in their care and the clients to whom those animals belong.
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