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President’s Message
Le mot de la présidente

The “wicked” problem of our workforce shortage
L’épineux problème de la pénurie de main-d’œuvre

I have not really known anything else in my career other than staff shortages. Even 20 years ago when I graduated, finding work was not a problem, at least not here in Quebec. It was one of the upsides of going into our profession: job security. So, when I would speak with colleagues in other parts of the world, such as Spain and Brazil, I was taken aback to hear they had too many vets. How was this even possible?

In the spring of 2020, the CVMA took on a very considerable mandate: a Canada-wide workforce study (full study available to members only via the CVMA website). The study demonstrated that the demand for veterinary services will outpace the supply of veterinarians by 2040. As an independent practice owner, I can assure you this is not a WILL, this is a NOW. It is not a regional problem; it is vast and encompasses all regions of our country. It affects all areas of the profession, from equine vets in rural communities to small animal urban vets. There is a need and we feel it deeply.

Throughout the years, I have been asking myself, is it simply a case of supply and demand? Do we really not have enough vets or are there other factors that are influencing our shortage? Increasing Canadian population, increasing household income, more pets (large and small!), and more food needing to be produced all result in more animals requiring medical care. A + B = C. So why do I still hear so many of my colleagues, and truth be told, sometimes myself, commenting on generational differences?

The workforce study clearly demonstrates that vets age 29 or less work long hours. Thirty-seven percent of them are working 45 hours or more! Having hired and mentored quite a few new graduates in the past 20 years, I can say that millennials and Generation Z do prioritize good work/life balance. They tend to ask for more vacation, improved work schedules, less on-call, etc. They are advocating for their health, and so should they!

While working with our CVMA team on the “It’s Time to Talk Mental Health in Vet Med” campaign and closely with Dr. Kathy Keil, our mental health champion, a disturbing study

Depuis le début de ma carrière, je n’ai pas connu de contexte sans pénurie de personnel. Même il y a 20 ans, quand j’ai obtenu mon diplôme, trouver du travail n’était pas difficile, du moins pas ici au Québec. C’était l’un des avantages de notre profession : la sécurité d’emploi. J’étais donc surprise quand je parlais à des collègues d’autres régions du monde, comme l’Espagne et le Brésil, et que j’apprenais qu’ils avaient le problème inverse et trop de médecins vétérinaires. Comment cela était-il possible?

Au printemps de 2020, l’ACMV a entrepris le projet colossal de mener une étude pancanadienne sur la main-d’œuvre (dont le compte rendu complet est accessible aux membres sur le site Web de l’ACMV). Cette étude a démontré que la demande pour les services vétérinaires dépassera l’offre d’ici 2040. En tant que propriétaire d’un établissement vétérinaire indépendant, je peux vous assurer que ce n’est pas quelque chose qui arrivera dans le FUTUR, c’est quelque chose qu’on vit MAINTENANT. Ce n’est pas non plus un problème local – c’est un problème de grande envergure qui touche toutes les régions de notre pays. Il affecte tous les secteurs de la profession, des médecins vétérinaires équins dans les communautés rurales aux médecins vétérinaires pour petits animaux dans les grandes villes. Il y a un besoin, et nous le ressentons de façon très évidente.

Au fil des ans, je me suis demandé s’il s’agissait simplement d’une question d’offre et de demande. Manquons-nous vraiment de médecins vétérinaires ou y a-t-il d’autres facteurs qui influent sur la pénurie qu’on perçoit? L’augmentation de la population canadienne, l’augmentation du revenu des ménages, le plus grand nombre d’animaux de compagnie (grands et petits) et la nécessité de produire plus d’aliments font en sorte que plus d’animaux ont besoin de soins médicaux. A + B = C. Alors pourquoi est-ce que j’entends encore beaucoup de mes collègues, et j’avoue le faire moi aussi à l’occasion, faire des commentaires sur les différences générationnelles?

Le travail de l’étude sur la main-d’œuvre démontre clairement que les médecins vétérinaires âgés de 29 ans ou moins travaillent longtemps. Trente-sept pour cent d’entre eux travaillent plus de 45 heures par semaine! Ayant embauché et formé plusieurs nouveaux diplômés au cours des 20 dernières années, je peux dire que les millénaristes et la génération Z placent la priorité sur un équilibre travail/vie privée. Ils demandent plus de congés, des horaires de travail améliorés, moins d’accidents, etc. Ils veillent à leur santé, et c’est bien ainsi!

Alors que je travaillais avec l’équipe CVMA sur la campagne “Il est temps de parler de la santé mentale en vétérinaire” et en étroite collaboration avec Dr. Kathy Keil, notre champion de la santé mentale, une étude choc.
came across my desk. In 2020, out of the 1403 veterinarians surveyed across Canada, 26.2% had considered suicide in the past year (1). This is substantially higher than is documented in the general population in which it is generally considered to be 10%. As we can clearly see, the old fashioned 60 hours a week and on-call 6 days a week… isn’t going to fly. There is a reason why it is called overtime — because it is OVERDOING IT.

In the past 8 months the CVMA Workforce Working Group, which Council mandated last summer, has been diving into the depths of the issues and has identified some key strategies and solutions. It is clear to all that this is a complex problem. We need to be looking intrinsically and extrinsically at the issue, as well as for short- and long-term solutions.

In the short term, we need to prioritize keeping our teams safe and well or we will not have any teams with which to work. Perhaps our present practice models and current delivery systems are problematic and inefficient. Could we do more with less? I am a firm believer that many practices today continue to underutilize veterinary technicians. However, we have a serious shortage of veterinary technicians as well! With the added pressures and change in workflow because of the pandemic, the shortage is touching all of us. Our hospital alone has increased support staffing by 20% in 8 months!

Our future depends on all of us advocating for change. As your national Association, we are fully committed to prioritizing and supporting the development of a national workforce strategy. Provinces need our support as they bid to obtain more funding, and universities need our support as they investigate innovative ways to increase the number of graduating veterinarians. Canadian students studying abroad need to be encouraged to come home when they graduate. Should we not be developing more clinical programs and encouraging graduates to come to Canada from non-accredited veterinary programs? These graduates are more likely to obtain their Certificate of Qualification in Canada.

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It certainly sounds as though we are dealing with a “wicked” problem; one in which there are so many interdependent factors it seems impossible to solve. But I am an optimist and I believe in the creativity and commitment of the leaders in our profession who are dedicated to solving this problem. It may not happen overnight, but we will get there.

Reference

Enid Stiles
Nous avons de toute évidence affaire à un problème épineux qui dépend de tellement de facteurs interdépendants qu’il semble impossible à régler. Mais je suis optimiste et j’ai confiance en la créativité et en l’engagement des leaders de notre profession qui s’efforcent de le résoudre. Cela ne se fera peut-être pas du jour au lendemain, mais nous y arriverons.

Référence

Enid Stiles
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Veterinary Medical Ethics
Déontologie vétérinaire

Ethical question of the month — February 2021
Your new associate is an outgoing individual and is well-liked by clients and staff. She is also open about her use of recreational marijuana when off duty. You soon learn that several of your staff now discuss their recreational use of marijuana as well. You have little experience with the drug and Internet searches indicate that some jurisdictions in North America forbid recreational marijuana use by physicians, pilots, law enforcement officers, and others. Some jurisdictions simply mandate minimum periods between consumption and return to work. No restrictions have been put in place by your provincial licensing body with the exception that practicing while impaired is forbidden. You are becoming overly sensitive to simple errors occurring at the clinic and wonder if there is an association with the staff’s use of marijuana. You want to ensure your professional standards are maintained but are not comfortable instituting restrictions on legal recreational drug use among your colleagues and staff. What is your professional responsibility in this situation?

An ethicist’s commentary on legal marijuana use
As this case illustrates, the legalization of marijuana in many Western countries has changed the playing field for professional activities. Just because legal restrictions on marijuana have been removed does not mean that the use of marijuana should have carte blanche. We all know that alcohol is legal for people above a certain age, but that does not mean that people should be drinking at work, for example surgeons prior to surgery. One would hope that common sense would mandate such limitations, but it is well-known that common sense is not all that common.

So what does one do in a situation such as the one described in this case? I think that it is perfectly legitimate for each clinic to set its own rules, but to do so judiciously. Manifestly, the use of such intoxicants during working hours puts patients at risk, animal and human, and even puts the reputation of the clinic, or an entire clinic at risk.

On the other hand, it probably does not serve a given clinic well for clients to know that medical practitioners at that clinic relax by using a recreational drug, certainly at work. It is easy to imagine one clinic defaming another by accusations of drug use at the latter clinic. So how does one address this?

It would probably behoove all clinics in a given area to avoid a “trade war” by universally adopting a policy of forbidding recreational drug use in situations that are likely to make clients uncomfortable about going to any veterinary clinic or medical facility. If I were to go to a human physician’s office and detect even traces of marijuana smell, I would leave, since marijuana is known to impair judgment. Such a decree should probably come from a veterinary association or a medical association.

Any activity that was illegal for a long time, even if legalized, will remain shrouded in suspicion. Restricting intoxicating drugs in medical situations therefore is a good idea.

Bernard E. Rollin, PhD

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A retired farmer keeps a few cattle, sheep, and poultry on his farm in part to keep himself mentally and physically engaged. These animals are kept in basic unheated shelters with outside access. He also has 2 dogs that are tied up most of the time and each has a doghouse. All the animals are in good physical condition. A passerby who sees the animals outside in the winter makes a complaint under the Ontario Provincial Animal Welfare Services Act. Investigators under this Act announce a farm inspection. You are asked to accompany the investigators (who are not veterinarians) as a third-party veterinarian on behalf of one commodity group. The investigators are trained on the legal requirements of the Act but have little to no farm experience. You point out that the housing, feeding, watering, and veterinary care of all species are acceptable in your professional opinion. The farm veterinarian who has worked with the retired farmer for years and who regularly attends to the needs of the animals, has never doubted the quality of the husbandry. Nevertheless, the investigators write up a number of orders for the farmer to implement, none of which you believe are required nor will improve the welfare of the animals. The retired farmer is extremely upset to be accused of sub-standard animal care and is considering getting rid of all his animals. The farm veterinarian who was never consulted likewise feels her expertise in animal husbandry is being disregarded. Should the law place the interpretation of the Provincial Animal Welfare Services Act by the provincial investigators above that of experienced, licensed veterinarians?

Submitted by Sue Burlatschenko, Goshen Ridge Veterinary Services and Joel Rumney, North Simcoe Veterinary Services

Responses to the case presented are welcome. Please limit your reply to approximately 50 words and forward along with your name and address to: Ethical Choices, c/o Dr. Tim Blackwell, 6486 E. Garafraxa, Townline, Belwood, Ontario N0B 1J0; telephone: 519-846-3413; fax: 519-846-8178; e-mail: tim.e.blackwell@gmail.com

Suggested ethical questions of the month are also welcome! All ethical questions or scenarios in the ethics column are based on actual events, which are changed, including names, locations, species, etc., to protect the confidentiality of the parties involved.
1. Which of the following is most correct concerning a typical reference range?
   A. It includes 80% of the population, with 10% of normal animals testing above and 10% testing below the range.
   B. It includes 90% of the population, with 5% of normal animals testing above and 5% testing below the range.
   C. It includes 95% of the population, with 2.5% of normal animals testing above and 2.5% testing below the range.
   D. It includes 100% of the population, with no normal animals testing above or below the range.

2. Which of the following abdominal wall layers is the holding layer that must be included into abdominal wall closures to prevent incisional dehiscence?
   A. Transversus abdominis muscle
   B. Peritoneum
   C. Falciform ligament
   D. Internal rectus fascia
   E. External rectus fascia

3. The prepatent period for heartworm development in the dog is which of the following?
   A. 3 days
   B. 6 weeks
   C. 3 months
   D. 6 months
   E. 1 year

4. In ruminants, grass tetany is associated with which of the following?
   A. Increased serum magnesium
   B. Decreased serum magnesium
   C. Increased serum calcium
   D. Decreased serum potassium
   E. Decreased serum phosphorus

1. Lequel des énoncés suivants est le plus exact à propos de l’étendue de référence caractéristique?
   A. Elle comprend 80 % de la population, avec 10 % des animaux normaux dont le testage est au-dessus et 10 % dont le testage est au-dessous de l’étendue.
   B. Elle comprend 90 % de la population, avec 5 % des animaux normaux dont le testage est au-dessus et 5 % dont le testage est au-dessous de l’étendue.
   C. Elle comprend 95 % de la population, avec 2,5 % des animaux normaux dont le testage est au-dessus et 2,5 % dont le testage est au-dessous de l’étendue.
   D. Elle comprend 100 % de la population, avec aucun des animaux normaux dont le testage est au-dessus ou en dessous de l’étendue.

2. Laquelle des couches de la paroi abdominale suivantes est la couche de retenue qui doit être comprise dans la fermeture de la paroi abdominale pour prévenir la déhiscence de l’incision?
   A. Muscle transverse de l’abdomen
   B. Péritoine
   C. Ligament falciforme
   D. Fascia du muscle droit interne de l’abdomen
   E. Fascia du muscle droit externe de l’abdomen

3. Laquelle des périodes suivantes est la période de prépatence pour le développement des vers du cœur chez le chien?
   A. 3 jours
   B. 6 semaines
   C. 3 mois
   D. 6 mois
   E. 1 an

4. Chez les ruminants, la tétanie d’herbage est associée à quel phénomène parmi les suivants?
   A. Augmentation du magnésium séréique
   B. Diminution du magnésium séréique
   C. Augmentation du calcium séréique
   D. Diminution du potassium séréique
   E. Diminution du phosphore séréique
5. In horses, an increase in ALT usually indicates which of the following?
A. Cholestasis
B. Hepatocyte injury
C. Muscle damage
D. Increased hemoglobin production
E. Exogenous steroid use

(See p. 527 for answers./Voir les réponses à la page 527.)

Questions and answers were derived from Review Questions and Answers for Veterinary Boards 2nd ed., a 5-volume series including Basic Sciences, Clinical Sciences, Small Animal Medicine and Surgery, Large Animal Medicine and Surgery, and Ancillary Topics, by kind permission of the publisher, Mosby–Year Book, Inc., St. Louis, Missouri.


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pH PCO₂ PO₂ Na K Cl iCa iMg TCO₂ Glu Lac Urea Creat Hct Hb SO₂ % O₂Hb COHb MetHb HHb HbF tBil

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Compact Size
Height: 18.2 in (45.7 cm)
Width: 14.2 in (35.6 cm)
Depth: 15.5 in (39.1 cm)
Veterinarians and veterinary students are busy, which can lead to feeling off-balance — mentally, physically and/or emotionally. The CVMA looks continually for valuable wellness programs and resources to offer members.

GoodLife, a long-standing CVMA partner, is more than just a gym. They want to give you the tools to live a happy, healthy, and “good life” inside and outside of the gym. Below, GoodLife offers advice on how to lead a healthy lifestyle in mind, body and spirit.

Create a foundation
When trying to strike a balance, it’s important to cover the basics first: nutrition, exercise and sleep. These areas are the key pillars of life you need to address before finding a healthy balance in every other area. You need to feel your best both physically and mentally, so creating healthy habits and sticking to them is the first step.

There’s no need for perfection; simply strive to create an overall healthy lifestyle that works for you.

Five Tips for Creating a Balanced Life
From Meditation to Prioritizing — Here’s How You Can Achieve Balance

Les médecins vétérinaires et les étudiants en médecine vétérinaire sont très occupés, ce qui peut mener à un sentiment de déséquilibre sur le plan mental, physique ou émotionnel. C’est pourquoi l’ACMV est continuellement à l’affût de programmes et ressources utiles concernant le mieux-être à offrir à ses membres.

GoodLife, partenaire de longue date de l’ACMV, propose plus que de simples gyms. Dans leurs centres, on vous donne des outils pour vivre heureux et en santé, tant à l’intérieur qu’à l’extérieur de la salle d’entraînement. Ci-dessous, GoodLife propose des conseils sur la manière d’adopter un mode de vie sain pour le corps et l’esprit.

Créez une fondation
Lorsque vous essayez de trouver un équilibre, il est important de d’abord couvrir les bases : l’alimentation, l’exercice et le sommeil. Ces trois aspects sont les principaux piliers qu’il faut consolider pour tenter d’atteindre un équilibre sain dans les autres aspects de votre vie. Vous devez vous sentir bien physiquement et mentalement, et la première étape pour y arriver est d’adopter de bonnes habitudes.
Recognize your priorities
Life can get busy from time to time. If you ever catch yourself feeling overwhelmed with everything you have on your plate, take a step back and re-emphasize what’s important to you.

By understanding what’s most important to you, be it your personal fitness, spending time with your loved ones or participating in various activities, you can begin to prioritize what you need to focus on and what you don’t.

Reduce stress
Speaking of prioritizing, part of this is learning to say “no.” Ask yourself if you’re putting unnecessary expectations on yourself by committing to do too many things. If you’re over-worked and trying to balance your personal life as well as your other priorities, letting go and saying no to some of the smaller things can improve your mental state and stress level.

Know where to put your energy. Doing this should take some pressure off, even if you don’t get around to the rest.

Schedule downtime
When seeking to find balance, try to leave some room for some much-needed down time. Everyone needs a day where they can do something for themselves, have a night to relax or to do something you love.

Many busy people struggle with the concept of relaxing. However, if you take the time to schedule it, you’ll be more likely to stick with it.

Do what works for you — even if it’s simply taking half an hour a day to read a book or watch your favourite show. Stepping away from work and other obligations will help you feel less stressed and more refreshed.

Meditate
Adding a meditation practice to your day can also help you achieve balance. Meditation has many benefits, including improved focus, productivity, and stress level. A meditation practice doesn’t have to be time-consuming either — simply start your day off with a 5- to 10-minute guided meditation, which will help balance energy.

And, exercise
CVMA members are eligible for a preferred GoodLife membership rate and receive a corporate discount up to 43% off regular individual membership rates. To view the GoodLife flyer or FAQs or to join now, visit the CVMA membership benefit webpage at (www.canadianveterinarians.net/member-benefits/exclusive-discounts-valued-partners). You will need your CVMA ID number to register. If you do not have or forgot your ID number or have additional questions, please contact the CVMA (admin@cvma-acmv.org).

Prenez du temps pour vous
Lorsque vous cherchez à trouver un équilibre, essayez de prévoir des pauses et des temps d’arrêt. On a tous besoin d’une journée où on peut faire quelque chose pour soi-même, passer une soirée à se détendre ou s’adonner à une activité qu’on aime.

Beaucoup de professionnels occupés ont du mal avec le concept du repos. Cependant, si vous prenez le temps de planifier des moments de pause dans votre horaire, vous serez plus susceptible de respecter cet engagement envers vous-même.

Faites ce qui vous convient, même si c’est simplement prendre une demi-heure par jour pour lire un livre ou regarder votre émission préférée. En vous éloignant du travail et de vos autres obligations, vous vous sentirez moins stressé et plus détendu.

Méditez
Intégrer la méditation à votre journée peut également vous aider à atteindre un équilibre. La méditation a de nombreux avantages, comme l’amélioration de la concentration, l’augmentation de la productivité et la diminution du stress. Une séance de méditation ne prend pas nécessairement beaucoup de temps — commencez simplement votre journée par une méditation guidée de 5 à 10 minutes, pour vous aider à équilibrer votre énergie.

Faites de l’exercice
Les membres de l’ACMV ont droit à un tarif préférentiel d’abonnement à GoodLife et bénéficient d’un rabais de groupe pouvant atteindre 43 % sur le prix de l’abonnement individuel régulier.

Pour en savoir plus sur l’offre de GoodLife ou pour vous inscrire, visitez la page des avantages pour les membres de l’ACMV (www.veterinairesaucanada.net/member-benefits/exclusive-discounts-valued-partners). Vous aurez besoin de votre numéro de membre de l’ACMV pour vous inscrire. N’hésitez pas à communiquer avec l’ACMV (admin@cvma-acmv.org) si vous ne connaissez pas votre numéro de membre ou si vous avez des questions supplémentaires.
Given the COVID-19 pandemic, the resulting uncertainties, and keeping in mind continued health and safety measures, the CVMA’s 2021 Annual General Meeting (AGM) will take place virtually, on **Thursday, July 22 from 12:00 noon to 2:00 pm EDT**. All CVMA members will receive remote dial-in instructions by e-mail prior to the meeting. Please sign in and review your membership profile at (https://cvma.member365.com/sharingnetwork/myProfile) to ensure that your e-mail address is accurate.

Compte tenu de la pandémie et des incertitudes qui en découlent, et pour assurer la santé et la sécurité de tous, l’assemblée générale annuelle de 2021 de l’ACMV aura lieu de façon virtuelle, le **jeudi 22 juillet de 12 h à 14 h (HAE)**. Tous les membres de l’ACMV recevront des instructions par courriel avant la réunion pour pouvoir y accéder à distance. Nous vous prions de vérifier vos coordonnées dans votre profil de membre (https://cvma.member365.com/sharingnetwork/myProfile) pour vous assurer que votre adresse courriel est exacte.

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Choosing which metrics to use when reporting antimicrobial use information to veterinarians in the Canadian swine industry

Angelina L. Bosman, Anne E. Deckert, Carolee A. Carson, Richard J. Reid-Smith, Zvonimir Poljak, Scott A. McEwen

Abstract — The objective of this study was to evaluate preferences for various metrics and denominators among Canadian swine veterinarians, in order to improve reporting of antimicrobial use (AMU) information to these stakeholders and to facilitate enhanced stewardship decisions. An online survey was made available to swine veterinarians across Canada; 12 responses (estimated response rate 17.6%) were submitted and analyzed. Responses represented veterinarians from every major pig-producing province and from a range of year of graduation from veterinary college. Participants self-evaluated their understanding of dose-based metrics as higher than weight- and frequency-based metrics and interpreted most results of AMU analyses correctly. Participants preferred dose-based metrics over others, and had various objectives for AMU information, including improving AMU on their clients’ farms and enabling comparisons with other farms. The results are useful to those making decisions about which AMU metrics to use in reports targeted to swine veterinarians.

Introduction

Growing public health concern about the development of antimicrobial resistance (AMR) resulting from the use of antimicrobials in food animals, including pigs, has led to an increasing focus on the collection and analysis of antimicrobial use (AMU) information at the farm-level (1–3). Veterinarians can use the results of farm-level AMU analyses for many purposes. These include evaluating their prescribing and use practices in comparisons among herds or with the industry average, and developing and demonstrating good antimicrobial stewardship practices (4). However, the results of AMU analyses are only useful to veterinarians if they are understood and accessible (5).

Antimicrobial use information can be described in quantitative terms using various metrics (6,7). These metrics include frequency- or count-based metrics (e.g., the percentage of rations...
on a farm that are medicated with antimicrobials, the prevalence or incidence of administration of a given antimicrobial), weight-based metrics (e.g., total kilograms of antimicrobial used), and dose-based metrics (e.g., defined daily doses for animals) (8). Weight-based and dose-based metrics may be further refined by applying a denominator that adjusts the metric by size and/or weight of the population of animals at risk of treatment and, in some cases, by the days at risk (or length of the production cycle) (6). When characterizing AMU, choosing which metrics and denominators to use is an important decision that may be affected by factors such as the intended audience.

Limited research has been done to assess the degree of understanding of AMU metrics among veterinarians, or on their preferences for and comfort level with them. Benedict et al (9) administered a questionnaire to beef industry stakeholders, including veterinarians and producers, about various AMU measures and their perceived accuracy and clarity. Dose-based measures standardized to 1000 animal-days were perceived to be accurate and appropriate for reporting comparisons in use and relationships with AMR, and 64% of participants correctly interpreted this measure (9).

In Canada, there are approximately 7700 pig farms (10), an estimated 68 veterinarians practicing predominately swine medicine and herd health (Anne Deckert, personal communication, 2017), and an unknown number of veterinarians in mixed practice with swine clients. The Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) has been collecting and analyzing AMU data from sentinel grower-finisher herds across Canada since 2006 (82 herds in 2017) (11,12). This information is available for swine veterinarians and producers to help make antimicrobial stewardship decisions. Knowledge of veterinary understanding of and preferences for AMU metrics is of use to those who communicate AMU information to veterinarians and other stakeholders involved in antimicrobial stewardship. The objective of this study was to evaluate preferences for various AMU metrics and denominators among Canadian swine veterinarians to improve reporting of AMU information to these stakeholders and to facilitate antimicrobial stewardship decisions. We anticipated that simpler metrics (e.g., frequency-based) would be better understood and preferred over more involved metrics (e.g., dose-based).

Materials and methods
The study was designed to evaluate the AMU metric and denominator preferences for both swine veterinarians and producers. Producers were invited, in a manner similar to that described below for the veterinarians, to participate in the study. However, the producer response was too limited to allow meaningful analysis. This paper, therefore, focuses entirely on the veterinary survey and responses.

Questionnaire development
An anonymous, online questionnaire was developed using the Qualtrics Research Core Platform (Qualtrics, Provo, Utah, USA). As an alternative, a mail-based paper version was made available with pre-addressed, stamped envelopes. The questionnaire was available in English and French (the official national languages of Canada). The French version was reviewed by a French-speaking industry expert familiar with Québécois French. The questionnaire is included in supplementary materials available from the authors.

The questionnaire had 4 sections: Research Summary and Consent, Understanding, Preferences, and Demographics. As part of the Research Summary, consenting participants were asked to identify their occupation and to self-evaluate their understanding of AMU metrics and denominators before being introduced to the various metrics in the Understanding section.

The Understanding section included a general introduction to AMU metrics and a short description, with examples, of frequency-, weight-, and dose-based metrics and denominators. Fictitious results from analyses using each type of metric were provided and participants were asked questions to test their understanding. Each question included an “Unsure” response option. The AMU metrics included the percentage of farms using an antimicrobial, the percentage of rations medicated with antimicrobials, and the percentage of days medicated (frequency-based metrics), the total kilograms of antimicrobials used, and milligrams of antimicrobials used per kg of pig (weight-based metrics), and the defined daily doses for animals per pig or per 1000 pig-days (dose-based metrics) (Table 1). Three questions were included in this section, with 1 question each for frequency-, weight-, and dose-based metrics.

The Preferences section included 3 questions about which metrics participants preferred and deemed most useful, factors that influenced their preferences, and their needs for AMU information. Two optional open-text questions allowed participants to provide additional information.

The Demographics section comprised 5 questions: their province(s) of employment; highest education level, how comfortable they felt explaining the various AMU metrics to their swine clients, whether their veterinary practice is limited to pigs, and their decade of graduation (to avoid collecting potentially identifying information).

The questionnaire was piloted by graduate students involved in AMR studies, including 3 veterinarians, resulting in modifications to improve clarity and reduce ambiguity. In addition, 2 veterinary researchers knowledgeable in the field of AMU provided a scientific review of the study design and the questionnaire as part of the ethics review process. The University of Guelph (#18-06-013) and Health Canada’s (#2018-0010) research ethics boards reviewed and approved the study and the questionnaire.

Questionnaire administration
Invitations to complete the online questionnaire were distributed across Canada between November 2018 and June 2019. Paper copies of the survey were made available in 2019 for those who preferred this format. Invitations to participate were e-mailed by the industry and veterinary associations listed in Table 2 to their members, and in some cases, posted on social media. Paper invitations were also distributed at veterinary meetings and conferences, including the Western Canadian Association of Swine Veterinarians’ annual conference, the Canadian Association of Swine Veterinarians’ Annual General
Participants were asked to rate their understanding of frequency-, weight-, and dose-based metrics, as well as biomass and animal-time denominators, on a scale of very poor to excellent (Figure 1). Among the AMU metrics, responses ranged from very poor to excellent, with dose-based metrics having the highest number of responses (9/12). When the AMU metrics and denominators were ordered according to the number of good and excellent responses, dose-based metrics had the highest number of responses (9/12), followed by frequency-based metrics (8/12), animal-days denominators (8/12), biomass denominators (7/12), and weight-based metrics (6/12). Five out of 12 (42%) participants rated their understanding of all metrics and denominators as good or excellent, whereas 2/12 (17%) participants did not have any good or excellent ratings for any metrics or denominators. The remaining 5/12 (42%) participants had mixed responses.

In the Understanding section, the frequency-based questions were similar between the 2 types of denominators (Figure 1). When the AMU metrics and denominators were ordered according to the number of good and excellent responses, dose-based metrics had the highest number of responses (9/12), followed by frequency-based metrics (8/12), animal-days denominators (8/12), biomass denominators (7/12), and weight-based metrics (6/12). Five out of 12 (42%) participants rated their understanding of all metrics and denominators as good or excellent, whereas 2/12 (17%) participants did not have any good or excellent ratings for any metrics or denominators. The remaining 5/12 (42%) participants had mixed responses.

### Table 1. The antimicrobial use metrics used in the study including formulas and abbreviations.

<table>
<thead>
<tr>
<th>Antimicrobial use metrics</th>
<th>Abbreviation</th>
<th>Formula for calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency-based</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of farms</td>
<td>% farms</td>
<td>Number of farms using an antimicrobial</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total number of farms</td>
</tr>
<tr>
<td>Percentage of rations medicated</td>
<td>% rations</td>
<td>Number of rations medicated with antimicrobials</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total number of rations</td>
</tr>
<tr>
<td>Percentage of days medicated</td>
<td>% days</td>
<td>Number of days medicated with antimicrobians</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total days in the production cycle</td>
</tr>
<tr>
<td>Weight-based</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kilograms used</td>
<td>kg</td>
<td>∑ kg of antimicrobial used</td>
</tr>
<tr>
<td>Milligrams adjusted by animal biomass</td>
<td>mg/kg&lt;sub&gt;st&lt;/sub&gt;</td>
<td>Number of pigs × standard weight at treatment (kg)</td>
</tr>
<tr>
<td>Dose-based</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Canadian defined daily doses for animals</td>
<td>nDDDvetCA</td>
<td>mg of antimicrobial used</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DDDvetCA × standard weight at treatment (kg)</td>
</tr>
<tr>
<td>Canadian defined daily doses for animals adjusted by animal numbers</td>
<td>DDDvetCA/pig</td>
<td>Number of pigs</td>
</tr>
<tr>
<td>Canadian defined daily doses for animals adjusted by animal-time</td>
<td>DDDvetCA/1000 pig-days</td>
<td>(Number of pigs × Number days at risk) × 1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 2. Swine industry and veterinary associations that assisted with distributing invitations to participate in the survey.

<table>
<thead>
<tr>
<th>Association</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td></td>
</tr>
<tr>
<td>Canadian Pork Council</td>
<td>National</td>
</tr>
<tr>
<td>Ontario Pork</td>
<td>Provincial</td>
</tr>
<tr>
<td>Manitoba Pork</td>
<td>Provincial</td>
</tr>
<tr>
<td>Veterinary</td>
<td></td>
</tr>
<tr>
<td>Canadian Association of Swine Veterinarians</td>
<td>National</td>
</tr>
<tr>
<td>Ontario Association of Swine Veterinarians</td>
<td>Provincial</td>
</tr>
<tr>
<td>Association des vétérinaires en industrie animale du Québec</td>
<td>Provincial</td>
</tr>
<tr>
<td>Western Canadian Association of Swine Veterinarians</td>
<td>Provincial</td>
</tr>
</tbody>
</table>

### Results

Sixteen practicing veterinarians agreed to participate, 12 of whom completed and submitted the survey. Assuming all swine veterinarians in Canada received a survey invitation and the estimate of 68 veterinarians practicing predominately swine medicine and herd health is correct, the response rate was 17.6%. Most participants were from the highest pig producing province in Canada (Quebec), followed by Ontario and Alberta (Table 3). Most participants worked with primarily swine farm clients, completed the questionnaire in English, and graduated from veterinary college prior to 2010 (Table 3). Two veterinarians completed the paper version of the questionnaire, whereas the remainder completed the online version.

Participants were asked to rate their understanding of frequency-, weight-, and dose-based metrics, as well as biomass and animal-time denominators, on a scale of very poor to excellent (Figure 1). Among the AMU metrics, responses ranged from poor to excellent, with dose-based metrics having the highest number of excellent responses (Figure 1). Participants' responses...
Participants were asked to indicate which listed objectives they would like to achieve when provided with quantitative AMU data. They were also asked to provide any additional objectives that were not listed. All 12 respondents selected the objective of improving AMU on their clients' farm. Eighty-three percent (10/12) of respondents wanted to be able to compare AMU on their client's farm with provincial reports on AMU on swine farms and detect changes in AMU on their client's farm. Sixty-seven percent (8/12) of respondents wanted to be able to compare AMU on their client's farm with other farms, and 42% (5/12) of respondents were interested in providing data for research. Additional objectives provided by the respondents included comparing AMU among a group of like-minded producers and evaluating AMU by class of antimicrobial and stage of production.

An additional question for veterinarians, added to the demographics section, asked participants to rate their level of comfort in explaining the results of AMU analyses, using the various AMU metrics and denominators, on a scale of very uncomfortable to extremely comfortable (Figure 4). No participants felt very uncomfortable explaining any of the metrics or denominators (Figure 4). Only the 2 denominators received ratings of somewhat uncomfortable. Frequency- and weight-based metrics received the highest number of extremely comfortable ratings, whereas dose-based metrics received more mixed ratings, ranging between neither comfortable nor uncomfortable and extremely comfortable (Figure 4).

Discussion

This survey indicated that veterinarians in the swine industry have a basic to very good understanding of the metrics that are used to report AMU information, and identified their preference for dose-based metrics over others, in contrast with our original expectations. The survey also provided some insight into why veterinarians prefer dose-based metrics.

The questions that tested participants' understanding of AMU metrics were largely answered correctly, indicating that participants were able to interpret the results of AMU analyses using each type of metric. One participant skipped the dose-based question, which may indicate uncertainty in how to answer the question, although an "unsure" option was available. Although the participants rated their understanding of denominators lower than the numerators, they were still able to correctly interpret results when denominators were used. This suggests that although practicing swine veterinarians may not have the same comfort level with AMU metrics as those who frequently work with them, they do have sufficient knowledge about the various components of the metric (e.g., frequencies, doses, animal weights) to interpret and make use of the information. In a future study, it would be useful to investigate what aspects of the denominators were less well understood, such as denominator calculation, denominator purpose, or other elements.

Compared to Benedict et al (9), a higher percentage of participants (91% and 100% versus 64%) were able to correctly interpret AMU information using dose-based metrics (9). However, differences in methodology may at least partially

| Table 3. Descriptive information about the veterinary participants (N = 12), including the province(s) in which they work with the number of pig farms in the province for comparison, the language in which they completed the questionnaire, the type of veterinary practice, and the decade in which they graduated from veterinary college. |
|---|---|
| Information about the participants | n (number of pig farms in the province)² |
| Primary province of work² |  |
| British Columbia | 1 (790) |
| Alberta | 3 (1140) |
| Saskatchewan | 1 (625) |
| Manitoba | 1 (580) |
| Ontario | 3 (2630) |
| Quebec | 6 (1915) |
| Language preference |  |
| English | 8 |
| French | 4 |
| Type of practice |  |
| Primarily pigs | 10 |
| Pigs and other species | 2 |
| Year of graduation |  |
| 1970 to 1979 | 3 |
| 1980 to 1989 | 4 |
| 1990 to 1999 | 1 |
| 2000 to 2009 | 3 |
| 2010 to 2019 | 1 |

¹ As of January 1, 2018 (Statistics Canada. Table 32-10-0202-01 Hogs statistics, number of farms reporting and average number of hogs per farm, semi-annual).
² Some veterinarians worked in more than 1 province.

answer to the question about the number of defined daily doses per 1000 pig-days.

In the Preference section, participants were asked to select which metrics and denominators they preferred or regarded as most useful when receiving information about AMU on their clients' farms (Figure 2). Participants were able to choose more than one preferred metric. Dose-based metrics were chosen more often than frequency- and weight-based metrics. Biomass and animal-days denominators were chosen an equal number of times.

Participants were asked to rate the importance of various factors that may influence their preferred choice, from not at all important to extremely important (Figure 3). The ability to make comparisons in AMU, detect changes in use, and to account for antimicrobial dose, received the highest number of very and extremely important ratings. The factor with the widest range of ratings was accounting for the number of animals (Figure 3). Simplicity, ability to detect changes in AMU, and accounting for the dose of the antimicrobial all received ratings between moderately and extremely important (Figure 3). When asked to indicate any additional factors influencing their preferences, respondents commented that reporting by class of antimicrobial was important to them (n = 3), and reporting AMU using measurements that account for dose made more sense to them than those that are weight-based only (n = 2). One respondent suggested that weight-based metrics are often reported without context, leading to a focus on reducing the total amount of antimicrobial use by weight (versus a focus on prudent use or good antimicrobial stewardship practices).
explain the different results. In our study, we tested participants’ understanding by providing them with a chart displaying AMU information using dose-based metrics and asked them to identify the incorrect interpretation. By providing a visual representation of the data, the participants’ ability to interpret charts was also tested. In Benedict et al study (9), participants were provided with AMU information using dose-based metrics in text form and were asked to interpret the information in their own words. Asking participants to interpret AMU information in their own words was likely more challenging than asking them to choose the incorrect interpretation from a list of options. In addition, the Benedict et al study (9) was targeted to the beef industry, including non-veterinarians, and was distributed across 10 countries (including Canada). It is also possible that veterinarians, including the swine veterinarians responding to our survey, have, from ongoing exposure, become more comfortable with AMU metrics over time.

We also measured participants’ understanding of each metric by assessing how comfortable they felt explaining AMU information using metrics to their clients. In this case, the results differed from their self-reported understanding, as frequency- and weight-based metrics received higher comfort ratings than dose-based metrics. Participants may have more experience and practice explaining frequency- and weight-based metrics since these metrics have been in use in veterinary medicine for longer than dose-based metrics. These findings may also be related to the degree of complexity of each metric, with the more straightforward frequency and weight-based metrics being easier to explain than dose-based metrics. Regardless, the participants expressed a basic level of comfort with all metrics.

The participants’ preference for dose-based metrics was contrary to our expectation that more straightforward metrics, such as those that are frequency- or weight-based, would be preferred and better understood. When examining the ratings for the factors that influenced the participants’ preferences, it was evident that the ability to make comparisons in use, whether between farms or with regional/national averages, was highly rated, as was the ability to detect changes in use. These factors may explain why dose-based metrics were preferred, as they adjust for differences in antimicrobial dose, facilitating comparisons among various types of antimicrobials are used or when dosing differs between farms. Dose-based indicators also include adjustments for animal numbers and weight, and when the animal-time
denominator is used, for days at risk. These adjustments enhance comparisons and reduce the number of factors that can affect the reporting of changes in AMU over time.

Although the importance of factors such as the ability to make comparisons in use and to detect changes in antimicrobial use were highly rated, the importance of factors that involve denominator preference received lower ratings (e.g., accounts for days at risk, accounts for number of animals). These findings were unexpected, as making appropriate comparisons relies on the use of denominators to adjust quantitative estimates of AMU by variables that contextualize differences among herds (i.e., animal numbers, animal weights, antimicrobial dosages, time at risk). These common variables can also vary over time in the same herd and controlling for them can help identify true changes in AMU for other reasons. These findings, in addition to the lower ratings for understanding, could indicate a need for education on the function of denominators in AMU indicators, or it could simply indicate a relative difference in the importance of the factors.

The ability to make comparisons with AMU data and to detect changes in AMU also rated highly as overall objectives of AMU analyses. It was encouraging to note that most participants wanted to use AMU information to improve AMU on their clients’ farms, which confirms the importance of collecting farm-level AMU information for AMU stewardship purposes. When preparing AMU reports for veterinary stakeholders, it would also be useful to keep in mind their additional objective of describing AMU by class of antimicrobial. It was encouraging that almost half of participants were interested in providing data for research purposes, as these data are needed to aid in the development of AMU policies and stewardship guidelines, and in the study of associations between AMU and AMR.

As the response rate was low, caution is needed in generalizing the results more broadly beyond our group of participating swine veterinarians. Although only 12 veterinarians participated, we received responses from every major pig-producing province in Canada. Quebec is the highest pig-producing province in Canada, whereas Ontario has the greatest number of pig farms (10,17). There are no available data on the number of actively practicing swine veterinarians in each province in Canada and whether the number of veterinarians practicing predominately swine herd health is proportional to the number of farms or the number of pigs in the province is unknown. It is difficult to determine, then, if the number of participants from each province represented the distribution of swine veterinarians across Canada. It is possible that Quebec was over-represented in this study, and Ontario and the western provinces under-represented.

Our sample represented veterinarians with a range of years of practice experience, graduating from the 1970s to the current decade. Since the issue of AMR is a growing concern, we could also speculate that the amount of instruction on AMR and antimicrobial stewardship varied with year of graduation from veterinary college. However, with the increased profile of the AMU/AMR issue, it is also possible that the sampled veterinarians have acquired updated information through continuing education or personal study.

Factors that may have affected our response rate include interest in the topic and the presence of survey fatigue among the survey population, recruitment methods, aspects of
questionnaire design such as mode (by mail, online, or mixed), length, and the use of incentives (18–21). The subject of AMU in animal production is a topic of current interest worldwide due to growing concerns about AMR, particularly to veterinarians, who are antimicrobial stewards (4). Due to its more technical nature, there may be less interest in how AMU is described and reported, leading to difficulties engaging veterinarians on this subject. However, having some understanding of how to interpret quantitative AMU information can help veterinarians make full use of AMU reports. Survey (or respondent) fatigue likely also contributed to the low response rate, since the number of veterinarians in Canada who practice swine herd health is relatively small, and they receive many requests to participate in research. We hoped to address survey fatigue by providing a choice of survey modes (online or paper) and by attempting to keep the time to complete the questionnaire to less than 20 min. Although unconditional incentives have been shown to improve survey response rates (18,22), difficulties administering such an incentive using an online questionnaire format precluded their use in this study.

Indirect methods of participant recruitment were used, due to difficulties obtaining the names and contact information of veterinarians practicing swine herd health in Canada as a result of privacy legislation and individual organization’s privacy codes (23,24). We attempted to reach every veterinarian practicing swine herd health in Canada by using multiple indirect methods of recruitment and asking associations to send or post reminders to participate. However, it is possible that this method of recruitment was less effective than direct mailings and reminders in soliciting participation.

Acknowledging the low response rate in this survey and the complex reasons why it may have occurred, a related question is whether non-response bias could be present in our data (21,25). In our survey, the primary factor that may contribute to non-response bias is the topic itself. Due to the specific and technical nature of the topic, it is possible that the responses we received were from veterinarians with pre-existing knowledge and interest in the subject. As a result, our results may show a higher level of understanding and comfort than would be expected among swine veterinarians in general. Preferences for AMU metrics may also be different between those who have experience and interest in the topic and those with less interest. It is possible, then, that our results are more reflective of a sub-group of swine veterinarians with an interest in and experience with measuring AMU. It is also reasonable to assume that these swine veterinarians with an interest in AMU are more likely than others to engage in detailed AMU and antimicrobial stewardship discussion with their clients and, therefore, make use of the study findings.

In conclusion, our study provided some insight into swine veterinarians’ understanding of and preferences for AMU metrics, with the caveat that our small sample size and response rate limited our ability to generalize the findings broadly. It would be useful to repeat the study, with other groups of veterinarians, to determine if our observations hold true for swine veterinarians in other areas, or for veterinarians with other species’ focus. We determined that participating swine veterinarians preferred and understood dose-based metrics, although they may benefit from resources to enable them to explain them to clients in plain language. Moreover, study participants indicated that they want/need farm level AMU information for stewardship purposes, to

Figure 4. Self-reported comfort level with explaining various antimicrobial use metrics and denominators to swine producer clients, among 12 swine veterinarians in Canada.

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make AMU comparisons, and to monitor for changes in use. We believe the results of this study are useful to those making decisions about which metrics to use in AMU reports targeted to veterinarians. By keeping in mind veterinary preferences and objectives for AMU information when metric choices are made and by providing resources to help veterinarians explain these metrics, veterinary uptake and use of the information may be improved, which may ultimately influence the stewardship decisions made by both veterinarians and producers. It may also be helpful to emphasize the importance of and the function of denominators in AMU reports. For future studies of this type, expanding the survey to cover additional food animal sectors may help to improve the response rate and to determine if perceptions in the swine industry are reflected in other food animal industries. In addition, using other methods of engaging veterinarians and the farming community such as workshops at conferences, interactive presentations at producer meetings, focus groups, or interviews, may be helpful.

Acknowledgments

We thank the veterinarians who participated in the study. We also thank the organizations that assisted with distributing the questionnaire, including the Canadian Association of Swine Veterinarians, the Ontario Association of Swine Veterinarians, the Association des vétérinaires en industrie animale du Québec, the Western Canadian Association of Swine Veterinarians, the Canadian Pork Council, Ontario Pork, and Manitoba Pork.

References

Comparison of classic and needle arthroscopy to diagnose canine medial shoulder instability: 31 cases

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Abstract — This retrospective study compared surgery time, anesthesia time, and costs recorded with classic arthroscopy or needle arthroscopy when diagnosing canine medial shoulder instability. Signalment, examination findings, diagnostics, anesthesia time, surgery time, treatment, invoices, and complications were reported. All cases (classic arthroscopy, 14 cases; needle arthroscopy, 17 cases) were diagnosed with medial shoulder instability. Anesthesia times, surgery times, and invoices were statistically compared for classic and needle arthroscopy ($P < 0.05$). No significant differences were reported for surgery time ($P = 0.13$) but existed for anesthesia time (35 minutes shorter with needle arthroscopy; $P < 0.0001$) and invoice (38% lower with needle arthroscopy; $P < 0.0001$). No complications were recorded by the time of last direct follow-up, which was at a mean of 12.4 weeks after surgery. Needle arthroscopy offers an alternative, safe technique to reliably diagnose canine medial shoulder instability. Shorter anesthesia times and lower costs to the client may be advantages of needle over classic arthroscopy.

Résumé — Comparaison de l’arthroscopie classique à l’arthroscopie l’aiguille pour diagnostiquer l’instabilité médiale de l’épaule chez le chien : 31 cas. Cette étude rétrospective a comparé le temps de chirurgie et d’anesthésie ainsi que les coûts engendrés entre une arthroscopie classique et une arthroscopie à l’aiguille lors du diagnostic de l’instabilité médiale de l’épaule chez le chien. Sont rapportés dans cette étude, les commémoratifs, les résultats de l’examen clinique, les diagnostics, le temps d’anesthésie, le temps de chirurgie, le traitement, les coûts et les complications. Le temps d’anesthésie et de chirurgie ainsi que leur coût ont été comparés pour les deux techniques arthroscopie classique et arthroscopie à l’aiguille ($P < 0.05$) pour tous les cas diagnostiqués avec une instabilité médiale de l’épaule (classique = 14; aiguille = 17). Aucune différence significative n’a été mise en évidence pour la durée de la chirurgie ($P = 0,13$) à contrario de la durée de l’anesthésie, plus courte (35 min de moins avec la technique à l’aiguille; $P < 0,0001$) et moins coûteuse (38 % plus économique avec la technique à l’aiguille; $P < 0,0001$). Aucune complication n’a été enregistrée lors de la dernière consultation de contrôle post-opératoire qui avait lieu en moyenne 12,4 semaines après la chirurgie. Pour diagnostiquer une instabilité médiale de l’épaule, la technique à l’aiguille offre une alternative sûre, avec comme avantages, des durées d’anesthésie plus courtes et des coûts inférieurs pour le client, par rapport à la technique classique.

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Introduction

Medial shoulder instability (MSI) is a well-described, common cause of thoracic limb lameness in the dog (1–9). It typically results from separate or combined injuries to the medial shoulder structures, namely the subscapularis muscle tendon, the medial glenohumeral ligament, and the medial joint capsule (1–8,10). Reported imaging techniques to diagnose MSI include radiographs (RADS), ultrasound, computed tomography (CT), magnetic resonance imaging (MRI), and classic arthroscopy (CAS) (1–8,11). The latter is considered the “gold standard” to diagnose MSI (5). Classic arthroscopy provides high-resolution images and allows accurate inspection of the joint; if indicated, portals for probing of joint structures and simultaneous treatment of an underlying condition can be performed (12). Possible downsides of CAS can be costs of purchase and maintenance, large amount of storage space, cumbersome size precluding easy transport, need to move patients into the operating theater for surgery, duration for and risk of anesthesia, possible risk of infection or accidental damage of joint structures, and associated expenses. Although those shortcomings are acceptable when a clear indication for arthroscopic treatment using CAS is given (e.g., treatment of osteochondrosis...
dissecans of the humeral head), in cases in which arthroscopy (AS) is to be used for diagnostic purposes only, other imaging modalities might be preferable (13).

One such alternative diagnostic technique to CAS, possibly not associated with those shortcomings, could be needle arthroscopy (NES) (14–21). Compared to CAS, NES equipment is less expensive, needs less storage space, and the portability allows easy transport (15). The diameter of the NES equipment (1.0 to 1.6 mm with 2.0 to 2.5 mm cannulas) is also smaller than that of the CAS equipment. The smaller size is a reported advantage for humans and horses, in whom often 4.0 mm or even larger CAS diameter cameras are often used (16,21). However, whether there is a clinically relevant difference in size compared to the commonly used canine CAS arthroscopes (1.9 to 3.0 mm diameter with 2.4 to 4.3 mm cannulas), is unknown. The 0° to 10° angle semirigid NES arthroscopes of 1 system are passed through similar small cannulas (2 to 2.5 mm) into the joint (Biovision Veterinary Endoscopy, Denver, Colorado, USA) (16). Another system features a 0° camera, providing a 120° field of visualization due to a retractable needle lumen (1.6 mm total size diameter; no separate cannula; Trice Medical, Malvern, Pennsylvania, USA) (22). Another system has been described for dogs (0° telescope; 1-mm arthroscope; 1.3-mm cannula; Karl Storz Veterinary Endoscopy, Goleta, California, USA) (20). Irrigation is achieved by an assistant injecting fluids from a sterile syringe, or the joint is distended before introduction of the NES instrument (15,16); a pressure bag can also be used. The NES instrument can be re-sterilized and re-used (15).

In humans, NES is used to diagnose joint injuries rapidly, accurately and, due to in-office use, inexpensively (17,21). Shoulder NES was validated as safe, with no major complications in 1419 cases (22). A comparative study reported that complete accuracy of all pathologies in 106 human knees was established in 91.5% of cases with NES, in 100% of CAS, and in 61% of cases with MRI (23). Needle arthroscopy was less expensive than CAS or MRI (16,17,21). Based on publications on humans (17,21–24), horses (15,16,19), and abstracts on dogs (14,18,20), NES image quality during the actual procedure was sufficient to establish a diagnosis. That work confirmed the results of earlier peer-reviewed studies in humans, including a direct comparison assessing image quality between CAS and NES, yielding the same diagnostic results (13), supporting statements that in-office NES had sufficient image quality (25). Further technological advancements and improvement of NES image resolution and quality, specifically to diagnose abnormalities in the human glenohumeral joint, have been recently reported in the peer-reviewed literature (26). Finally, based on a canine cadaveric study, when specifically assessing canine medial shoulder disorders, NES provided the same diagnostic value when directly compared to CAS (27). However, the lower resolution of NES images, a result of the small diameter optic (19), was evident when projected on large screens. As this is clinically irrelevant, a direct comparison of image quality of NES to CAS is not warranted. In contrast, there is a lack of information on the duration and costs for clients when comparing CAS with NES in the dog. For the canine shoulder, the reported clinical use of NES is limited to an abstract on 4 cases (18), and, when

Figure 1. Differences in shaving and draping between classic shoulder arthroscopy (CAS; A,B) and needle arthroscopy (NES; C,D). The entire thoracic limb was shaved for CAS (A), and the patient was moved into the operating theater and completely draped; surgeons wore sterile gowns and gloves (B). For NES, patients remained in the surgical preparation area following shaving of a smaller area, centered over the acromion (box with yellow dotted lines; C). If an injection of platelet-rich-plasma was indicated, fur was shaved from the neck to access the jugular vein to harvest blood (shaved area cranial to the yellow box; C). Draping for NES was limited to an “eye-drape” (D), or “quarter-drapes (Figure 2 A’,B’).
specifically diagnosing canine MSI, NES has not been described or compared to CAS in a large clinical patient cohort. Indeed, to the best of our knowledge, there is no peer-reviewed publication on canine NES in the veterinary literature.

The purpose of this clinical communication was to demonstrate that NES can be used to diagnose canine MSI. Furthermore, we wanted to compare CAS with NES regarding surgical time, anesthetic time, and final invoice. We hypothesized that those parameters are all shorter/lower with NES.

**Materials and methods**

Medical records of all dogs undergoing shoulder arthroscopy with the diagnosis of MSI at Friendship Surgical Specialists (Institution A) and Sirius Veterinary Orthopedic Center (Institution B) from January 2017 to January 2020 were reviewed. Written owner consent was obtained for all cases before surgery. The choice of CAS versus NES was made based on surgeon preference and following a discussion with the owners. Owners had been informed that, with CAS, the procedure would be performed in the operating room, a diagnosis could likely be established, and if needed, treatment could be simultaneously performed. In contrast, NES was offered solely as a diagnostic method in the preparation area. Owners had been presented either with cost estimates for both options (Institution A, with estimates for CAS being higher than for NES), or with one estimate providing a wide range (Institution B). The low end of the range was for solely NES, the high end of the range was for a situation in which NES would indicate that moving to the operating theater and performing CAS would be needed. Such needed conversion from NES to CAS was explained to be necessary should the severity of MSI assessed to be too high (Grades 3 or 4) (9) or another intra-articular condition (e.g., a biceps tear requiring CAS biceps tendon release) be diagnosed. Higher costs on the estimate were attributed to the additional time and material needed for CAS. To avoid influence on anesthesia and surgery times from surgical treatment for MSI, only dogs were included for which a conservative treatment was recommended. This recommendation was made following arthroscopic evaluation of the shoulder joint with either arthroscopic technique, and establishment of MSI Grades 1 or 2 (9). Medial shoulder instability Grades 1 or 2 are typically treated conservatively. Patients with thoracic limb pathology other than MSI (such as biceps tears, elbow disease) and cases that had an additional procedure performed (e.g., lipoma removal, castration) were excluded. Based on those criteria, cases were excluded from this study during the review of all medical records, when summarizing data for this current study.

All dogs were routinely prepared for aseptic surgery under anesthesia. The difference between CAS and NES was that CAS involved shaving the entire limb from carpus to dorsal thoracic midline (as this is the standard type of preparation for CAS in our institutions and is based on general guidelines for patient preparations undergoing orthopedic procedures) (28). Needle arthroscopy, however, involved shaving an area \( \sim 6 \times 6 \text{ cm} \), centered over the tip of the acromion process (as this is the standard type of preparation for CAS in our institutions and is based on general guidelines for patient preparations undergoing orthopedic procedures) (28). Needle arthroscopy, however, involved shaving an area \( \sim 6 \times 6 \text{ cm} \), centered over the tip of the acromion process (as this is the standard type of preparation for CAS in our institutions and is based on general guidelines for patient preparations undergoing orthopedic procedures).
draped, as recommended for sterile procedures in an operating room (28). For NES [1.0-mm diameter arthroscope; 2-mm cannula: Biovision Veterinary Endoscopy, Denver, Colorado, USA; or 1.6-mm diameter (entire unit size): Trice Medical, Malvern, Pennsylvania, USA], the surgeon’s sterile attire was limited to gloves, draping was done using an “eye-drape” (Steris Animal Health, Birmingham, Alabama, USA) or “quarter-drapes” (Animal Hospital Supplies, Flowery Branch, Georgia, USA), and arthroscopy was performed in the surgical preparation area, similar to reported in-office NES in humans (30). Joint distension was achieved by sterile injection of saline by an assistant or a non-sterile assistant was instructed to manipulate the limb during either scope procedure. If needed, during NES, hemorrhage or cloudiness of synovial fluid limited visualization and repeated every 90 min thereafter.

All dogs received properly fitted shoulder stabilization systems (Dogleggs; York, Pennsylvania, USA). Gradual increase of activity and formal physical rehabilitation was recommended for all patients (31). Peri- and postoperative medications varied (Table 1), based on surgeon preference and patient needs. Following PRP injections, nonsteroidal anti-inflammatory drugs (NSAIDs) were withheld for a minimum of 1 wk.

Data recorded included signalment, affected limb, cause of injury, time from injury to surgery, previous treatment, lameness score at initial and last examination (32), orthopedic and physical examination findings, imaging-method (RADS, US, CT), surgery time, and anesthesia time. The latter was defined as charges limited to anesthesia and AS. Charges for joint injections were removed because a diagnosis of MSI was possible without that extra step. Imaging material was collected during the procedures (Figure 2). Once the diagnosis of MSI was made, some patients received an intra-articular joint injection consisting of methylprednisolone acetate (Zoetis, Parsippany, New Jersey, USA), hyaluronic acid (Kinetivet, Lexington, Kentucky, USA; or Anika Therapeutics, Bedford, Massachusetts, USA), or PRP (Companion Animal Health, New Castle, Delaware, USA). The skin was closed with 1 intradermal poliglecaprone 25 suture of 3-0 or 4-0 (Monocryl; Ethicon, Somerville, New Jersey, USA), or a small amount of tissue adhesive (Vetbond; 3M, St. Paul, Minnesota, USA).

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**Statistical analysis**

Descriptive statistics were used when indicated. Data were assessed for normality using the Shapiro-Wilk test. To avoid any breach of institutional confidential data, all figures for invoices were not presented as actual cost in dollars and differences between CAS and NES invoices were given relative to setting the median for all invoices as 100. The statistical analysis of invoice differences was based upon median values with 25th/75th percentile comparisons. Regression analysis was
performed when indicated. Wilcoxon rank-sum test was used to calculate P-values; P < 0.05 was considered significant (SAS 9.3; SAS Institute, Cary, North Carolina, USA).

**Results**

Thirty-one dogs met the inclusion criteria (Tables 2, 3). Further details are available from the authors upon request. Orthopedic examinations suggested shoulder pathology in all cases. Shoulder abduction angles were assessed in 16; all but 2 cases had larger angles on the affected compared to the normal side (Table 3). Shoulder imaging consisted of standard orthogonal RADS in 28 (all including elbows), complete thoracic limb CT in 5, and US in 6. The 3 cases without RADs had CTs. Preoperative imaging ruled out elbow disease in all cases. In all cases, MSI was diagnosed during the arthroscopic procedures (CAS: n = 14; NES: n = 17) (Table 4). There were no significant differences for surgery time (P = 0.13; Table 5), but there were for anesthesia time (shorter with NES; P < 0.0001) and invoice (lower with NES; P < 0.0001). Comparison of invoices, when taking the median of all invoices to be 100, revealed that the median invoice of NES was 38% lower than that of CAS (Table 6). In regression analyses, there were weak relationships between invoice and body weight for CAS (R² = 0.15) and NES (R² = 0.03). Thus, invoices were not significantly influenced by weight. Of 22 intra-articular injections, 2 (both CAS cases) were of hyaluronic acid, 1 (an NES case) of methylprednisolone acetate, and 19 of PRP (12 NES; 7 CAS). There was no significant difference in anesthesia time between cases that did or did not receive PRP (P = 0.6). Median anesthesia times (25th/75th quartiles) were 90 min (66.75/120) for cases without and 94 min (79/110) for cases with PRP injection. Formal physical rehabilitation was performed in 23 cases. Complications were not recorded at last follow-up, which was at a mean (± SD) of 12.4 (± 14.6) wk. Median lameness scores (25th/75th quartiles) were higher at initial presentation [2.5 (2.0/3)] compared to last follow-up [0 (0.0/1)] (P < 0.0001).

**Discussion**

This is the first report describing the use, experience, and outcome of 31 dogs diagnosed with MSI via evaluation with CAS and NES. A diagnosis of MSI was made on all cases, including all dogs that had NES. Therefore, NES can be used to establish a diagnosis of MSI. When compared to CAS, NES was associated with significantly shorter anesthesia times and costs for the
client. Surgery times were not significantly shorter. There were no complications, regardless of arthroscopy technique.

Shorter anesthesia times were attributed to 3 factors: size of the shaved area, transition from preparation area to operating theater with CAS-cases, and the difference in draping and set-up between arthroscopy techniques. Those preparation protocols are standard in our institutions for those procedures. Although not specifically measured nor recorded, the shaved area over the shoulder was smaller for NES and it seems logical that anesthesia times are longer when larger areas are shaved, especially if the difference is a small patch of approximately 6 × 6 cm over the shoulder, compared to shaving the entire thoracic limb from the toes to the thoracic midline (Figure 1). Shorter duration of anesthesia time might be of importance as longer anesthesia is a risk factor for surgical site infection (SSI) (34). However, the incidence of SSI in humans after CAS is 0.01 to 1%; in dogs it is 0.5% (21,35,36). Regardless of AS method, no SSI or complications were recorded in our cases, similar to 1419 human NES procedures with a 0% SSI rate (22). Another reason for extended anesthesia times with CAS cases could be that those were moved into the operating theater and fully draped. In contrast, NES was done in the surgical preparation area where the patient had been induced, shaved, and prepared. In addition, NES required only minimal equipment (Figure 2), demanding less time for setup. It is of note that the differences in shaving and draping were a result of surgeon/facility preference in this study and that others might consider shaving less or using smaller drapes for CAS. Although the mean surgery time for CAS was 6 min longer than for NES, this was not significant and not a clinically relevant difference.

Final invoices were significantly lower with NES than with CAS. However, there is a limitation that, although a statistically different P-value could be calculated, no account could be taken of differences in costings of cases at the 2 institutions (e.g., size/difficulty of handling dogs; location/financial position of institution; different state taxes). Therefore, the value of the statistical analysis for this factor must be cautiously assessed. The basic meaning of the median for NES having been 38% lower than CAS is that, overall, invoices for NES could be less than for CAS. This might be important because NES should allow a reduction in the low-end of an estimate. This could make the difference in a client’s decision to proceed with AS. However, we acknowledge that we as the practice owners can dictate the prices for both CAS and NES, and thus invoice adjustment might be possible. A direct per-use comparison of costs between CAS and NES was not possible due to the different purchase costs of the equipment used. When considering purchase costs, draping, operating room fees, needed equipment, expenses for cleaning, and sterilization, it seems reasonable to assume that the per-use cost of CAS is higher than that of NES. We could address the detected differences in anesthesia time and invoices by doing CAS with minimal shaving, preparation, and draping. A prospective comparative study would be indicated. Should results be similar, there would be motivation to make diagnostic CAS more efficient and quicker. Replacement of anesthesia by sedation for NES in dogs (18) could further reduce costs and procedure times. Sedated NES has been reported in standing horses for evaluation of various joints, including those of the cervical spine (15,16,19). The authors of the current study prefer anesthesia over sedation, as it allows unrestricted, pain-free manipulation of the limb, reduces time pressure and, if needed, permits imaging or preparation for and administration of intra-articular injections.

In the current study, joint probing was not done because a diagnosis of MSI was possible without that extra step. However, if needed, this can be done for either technique. Although not the topic of this report, NES might be economically preferable over CAS as it is less expensive to purchase, only has 1 part to be re-sterilized, and can be re-used (15). Indeed, the authors have used the same NES instrument in over 30 cases. Regardless, the authors note that, in a surgical referral practice, full CAS equipment should be available to treat cases with a clear indication for CAS, or if conversion from NES to CAS is indicated. If arthroscopy is only performed for diagnostic purposes, however, NES might be a good alternative to CAS.

As clinical examination and available diagnostics were highly suggestive of a primary shoulder pathology, and for logistic and financial reasons, many of our cases did not undergo advanced imaging. However, if available and owners can cover associated expenses, this can be considered, primarily to rule out other underlying causes for thoracic limb lameness, including elbow pathology (37). Due to time for imaging and costs, CT might be advantageous over MRI. In addition, and with respect to its sensitivity to diagnose MSI, MRI is also inferior to AS (38), as MRI results in many false findings in human joints (21). However, MRI might be helpful in detecting underlying neuropathy (37), a potential cause for thoracic limb lameness. Shoulder ultrasound, performed after CT, can also be helpful to rule out other soft tissue injury (39). Interestingly, the need for advanced imaging in a study of 1419 humans following NES was only 1.4% (22). Therefore, the diagnostic value considering associated costs with advanced imaging prior to arthroscopy needs to be clearly discussed with owners, particularly if medial shoulder pathology is suspected. Finally, NES can be used if advanced imaging is not available, as it permits assessment of the intra-articular structures and, if indicated, allows administration of intra-articular injections, and helps to design the most appropriate plan for physical rehabilitation.

Although not assessed in this study, another potential advantage of NES with its overall smaller diameter cannula might be that, following an intra-articular injection, the risk of extra-articular leakage through the portal following camera removal might be lower than with CAS. Therefore, it could be hypothesized that the beneficial effect of a targeted intra-articular injection might be higher if performed immediately following NES compared to CAS. However, further study is indicated to confirm such assumption.

Although we did not feel that there is a steep learning curve with NES, previous experience with CAS is helpful to successfully use NES. To standardize cases, we focused solely on dogs with MSI but, similar to CAS (6), other shoulder compartments can be assessed, and pathologies diagnosed via NES. Similarly, elbow pathology can also be detected via NES (14,18). Although we excluded such cases from this study, in clinical cases with
concern for elbow pathology, assessment of the elbow joint under the same anesthesia is recommended; simultaneous injuries in shoulder and elbow joints are reported in up to 47% of cases (40). Importantly, we do not suggest NES to be used in lieu of CAS for all cases. The decision on which arthroscopic technique is best used should be based on surgeon recommendation and patient needs. For example, in cases with a clear diagnosis of osteochondrosis dissicans based on radiographs, or in cases highly suspected to suffer from a primary biceps tendon injury, the authors would not recommend NES. If intra-articular imaging seems warranted, however, and is aiming to provide solely a diagnosis, then NES is our preferred choice.

Limitations of this study include its retrospective nature and low case numbers. A prospective randomized study might have revealed different results. Both procedures were not performed on the same patient so there are inter-patient differences that cannot be addressed. As various surgeons were involved, it is possible that surgery times were impacted by each individual. Similarly, anesthesia times might have been influenced by the efficiency of the nursing teams and proper recording (exact start and stop times). The results of our study have to be interpreted cautiously because the detected differences might not have been significant had the same amount of fur been shaved, the same room, drapes, and personal protective equipment been used. However, in our institutions, different protocols are associated with each specific arthroscopic technique. Based on communications with other surgeons, similar protocols are also used elsewhere. Finally, as the surgeons of this report were aware that shoulder abduction measurements are not as helpful (6,10,41,42) as originally described (4), those measurements were not part of each examination. Thus, our cases could not be graded following a previously suggested system (9). However, if using only the reported ‘typical arthroscopic findings’ of that system, all cases would have been categorized as Grades 1–2/4 (9).

In conclusion, NES can be considered an alternative method for diagnosing MSI in dogs. Based on our results, NES is associated with reduced anesthesia times and total client costs compared to CAS.

References

Surveillance of West Nile virus in horses in Canada: A retrospective study of cases reported to the Canadian Food Inspection Agency from 2003 to 2019

Antoine Levasseur, Julie Arsenault, Julie Paré

Abstract — The objectives of the study were to describe the regional and provincial incidence rates and the weekly distribution of 842 reported West Nile virus (WNV) cases in horses in Canada between 2003 and 2019. This study also investigated characteristics of cases reported to the Canadian Food Inspection Agency (CFIA) between 2015 and 2019. The western region (British Columbia, Alberta, Saskatchewan, and Manitoba) had higher incidence rates than the eastern region (Ontario, Quebec, and Atlantic provinces) and overall, Saskatchewan registered the highest incidence. Over the study period, an earlier weekly preliminary onset of WNV cases was observed in the western region. The vast majority of cases were unvaccinated (96%), most cases were Quarter Horses (68%) and the risk of mortality was 31.9%. The findings of this study may be useful in informing veterinary equine practitioners about measures to prevent WNV disease in horses in Canada.

Résumé — La surveillance du virus du Nil occidental chez les équins au Canada : une étude rétrospective des cas notifiés à l’Agence canadienne d’inspection des aliments de 2003 à 2019. Les objectifs de cette étude étaient de décrire les taux d’incidence régionaux et provinciaux, ainsi que la distribution hebdomadaire des 842 cas équins de virus du Nil occidental (VNO) notifiés à l’Agence canadienne d’inspection des aliments (ACIA) de 2003 à 2019. Les caractéristiques des cas notifiés de 2015 à 2019 ont également été investiguées. La région de l’Ouest (Colombie-Britannique, Alberta, Saskatchewan, Manitoba) a enregistré un taux d’incidence plus élevé que la région de l’Est (Ontario, Québec, provinces de l’Atlantique). Une incidence particulièrement élevée du VNO a été notée en Saskatchewan. Les cas sont survenus plus tôt dans l’Ouest que dans l’Est durant la période d’étude. La majorité des cas n’étaient pas vaccinés (96 %) et ils provenaient surtout de Quarter Horses (68 %). Le risque de mortalité était de 31,9 %. Cette étude fournit des éléments clés d’information pour guider les vétérinaires praticiens dans l’application des mesures de prévention du VNO chez les chevaux au Canada.

(Traduit par les auteurs)

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Introduction

West Nile virus (WNV) is an arthropod-borne flavivirus first reported in humans and horses in Canada in 2002 (1). Passive surveillance in animals began in 2003 when the Canadian Food Inspection Agency (CFIA) added WNV to its list of Immediately Notifiable Diseases (IND). Under the Health of Animals Regulations, any laboratory that diagnoses or suspects an IND in an animal in Canada shall notify the Minister (CFIA) immediately (2). This activity generates data that are collected uniformly nationwide for trade support, international reporting, and public health purposes.

In 2006, WNV became a World Organisation for Animal Health (OIE) listed disease (3), requiring cases to also be reported to the OIE.

The global prevalence of WNV in animals has increased in recent years (3), after rapidly becoming endemic in North America following its introduction in 1999 (4). In North America, WNV maintains an enzootic cycle involving mosquitoes and birds, with the latter acting as the amplifying hosts and reservoir species. The main vectors of WNV in Canada are Culex tarsalis in western Canada and Culex pipiens/restuans in eastern Canada (5). This cycle is influenced by ecological factors.
such as land use and meteorological conditions (4,6), affecting geographical and temporal variations in WNV transmission (5). Reported changes in mosquito feeding patterns from birds to mammals in summer months may be an important determinant for WNV spillover (7), but has yet to be confirmed as an important determinant for human and horse infections (8). Climate change reportedly has a significant effect on WNV ecology, but this is not fully understood (4). In Canada, establishment and expansion of WNV to new regions may be intensified by climate change, increasing the period of activity and the geographical distribution of WNV vectors (4,5,7).

Horses are frequent accidental hosts for WNV. Following an incubation period of 1 to 2 wk (6), 8 to 10% of WNV-infected horses exhibit neurologic signs of the disease (e.g., ataxia, weakness, paralysis) (9,10). Reported risks of mortality in WNV clinically affected horses vary from 22 to 44% (6), with no specific treatment, other than supportive care, leading to uncertain prognoses and often only partial recovery (6). Several vaccines are available for horses in Canada; they are effective at reducing viremia, clinical signs, and mortality (11). Other recommended risk reduction strategies include indoor housing and mosquito control (e.g., reducing standing waters, mosquito nets for windows) (6,12).

Regional outbreaks and potential risk factors associated with WNV in horses in North America have been described and investigated (13–17), but larger scale studies are warranted to evaluate spatiotemporal dynamic and continuous spread of WNV to new areas (4). The primary objectives of this study were to describe at regional and provincial levels: i) the average and annual incidence rates of WNV; and ii) the weekly distribution of equine case notifications. The regional level (eastern versus western regions) was determined according to main WNV vector species distribution. A secondary objective was to describe demographic data (age, sex, breed group), vaccination status, and subsequent clinical outcome of these cases, in order to better characterize horses infected with WNV in Canada.

Materials and methods

Study design, period, and area

A descriptive retrospective epidemiological study of equine WNV cases reported to the CFIA between 2003 and 2019 was undertaken. Canadian provinces were classified either as part of the western region (British Columbia, Alberta, Saskatchewan, and Manitoba) or the eastern region (Ontario, Quebec, and Atlantic provinces). Territories (Yukon, Northwest Territories, and Nunavut) were excluded from the study, as no evidence currently exists of virus circulation in mammals (unrelated to travel) (18,19), birds (20), or mosquitoes (19) within these regions.

Surveillance data and case definition

All laboratory notifications for WNV for the study period were extracted from the CFIA's IND database. Only confirmed positive cases were included, as defined by a combination of neurological signs (clinical history) and positive laboratory tests (including detection of IgM antibodies, seroconversion on paired sera, virus isolation, or identification of viral antigens by molecular methods or immunolabeling) (21,22). For each case, the laboratory reference number of the case, the name of the submitting laboratory, the date of sampling, the date of submission (i.e., date laboratory received sample), the date of confirmation (i.e., date laboratory result was released) and the patient province of residence were recorded. In addition, for cases between 2015 and 2019, demographic data (age, sex, breed group), vaccination status, and clinical outcome (dead or alive) of the cases were actively sought and collated. Data cleaning was done in SAS 9.4 (SAS Institute, Cary, North Carolina, USA) to remove any duplicate records.

Incidence

Total incidence counts and average annual incidence rate of WNV cases were reported at national, regional, and provincial levels. The average annual incidence rate for each geographic level was calculated as the average annual number of cases over the average annual horse population. The average annual horse population over the study period was based on Agricultural Census data from Statistics Canada (2001, 2006, 2011, and 2016) (23,24) and on intercensal estimates (all other years). For intercensal years, populations were estimated using a linear function between 2 consecutive census years. The linear function between 2011 and 2016 was then used to extrapolate data until 2019. The annual incidence rates were also calculated for regions and provinces. All incidence rates were reported by 100,000 horses.

Weekly distribution

The weekly distribution of cases cumulated over all years was calculated for each region and their constituting provinces using the date of sampling, date of submission, and date of confirmation. The week was defined in accordance with the Centers for Disease Control and Prevention (CDC), the Morbidity and Mortality Weekly Report (MMWR) (25).

Case characteristics

Over the 2015 to 2019 period, the distribution of WNV cases according to demographic data, vaccination status, and clinical outcome was described. Only horses reported to have been vaccinated for WNV within 12 mo before diagnosis were considered vaccinated. Horses euthanized following the onset of neurologic disease were considered dead due to WNV. For each characteristic, only horses with known values were kept for the descriptive analyses.

Results

Over the study period, 842 confirmed positive cases of WNV in horses were reported to the CFIA (Table 1).
The 2 highest peaks in incidence rates for the western region were in 2003 and 2018, whereas for the eastern region, the peak in incidence rates was in 2017. Between 2011 and 2018, there was a resurgence in the incidence of WNV in both regions studied (Figure 1).

The annual incidence rates of WNV varied within western provinces (Figure 1a), with multiple high peaks occurring in Manitoba, Saskatchewan, and Alberta. Saskatchewan had the highest annual seasonal peaks of infections. Alberta and Saskatchewan recorded similar overall counts of WNV (Table 1), but the annual incidence rates were consistently higher in Saskatchewan (Figure 1a). British Columbia had the lowest incidence rates of the western provinces.

The trends in annual incidence rates were similar between Quebec and Ontario (Figure 1b). Peaks of infection were identified in both provinces in the same years, but their peaks varied in amplitude between 2012 and 2014.

**Weekly distribution**

Dates of sampling (n = 524), submission (n = 818), and confirmation (all cases) were reported. Among all cases with a date of sampling, the total delay in notification (i.e., time lag between sampling and confirmation) had a median of 5 d (95th percentile = 15 d). The time lag between sampling and submission dates ranged from 0 to 26 d (median = 2 d, 95th percentile = 6 d) in the western region and from 0 to 12 d (median = 1 d, 95th percentile = 5 d) in the eastern region. Longer delays were observed when the sample was collected at euthanasia. The time lag between submission and confirmation date ranged from 0 to 47 d (median = 2 d, 95th percentile = 11 d) in the western region and from 0 to 35 d (median = 7 d, 95th percentile = 20 d) in the eastern region. Longer delays were observed, for example, when a horse died with neurological signs and a post-mortem rabies investigation was undertaken prior to WNV testing.

The distribution of cases per surveillance week reflected a different seasonal pattern for each region, with an earlier occurrence in the western region for all the dates collated (Figure 2). Also, the eastern region registered more cases later in the season: all cases were confirmed between weeks 24 and 43 (median = week 36, 95th percentile = week 39) in the western region, compared to weeks 27 to 45 (median = week 37, 95th percentile = week 43) in the eastern region. The provincial weekly distributions indicated a similar trend between the provinces of the same region (Figure 2).

**Case characteristics**

Between 2015 and 2019, 250 equine cases were reported to the CFIA. Age was collected for 234 of the 250 cases. A high proportion of young horses characterized the age distribution, but cases in horses up to 25 y of age were reported (median = 6 y) (Figure 3). No foals were reported as clinically affected by WNV. Sex was available for 239 cases, with the proportion of cases being similar between males and females (Table 2). Information on breed was available for 211 horses, with 19 breeds or breed group represented. Most reported cases were Quarter Horses (Table 2), and 90% of these were in the western region (n = 129). Standardbred cases were mostly reported in Ontario (10/14 cases).

Vaccination status was documented for 248 of the 250 cases. Most clinically affected horses were unvaccinated (Table 2). Among the 10 vaccinated cases, the age ranged from 1 to 13 y. Clinical outcome was known for 160 horses. Most horses recovered (overall risk of mortality of 31.9%) (Table 2). Among dead horses, only 1 had been vaccinated.

**Discussion**

This is the first extensive study of WNV in horses in Canada, describing 17 y of passive surveillance based on notifiable disease regulations. The results present the minimum number of WNV cases that occurred in the country during this period, as the source population was formed by cases investigated by equine practitioners and for which diagnostics for WNV were sought.

The high incidence of WNV in 2003 was likely due, along with local ecological factors, to the introduction of the virus into a naive horse population. Although some WNV activity occurred as early as 2002 (1), natural or vaccine-induced

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### Table 1. Total number and average annual incidence of equine West Nile virus cases reported to the Canadian Food Inspection Agency between 2003 and 2019 by region and province.

<table>
<thead>
<tr>
<th>Geographic level</th>
<th>Number of cases (% of the total)</th>
<th>Average horse population (% of the population)</th>
<th>Average annual incidence rate/100 000 horses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern region</td>
<td>155 (18.4)</td>
<td>109 786 (29.5)</td>
<td>8.3</td>
</tr>
<tr>
<td>Atlantic</td>
<td>0.0</td>
<td>6716 (1.8)</td>
<td>0</td>
</tr>
<tr>
<td>Quebec</td>
<td>56 (6.65)</td>
<td>23 019 (6.2)</td>
<td>14.3</td>
</tr>
<tr>
<td>Ontario</td>
<td>99 (11.76)</td>
<td>80 051 (21.5)</td>
<td>7.3</td>
</tr>
<tr>
<td>Western region</td>
<td>687 (81.6)</td>
<td>262 087 (70.5)</td>
<td>15.4</td>
</tr>
<tr>
<td>Manitoba</td>
<td>89 (10.6)</td>
<td>33 880 (9.1)</td>
<td>15.5</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>297 (35.3)</td>
<td>52 633 (14.2)</td>
<td>33.2</td>
</tr>
<tr>
<td>Alberta</td>
<td>279 (33.1)</td>
<td>132 407 (35.6)</td>
<td>12.4</td>
</tr>
<tr>
<td>British Columbia</td>
<td>22 (2.6)</td>
<td>43 167 (11.6)</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>842 (100)</td>
<td>371 873 (100)</td>
<td>13.3</td>
</tr>
</tbody>
</table>

* Nova Scotia, New Brunswick, Prince Edward Island, Newfoundland and Labrador provinces.
Figure 1. a – Annual incidence rate of equine West Nile virus cases in the western region and provinces of Canada [British Columbia (BC), Alberta (AB), Saskatchewan (SK), and Manitoba (MB)]. b – Annual incidence rate of equine West Nile virus cases in the eastern region and provinces of Canada [Quebec (QC) and Ontario (ON)]. No cases were reported in Atlantic provinces. Annual incidence rates are reported as number of cases/100,000 horses. Horse population is based on data from the Canadian Census of Agriculture (23,24).
immunization of the horse population in 2003 was likely low. Although WNV vaccines were first sold in Canada in 2003, the extent of vaccination is unknown.

The results of this study were consistent with the “boom and bust” epidemiological patterns reported for WNV (26), emphasizing the probable increase of vaccination following an outbreak in horses and the natural immunity in recovered horses (27). This pattern was also likely related to yearly weather variations which influence the virus transmission cycle (5,26). However, for most western provinces, the results of this study indicated a lower decline in incidence between annual peaks in the last decade than when WNV was introduced in the early 2000s. Since 2011, an increase in incidence rates was noted in both regions, suggesting a recent increase in WNV activity.

Surveillance of WNV cases in horses could be relevant to a One Health perspective, to inform both the animal and public health sectors regarding the risk of infection. As reported by others (28), the surveillance in horses provides indication on WNV activity in rural areas. Moreover, according to a study undertaken in Quebec, the seroprevalence in horses was reported to be higher than in humans (29), suggesting that horses could be sentinels for predicting human risk of exposure. However, there is limited information on distribution of various mosquito vectors in Canada and on the role of each in effectively infecting humans and horses. Interestingly, in this study, Saskatchewan had consistently high incidence rates of equine infection, yet few human cases were reported in this province over the same time period (18). This contrasts with the high number of both equine and human cases reported in Manitoba and Alberta for the same period (18). Spatial variations in the risk of infection due to local ecological factors and vaccination coverage in horses may affect the sensitivity of equine WNV surveillance in predicting human exposure and would warrant further investigation.

Two main sources of bias need to be considered when comparing regional or annual incidence of reported cases of WNV. First, the likelihood that a suspected clinical case would be
submitted for WNV testing is unknown and may have varied in time and space, depending on factors related to horse owners and their veterinarians as well as on regional initiatives. In fact, throughout the study period, some provinces implemented additional regulations for WNV that may have encouraged veterinarians to submit samples and investigate WNV infections in horses. For example, in Alberta, WNV is an immediately notifiable disease and when suspected, the disease must be reported to the chief provincial veterinarian within 24 h (30). Another example is the free testing offered in Quebec until 2015 as part of the provincial surveillance program (31). A second source of bias may have been an inconsistent underestimation of the horse population by province. In fact, the Agricultural Census was used in this study to estimate the horse population, because it was the only available source of data on horse demographics consistently collected over the area and study period. However, only information on horses housed on agricultural operations (i.e., farms that produce agricultural products for sale) is captured in these census data, whereas declared horse cases of WNV could originate from all types of premises. A study from Equestrian Canada (32) conducted in 2010 indicated that 50% of the horses in Canada were housed on agricultural operations overall, but British Columbia and Quebec were the only provinces with lower numbers of horses on agricultural operations than on non-census operations. This might have led to an uneven overestimation of WNV incidence rates in space and time.

The results supported an earlier yearly onset of cases in the western region than the eastern region, suggesting different regional timing for viral transmission of WNV to horses. Regional differences in the seasonal shift in mosquito feeding preferences could have a role, as this factor has been reported to correlate with the timing of WNV infections in mammals (7). Other ecological factors driving the viral transmission of WNV could be involved, such as regional variations in climatic factors influencing mosquito abundance (5) or differences in feeding preferences of mosquito species specific to each region (4,33).

The earlier seasonal incidence in the western region and the late extent of the WNV season in the eastern region were consistently observed for all surveillance dates. However, the date of sampling and the date of submission are likely more relevant than the date of confirmation for capturing ecological differences in the timing of infection since they are not influenced by the local availability of WNV diagnostic tests. In fact, serological tests are readily available in only 1 laboratory that almost exclusively receives samples from the western region, whereas other laboratories send samples for serological testing outside of Canada. This likely also contributed to longer delays between date of submission and date of confirmation for the eastern region.

The different surveillance dates can provide useful information for the seasonal planning of WNV testing by laboratories and horse vaccination by equine practitioners in Canada. When considering the incubation period, it is likely that horses were infected 1 to 2 wk before the date of sampling, which itself occurs 1 to 2 wk before case confirmation. Furthermore, as full immune protection after vaccination can take 2 wk to 1 mo (6,11) and given all the delays in case notifications, to ensure maximum protection, horses should be vaccinated at least 2 mo before the first confirmed cases in each region. In practice, this corresponds to mid-April in western provinces and early May in eastern provinces.

The distribution of age among the affected horses indicated that horses of any age, except for yearlings, can be clinically infected 1 to 2 wk before the date of sampling, which itself occurs 1 to 2 wk before case confirmation. Furthermore, as full immune protection after vaccination can take 2 wk to 1 mo (6,11) and given all the delays in case notifications, to ensure maximum protection, horses should be vaccinated at least 2 mo before the first confirmed cases in each region. In practice, this corresponds to mid-April in western provinces and early May in eastern provinces.

### Table 2. Summary of case characteristics of equine West Nile virus cases in Canada between 2015 and 2019 (n = 250 horses).

The percentage of cases were calculated for each characteristic and excluded missing values.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Number of cases (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breed group</td>
<td></td>
</tr>
<tr>
<td>Quarter Horse</td>
<td>144 (68.2)</td>
</tr>
<tr>
<td>Standardbred</td>
<td>14 (6.6)</td>
</tr>
<tr>
<td>Draft&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9 (4.3)</td>
</tr>
<tr>
<td>Warmblood</td>
<td>9 (4.3)</td>
</tr>
<tr>
<td>American Paint</td>
<td>8 (3.8)</td>
</tr>
<tr>
<td>Thoroughbred</td>
<td>7 (3.3)</td>
</tr>
<tr>
<td>Other&lt;sup&gt;b&lt;/sup&gt;</td>
<td>20 (9.5)</td>
</tr>
<tr>
<td>Vaccination status&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Vaccinated</td>
<td>10 (4)</td>
</tr>
<tr>
<td>Not vaccinated</td>
<td>238 (96)</td>
</tr>
<tr>
<td>Clinical outcome</td>
<td></td>
</tr>
<tr>
<td>Alive</td>
<td>109 (68.1)</td>
</tr>
<tr>
<td>Dead&lt;sup&gt;d&lt;/sup&gt;</td>
<td>51 (31.9)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Belgian (n = 1), Canadian (n = 1), Clydesdale (n = 2), Percheron (n = 5).
<sup>b</sup> Appaloosa (n = 1), Arabian (n = 2), Fjord (n = 3), Friesian (n = 1), Hallinger (n = 2), Miniature (n = 3), Morgan (n = 1), Pony, unspecified breed (n = 4), Tennessee Walker (n = 2), Welsh Cob (n = 1).
<sup>c</sup> Only horses reported to have been vaccinated by the submitting veterinarian in the last 12 mo prior to the infection were considered vaccinated.
<sup>d</sup> Dead includes horses that were euthanized.

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**Figure 3.** Age of equine West Nile virus cases from 2015 to 2019 in Canada (n = 234).
females was similar, as suggested by others (27). Compared to any other breed, Quarter Horses were more frequently observed among the cases in this study, similar to other studies (16,17). The high population of Quarter Horses in western provinces may partially explain their increased cases (34). In addition, as many western Quarter Horses work outdoors on feedlots, they could be at higher risk of exposure to vectors. In a study of owners with a WNV-infected horse, a higher percentage of Quarter Horse owners did not report on-farm use of mosquito control measures compared to owners of other breeds (13).

Most affected horses in our study had not been vaccinated in the year before diagnosis. This was consistent with a previous study from Saskatchewan which indicated that vaccination likely provided protection against development of WNV clinical disease (35). Along with the clinical portrait of affected horses in this study, this illustrated the importance of vaccination of horses of any age, sex, or breed. Mortality risk was similar to that reported in other studies, with approximately 1/3 of affected horses dying (6).

The findings of this study may be useful to inform veterinary equine practitioners on the occurrence of West Nile virus infections in Canada, as well as to characterize the clinically infected horses based on a nationwide standard case definition for all surveillance years. There were apparent differences between western and eastern regions in seasonality and incidence of WNV cases. Furthermore, there was high variability from year to year, but a consistent increase in incidence in the last decade. Moreover, even if higher incidence rates were recorded in western Canada, an important increase in case notifications in eastern Canada in recent years was also recorded. These findings can be used as a starting point for studies assessing seasonality, risk factors, and spatiotemporal patterns of the disease in horses in Canada on a more refined geographic scale.

Acknowledgments

The authors acknowledge the support of the Natural Sciences and Engineering Research Council of Canada (NSERC) with a student grant attributed to Antoine Levassure. The project was also supported by the Veterinary Student Internship Program of the CFIA. The authors extend their appreciation to CFIA, Provincial and Laboratory staff for their contributions to data collection.

References


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**Book Review**

**Compte rendu de livre**

*Farm Animal Behaviour. Characteristics for Assessment of Health and Welfare. 2nd edition*


*Farm Animal Behaviour,* is a lovely review of behavior, care, and history of domesticated mammals (horse, swine, rabbit, cattle, sheep, and goats), domesticated birds (domestic fowl, turkey, goose, domestic duck), and non-domesticated farmed animals (fallow, red deer, ostrich, and emu). Each chapter is well-organized with sub-titles and headers for each topic covered. It is full of wonderful photos both black and white and colored.

Being well-researched in behavior there does remain author opinion, and perhaps bias, on certain procedures deemed “mutilations” (i.e., tail docking, castration, other). The authors suggest that most countries could do better with procedures requiring anesthesia and analgesia as they are known to be painful in our day and age. The book does seem to focus on issues from the Europe, United Kingdom, and Australia without mention of how things compare in North America.

Overall, this book is a pleasant go-to for husbandry and a guide of ideal situations and raising practices for common farmed animals. It reviews stereotypic behaviors, common injuries, and disease (usually resulting from improper management) and how they can be remedied. It would be something I would advise for clients if they wanted decent all-round information or if they plan to add to their farm, especially before the purchase of the animals. This would also be good in a mobile veterinarian’s library if you must look at an animal you don’t see quite that often.

*Reviewed by Hannah Titus, DVM, Geary, New Brunswick.*
Defining important canine zoonotic pathogens within the Prairie Provinces of Canada

Erica Sims, Tasha Epp

Abstract — The goal of this study was to establish a short list of zoonotic pathogens involving the domestic dog that can be prioritized for a companion animal surveillance program specific to the Prairie Provinces of Canada. A list of pathogens documented in dogs was created through a comprehensive review of infectious disease textbooks for the following taxonomical categories: bacteria, ectoparasites, fungi, helminths, protozoa, rickettsia, and viruses. This created an initial list of 594 pathogens that was then pared down through an extensive review of the literature using the following criteria: i) the pathogen is zoonotic/sapronotic/anthroponotic; ii) the dog is involved in transmission to humans, maintenance, or detection of the pathogen; and iii) there is a level of risk for occurrence of the pathogen in Canada. This process yielded a final list of 84 pathogens and 3 supplementary lists of canine zoonotic/sapronotic/anthroponotic pathogens that may become relevant to future surveillance programs.

Résumé — Définition des agents pathogènes zoonotiques canins importants dans les provinces des Prairies du Canada. Le but de cette étude était d’établir une courte liste d’agents pathogènes zoonotiques impliquant le chien domestique qui peuvent être priorités pour un programme de surveillance des animaux de compagnie propre aux provinces des Prairies du Canada. Une liste d’agents pathogènes documentés chez les chiens a été créée grâce à un examen complet des manuels sur les maladies infectieuses pour les catégories taxonomiques suivantes : bactéries, ectoparasites, champignons, helminthes, protozoaires, rickettsies et virus. Cela a créé une liste initiale de 594 agents pathogènes qui a ensuite été réduite grâce à un examen approfondi de la littérature en utilisant les critères suivants : i) l’agent pathogène est zoonotique/sapronotique/anthroponotique; ii) le chien est impliqué dans la transmission à l’homme, le maintien ou la détection de l’agent pathogène; et iii) il existe un niveau de risque d’apparition de l’agent pathogène au Canada. Ce processus a donné une liste finale de 84 agents pathogènes et trois listes supplémentaires d’agents pathogènes zoonotiques/sapronotiques/anthroponotiques canins qui pourraient devenir pertinents pour les futurs programmes de surveillance.


Introduction

The relationship between humans and companion animals has become increasingly intimate over time (1). According to the Canadian Animal Health Institute, there were an estimated 8.2 million dogs and 8.3 million cats residing in Canada in 2018. It is reported that 41% of Canadian households own at least 1 dog and 38% own at least 1 cat (2). Unfortunately, there is limited information on zoonotic disease prevalence in the animals with which people share the most time and closest contact (1). Thus, there is a growing need for information on companion animal diseases that can also affect humans. Of the approximately 1500 infectious organisms known to cause human disease, 60% are zoonotic and originate from animal sources (3). Exploring companion animal zoonotic pathogens from a One Health perspective becomes especially important for the most vulnerable populations. This includes those who are immunocompromised (4), and remote communities with limited access to both medical and veterinary resources (5).

There are currently little to no data on the prevalence of canine zoonotic pathogens within the Prairie Provinces of Canada. Although several studies exist in the Prairie Provinces for individual canine pathogens (5–7), those most significant from a public health standpoint, as well as prioritization of these pathogens to guide public/animal health policy, have yet to be...
explored. Determining pathogens of significance is a foundational step in developing a surveillance program.

Surveillance systems are already well-established in human medicine (1,3). Several examples also exist in the Canadian livestock industry from both a veterinary and public health perspective (8,9). In addition, wildlife surveillance occurs in Canada at both the provincial and federal levels (10,11). Currently, rabies is one of the only companion animal zoonotic pathogens that is routinely monitored through federal and provincial surveillance programs (12,13). The Ontario Animal Health Network is the first provincial initiative to collectively monitor companion animal disease trends in Canada (14). Although companion animal surveillance programs are well-established in other parts of the world (15), there is a clear gap that needs to be filled for companion animal health data in the Prairie Provinces. A companion animal surveillance program could provide both animal health data (demographic and disease data) and relevant public health data.

The first step to establishing a companion animal surveillance program in the location of interest was to determine which pathogens are significant, focusing on the domestic dog. The primary objective of this study was to establish a short list of pathogens seen in the domestic canine population that have public health implications within the Prairie Provinces. A secondary objective was to formulate additional lists of those pathogens that may be important to future surveillance initiatives.

Materials and methods

Initial list and stepwise approach

A list of pathogens in the taxonomical categories bacteria, ectoparasites, fungi, helminths, protozoa, rickettsia, and viruses documented in dogs was created by reviewing the most up-to-date, authoritative veterinary infectious disease textbooks (4,16–18). If a pathogen was listed as having been identified in dogs in any of these textbooks, it was included in this initial list. The list was supplemented with the addition of pathogen Sars-CoV-2 (COVID-19) (19). Several ectoparasites were also included but were limited to mites and fleas. Pathogens were classified to species level whenever possible. This was often dependent on how taxonomic ranking was documented in the literature. When several species were involved (e.g., with dog bite and enteric pathogens), or when the species level was not reported, pathogens were characterized no further than the genus level.

A subsequent extensive and structured literature search followed a stepwise approach (Figure 1) to narrow down this initial pathogen list. The first step was to assess any evidence that the pathogen was zoonotic, saprotonotic, or anthropotonic. The second step was to assess any evidence that dogs had a role in how humans acquire the pathogen. Roles included the direct transmission of the pathogen from dogs to humans, dogs maintaining the pathogen in the environment as a definitive or reservoir host, and finally, that dogs can be used to detect the pathogen in the environment as a sentinel for human exposure. The third step was to assess any evidence for each pathogen’s level of risk for occurrence in Canada, since few publications were known to exist specifically for the Prairie Provinces. These steps were developed through in-depth discussions by the authors.

Defining zoonotic/saprotonotic/anthropotonic (Step 1)

For the purposes of this study, pathogens advanced from Step 1 if they were zoonotic, saprotonotic, or anthropotonic. Zoonotic pathogens are those that are transmitted from animals (or animal tissue) to humans and results in human illness (20). Transmission can include direct contact (by skin, inhalation, or ingestion), indirect contact through fomites or a contaminated environment, and vector transmission (4,17,20). Saprotonotic pathogens are those that infect both animals and humans from a shared environment without transmission between hosts (4,20). Finally, anthropotonic pathogens are those that are transmitted from humans to animals (4).

An extensive search of the literature and infectious disease textbooks (4,16–18) was done to determine if a pathogen was zoonotic, saprotonotic, or anthropotonic. This included searches using the pathogen name, followed by “human illness,” “in humans,” or “human disease” in research databases Google Scholar and PubMed. There were no limitations placed on publication year during searches. If at least 1 source identified the pathogen as zoonotic/saprotonotic/anthropotonic, or if the pathogen was reported to cause clinical illness in humans, then the pathogen was not discarded (this included opportunistic pathogens). Pathogens were assessed in Step 1 regardless of whether or not the dog was involved in transmission of the pathogen to humans. If a pathogen did not meet the definition of zoonotic/saprotonotic/anthropotonic, or if there was no evidence in the literature to support infection in humans, it was removed from the list.

Role of the dog (Step 2)

An extensive review of the literature and infectious disease textbooks (4,16–18,22) was used to evaluate the role of the dog for all of the pathogens that advanced from Step 1. This included searches using the pathogen name, followed by “dog to human,” “dog transmission,” and “dog sentinel” in research databases Google Scholar and PubMed. Pathogens advanced if the dog was involved in direct transmission of the pathogen, acted as a reservoir host, helped to maintain the pathogen in the environment (e.g., acted as a definitive host in a parasitic life cycle), or acted as a sentinel for human infection and detection of the pathogen. If the dog was historically involved in transmission to humans, maintenance or detection of the pathogen, regardless of how common the pathogen is, it advanced to Step 3. If there was not enough evidence in the texts or literature, such that the role of the dog was still largely unknown, it was discarded from the list. For several pathogens, there was not enough evidence in the literature to prove or disprove the role of the dog in transmission to humans, maintenance, or detection of the pathogen. Therefore, a supplementary list denoted Grey-Zone Pathogens was created to highlight these particular pathogens for their possible public health significance in the domestic canine population.

Presence in Canada (Step 3)

Once it was established that the dog was involved in transmission to humans, maintenance, or detection of the pathogen, Step 3 was to determine the level of risk for occurrence in
Canada of each remaining pathogen using a 4-tiered approach (Figure 2). These tiers included Tier 1: the pathogen has been reported in dogs in Canada historically at least once; Tier 2: the pathogen has been reported in Canada historically at least once, but canine-specific reports are lacking; Tier 3: the pathogen has not historically been reported in Canada, or its distribution is unknown, but there is a level of risk for occurrence of the pathogen in Canada due to appropriate climate, vectors, reservoir hosts, and lifestyle; and Tier 4: the pathogen is unlikely to occur in Canada because the main reservoir host is missing, the current climate in Canada would not support survival of the pathogen or vector, or the lifestyle does not fit with contraction of the pathogen.

Using a 4-tiered approach allowed for the recognition of those pathogens that may not be significant to the Canadian canine and human population at this time, but could become relevant in the future. Information about each pathogen’s presence or capacity for occurrence in Canada was obtained through an extensive search of the literature using the pathogen name followed by “in Canada” and “in Canada in dogs” in research databases Google Scholar and PubMed. This step included reports of pathogens in all of Canada because of the limited research available for the Prairie Provinces exclusively. If a Canadian report specifically involved the dog, the pathogen was the pathogen was placed in Tier 1. If canine-specific reports were not identified but the pathogen has been documented in Canada (in human studies or other species, as well as environmental examples) these pathogens were placed in Tier 2. If the pathogen was not documented in Canada at the time of this study, additional searches were performed to identify whether the pathogen had the potential to occur in Canada. For example, searches were completed to determine the geographical distribution of vectors, or first and second intermediate hosts depending on the pathogen. If this information supported possible survival of the pathogen in Canada (i.e., the vector or intermediate hosts have been reported in Canada), then these pathogens were placed in Tier 3. It was assumed that bacterial pathogens not currently reported in Canada (such as several dog bite pathogens) have the capacity to occur in Canada since they are not reliant on vectors or intermediate hosts. For this reason, additional searches were not required for bacterial pathogens that did not qualify for Tier 1 or Tier 2, and these bacteria were automatically placed in Tier 3. If there was no evidence at the time of this study to support survival of the pathogen in Canada, or the distribution of vectors and intermediate hosts did not include Canada, these pathogens were placed in Tier 4. Pathogens grouped in Tier 1 represented the final shortlist. Tier 2 and Tier 3 pathogens represented supplemental shortlists to highlight pathogens that may become significant to canine surveillance initiatives in the future. Grey-Zone Pathogens identified in Step 2 were also further categorized as being present in Canada or having the potential to occur in Canada using the same search strategy.

Results

A total of 594 infectious pathogens were identified in canines (Appendix A — available from the authors upon request; Figure 3). Of these, 235 were bacteria (40%), 14 were ectoparasites (2%), 79 were fungi (13%), 109 were helminths (18%), 62 were protozoa (10%), 19 were rickettsias (3%), and 76 were viruses (13%). From this initial list, a total of 486 pathogens (82%) were then identified as zoonotic/sapronotic/adaptational. Of these 486 pathogens, 71 were specifically classified as sapronotic (15%).

From the previous 486 pathogens, a total of 241 pathogens (50%) were further identified as involving the dog in human infection through either direct transmission, maintenance of the pathogen in the environment, or as sentinels for human exposure (Appendix A — https://wcvm.usask.ca/documents/college/appendix-a-final-.pdf). An additional 29 pathogens were classified as Grey-Zone Pathogens. This represented pathogens for which there was evidence to suggest the dog’s role in transmission to humans, maintenance, or detection of the pathogen but there was not enough evidence to prove or disprove the role of the dog at this time. Of these 29 pathogens, 19 were present in Canada and 7 had the potential to occur in Canada (Appendix B — https://wcvm.usask.ca/documents/college/appendix-b-d-final.pdf).

Of the previous 241 pathogens, 84 pathogens were identified in dogs in Canada (Tier 1; Table 1), 74 were reported in Canada...
Figure 3. Resulting number of pathogens that fulfilled the criteria for each step. Tier 1 = final shortlist. “Grey-Zone,” Tier 2, Tier 3 = supplementary lists.

but canine-specific reports were lacking (Tier 2; Appendix C — https://wcvm.usask.ca/documents/college/appendix-b-d-final.pdf), and 31 pathogens were classified as having the potential to occur in Canada (Tier 3; Appendix D — https://wcvm.usask.ca/documents/college/appendix-b-d-final.pdf). A total of 52 pathogens were identified as unlikely to occur in Canada (Tier 4).

Discussion

Using a stepwise approach, the authors were able to create an initial list of 594 pathogens identified in dogs and reduce this list to 84 pathogens (Tier 1) relevant to the Prairie Provinces from a public health perspective. In addition, 3 supplemental lists (Tier 2, Tier 3, and Grey-Zone Pathogens) were created to highlight several other groups of pathogens that may become relevant to future surveillance initiatives. To the best of the authors’ knowledge this is the first study in Canada to summarize and list relevant to future surveillance initiatives. The veterinary infectious disease textbooks used to create the initial pathogen list are comprehensive and well-founded, and are likely to capture the majority of the pathogens identified in dogs. However, the initial list may not be exhaustive and there is an opportunity for rare pathogens to be missed. It is also possible that emerging pathogens will arise during the course of this research. Depending on how one chooses to define zoonotic, classification of a pathogen may be subjectively based on who is creating the list and their personal objectives. Therefore, the final short list is not rigid but is not likely to change substantially. The authors did not employ double-blind methods for paring down the list and doing so may have altered the final shortlist. Follow-up ranking exercises will provide the opportunity to revise pathogens on the list.

A significant portion of this review became an exercise on what constitutes a zoonotic pathogen. There were several instances of contradicting views in the literature on whether or not a pathogen was categorized as zoonotic (4,17,18,21). This was the reason that a clear definition of zoonotic/sapronotic/anthroponotic was determined prior to condensing the list. A priority for the authors was to ensure that if a pathogen detected in dogs impacts human health in any way that it was not overlooked if it was not zoonotic in the traditional sense (direct animal to human transmission). Several definitions were used to explore how a pathogen related to human disease. For example, sapronoses were assessed in Step 1 because although they are not directly zoonotic, dogs can serve as sentinels for sapronotic pathogens and reveal a risk for human exposure from a shared environment (4). Anthroponoses were also assessed in Step 1 to explore the idea that if a pathogen can be transmitted from human to dog, there is also a concern for transmission to occur in the other direction. Unfortunately, it is often challenging to verify zoonotic transfer versus shared environmental exposure (22), which is why it is also important to consider dogs as sentinels for many of these pathogens.

The authors chose to include several ectoparasites in the initial list of pathogens. Many ectoparasites (including fleas, ticks, and sandflies) are important from a public health perspective because they can act as vectors for zoonotic disease transmission (23–25). This exercise explored whether the ectoparasite itself should be classified as zoonotic. This became particularly relevant for the flea. Fleas are known to transmit several very serious pathogens to humans (25) but they can also directly cause clinical signs in humans, including erythema, pruritis, and dermatitis (18). Consequently, the flea was also classified as zoonotic in addition to the many pathogens this vector can harbor and transmit to humans. Although the clinical signs caused by the flea are far less severe than those caused by many of the pathogens they harbor, based on the extensive definitions employed in this study, the flea was included in the zoonotic category.

In exploring how the dog plays a role in transmission to humans, maintenance and detection of these zoonotic/sapronotic/anthroponotic pathogens, a subcategory denoted
Grey-Zone Pathogens was also created. This represented pathogens for which there was some evidence in the literature that dogs are likely to contribute to human infection, either directly or as sentinels; however, nothing has been definitively proven at this time. It is either because there has not been enough research done on the pathogen, or it could not be determined whether transmission or shared environmental exposure occurred if infection in the dog was not explicitly identified (22). These pathogens may have a role in canine zoonoses in the future and should not be overlooked. Step 2 in particular exposed an overall lack of research in canine transmission of zoonotic pathogens. Several pathogens were excluded from Step 2 because there is simply not enough evidence at this time for the dog’s role in transmission, maintenance, or detection of the pathogen. These Grey-Zone Pathogens were further assessed for presence in Canada, and the potential to occur in Canada as a way to help highlight those pathogens that may become most important to the Prairie Provinces.

There was limited research available specific to the Prairie Provinces; therefore, literature encompassing all of Canada was included in Step 3 to evaluate occurrence of a pathogen in Canada. This lack of research emphasizes the need to identify pathogens relevant for surveillance programs because companion animal zoonotic disease prevalence is so limited in local regions. It is important to note that inclusion of a pathogen in Step 3 was based on what is currently available in the literature. In an evolving world, through globalization and the impacts of climate change, the authors recognize that some of the pathogens listed in the 3rd and 4th tiers may become more relevant to Canada in the future and should not be completely discounted for prospective surveillance studies. For example, non-native species of-snails that act as first intermediate hosts in several parasitic lifecycles have invaded regions of the world where they were not previously detected (26). In particular, climate change also impacts the distribution of many important vectors (27). The authors chose to also highlight the pathogens in

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**Table 1.** Shortlist of 84 canine pathogens (Tier 1) identified as having public health implications in the Prairie Provinces of Canada.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Pathogen</th>
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<tbody>
<tr>
<td>Bacteria</td>
<td><em>Actinomyces viscosus</em>&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td></td>
<td><em>Bartonella henselae</em></td>
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<td></td>
<td><em>Bartonella vinsonii</em> subsp. <em>berkhoffii</em></td>
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<td></td>
<td><em>Bordetella bronchiseptica</em></td>
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<td></td>
<td><em>Borrelia burgdorferi</em> senso stricto</td>
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<td></td>
<td><em>Brucella canis</em></td>
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<td></td>
<td><em>Campylobacter coli</em></td>
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<td></td>
<td><em>Campylobacter jejuni</em></td>
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<td></td>
<td><em>Campylobacter upsaliensis</em></td>
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<td></td>
<td><em>Capnocytophaga canimorsus</em></td>
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<td></td>
<td><em>Clostridium difficile</em></td>
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<td></td>
<td><em>Clostridium perfringens</em></td>
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<tr>
<td></td>
<td><em>Coxiella burnetii</em></td>
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<tr>
<td>Ectoparasites</td>
<td><em>Cheyletiella yasguri</em></td>
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<tr>
<td></td>
<td><em>Cytophthodes canis</em></td>
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<td></td>
<td><em>Cytophthodes felis</em></td>
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<tr>
<td>Fungi</td>
<td><em>Blastomyces dermatitidis</em></td>
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<td></td>
<td><em>Cryptococcus gattii</em></td>
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<td></td>
<td><em>Histoplasma capsulatum</em></td>
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<td></td>
<td><em>Malassezia pachydermatis</em></td>
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<tr>
<td>Helminths</td>
<td><em>Acanthocheilus reconditum</em></td>
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<td></td>
<td><em>Alaria alata</em></td>
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<td></td>
<td><em>Alaria americana</em></td>
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<td></td>
<td><em>Alaria canis</em></td>
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<td></td>
<td><em>Alaria marcianae</em></td>
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<td></td>
<td><em>Apophallus donnicius</em></td>
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<td></td>
<td><em>Baylisascaris procyonis</em></td>
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<tr>
<td>Protozoa</td>
<td><em>Cryptosporidium canis</em></td>
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<tr>
<td></td>
<td><em>Giardia duodenalis assemblage A1</em></td>
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<td></td>
<td><em>Giardia duodenalis assemblage B</em></td>
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<tr>
<td></td>
<td><em>Trypanosoma cruzi</em></td>
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<tr>
<td>Rickettsia</td>
<td><em>Anaplasma phagocytophilum</em></td>
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<tr>
<td></td>
<td><em>Ehrlichia canis</em></td>
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<tr>
<td></td>
<td><em>Rickettsia rickettsia</em></td>
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<tr>
<td>Viruses</td>
<td><em>Rabies</em></td>
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</table>

<sup>a</sup> *Escherichia coli* pathogens: enterohemorrhagic *E. coli* (EHEC), enteropathogenic *E. coli* (EPEC), adherent invasive *E. coli* (AIEC), uropathogenic *E. coli* (UPEC), necrotosigenic *E. coli* (NTEC), enterotoxigenic *E. coli* (ETEC).

<sup>b</sup> *Leptospira interrogans* serovars autumnalis, bratislava, canicola, grippotyphosa, hardjo, icterohaemorrhagiae, pomona.

<sup>c</sup> Dog bite specific pathogen.
Tier 2 and Tier 3 as a reminder that just because a pathogen hasn’t been recorded in Canada, or identified specifically in the dog in Canada, doesn’t mean the pathogen isn’t relevant for canine surveillance. It could simply mean these canine pathogens haven’t yet been identified in this region because researchers haven’t been looking for them. It is important to also acknowledge the effect of canine zoonotic pathogens on rural populations within the Prairie Provinces and the challenges these areas face with limited access to both medical and veterinary services (5).

Several other interesting findings emerged during the course of this study, including dog-bite relevance in Canada. During the review process it became apparent that there was little information on dog bite pathogens and reports in Canada. Although it is suspected that several dog bite pathogens are present in Canada, for many of these pathogens there were no reports to confirm this. This is likely related to the challenges associated with bacterial isolation from contaminated bite wounds. Often initial cultures are not representative of true infection. The recommended treatment for dog bite wounds is wound management alone and cultures are only performed in persistent infections (28). In cases in which the wound persists and cultures are collected, a surveillance program to monitor pathogens isolated in unresolved dog bite wounds may be worth establishing. This is of particular importance for dog bite pathogens such as Capnocytophaga canimorsus that can cause fatal disease (29). One particular Canadian study explored the overall occurrence of dog bites and degree of injury in children; however, the pathogens involved in these wounds were not the focus of the study (28).

Antimicrobial resistant pathogens in canines are significant as this study continues to be a growing area of concern and research. Canine bacterial isolates of interest on the final shortlist included methicillin-resistant Staphylococcus aureus (MRSA), methillin-resistant Staphylococcus pseudintermedius (MRSP), vancomycin-resistant Enterococcus spp., Escherichia coli, Salmonella spp., and urinary isolates of Klebsiella spp., and Pseudomonas aeruginosa. Pathogens that are resistant to antimicrobials, particularly multi-drug resistant (MDR) pathogens, are a major public health concern. Dogs living in close contact with their owners may shed these pathogens in the environment and act as a source for human infection (30,31). For a large number of pathogens identified in this study, including antimicrobial resistant and MDR pathogens, emphasis should be placed on the consequences of these infections in immunocompromised individuals (4,22). Surveillance of antimicrobial resistance in dogs and other companion animals is an area in which additional research should be considered.

The current study focused on the domestic dog only. Other companion animals such as cats, exotic pets, small mammals, and birds were excluded. These species should be considered for future research. Because the primary goal of this research is to advise on a companion animal surveillance program, the current study focused on evidence in the literature based specifically on the domestic dog. The authors recognize that several of the zoonotic pathogens identified here are also relevant to wild canids within Canada (32,33). This is an additional area to be explored for provincial surveillance programs. The methods applied in this study can be used for any of the above-mentioned species.

Challenges in this study included reclassification of pathogen names or several names applying to the same pathogen, in particular with bacterial and parasitic species. This often made it challenging to find accurate information in the literature and many pathogens have been potentially misclassified in older studies. For example, with over 2500 serovars for Salmonella spp, and variations among authors on nomenclature, it was difficult to find consistent reports on which Salmonella species were actually isolated in each particular case (34). For simplicity, Salmonella enterica was grouped together and emphasis was placed only on serovars enteritidis and typhimurium where distinct reports related to the dog were found (35).

In conclusion, the authors identified 84 pathogens present in dogs that are of possible public health importance within the Prairie Provinces of Canada. In addition, several other groups of pathogens were highlighted that may become important in the Prairie Provinces for future surveillance research.

References
Article

Companion animal preventive care at a veterinary teaching hospital — Knowledge, attitudes, and practices of clients

Michelle Evason, Melissa McGrath, Jason Stull

Abstract — Preventive care is the cornerstone of health. However, veterinary staff to client (pet owner) communication of disease prevention may be limited resulting in increased pet risk. Our objectives were to evaluate knowledge, attitudes, and practices of clients regarding vaccination and parasite control and describe information sources influencing client preventive care. Over a 6-week period, clients visiting a veterinary teaching hospital in Prince Edward Island, Canada, were invited to complete a written questionnaire. Of those invited, 81% (105/129) completed the questionnaire. Respondents reported low (19 to 33%) to moderate (66 to 79%) coverage for canine “lifestyle” and core vaccines, respectively. Half of the participants reported that they had concern for their pet's health from endo/ectoparasites compared to concern for their/household member's health (27%), despite 45% reporting a person at increased zoonotic risk in their household. Veterinarians (89 to 92%) and online information (39 to 51%) were the highest client-reported resources for vaccine and parasite education. Our work provides a baseline for preventive care practices and highlights a need for improvement.

Résumé — Soins préventifs des animaux de compagnie dans un hôpital d'enseignement vétérinaire — Connaissances, attitudes et pratiques des clients. Les soins préventifs sont la pierre angulaire de la santé. Cependant, la communication entre le personnel vétérinaire et le client (propriétaire de l’animal) concernant la prévention des maladies peut être limitée, ce qui augmente le risque pour les animaux de compagnie. Les objectifs de l’étude étaient d’évaluer les connaissances, les attitudes et les pratiques des clients en matière de vaccination et de lutte antiparasitaire et de décrire les sources d’information influençant les soins préventifs prodigués par les clients. Sur une période de 6 semaines, les clients visitant un hôpital d’enseignement vétérinaire de l’Île-du-Prince-Édouard, au Canada, ont été invités à remplir un questionnaire écrit. Parmi les invités, 81 % (105/129) ont rempli le questionnaire. Les répondants ont rapporté une couverture faible (19 à 33 %) à modérée (66 à 79 %) pour les vaccins « style de vie » canin et de base, respectivement. La moitié des participants ont déclaré s’inquiéter pour la santé de leur animal de compagnie relativement aux endo/ectoparasites comparativement à des inquiétudes pour leur santé ou celle des membres de leur famille (27 %), bien que 45 % aient déclaré qu’une personne présentait un risque zoonotique accru dans leur ménage. Les vétérinaires (89 à 92 %) et les renseignements en ligne (39 à 51 %) étaient les ressources les plus importantes déclarées par les clients pour l’éducation sur les vaccins et les parasites. Notre travail fournit une base pour les pratiques de soins préventifs et met en évidence un besoin d’amélioration.

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Introduction

Preventive care is generally considered the foundation of animal health and protection from disease (1,2). In the United Kingdom (UK), it is estimated that 1/3 of all dog and cat veterinary appointments focus on preventive care (3). However, despite the frequency and importance of preventive veterinary care consultations, owner education on preventive care topics and infectious disease risks may be limited, misunderstood, or perceived by veterinary care teams as less-valued by clients (1,3–10). Research regarding the quality and quantity of preventive care discussions occurring between veterinary staff and their clientele in veterinary clinics is sparse (3–10). One study reported that educational discussion on preventive care formed a minor component of wellness visits in Canada (10).
and another study noted variation in the content of preventive care discussion, dependent on whether the pet was an adult or juvenile, with greater emphasis on preventive care occurring during primary vaccination appointments (6). Furthermore, there may be a disconnect between what veterinary teams perceive as valued by clients with respect to preventive care compared to what clients truly regard as important or essential (1,4–7).

As such, research investigating pet owner knowledge, attitudes, and practices (KAPs) related to preventive care is indicated to identify education gaps and target areas for improved preventive care communication, thereby impacting owner practices and ultimately reducing infectious disease risks and improving companion animal health.

The American Animal Health Association (AAHA), American Veterinary Medical Association (AVMA), and other stakeholders established the Partnership for Healthy Pets (PHP) in 2011, with the goal of providing veterinary teams resources for communicating the importance of preventive care to pet owners (11). This initiative evolved, in part, due to veterinary and stakeholder concerns related to pet owner attitudes about preventive care becoming less favorable and an observed decrease in preventive care veterinary visits in the USA (1,12,13). A contributing factor to these changes was thought to be increasing pet owner reliance on non-veterinarian-approved internet-based information sources instead of directly from veterinary teams (1,12,13). Pet owner information sources may vary regionally, nationally, or globally, and data on Canadian pet owner information sources are currently lacking.

In many regions of Canada, pet infectious disease exposure and risk related to pathogens, namely tick-borne and Leptospira spp., have changed dramatically in recent years, particularly in regions of the Maritimes and Eastern Canada (14–19). Other companion animal infectious disease risks, such as those related to endoparasites (i.e., roundworms, Giardia lamblia) have largely remained unchanged or vary by region (20). In addition, individual pet-specific risks, such as animal travel or involvement in group animal settings (e.g., dog daycare, boarding, dog shows) may increase a pet’s infectious disease risks further through exposure to regional pathogens during travel, or to an increased number of other, potentially infectious animals and contaminated fomites in a group setting (21). Individual pet, travel, and regional risk factors for infectious disease exposure all impact and necessitate adjustments to the unique pet’s preventive care plan (22).

As many pathogens affecting companion animals are zoonotic, with pets directly infecting (or facilitating movement of tick/ flea vectors) human household members, lapses in canine and feline preventive care have direct public health impacts (e.g., toxocariasis, borreliosis) (23). Such pet-associated public health risks are greatest for household members who are at risk because of age, pregnancy, or immunocompromise (e.g., cancer or associated therapy), whereby zoonotic infections are generally more common and severe than in other individuals (24). As such, the veterinary team serves a central role in influencing KAPs of pet owners with likely direct impacts on pet and owner health.

Due to these various concerns, there is a critical need to determine clients’ preventive care practices and, if suboptimal, investigate possible modifiable factors influencing uptake of veterinary recommendations. By assessing client knowledge of preventable infectious diseases and preventive care options, as well as their attitudes regarding these, veterinary health professionals can target knowledge gaps or correct misinformation by providing clients with credible sources of information regarding preventive care for their pets. The objectives of this study were to: i) evaluate companion animal clients’ knowledge, attitudes, and practices surrounding pet preventive care at a veterinary teaching hospital in Atlantic Canada; and ii) describe client information sources influencing preventive care.

### Materials and methods

This was an observational cross-sectional study. Clients of the Atlantic Veterinary College (AVC), University of Prince Edward Island (UPEI), Small Animal Veterinary Teaching Hospital (VTH) were invited over a 6-week period (June to July 2019) to complete a 7-minute written questionnaire.

Clients waiting in the reception area of the VTH for companion animal general practice or referral appointments (e.g., surgery, cardiology, internal medicine, dermatology), were individually approached by a co-author (MM) and invited to complete the questionnaire. Any clients appearing visibly distressed, regardless of their appointment type, were not approached.

Combinations of open- (e.g., short answer) and closed-ended (e.g., modified 5-point Likert-type) questions were used to collect information on: i) clients’ KAPs surrounding canine/feline preventive care; and ii) client information sources influencing pet preventive care decisions. All responses were anonymous and confidential and were only accessible by members of the research team. Clients were asked to provide answers based on the pet(s) that they had with them at the VTH at the time of questionnaire distribution. The survey was in English, reviewed and deemed a program evaluation by the University of Prince Edward Island’s
Table 2. Pet owner reported preventive care practices and perceived education needs at a small animal teaching hospital (N = 105).

<table>
<thead>
<tr>
<th>Question</th>
<th>Frequency</th>
<th>Percentage (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has your dog(s) been vaccinated against or had titers run (DAPP) for the following in the past 3 years? (n = 96)</td>
<td>Rabies</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>Combo (DAPP)</td>
<td>63</td>
</tr>
<tr>
<td>Has your dog(s) been vaccinated against the following infectious diseases in the past 12 months? (n = 96)</td>
<td>Canine influenza</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Bordetella (kennel cough)</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Leptospirosis</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Lyme disease</td>
<td>18</td>
</tr>
<tr>
<td>In a typical month, where does your dog spend time while outside of the house? (n = 96)</td>
<td>Dog parks</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Neighborhood walks</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>Dog-friendly beaches</td>
<td>24</td>
</tr>
<tr>
<td>Do you use home remedies/ holistic/ natural flea/tick/worm prevention methods? (n = 100)</td>
<td>YES</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td>92</td>
</tr>
<tr>
<td>Are you interested in learning more from your veterinarian about the types of parasites and infectious diseases your pet can contract and how/where they may get them? (n = 104)</td>
<td>Yes</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Unsure</td>
<td>22</td>
</tr>
<tr>
<td>Do you receive reminders from your veterinary clinic about keeping your pet's vaccines/boosters or preventative medication up to date? (n = 102)</td>
<td>Yes</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>Sometimes</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Unsure</td>
<td>7</td>
</tr>
</tbody>
</table>

a Respondents were able to report multiple responses; as such, the sum is greater than 100%.

b Examples provided included amber necklace, diatomaceous earth, brewer’s yeast, essential oils, witch hazel.

Italics used to denote exact phrasing of survey questions.

Research Ethics department, and exempt from further review. A copy of the questionnaire is available from the author (ME) upon request. An a priori sample size calculation suggested a minimum of 96 respondents were needed for the study (assuming a conservative estimate of providing for a given question a 95% CI for an estimated proportion of 50%, with a total CI width of 20% and an alpha of 0.05).

Data were analyzed using descriptive statistics and reported as counts or percentages with corresponding 95% CIs. Commercial statistical software (Stata version 14; StataCorp, College Station, Texas, USA) was used for analyses.

Results

A total of 129 clients were invited to participate, with most (90%, 116/129) consenting to do so. Questionnaires were fully completed by the majority of those invited (91% completion, 105/116), providing data on 105 pets: 96 dogs and 9 cats. Most (93%) of the pets were adults (at least 1 y old) and had been examined by a veterinarian in the past 12 mo (93%; Table 1). Dogs (n = 94) ranged in age from 2 mo to 16 y [mean 7.6 y; standard deviation (SD): 4.2 y], whereas cats (n = 9) ranged in age from 11 mo to 7 y (median: 2.0 y). Over half of the participants (55%), responded that their pet had a currently diagnosed health condition including, orthopedic (19%), internal medicine (18%), cardiac (17%),

Table 3. Pet owner reported knowledge and attitudes on canine and feline infectious disease and related prevention at a small animal teaching hospital (N = 105).

<table>
<thead>
<tr>
<th>Question</th>
<th>Frequency</th>
<th>Percentage (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>How concerned are you about the health of yourself and those who live with you with regards to transmission of flea/ticks/ worms and their potentially associated diseases from pets? (n = 105)</td>
<td>Very concerned</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Concerned</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Somewhat concerned</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Minimal concerns</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Not at all concerned</td>
<td>30</td>
</tr>
<tr>
<td>How knowledgeable do you feel you are regarding practices, vaccines, and medications used to prevent infections in your pet(s) (n = 103)</td>
<td>Very knowledgeable</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Somewhat</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Neutral</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Not very</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Not knowledgeable</td>
<td>0</td>
</tr>
<tr>
<td>Based on information received from your veterinarian, I believe that the benefits of vaccines outweigh the health risks that may occur to my pet(s) (n = 104)</td>
<td>Strongly agree</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Somewhat agree</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Neutral</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Somewhat disagree</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>This has never occurred</td>
<td>0</td>
</tr>
<tr>
<td>I trust my veterinarian’s recommendations regarding tick/flea/worm preventative measures for my pet(s) (n = 100)</td>
<td>Strongly agree</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Somewhat agree</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Neutral</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Somewhat disagree</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>This has never occurred</td>
<td>2</td>
</tr>
<tr>
<td>How concerned are you about your pet’s health with regard to transmission of flea/ticks/worms and their potentially associated diseases (n = 105)</td>
<td>Very concerned</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Concerned</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Somewhat concerned</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Minimally concerned</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Not at all concerned</td>
<td>9</td>
</tr>
</tbody>
</table>

a One-sided, 97.5% confidence interval. Italics used to denote exact phrasing of survey questions.
neurologic (16%), cancer (10%), dermatologic (7%), dental disease (3%), or the participant responded that they were unsure (10%).

Home provinces of clients and their pets (i.e., where the pet spent much of its time) were reported by the majority of respondents (80%, 84/105). Home provinces included Prince Edward Island (PE) (n = 49), Nova Scotia (NS) (n = 21), New Brunswick (NB) (n = 9), Ontario (ON) (n = 8), and British Columbia (BC) (n = 2); multiple provinces were provided by respondents if their time was spent equally in more than 1 province throughout the year.

Respondents frequently reported that pets had spent time outside of their home environment, including local and inter-provincial travel, during the preceding 12 mo. Participants (n = 103) reported that their pet routinely spent time outside their home (dogs 94/94; cats 6/9), and that most of these events for dogs (84%) consisted of neighborhood walks (55%), visiting a dog park (8%) or being on dog-friendly beaches (23%; Table 2). Travel outside of PE, but within Canada, accounted for 40% of responses and included travel to NS (n = 23), NB (n = 17), and Newfoundland and Labrador (NL; n = 2). Travel to other Canadian provinces accounted for the remaining 20% of responses and included travel to ON, Quebec (QC), Manitoba (MB), Saskatchewan (SK), Alberta (AB), and BC. Participants also reported international travel with their pet, with 5% of pet owners reporting travel to the United States (n = 4) and the Bahamas (n = 1).

Knowledge of infectious disease
Most participants (89% of 103) reported they felt knowledgeable regarding practices, vaccines, and medications used to prevent infections in their pets; 39% reported they were very knowledgeable, and 50% stated they were somewhat knowledgeable (Table 3). The majority of respondents (87/100) were able to correctly select Lyme disease as the only disease/pathogen transmitted by a tick when provided a list of regionally important pet infectious diseases/pathogens [list included: leptospirosis, Lyme disease, rabies, Dipylidium caninum (tapeworm), canine influenza, heartworm, lungworm, none of the above]. Few participants (15%; 11/72), given the same list, identified Dipylidium caninum (tapeworm) as the only disease/pathogen transmitted by fleas.

Vaccination attitudes and practices
Respondents (n = 104), generally agreed (strongly agree: 70%, somewhat agree: 18%) with the statement that based on information received from your veterinarian, I believe that the benefits of vaccines outweigh the health risks that may occur to my pet(s) (Table 3). Most dog-owning respondents (n = 96) reported their adult dogs had received core vaccinations or had titers performed in the past 3 y [rabies: 79%; DAPP (distemper, adenovirus, parainfluenza, parvovirus): 66%; Table 3]. More than half (57%) of the participants reported their dog had received at least 1 “lifestyle” vaccine in the past year, with overall low coverage by individual vaccines [19% (Borrelia burgdorferi) to 33% (Bordetella); Table 3]. Cat-owning respondents (n = 9) reported cats received core and “lifestyle” vaccinations as: rabies (n = 3);
combination [FVRCP (feline viral rhinotracheitis, calicivirus, panleukopenia) \( n = 3 \)]; feline leukemia virus (FeLV) \( n = 4 \); feline immunodeficiency virus (FIV) \( n = 3 \); and Bordetella bronchiseptica \( n = 1 \).

### Parasite control attitudes and practices

Most respondents \( 95/100 \) reported that they agreed with the statement, *I trust my veterinarian’s recommendations regarding tick/flea/worm preventative measures for their pet(s)* (strongly agree: 84%; somewhat agree: 11%; Table 3). Many clients \( 71\% \) of 103) reported concern regarding the transmission of ecto- and endo-parasites (e.g., fleas, ticks, tapeworm, heartworm) and their associated diseases to their pets (very concerned 24%, concerned 26%, somewhat concerned 20%; Table 2). Most \( 90\% \) respondents indicated that they had purchased flea and tick medication for their pet(s) (topical, oral) in the past year. A small number of participants \( 8\% \) of 100) reported use of home remedies (e.g., amber necklace, brewer’s yeast, essential oils) for endo- and ecto-parasite control for their pets (Table 2).

### Information sources

Respondents cited various resources they used to learn about specific vaccine \( n = 103 \) and parasite needs for their pets \( n = 101 \) (Figure 1). Face-to-face conversations with a veterinarian was the most frequently reported resource for both vaccine and parasite education needs (vaccine: 89%; parasite: 92%), followed by on-line (vaccine: 50%; parasite: 39%) and previous experience (vaccine: 19%; parasite: 13%).

### Zoonotic disease attitudes and household risk

Nearly half of respondents \( 45\% \) of 96) reported having 1 or more individuals in their household who were at increased risk of zoonoses due to underdeveloped or weakened immune systems (Table 1). Less than half \( 47\% \) of 105) of respondents reported concerns (very to somewhat) regarding the health of themselves and human household members with respect to the transmission of fleas/ticks/worms and their potentially associated diseases from pets, with \( 54\% \) responding that they had minimal \( (25\%) \) or no \( (29\%) \) concerns (Table 2).

### Veterinary clinic interactions and preferences

Many respondents \( 77\% \) of 102) recalled receiving reminders from their veterinary clinic for vaccinations and preventive care. Of the participants who did not recall receiving reminders \( 16\% \), most \( 74\% \) replied that they would like to receive these communications. Approximately half of all survey respondents \( 46\% \) of 104) indicated that they would be interested in learning more from their veterinarian about parasites and infectious disease (Table 2).

### Discussion

Overall, our work indicated that there are critical gaps in preventive care practices by pet owners visiting the AVC-VTH that may translate into inadequate infectious disease prevention for the respondents’ pets. Furthermore, our results indicated low reported coverage for canine and feline “lifestyle” vaccines, with less than \( 1/3 \) of dog owners recalling vaccination for leptospirosis in the past year. This reported low vaccine coverage is concerning considering the known risk of leptospirosis exposure in the Maritimes \( 17–19 \) and a high-profile outbreak of leptospirosis in the Halifax, NS region in 2017 \( 19 \). In addition, there was high respondent reported pet travel from PE and within Canada, particularly within the Atlantic Canada provinces. Along with the low coverage for leptospirosis vaccination, only \( 18\% \) of dogs were reported to have been vaccinated for Lyme disease, despite 2 Maritime provinces (NS, NB) and other regions of Canada (ON, QC, MB) having known Lyme disease risk regions \( 25 \).

This variability and disconnect in knowledge of infectious disease complex pathogens or other pathogens.

There was a difference in ages between the cats and dogs in our study; however, and as we had only 9 cat-owning respondents, we were unable to derive clear findings from this group of owners. Our preliminary work here indicated that only 3 of 9 cats had received core or “lifestyle” vaccines in the past 1 to 3 y. Another study reported a large gap between pet owner and veterinary team feelings on a follow-up plan for cats; this may partially explain the low vaccination reports in our results, as cat-owners may not feel a need to repeat vaccination beyond the primary feline visits \( 4 \). Regardless of the reason for low reported feline vaccination, this preliminary finding was concerning for feline risk of infectious disease, some of which have high human health risk implications, e.g., rabies virus.

We observed variable responses regarding pet owner infectious disease knowledge, with high awareness of Lyme disease and its tick vector \( 87\% \), compared to relatively low knowledge regarding endoparasites, (i.e., tapeworms \( 15\% \)), and their vector, fleas. These findings were despite a pet owner self-reported high knowledge base surrounding infectious disease and pets \( 89\% \).

This variability and disconnect in knowledge of infectious disease have been noted in other studies \( 4–8 \) and within Canada \( 18 \). Fortunately, similar to these studies \( 4–7,18 \) a high reported trust \( 95\% \) in veterinary recommendations related to infectious disease and preventive care (i.e., vaccination, parasite control) was observed in our work, together with a strong indication that many pet owners \( 46\% \), even those with adult animals, were interested in learning more about preventive care from their veterinary providers. This is potentially useful information for practitioners to target educational discussions of preventive care towards topics about which pet owners may be less knowledgeable, e.g., flea prevention, regular deworming, and
to do so with the awareness that many clients want these discussions to occur, even beyond puppy- or kittenhood evaluations.

Ideally, reliable and credible sources of information would be provided and used by clients to help inform options and key needs for preventive care for pets. Similar to other work, our study determined that veterinarians (89 to 92%) remain the most influential and trusted source of information relating to preventive care topics, such as vaccination, parasite control, and nutrition, respectively (4–7,18,28). We determined that most pet owners were receiving preventive care reminders, and those who were not wanted this form of veterinary communication. Once again, this is potentially useful information for veterinary teams to allay concerns that clients are not interested in preventive care information and to increase time dedicated to educational discussions of preventive care during appointments for adult animals along with puppies and kittens.

It is clear from our work that pet owners have some concerns (29% concerned/very concerned) regarding infectious disease risks to themselves from their pets, and nearly half reported that an immunocompromised member of their household would be at a higher risk for infectious disease and zoonosis. These findings were similar to a previous Canadian study (22) that documented a comparable level of higher risk household members (52%) and a somewhat lower level of concern (7% concerned/very concerned) compared to our findings. Although pathogen testing was not available on our study animals, previous work within Atlantic Canada, on a comparable study population to ours, reported that the proportional infection of dogs and cats with endoparasites was 15% (20). Canine and feline endoparasites, including Cryptosporidium spp., Echinococcus spp., and Toxocara spp., do pose health risks to owners (24). Taken together, in our study, the low reported knowledge surrounding endoparasites, high level of concern for pet-associated zoonoses, and high proportion of higher risk household members reinforced the need and interest by the public to receive education on pet-associated zoonoses and prevention efforts, including regular preventive care.

Limitations of this work include the lack of information obtained on study population demographics and its impact on the external validity of our findings, i.e., generalizability to other regions. Participants in our study were convenience sample respondents and consisted of a mixture of AVC-VTH new appointments and reassessment clientele, visiting as: i) referrals presenting to specialty services, i.e., dermatology, internal medicine, cardiology and surgery; and ii) community (general) practice clients. As such, our findings may not reflect the “average” veterinary clinic clientele and may not be representative of a wider population. The overall advanced age of our study groups’ pets, particularly dogs, likely reflected our mixed referral/general practice clientele and may have impacted reported KAPs. Additionally, as many participants were presenting to a known student teaching and specialty (referral) care hospital and participation was voluntary, our results may have been biased by a higher-than-typical interest in educational topics discussed by their veterinarian. However, given the high response proportion we observed and the inclusion of general practice clients, the impact of this selection bias is likely limited.

We hope the results of this study will lead to improved veterinary understanding of Canadian pet owner infectious disease preventive care in order to aid communication of pet health needs, particularly those related to prevention of regional and travel-related infectious disease risks and zoonotic concerns. By identifying, understanding, and mitigating client education gaps, veterinarians will be able to more effectively communicate the importance of preventive care and continue to provide a source of trusted information to their clients, thus increasing the preventive care that pets receive and reducing risk of infectious disease to pets and humans.

Acknowledgments

We acknowledge our cooperative clientele and supportive referring veterinarians in the Atlantic Canada region for their commitment to (and assistance with) our companion animal clinical research programs.

References

Behavioral evaluation of 65 aggressive dogs following a reported bite event

Diane Frank, Suzanne Lecomte, Guy Beauchamp

Abstract — Peer-reviewed scientific publications on the topic of dog bites are numerous. Montreal was one of the first municipalities in the province of Quebec to require mandatory assessment of aggressive dogs by veterinarians. In 2019, dogs reported as aggressive and considered a potential risk to public safety by city officials were scheduled for a mandatory behavioral assessment by a veterinarian. For the purpose of this study, only aggressive dogs that had bitten (N = 65) were included. The goals were to better describe the aggressive behavior of these dogs (behavioral sequence, type of aggression, and overall reactivity) and perhaps identify new possible risk factors related to severity of injury and dangerousness. The number of signs of increased arousal/reactivity was positively and significantly associated with the injury severity score. Dangerousness increased with size of dogs. Entire males were most dangerous despite absence of recognizable differences in body weight between neutered and unneutered males.

Résumé — Évaluation comportementale de 65 chiens agressifs à la suite d’un épisode de morsure. Les publications scientifiques révisées par des pairs sur le sujet des morsures canines sont nombreuses. La Ville de Montréal fut parmi les premières municipalités du Québec à exiger l’évaluation comportementale de chiens agressifs par des médecins vétérinaires. En 2019, les chiens rapportés comme agressifs et jugés plus problématiques par des représentants de la ville furent soumis à une évaluation comportementale obligatoire par un médecin vétérinaire. Dans le cadre de cette étude, seuls les chiens ayant mordu (N = 65) ont été inclus. Les objectifs de l’étude étaient de mieux décrire le comportement agressif et d’identifier possiblement des facteurs de risques quant à la sévérité des blessures et la dangerosité des chiens. Le nombre de signes de réactivité augmentée était positivement et significativement associé avec le score de sévérité des blessures. La dangerosité augmentait avec le poids de l’animal. Les mâles entiers étaient plus dangereux que les mâles castrés et ce, sans différence de poids significative entre les chiens stérilisés ou entiers.

Introduction

Dog bites are a public health concern and a complex issue. Peer-reviewed scientific publications on the topic of dog bites are numerous (1–11). Human medical literature covers injuries, treatments, costs, morbidity, and mortality. Studies on reported bite injuries from medical data records are generally retrospective. Unfortunately, according to 1 published article, information about clinical topics related to treatment and management of dog bites by human health care professionals (medical doctors, nurses, public health experts, and mental health professionals) is assumed to be correct, but information on canine behavior is often incorrect (1). Examples according to these authors included misinformation on human-canine interactions, the significance of breed and breed characteristics, and the frequency of dog bite injuries.

The literature in veterinary medicine on dog bites covers dog characteristics, behavior, circumstances, targets (person or animal), injuries, and the victim’s behavior.

Canine behavior can be normal or abnormal. Normal behavior in the dog can be desirable or undesirable from our point of view (species-appropriate behavioral patterns that humans disapprove or dislike). Abnormal behavior can be associated with both medical and behavioral disorders (“mental illness”) and is characterized by one or several of the following signs: an altered behavioral sequence, inappropriate behavior given the context, excessive frequency given the context, and excessive duration and/or excessive severity given the context (12). Canine aggressive behavior is context-specific. Aggression may be appropriate under some circumstances (e.g., self-defense, communication).
or inappropriate in other contexts (e.g., person walking away from dog yet chased and bitten without any prior interaction). In cases of inappropriate aggressive behavior, veterinarians will rule out medical conditions such as, but not limited to, neurological diseases, painful conditions, or anxiety disorders. These cases are considered “abnormal” aggression because they are associated with physical or mental disorders (12,13). Other contributing factors aside from health issues include individual genetics, fear, and learning.

Montreal was among the first municipalities in the province of Quebec to require mandatory assessment of aggressive dogs by veterinarians. Data specifically on behavioral assessments of aggressive dogs (detailed behavioral sequences, type of aggression, and overall reactivity) have, to the authors’ knowledge, never been published. The purpose of this study was to compile data collected during behavioral evaluations of aggressive dogs with a reported bite event and a mandatory behavioral assessment required by the city. The goals were to better describe the aggressive behavior and perhaps identify new possible risk factors related to injury severity and dangerousness.

**Materials and methods**

From 2016 to 2018, to improve public safety and prevent dog bites, the city of Montreal restructured animal services and made changes to by-laws. A new team of city officials and prevention agents working together now handle all reports of aggressive dogs. Reports come from various sources, mainly citizens and police officers. Prevention agents initially meet with the victims and dog owners to complete various forms. Based on their own assessment of the dog’s behavior during their visit, the dog’s environment, and the reported complaint (aggressive behavior with or without a bite, severity of injuries, context, etc.), the agents triage the cases. Dogs reported as aggressive and considered a potential risk to public safety by city officials are scheduled for a mandatory behavioral assessment by a veterinarian. This study covered dogs assessed in 2019 by either a veterinarian with additional training in dangerousness assessment (SL) or a Board-certified veterinary behaviorist (DF).

Information before and during the veterinarian’s behavioral assessment was compiled from police records, photographs of injuries, written witness declarations, direct observation of the dog, and owner input. During the appointment, the owners answered specific questions pertaining to the dog and their account of the event. Photographs of injuries were generally available. In some cases, veterinary medical records for the canine victims were also available.

During the evaluation, the dog’s signalment was recorded (breed according to owner, gender, spay-neuter status, estimated weight, age at adoption, source of the dog, and age at the time of the bite event). Specific questions on context, behavioral sequence of the dog (warning, pause, bite, and end), number of bites (single versus multiple) during the reported event, severity of the bite(s), victim (familiar, unfamiliar, person, or animal) and type of aggression (defensive, offensive, or predatory) were asked.

Questions on context were to determine if the aggressive behavior and/or severity, and/or duration, and/or frequency was/were appropriate given the circumstances. Aggression in the context of pain or of a serious physical threat, for example, can be appropriate behavior. On the other hand, biting a person (or dog) who was not interacting with, not threatening, or even walking away (increasing distance), becomes inappropriate aggressive behavior given the context. Other examples of inappropriate behavior include all cases in which the severity of the single bite was excessive for the circumstances, events with multiple bites even if the victim was trying to withdraw or avoid interaction, and offensive aggression.

Questions on the behavioral sequence were to compile information about warning signs (growling, lip lifting, barking, etc.) prior to the bite. Additional questions included data on whether the dog paused between the warning and bite and whether the end of the aggressive sequence was volitional or required external intervention. The behavioral sequence was considered complete or “normal” if the sequence began with a warning (initiation), followed by a pause (the dog communicated and was waiting for a response/analyzing the situation), a single bite (action) followed with immediate volitional release (end of sequence).

The behavioral sequence was considered as modified if some of the steps were omitted or altered (no warning, no pause, no spontaneous release of the bite, etc.) or rapid (warning, pause present but extremely short, single bite, spontaneous release).

Severities of injury were categorized into 5 groups: i) absent, ii) superficial, iii) moderate, iv) severe, and v) death. In cases without injury, the dog may rip clothing or pull hair but did not cause any visible lesion. Superficial injuries included abrasions, scratches, redness, superficial punctiform lesions, and mild bruises. Moderate lesions included deeper bite wounds (punctiform) and lacerations. Severe injuries required sutures, surgery, and hospitalization.

Aggression was defined as defensive if displayed to interrupt physical or verbal interactions and/or approaches from another individual, whereas aggression was considered offensive when the aggressor attacked the victim (victim did not actively interact with or approach the dog). Predatory aggression for the reported event was determined based on the behavioral sequence (silent direct approach, single bite not released volitionally, lifting and shaking the victim/animal, or multiple severe bites during the event, requiring external intervention to end the aggressive sequence) and/or death of the victim. History of predatory aggression was recorded when a dog had already captured and killed another animal prior to the reported event.

Signs compatible with increased arousal or reactivity (appears “unable to heat,” piloerection, rapid or modified behavioral sequence, startles easily, redirected aggression, offensive aggression, long recovery time following an event, multiple bites during the event) were also compiled based on owner report or observed during the appointment.

During evaluation, information was gathered regarding prior documented history of bite events as well as signs compatible with anxiety disorders and other medical conditions. Details collected regarding the bite event included interactions between the presented dog and the person or dog bitten, necessity of hospitalization and/or surgery for person or dog, and whether the presented dog was on leash or not at the time of the event.
Finally, dangerousness was based primarily on severity of injuries as well as appropriateness of aggressive behavior given the context, behavioral sequence, and type of aggression. Dangerousness levels were categorized as: very low, low, moderate, high, and very high. In cases of a very low level of dangerousness, the dog gives ample warning and then pauses. If this dog does eventually bite, there is no injury or perhaps a superficial scratch. The behavior is generally appropriate for the context (i.e., we understand and can justify why the dog was aggressive under the circumstances). The aggression is defensive and easily preventable. The following is an example of a low level of dangerousness: a dog bites once (single bite), the behavioral sequence may have been a little more rapid (no or little pause between the warning and bite), the skin is broken (punctiform injury) but the injury remains superficial. The aggressive behavior may or may not be appropriate for the context. The aggression is defensive. In the case of a moderate level of dangerousness, the dog has a rapid or modified behavioral sequence, bites once (single bite), and the injury is more severe than required by the context (i.e., behavior not appropriate for the context because of the increased severity or increased frequency of the behavior). The aggressive behavior is either defensive or offensive. High levels of dangerousness include several elements: the behavior of the dog is not appropriate for the context (and the severity, and/or the frequency, and/or the duration are excessive for the context), the behavioral sequence is modified, injuries may require medical attention (antibiotics), and the aggressive behavior is offensive. Very high levels of dangerousness include the above elements, but the injuries are very severe (often multiple bites during an event) and require hospitalization and/or surgery. The outcome for the victim may even be fatal.

A victim was familiar if the person or animal lived in the same household as the aggressive dog. Otherwise, the victim was an unfamiliar individual.

Statistical analyses

Weight of the dog was assigned to 1 of 4 ordinal categories: $< 11$ kg, $\geq 11$ and $\leq 22$ kg, $> 22$ and $< 34$ kg, and $\geq 34$ kg. To test the association between nominal variables such as sex and ordinal variables such as weight class, injury severity, or dangerousness scale, we used the exact Mantel-Haenszel Chi-square. The exact Chi-square test was used to examine the association between nominal variables. The Spearman non-parametric correlation was used to examine the association between the number of signs and severity of injury. The effect of sex on actual weight was examined with the unequal variances t-test. The level of statistical significance was set at 0.05 throughout.

Results

General information

City officials received 538 reports of aggressive dogs in 2019, 467 of which required a meeting with the dog owner by prevention agents. Of the 121 dogs scheduled for a veterinary behavioral assessment, 18 dogs had been aggressive without biting (barking, growling, or lunging) and 76 had bitten, and 27 owners did not present themselves for the appointment.

For the purpose of this study, only aggressive dogs that had bitten were included. Sixty-five dogs were included (all assessed in 2019) with 38 males (58.5%) and 27 females (41.5%). Twenty-one males were neutered (55%) and 16 females were spayed (59%).

Owners named 18 different purebreds, as well as “pit bull” or other various mixed breeds. Forty percent of dogs were purebred, 32% were mixed breeds, and 27.7% were “pit bull” types/“pit bull” crosses.

Age at adoption ranged from birth to 9 y with a median of 3 mo. Age at the time of the bite ranged from 0.6 to 11.5 y with a median of 4 y. Weight ranged from 6.1 to 66 kg with a median of 27 kg.

Context and behavioral sequence

Aggressive behavior given the context was not appropriate in 63 of the 65 cases (97%). Overall, the behavioral sequence was modified (absence of warning and/or pause; multiple bites, no volitional release of bite, or spontaneous end of the aggressive sequence) in 50 out of 52 cases with available information (96.1%). Two dogs out of 52 (3.8%) had a complete behavioral sequence (warning, pause, single bite, release). Information on the entire behavioral sequence was missing in 13 of total cases (20%). Specific information on warning signs was missing in 7 cases (10.8%). Twenty-two of 58 dogs (38%) presented a warning such as barking, growling, or barking and growling prior to biting. Thirty-six out of 58 dogs (62%) did not bark or growl prior to biting. Forty-seven out of 52 dogs (90%) did not pause between the warning and the bite whereas 2 dogs (4%) did pause. Forty-nine out of 64 dogs bit once (76.5%) and 15 dogs bit multiple times during the reported event (23.4%). Information was contradictory between owner and victim for 1 of the 65 cases (1.5%).

Thirty-seven dogs bit a person (57%), 24 dogs bit another dog (36.9%), and 4 dogs (6.1%) bit both a person and dog during the reported event. Of the total 41 people bitten, 22 were men (53.6%), 10 were women (24.4%), 1 was a 16-year-old male teenager (2.4%), and 1 was a 17-year-old female teenager (2.4%). Seven children (17.1%), of which 3 girls (two 4-year-olds and one 11-year-old) and 4 boys (one 5-year-old, two 8-year-olds and one 11-year-old) were victims.

The person bitten interacted specifically with the dog in 11 cases. Examples included a man playing with an unfamiliar unleashed dog that became aroused and started biting, a person grabbing the dog by its collar and pinning the dog to the ground, a police officer using a stick to keep the dog at a distance, or an unfamiliar person accidentally touching the dog with his foot. Other examples listed such as a child running right up to a dog, a woman presenting her hand to a barking dog’s face, a woman trying to open the dog’s mouth (trying to separate fighting dogs), or 1 child hugging to kiss an unfamiliar dog were described. In all these cases except 2, the severity or number of bites were excessive for the circumstances. Interestingly, the dog threatened (he was not hit) with the stick, behaved appropriately. He growled, paused, and because the threat was still present, bit once and released volitionally without causing injury.
Severity of injuries

Severity of injuries varied from absent \( (n = 4) \) to superficial \( (n = 28) \), moderate \( (n = 26) \), or severe \( (n = 5) \). There were no fatal outcomes in the reported bite events of this study. Information on severity of injury was missing for 2 dogs. Surgery and hospitalization were necessary in 2 cases (1 woman and 1 child). Three victims required sutures (1 man, 1 woman, and 1 child). Two dogs required sutures and 1 dog required surgery (enucleation). One man hospitalized for a bite wound infection, required intravenous antibiotics for 7 d. The distribution of injury severity scores did not differ significantly with gender of the victim \( (P = 1) \), sterilization status of all dogs \( (P = 0.086) \), sterilization status of female dogs \( (P = 0.50) \), sterilization status of male dogs \( (P = 0.17) \), weight class of the dogs \( (P = 0.18) \), type of victim \( (P = 1) \), and whether dogs were free or on leash \( (P = 0.71) \). The distribution of injury severity scores was not significantly different if the dogs were on the leash or not for human victims \( (P = 0.21) \) or for dog victims \( (P = 0.21) \).

Type of aggression

The aggression was defensive in 35 cases (53.8%), offensive in 20 cases (30.8%), predatory in 2 cases (3.1%). One dog presented both defensive and offensive aggression (multiple bites to a woman and a familiar dog) and another dog presented redirected aggression to its owner and offensive aggression towards an unfamiliar dog. One dog with offensive aggression had a pattern of predatory aggression, but this was not confirmed with absolute certainty. The type of aggression could not be determined in 6 cases (9.2%). Twenty-six people were victims of defensive aggression (14 men, a 16-year-old teenager, 6 women, and 5 children: 4 boys and 1 girl). Thirteen people were victims of offensive aggression (7 men, 3 women, one 17-year-old teenager, and 2 children: 2 girls). Eight dogs were victims of defensive aggression and 11 dogs were victims of offensive aggression. The dog (aggressor) was unfamiliar to the victim in all cases except 3: i) one dog bit an unfamiliar dog and bit his own owner (redirected aggression); ii) a son’s dog bit both the son’s mother and the mother’s dog; and iii) 1 woman was bitten by her roommate’s dog. One event was predatory aggression on a small dog and 3 events were potentially predatory aggression (unconfirmed). Victims were respectively 1 adult male, 1 adult female, and 1 small dog. External intervention by owners or witnesses ended these 3 aggressive behavioral sequences.

Increased vigilance/reactivity

The number of signs of increased arousal/reactivity was positively and significantly associated with the injury severity score \( (r_{s} = 0.28, n = 63, P = 0.028) \).

Signs compatible with increased arousal and reactivity were: 4 “appear unable to hear,” 44 piloerection, 11 startle easily to benign sounds (unrelated to the bite event), 5 redirected aggression, 25 offensive aggression (predatory aggression was added), 3 long recovery time after an event, 15 multiple bites during the event, 48 modified and 14 rapid behavioral sequence. Sixty-four (98.5%) dogs presented 1 to 5 signs compatible with increased arousal and reactivity. One dog had no signs. Eleven dogs (16.9%) had 1 sign, 19 dogs had 2 (29.2%), 20 dogs had 3 (30.8%), 11 dogs had 4 (16.9%), and 3 dogs (4.6%) had 5 signs.

Other information

Prior documented history of bites was available in 8 cases. Twenty dogs (30.7%) were on leash at the time of the bite event. Eight dogs on leash (12.3%) were able to release themselves from the owner’s grip or other support. Three dogs (4.6%) were wearing their leash but no one was holding the leash. Thirty-four dog were leash-free (52.3%). Sixteen were completely free outdoors (24.6%), 6 were free in the home (9.2%), 4 were free in a fenced-in yard (6.1%), 7 were free in a dog park (10.8%), and 1 was sitting in a car with open doors (1.5%). Prior history of predatory aggression was noted in 6 cases (9.2%). Owners reported medical conditions diagnosed by their veterinarian in 26 cases (40%). At least 7 owners reported allergies (10.7% of total dogs), 1 dog had an undiagnosed dermatological condition and 1 dog exhibited severe pruritus during the appointment. Fifty-eight dogs (89%) displayed signs compatible with an anxiety disorder.

Dangerousness

Dangerousness level was assessed as very low in 6 cases (9.2%), low in 22 cases (33.8%), moderate in 23 cases (35.4%), high in 8 cases (12.3%), and very high in 6 cases (9.2%). The distribution of dangerousness scores did not differ significantly in relation to the gender of the dog \( (P = 0.063) \). Approximately 29% of males \( (11/38) \) had a high level or very high level of dangerousness compared to 11% \( (3/27) \) of females (Figure 1). The distribution of dangerousness scores was shifted toward greater levels in entire versus sterilized dogs \( (P = 0.02) \). Indeed, almost 29% \( (8/28) \) of entire dogs had high or very high dangerousness levels compared to 16% \( (6/37) \) of sterilized dogs. The distribution of dangerousness scores was shifted toward greater levels in larger dogs \( (P = 0.029) \). Approximately 35% \( (6/17) \) of dogs weighing more than 34 kg had high or very high dangerousness levels compared to 0% of dogs weighing less than 11 kg, 12.5% of dogs weighing >11 and <22 kg, and 19% of dogs weighing >22 and <34 kg. The distribution of dangerousness scores did not differ with sterilization status in female dogs \( (P = 0.56) \) but...
was shifted toward greater levels in entire male dogs \((P = 0.026)\). Almost 41% \((7/17)\) of entire males had a high or very high level of dangerousness \(versus\) 19% \((4/21)\) of castrated dogs. Males overall weighed more on average than females \((P = 0.015)\), but average weight did not differ according to sterilization status in all dogs \((P = 0.72)\), in males only \((P = 0.85)\) or females only \((P = 0.32)\).

**Discussion**

This study adds new information on a certain population of aggressive dogs. For dogs to be included in this study, a citizen or police officer had to report an aggressive dog. The likelihood of reporting an event generally depends on the victim (choosing to report or not), a witness of the event, or the severity of the bite injury. It is therefore impossible to ascertain the total number of events \(versus\) reported events. Reported frequency of dog bites in 2005 in 22 Canadian municipalities ranged from 0 to 9 \((median: 1.9)\) per 10 000 people, although these numbers were thought to represent a fraction of all dog bites that occurred in those municipalities \((14)\). In a study covering a 6-year period, the city of Calgary in Canada had 4433 reported incidents of dog aggression towards people or other animals, 2906 \((65\%)\) of which were confirmed \((5)\). In the Calgary study, severe dog-bite injuries to humans occurred more frequently in the family home than in any other setting. In a study of dog bites to humans in Chile, the authors reported that the victim knew the offending dog in most cases \((63.7\%)\) and 86.6\% of the cases were single bites \((15)\). A higher percentage of animal bite victims were men \((56.6\%)\) compared to women \((43.3\%)\). In contrast, in our study most victims were not familiar with the offending dog. As with the study from Chile, single bites \((76.5\%)\) occurred more frequently than multiple bites in our study.

The more signs compatible with increased arousal and reactivity a dog presented, the more severe were the injuries incurred by the victim. This result may improve earlier detection of “potentially dangerous” (dogs that are aggressive but have not bitten yet) and truly dangerous dogs. These dogs are exhibiting “abnormal” aggression (behavior or severity not appropriate for the context, altered behavioral sequence, and increased arousal and reactivity levels). One study reported that “reactivity to stimuli” (physical reactivity to sudden movement or sound at home) was involved in several types of canine aggression (owner-, child-, stranger-, and dog-directed) \((16)\). Another study on development and validation of a psychometric tool for assessing impulsivity in the dog questioned owners on whether their dog “overreacts” (i.e., a relatively small event produces an excessive reaction) \((17)\). In our study, we compiled “excessive startle responses,” which occurred with benign sounds or rapid movements not directed at the dog. Terminology varies from one study to another, but the signs observed are likely similar if not identical.

Intact males were most dangerous in our study group despite absence of recognizable differences in body weight between neutered and unneutered males. This finding may be a consequence of higher testosterone concentrations in entire males.

Owners recognizing signs of increased vigilance and reactivity in their dog could seek help from veterinary behaviorists or veterinarians with specific training in behavioral medicine. Veterinary behaviorists treat aggressive dogs regularly, as reported in a study of 1644 dogs over a 10-year period in which 72.4\% of dogs were presented for assessment and treatment of aggression \((18)\). Increased arousal and reactivity can generally be reduced with medication.

Future studies are needed to determine if similar findings among other types of aggressive dogs (e.g., dogs aggressive towards family members or familiar dogs) are also observed.

Some published studies tried to gain insight into circumstances using terms not always well-defined such as provoked or unprovoked. Without a proper definition, such words do not necessarily add relevant information. In this group of dogs, the aggression was offensive for 13 human victims and 11 dog victims. Offensive aggression is generally unpredictable as opposed to defensive aggression in which context of active interaction or approach at close range allows predictability. Offensive aggression is “unprovoked” for the victim. One study on child-directed canine aggression reported that unfamiliar children bitten in the dog’s home had not actively interacted with the dog in 19\% of cases \((19)\). Unfamiliar children were bitten away from the dog’s home or yard in the absence of interaction in another 5\% of cases. These canine behaviors are examples of inappropriate aggression, given the context of absence of child-initiated interaction prior to the bite. In this study of 111 cases, anxiety screens revealed abnormalities (i.e., anxiety disorders) in 77\% of dogs. Fifty percent of these dogs had potential identified or suspected contributory medical conditions. Our study compiled objective information on the behavioral sequence and specifically on the presence or absence of warning prior to a bite. Sixty-two percent of dogs did not warn, making the aggression “abnormal.” Vocal warning signs are not expected during predation or in a context of perceived urgency of self-defense by the biting dog.

Prior predatory aggression events were compiled because data on prevalence of predatory aggression in dogs is lacking. In reported cases of fatal dog bites some of the dogs had a history of predatory attacks on prey prior to the fatal bites of humans \((20,21)\). In some case reports, necropsy of dogs revealed various human body parts in the dog’s stomach confirming predatory aggression toward humans \((22,23)\). In 16 fatal attacks in Spain, 3 dogs had already presented aggressive behavior toward humans or dogs in the past \((24)\). In 4 cases, the dogs had no history of previous aggressive behavior, and the information was missing in 9 cases. The authors did not mention any prior history of predatory aggression of these dogs toward prey before the fatal attacks on humans. Future studies on dogs with predatory aggression (killing prey) could look at presence or absence of overall increased arousal and reactivity signs in these dogs. Not all dogs with predatory aggression are dangerous to humans. A subgroup is dangerous, and more research is required to detect these dogs early on before a fatal bite event.

Most scientific papers (human and veterinary) focus on breeds responsible for bites even though visual identification, the most common method of breed identification is difficult, imprecise, and unreliable \((25,26)\). In a study on human-directed aggression, the authors reported that for all types of aggression,
the variables measured explained a relatively small amount of the variance between aggressive and non-aggressive animals, suggesting a much greater importance of factors specific to the experience of the individual dogs in the development of aggression (6). The data therein suggest that although general characteristics of dogs and owners may be a factor at population level, it would be inappropriate to make assumptions about an individual animal’s risk of aggression towards humans based on characteristics such as breed. These authors also studied inter-dog aggression and suggested that general characteristics such as breed had a relatively small overall influence on the development of dog-directed aggressive behavior (7).

In conclusion, this study provides a portrait of aggressive behavior in dogs. We determined that the number of signs of increased arousal/reactivity was positively and significantly associated with the injury severity score. Dangerousness increased with size of dogs. Entire males were most dangerous despite neutered and unneutered males. Larger studies in the future would allow us to tease apart the contributions of various risk factors such as sex, body weight, overall arousal/reactivity, and prior history of aggression on aggressive behavior using more sophisticated statistical tools than simple univariate models.

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References

Case Report Rapport de cas

Transoral approach for mandibular and sublingual sialoadenectomy in a cat

Melania Dallago, Paolo Buracco

Abstract — Sialocele is an uncommon condition in cats. The treatment of choice for sublingual sialocele is excision of the ipsilateral mandibular and sublingual salivary gland/duct complex. Lateral and ventral cervical approaches have been described for mandibular-sublingual sialoadenectomy; however, the transoral approach, described here, has never been reported in cats. Ranula in the present case was likely caused by an inadvertent trauma of the sublingual duct during resection of a sublingual lesion performed by the referring veterinarian. The definitive surgery consisted of mass removal and sialoadenectomy through a unique oral approach. The surgery was effective without complications encountered after 6 months of follow-up.

Key clinical message:
This article reports a novel, transoral approach, for mandibular and sublingual sialoadenectomy in the cat. This approach decreases the surgical time and prevents recurrence of the mucocele.

Résumé — Approche trans-orale pour la sialo-adénectomie mandibulaire et sublinguale chez un chat.
La sialocèle est une maladie rare chez les chats. Le traitement de choix pour la sialocèle sublinguale est l’excision du complexe glandes salivaires/canal salivaire ipsilatéral mandibulaire et sublingual. Des approches cervicales latérales et ventrales ont été décrites pour la sialo-adénectomie mandibulaire-sublinguale; cependant, l’approche trans-orale, décrite ici, n’a jamais été rapportée chez les chats. Dans le cas présent, la ranula a probablement été causée par un traumatisme involontaire du canal sublingual lors de la résection d’une lésion sublinguale réalisée par le vétérinaire référent. La chirurgie définitive consistait en un enlèvement de masse et une sialo-adénectomie par une approche orale unique. La chirurgie a été efficace sans complications rencontrées après 6 mois de suivi.

Message clinique clé :
Cet article rapporte une nouvelle approche trans-orale pour la sialo-adénectomie mandibulaire et sublinguale chez le chat. Cette approche diminue le temps chirurgical et empêche la récidive de la mucocele.

Sialocele is frequently encountered in dogs but is rare in cats (1). Salivary mucocele, also called sialocele, is a subcutaneous or submucosal collection of saliva surrounded by reactive tissue due to extravasation of saliva as a result of discontinuity along the salivary gland-duct complex (2). The gland which is most frequently affected is the sublingual gland, formed by both a posterior monostomatic part in contact with the mandibular gland, with which it shares the same capsule, and an anterior polystomatic part (2–5). The duct of the mandibular gland passes along the superficial surface of the sublingual gland and then runs alongside the sublingual duct up to the oral cavity (4). In 1/3 of dogs, these glands share one common duct opening that exits into the buccal cavity at the level of the ipsilateral buccal floor, lateral to the sublingual frenulum (3). In the remaining dogs and in cats there are 2 separate duct openings (3,6).

In cats, the collection of saliva originating from the sublingual gland/duct is more often sublingual (ranula). Other locations similar to those in dogs include cervical and pharyngeal sialoceles.

Diagnosis of mucocele is based on history and clinical signs. Following centesis, the fluid that is obtained is a dense,
honey-colored or blood-stained highly viscous fluid of low cellularity on cytologic examination (2).

Treatment for sublingual sialocele includes excision of the affected mandibular and sublingual salivary gland/duct complex (2,7,8). The mandibular gland is removed even when it is not affected because of its intimate anatomic association with the sublingual gland (2). Concurrent marsupialization of the ranula into the oral cavity has been suggested (2). Ventral and lateral approaches have been described for mandibular and sublingual sialoadenectomy (7–9), but a transoral approach has never been reported in cats; this approach is described herein.

**Case description**

A 12-year-old, castrated male Persian cat living indoors and weighing 3 kg was referred for further investigation and treatment of an oral mass/swelling, located at the left side of the buccal floor, below the tongue and first observed 4 wk earlier. Other reported clinical signs were dysphagia and drooling.

Three weeks before presentation to our clinic, the cat underwent fine-needle aspiration of the sublingual lesion; cytology was suggestive of a malignant mesenchymal tumor. A marginal resection was attempted by the referring veterinarian; histological diagnosis at that time was suggestive of a reactive cystic wall lined by normal fibroblasts. After surgery, an acute swelling of the left side of the buccal floor developed. The day after this surgery the fluid-filled swelling was still present and was drained by needle aspiration by the referring veterinarian. The fluid aspirated was viscous, honey-colored, and of low cellularity by cytologic examination. One week later the cystic lesion reappeared and the case was referred to our clinic.

On clinical examination, the cat was alert, but mildly dehydrated, and had a body condition score of 3/9. A direct oral inspection revealed a right-sided tongue deviation caused by a non-painful, 25 × 15 × 12 mm pedunculated, exophytic, and pinkish lesion localized on the left side of the buccal floor. The day after this surgery the fluid-filled swelling was still present and was drained by needle aspiration by the referring veterinarian. The fluid aspirated was viscous, honey-colored, and of low cellularity by cytologic examination. One week later the cystic lesion reappeared and the case was referred to our clinic.

On palpation, the left salivary mandibular complex appeared enlarged (Figure 1c) compared to the contralateral side; the physical examination was otherwise unremarkable. A signed owner consent for the surgical treatment of both conditions, the sublingual mucocele and the sublingual lesion, was obtained.

The cat was premedicated with methadone (Eptadone 10 mg/mL; L. Molteni & C. dei Fili Alliti Società di Esercizio S.p.a., Firenze, Italy), 0.2 mg/kg body weight (BW), IV, and anesthesia was induced with propofol (Propvet 10 mg/mL; Zoetis Italia S.r.l., Rome, Italy), 4 mg/kg BW, IV. Following endotracheal intubation, anesthesia was maintained with isoflurane in oxygen.

The endotracheal tube was secured to the right side of the tongue to facilitate left-sided maneuvers during surgery. The cat was placed in sternal recumbency, with the head fixed to the surgical table with the help of a gauze tie; gauzes were also applied caudal to the superior and inferior canine teeth and fixed to the surgical table to keep the cat’s mouth open. Diluted chlorhexidine digluconate (0.2%) (Clorexisan 0.2%; Ogna Laboratori Farmaceutici S.r.l., Monza-Brianza, Italy) was used for local disinfection of the oral cavity. Finally, a sterile surgical drape with a hole was adapted around the mouth of the cat, to avoid gross contamination.

A mucosal elliptical incision was made around the base of the lesion base and saliva was aspirated. The incision involved all the left buccal floor, starting 1 cm rostral to the mandibular angle and extending rostrally just caudal to the mandibular symphysis, leaving the alveolar mucosa and the frenulum intact; the incision was made with 1 to 2 cm margins of healthy mucosa. The mass was resected through both sharp and blunt dissection. The excised lesion was placed in formalin for histologic investigation. Bleeding was controlled through electrocauterization.

Since the left buccal floor mucosa was almost completely removed, the sublingual-mandibular ducts were exposed and easily identified (Figure 1d); they were grasped with a pair of hemostatic forceps and pulled cranially. Then, a progressive blunt dissection was made around the ducts in an aboral direction using Metzenbaum scissors. During dissection, the chorda tympani nerve, derived from the lingual nerve and passing backward along the ducts to supply the glands with parasympathetic fibers (4), was identified and preserved.

Digital palpation and gentle ducal cranial traction allowed for easy identification of the sublingual mandibular gland complex on the caudal floor of the mouth, just medial to the angle of the mandible, with the interposition of the digastric muscle and oral mucosa. By blunt dissection through the...
The digastric muscle, which was ventrally retracted with the aid of a thin curved hemostatic forceps (Figure 2a), access to the gland complex was gained. The salivary gland complex was freed of surrounded tissue and further dissected by incision and retraction of the capsule.

Once isolation of the gland-duct complex was complete (Figure 2b), the chorda tympani nerve was cut. The entire complex was submitted for histologic evaluation (Figure 2c). The surgical wound was closed by placement of 4-0 poliglecaprone 25 suture material (Monocryl, Ethicon; J&J Medical N.V., Courcelles, Belgium) in a simple interrupted pattern.

Finally, an esophageal feeding tube was placed to manage feeding for the next 6 d. The cat recovered uneventfully and received robenacoxib (Onsior 6 mg; Elanco Italia S.p.a., Firenze, Italy), 2 mg/kg BW, PO, q24h and cefalexin (Icfvet granulare 50 mg/mL; I.C.F., Ind. Chimica Fine SRL, Palazzo Pignano (CR), Italy), 20 mg/kg BW, IV, q12h, for 5 postoperative days. Antimicrobial therapy was used to decrease the odds of esophageal tube stoma site infection, since it was reported to occur in 12.1% of cats that underwent esophageal tube placement in a recent study (10).

Drooling and dysphagia resolved within 2 postoperative days. Two days after surgery, feed was offered and the cat was able to eat spontaneously. Six days after surgery, the buccal mucosa had healed, the esophageal tube was removed, and the cat was discharged.

On histological examination, the sublingual lesion was marked by chronic ulcerative stomatitis with proliferation of granulation tissue. The possible related cause may have been a chronic infectious event (without any evidence of an etiological agent) or a previous trauma. The pathological tissue appeared completely excised. The mandibular and sublingual glands-ducts complex had chronic lymphoplasmocellular and neutrophilic interstitial and periductal sialadenitis with mild interstitial fibrosis and chronic inflammation of the soft tissues surrounding the extra-glandular salivary ducts. This finding was compatible with sialocele and inflammation of the glandular tissue which may be secondary to retention of glandular secretion and/or ascending bacterial infection.

The cat was re-examined at 2 wk (Video 1, available from the authors), 1 mo, and 2 mo (Video 2, available from the authors) after surgery and was in good health. At the time of writing, 6 mo after surgery, the owner reported that the cat was free of clinical signs.

Discussion

Mucocele is a rare condition in the cat; it usually originates from the sublingual salivary glands (ranula) (1,2,11), as in the cat in the present report. The etiopathogenesis of mucocele remains unknown. The most likely cause is trauma, but other causes include sialolithiasis, foreign bodies, inflammation, and neoplasia (2). In experimental studies in dogs, either ligation of or trauma to the sublingual salivary gland or duct may result in atrophy of the gland or rapid healing of the salivary duct, thus negating trauma as a possible cause of mucocele (12). However, in cats, ligation of the sublingual duct led to extravasation of saliva in more than 50% of the cases in another study (4), suggesting ductal obstruction as a possible cause in this species. The cat in the present report was affected by a ranula concurrent with sialadenitis, which occurred acutely after the reactive tissue removal performed by the referring veterinarian. However, brachycephalic cats may often be affected by dental occlusion disorder which may cause continuous trauma, also along the inferior mucosa, finally resulting in proliferative and/or ulcerated lesions, that may even be confused with malignant tumors (13,14). Based on this, it may be speculated that the first lesion operated on by the referring veterinarian was just a reactive lesion, probably associated with self-trauma, as no history of an external trauma was reported by the owner. It is also likely that the development of the ranula was caused by ligation of or trauma to the glandular ducts during the first surgery, with consequent collection of saliva and inflammation of the sublingual gland, as proposed by the histopathology report.

The treatment of choice for sublingual sialocele is excision of the affected mandibular and sublingual salivary gland/duct complex; marsupialization of the ranula has also been suggested (2). For mandibular and sublingual sialoadenectomy, ventral and lateral cervical approaches have been reported (7–9), although
a transoral approach has apparently never been reported in cats. An oral approach for the removal of remnants of the sublingual gland in case of sialocele recurrence in 4 dogs has been described (15). In this case report, sialoadenectomy along with an en bloc left buccal floor mucosa removal was performed (Figure 1d) through a single transoral approach. This was facilitated by the fact that the removal of the lesion was associated with the excision of most ventral buccal mucosa, thus exposing the salivary ducts (Figure 1d). Blunt dissection as close as possible to the ducts helped to avoid any damage to the surrounding soft tissues and lingual nerve. Bleeding was controlled effectively through electrocauterization. The procedure was effective and did not result in any intraoperative or postoperative complications within 6 mo after surgery.

This case shows that, with sublingual sialocele in cats, a transoral approach may be feasible, thus reducing the surgical time and allowing a complete glandular-ductal complex removal. However, it should be noted that an excessive cranial traction on the ducts may cause their rupture, thus forcing the surgeon to proceed with a lateral or a ventral approach. Complications after sialoadenectomy are uncommon and include seroma, infection, and recurrence (15,16). The reported mucocele recurrence after sialoadenectomy is 5% and usually results from incomplete removal of the affected glands (2). Recurrence was not seen in this cat 6 mo after surgery, as this approach allowed a complete glandular and ductal removal.

References
Anesthesia techniques used for field castration of 10 intractable horses

Bruce C. Stover, Nigel A. Caulkett

Abstract — Dealing with an intractable horse is a reality for nearly every equine or mixed animal veterinarian. Establishing an adequate level of sedation prior to induction of anesthesia for various clinical procedures involves little margin for error regarding the safety of the veterinarian, handler, and patient. This is further compounded by the extreme difficulty of gaining venous access required to obtain rapid and reliable results. This case series describes a technique of intramuscular sedation used for field castration of 10 captive, formerly wild horses, which may be useful for various other types of intractable horses.

Key clinical message:
An alternative method to sedate intractable horses for induction of anesthesia is outlined. The techniques described are accessible for most veterinary practitioners, providing small-volume, fast, and reliable intramuscular sedation.

Case descriptions
Horses at the WHOAS facility ranged from yearling colts to mature breeding stallions. Prior to arrival at the facility, all the horses were wild (i.e., living freely in nature in the eastern slopes of the Rocky Mountain range in Alberta, Canada and assumed to have been previously unowned by any person). Gentling had been initiated, and training to accept a halter adequate restraint is available or by remote drug delivery (RDD) i.e., via dart, if a low volume, highly concentrated combination can be administered. When safe to do so, manual injection is preferred to minimize the risk of tissue trauma associated with RDD (3). Once the animal is deeply sedated, venous access may be safely obtained and induction drugs administered by IV injection. The main focus of this case series is the use of a low volume IM sedation technique followed by IV induction of anesthesia with diazepam and ketamine for field castration of 10 captive, formerly wild horses at varying stages of gentling at the Wild Horses of Alberta Society (WHOAS) facility. Field castration techniques are described in detail for the benefit of practitioners working with mature stallions.
Horses of Alberta Society facility in Alberta, Canada.

and lead line accomplished to varying degrees before castration. Routine pre-anesthetic physical examinations were not performed due to safety considerations surrounding the intractable nature of the horses. Each horse was restrained in a custom chute system with a taught lead line and/or a neck rope (Figure 1), and simple distraction techniques were employed, such as rubbing or simulation of pressure near the injection site. An IM injection of medetomidine (30 mg/mL; Bow Valley Research, Calgary, Alberta), acepromazine (Acevet 25 injectable; Vétoquinol, Lavaltrie, Quebec), and butorphanol (Torbugesic; Zoetis Canada, Kirkland, Quebec) was then administered in the neck close to a neck twitch (i.e., a section of skin being manually pinched between the fingers and thumb). Drug doses were calculated based on visual weight estimations, age, and temperament and are presented in Table 1.

Horses were observed for time to onset of ataxia (Table 2) in the chute and subsequently moved to a larger pen for induction and surgery, thus allowing a safe environment for the progression towards deep sedation. A lead line, secured to a pen panel for added restraint, enabled induction of anesthesia in the standing horse by IV administration of diazepam (Diazepam Injection USP; Sandoz Canada, Boucherville, Quebec) and ketamine (Ketaset; Zoetis Canada). Doses are presented in Table 1.

Post-induction heart and respiratory rates (Table 3) were collected in all 10 horses. Heart and respiratory rates were measured and recorded within 10 min of induction. Blood gas parameters (Table 3) corrected for body temperature were measured in arterial heparinized blood samples collected from the transverse facial artery in 5 of 10 horses within the first 15 min post-induction using a hand-held analyzer (iSTAT 1; Abbott Laboratories, Abbott Park, Illinois, USA).

After induction, horses were placed in dorsal recumbency with their hind limbs restrained using a 2-inch braided cotton rope. Eye lubrication (Optixcare eye lube; Aventix Animal Health, Burlington, Ontario) was applied and their eyes were protected with a towel. The scrotal area was prepared routinely for surgery using povidone-iodine (Prepodyne Gen; West Pennetone, Montreal, Quebec) and 70% isopropyl alcohol (Rafer 8 products, Calgary, Alberta). Intratesticular injection of 10 mL of lidocaine with epinephrine (2%; Bimeda-MTC, Cambridge, Ontario) per testicle was performed, followed by the final surgical preparation.

A closed surgical castratation technique (4) was initiated with 2 parallel testicle-length incisions, 1 on either side of the median raphe through the scrotal skin and fascia. The parietal tunic was grasped, and the scrotal fascia stripped free using sterile gauze until exposure of the cremaster and parietal tunic was sufficient for application of an emasculator. Serra emasculators (Jorgensen Labs, Loveland, Colorado, USA) were applied to the cremaster and spermatic cord. In mature horses, the emasculature of the cremaster and spermatic cord was achieved individually, facilitated by further blunt dissection of the cremaster from the spermatic cord (4), and the median raphe was removed. In all cases, ligation of the spermatic cord and cremaster was performed with a Modified Miller’s knot (i.e., strangfe knot) (5) using catgut chrom USP 3 (B. Braun surgical, Barcelona, Spain). Care was taken to ensure minimal tension on the spermatic cord during placement of the emasculator. Emasculators were left in place for approximately 3 min, and release of the cord was controlled via hemostatic forceps upon removal of the emasculator to ensure appropriate hemostasis had been achieved. Scrotal incisions were stretched manually and left to heal by second intention. Wolf teeth were removed, and a freeze-brand was placed on the right hip.

Intraoperative phenylbutazone (20%, Rafer 8 Products) was administered IV at 4 mg/kg body weight (BW) (2 mL/100 kg BW). Because of the increased risk of and difficulty in dealing with any post-surgical complications, ceftiofur (Excede 200; Zoetis Canada) was administered during surgery and again 4 d later by IM injection at 6.6 mg/kg BW (3.3 mL/100 kg BW). Also, horses received a parenteral multivalent viral vaccine (Vetera EWT + WNV, encephalomyelitis-West Nile virus vaccine; Boehringer Ingelheim Vetmedica, St. Joseph, Missouri, USA).

Horses were placed in lateral recumbency after the procedure and evaluated for times to achieve sternal recumbency and to establish a standing position (Table 2). Atipamezole (10 mg/mL, Bow Valley Research) was administered where recoveries were considered prolonged, generally 90 min post-induction (Table 2). Average time from induction to completion of surgery was 19.9 ± 3.4 min. Two horses required an IV top-up of anesthetic agents at the initiation of surgery due to slight limb movement and tension: horse 5 received 50 mg of xylazine and 100 mg of ketamine, and horse 7 received 200 mg of ketamine.

Discussion

The risk of severe injury and mortality associated with general anesthesia of horses is considerable (6,7). The additional complications involved with the management of intractable or fractious horses compound these factors. Heavy sedation achieved by IM injection can provide an increased margin of safety when used in wild or intractable animals (8). To be suitable for IM injection, drug combinations must be of a low volume, provide fast and reliable induction or sedation, be reversible, be safe for users, and provide dependable recoveries (8,9).

Numerous drug combinations have been used for anesthesia of wild or feral equids (10). Most commonly, drug combinations including ketamine or tiletamine — zolazepam (Telazol, Zoletil) mixed with α-2 agonists have been described for use in domestic...
and feral horses and donkeys (8–11). These various combinations have proven largely effective in their corresponding studies; however, the authors have reported many to be unreliable in very fractious horses. Selectivity of a drug for the α-2 receptor is an indication of potency. Medetomidine has an α-2:α-1 selectivity of 1620:1; whereas detomidine has a selectivity of 260:1. More potent α-2 agonists can be administered at a lower dose and volume (12). Detomidine (10 mg/mL), administered at a dose of 40 μg/kg BW would require a volume of 2 mL in a 500 kg horse. Medetomidine (30 mg/mL) administered at a dose of 20 μg/kg BW to a 500 kg horse requires a volume of 0.33 mL. The small volume requirements and potency facilitate rapid IM injection. Based on our experience with these horses, we would recommend administering the IM sedation at an estimated dose of 0.02 mg/kg BW of medetomidine, 0.05 mg/kg BW of acepromazine, and 0.02 mg/kg BW of butorphanol. At the drug concentrations used in these animals, this equates to an IM sedation volume of 0.47 mL/100 kg BW for wild horses and a 0.2 mL/100 kg BW for feral horses. This low volume is easy to administer by hand injection, pole syringe, or RDD. Caution must be used when dealing with highly concentrated drugs and the use of appropriate personal protective equipment (i.e., gloves, coveralls, eye protection) by trained personnel is recommended (13). Medetomidine, administered at a dose of 10 μg/kg BW, IV, was shown to produce a similar degree of sedation as 1 mg/kg BW of xylazine but ataxia was more pronounced (14).

In the current study, ataxia was also pronounced and a cautious approach to the animal is recommended when the induction drugs are administered. The increased dose of medetomidine appeared to result in longer duration of recumbency, which necessitated the use of atipamezole to speed recovery. In horse 6 (Table 1), atipamezole was administered IM in a 1:1 ratio with little result. Increasing the atipamezole dose to a 3:1 ratio and administering half the volume IV and half IM appeared to give little result. Increasing the atipamezole dose to a 3:1 ratio and administering half the volume IV and half IM appeared to give better results. It is recommended that atipamezole be available for reversal when using this protocol. The time from completion of surgery to recovery was relatively prolonged. Appropriate padding should be provided for horses experiencing a prolonged down time.

### Table 1. Doses of medetomidine, acepromazine, and butorphanol administered intramuscularly for sedation, diazepam and ketamine administered intravenously for induction of anesthesia, and atipamezole administered as a reversal agent during field castration of 10 captive, formerly wild horses.

<table>
<thead>
<tr>
<th>Horse</th>
<th>Estimated weight (kg)</th>
<th>Medetomidine (mg/kg BW)</th>
<th>Acepromazine (mg/kg BW)</th>
<th>Butorphanol (mg/kg BW)</th>
<th>Diazepam (mg/kg BW)</th>
<th>Ketamine (mg/kg BW)</th>
<th>Atipamezole (mg/kg BW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>200</td>
<td>0.015</td>
<td>0.05</td>
<td>0.02</td>
<td>0.05</td>
<td>2.5</td>
<td>—</td>
</tr>
<tr>
<td>2</td>
<td>200</td>
<td>0.015</td>
<td>0.05</td>
<td>0.02</td>
<td>0.05</td>
<td>2.5</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>200</td>
<td>0.015</td>
<td>0.05</td>
<td>0.02</td>
<td>0.05</td>
<td>2.5</td>
<td>—</td>
</tr>
<tr>
<td>4</td>
<td>300</td>
<td>0.015</td>
<td>0.03</td>
<td>0.02</td>
<td>0.05</td>
<td>2.5</td>
<td>—</td>
</tr>
<tr>
<td>5</td>
<td>150</td>
<td>0.016</td>
<td>0.05</td>
<td>0.02</td>
<td>0.05</td>
<td>2.5</td>
<td>—</td>
</tr>
<tr>
<td>6</td>
<td>400</td>
<td>0.030</td>
<td>0.05</td>
<td>0.02</td>
<td>0.05</td>
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<tr>
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<td>0.06</td>
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</tr>
<tr>
<td>10</td>
<td>450</td>
<td>0.022</td>
<td>0.03</td>
<td>0.013</td>
<td>0.07</td>
<td>2.7</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Mean 325 0.021 0.04 0.018 0.06 2.5 0.08
SD 129 0.006 0.007 0.003 0.01 0.25 0.03

“—” indicates no reversal agent was administered; BW — body weight; SD — standard deviation.

### Table 2. Time in minutes from initial administration of intramuscular sedation (medetomidine, acepromazine, and butorphanol) to onset of ataxia, administration of intravenous induction dose (ketamine and diazepam), administration of reversal agent (atipamezole), and achieving sternal recumbency and standing after surgery in 10 captive, formerly wild horses anesthetized for field castration.

<table>
<thead>
<tr>
<th>Horse</th>
<th>Ataxia (min)</th>
<th>Induction (min)</th>
<th>Reversal (min)</th>
<th>Sternal (min)</th>
<th>Standing (min)</th>
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<tbody>
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<tr>
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<td>13</td>
<td>21</td>
<td>—</td>
<td>68</td>
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<td>68</td>
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<td>14</td>
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<tr>
<td>10</td>
<td>12</td>
<td>19</td>
<td>54</td>
<td>77</td>
<td>77</td>
</tr>
</tbody>
</table>

Mean 11.1 17 72 75.6 82.9
SD 3.5 7.5 19.6 18.5 22.9

“—” indicates no reversal agent was administered; SD — standard deviation.

and and feral horses and donkeys (8–11). These various combinations have proven largely effective in their corresponding studies; however, the authors have reported many to be unreliable in their respective study populations. Animal welfare concerns have resulted in diminished use of succinylcholine (9). Ultra-potent opioids, although effective, have become less readily available due to the recent opioid crisis, and many practitioners are reluctant to handle these drugs due to human safety concerns (10). Other drugs require specialized handling precautions, involve the use of products which are increasingly difficult to acquire, or require an emergency drug release in Canada (e.g., Telzol). As a result, we believe there is a need to continue to search for safe, economical, and readily available protocols for the sedation and induction of wild or intractable horses.

In this case series, reliable sedation was induced with an initial dose of medetomidine of 0.015 mg/kg BW in many of the smaller horses but had to be increased to approximately 0.2 to 0.3 mg/kg BW in the larger, more mature stallions (Table 1). Medetomidine was used in these horses due to its potency and small volume requirement with the compounded formulation. Detomidine is often a good option in fractious horses but not always reliable in very fractious horses. Selectivity of a drug for the α-2 receptor is an indication of potency. Medetomidine has an α-2:α-1 selectivity of 1620:1; whereas detomidine has a selectivity of 260:1. More potent α-2 agonists can be administered at a lower dose and volume (12). Detomidine (10 mg/mL), administered at a dose of 40 μg/kg BW would require a volume of 2 mL in a 500 kg horse. Medetomidine (30 mg/mL) administered at a dose of 20 μg/kg BW to a 500 kg horse requires a volume of 0.33 mL. The small volume requirements and potency facilitate rapid IM injection. Based on our experience with these horses, we would recommend administering the IM sedation at an estimated dose of 0.02 mg/kg BW of medetomidine, 0.05 mg/kg BW of acepromazine, and 0.02 mg/kg BW of butorphanol. At the drug concentrations used in these animals, this equates to an IM sedation volume of 0.47 mL/100 kg BW or 2.35 mL in a 500 kg horse. This low volume is easy to administer by hand injection, pole syringe, or RDD. Caution must be used when dealing with highly concentrated drugs and the use of appropriate personal protective equipment (i.e., gloves, coveralls, eye protection) by trained personnel is recommended (13). Medetomidine, administered at a dose of 10 μg/kg BW, IV, was shown to produce a similar degree of sedation as 1 mg/kg BW of xylazine but ataxia was more pronounced (14).
Recoveries were smooth and reliable, with horses typically standing on the first attempt. If recovery was prolonged, horses were manually rolled into sternal recumbency and would typically stand with this stimulation. It is important to note that overstimulation can result in excitement and rough recoveries. Once in sternal recumbency, it is advantageous to remove any source of stimulation, allowing the horse to stand of its own accord.

Assessment of blood gas parameters illustrated little impact on ventilation but some degree of hypoxemia, likely the result of V-Q mismatching because horses were in dorsal recumbency at the time when samples were obtained. Only 1 blood gas sample was obtained from these horses as we did not want to stimulate the horse during the recovery period. It is possible that PaO₂ may have further decreased with prolonged recumbency. Supplemental inspired oxygen should be considered when using this protocol.

Ligation of the spermatic cord and cremaster was performed to minimize the risk of hemorrhage. This technique was adopted through a combination of previous experience with domestic horses, consultations with equine surgeons, and by reviewing the literature; although efficacy data for the prevention of hemorrhage, herniation, and evagination vary based on study along with the post-surgery infection rate associated with ligature placement (4,5). To date, the authors have performed over 75 castrations on feral horses and have had only 1 case of post-surgical complication; that case involved infection. No post-surgical complications were observed during or upon follow-up to this case series.

It is important to note that this protocol was used for castration of healthy horses. More detailed studies of the cardiovascular effects of this protocol should be performed before it can be advocated for horses suffering from significant trauma or hemorrhage.

The authors acknowledge the use of estimated weights as being a potential limitation to the interpretation of the results of this case series; however, the procedures were performed under field conditions and a scale was not available. This is likely representative of many or most clinical situations for field anesthesia of intractable horses.

In conclusion, this case series outlines an effective method to sedate intractable horses for induction of anesthesia that would be available to most veterinary practitioners and suitable for various procedures. The techniques described provide suitable alternatives to conventional sedation or induction protocols, allowing for fast, reliable IM sedation, which is important when dealing with feral or intractable horses. It is our opinion that this protocol may offer an increased margin of safety for the patient, veterinarian, and handler. The increased duration of anesthesia provided could be a significant asset, useful for mature castrations or other significant surgical procedures in the field.

Acknowledgments

The authors extend their gratitude to the Wild Horses of Alberta Society for logistical support, Dr. Merle Olson of Bow Valley Research for in-kind contribution of pharmaceuticals, the University of Calgary Faculty of Veterinary Medicine for equipment, numerous volunteers (particularly Tony Stevens) for their technical assistance, and Dr. Claire Windeyer for help preparing this manuscript.

References

Case Report  Rapport de cas

Lacrimal bone agenesis in a dog

Riccardo Rossi, Domenico Sainato, Vim Kumaratunga, Helen Renfrew

Abstract — A 20-month-old neutered male dachshund dog was referred because of a 10-week history of swelling close to the medial canthus of the left eye. Recurrence of the lesion and cytological appearance of the fluid content were suggestive of inflammation. Computed tomography revealed a triangular-shaped bone defect in the skull deep to the lesion. Computed tomography dacryocystography demonstrated contrast medium pooling within the maxillary recess and nasal cavity rather than filling the lacrimal duct. Lacrimal bone agenesis was diagnosed.

Key clinical message:
Congenital skull including lacrimal bone agenesis may be responsible for swelling of the medial canthus of the eye and computed tomography dacryocystography is helpful in making a diagnosis.

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Differential diagnoses for medial canthal swelling are numerous and can involve the eye, the nasolacrimal system (NLS), salivary glands, bones, and soft tissues. Therefore, a thoughtful evaluation of the history and signalment of patients presented for medial canthal swelling is required.

Case description
A 20-month-old dachshund dog was referred for a swelling rostromedial to the medial canthus of the left eye, first observed 10 wk previously. The dog had no history of trauma or health conditions and was up-to-date with vaccines and parasite control. The owner of the dog, the referring veterinarian, initially observed an acute firm swelling at the medial canthus of the left eye and mild epiphora. Cannulation of the lower left lacrimal puncta was unsuccessful. Systemic non-steroidal anti-inflammatory therapy (Meloxaid 1.5 mg/mL Oral Suspension for Dogs; MiPet, Diss, Norfolk, UK) in addition to topical steroid and antibiotic eye drops (Maxitrol eye drops; Novartis, Basel, Switzerland) were prescribed. On the 3rd day the swelling was unchanged; epiphora was still present and there were no signs of mucopurulent discharge. A second attempt to cannulate the lacrimal puncta and flush the left lacrimal duct was unsuccessful. The lesion was drained completely by fine-needle aspiration and 2 mL of serosanguinous fluid were collected. Cytology indicated that there was mild inflammation and hemorrhage, possibly due to the recent flushing attempt. A week later the swelling had recurred, and the lesion was drained again. The swelling, however, returned a few days later, as before. The swelling then suddenly disappeared while the dog was in the kennel without owner supervision. A minor trauma to the head was suspected which could have led to the remission of the swelling. The swelling has not reappeared.

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The abstract of this paper was presented to the EAVDI-BID Autumn Meeting, November 8–9, 2019, Belfast (UK) and at the BrAVO Congress November 8–10, 2019, Birmingham (UK).
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Ten weeks after the first presentation, and 10 d after resolution of the swelling, the dog was referred for a specialist ophthalmological consultation at our private referral hospital (Eastcott Referrals). At the ophthalmic examination, incongruity of the orbital rim of the left eye compared to the right eye, and mild erythema and subtle swelling of the medial canthus of the left eye were noted. Menace, dazzle, and pupillary light reflexes were normal in both eyes. Nasolacrimal punctae were all present and patent. Jones test 1 was within normal limits for the right eye but negative for the left eye. No other ocular abnormalities were observed.

The dog was sedated with a combination of medetomidine (Sedastart 1 mg/mL; Animalcare, York, UK), 5 mg/kg body weight (BW), IV, and methadone (Synthadon 10 mg/mL; Animalcare), 0.2 mg/kg BW, IV, induced with alfaxone 2 mg/kg (Alfaxan 10 mg/mL; Jurox, Crawley, West Sussex, UK), 2 mg/kg BW, IV, and maintained under general anesthesia with isofluorane (Isofluorane; Merial, Bracknell, Berkshire, UK). Lactated Ringer’s solution (Aquapharm; Animalcare) was administered at a rate of 5 mL/kg BW per hour during the procedure.

Cross-sectional computed tomographic (CT) imaging (GE Healthcare Lightspeed Plus 4 Slice; GE Healthcare, Chicago, Illinois, USA) was chosen over digital radiology to better evaluate the NLS, given its superior spatial resolution (1,2). A plain CT scan of the head, from the nares to C3, using soft tissue and bone filters was acquired, along with computed tomographic dacryocystography (CTDCG) to evaluate the lacrimal system, orbital region, and surrounding structures. The dog was positioned in sternal recumbency with the forelimbs extended caudally.

Plain CT revealed a 12-mm, rounded, triangular skull defect at the rostromedial aspect of the left orbit, with the tip pointing rostrally. Adjacent frontal, maxillary, and zygomatic bones had smoothly thickened edges that were mildly convex in cross-section perpendicular to the skull surface in place of the normal fine suture margins, and en face these edges described a gently curved perimeter to the skull deficit. There was no evidence of osteolysis. Deep to this, an air-filled cavity was bordered medially by a thin bony wall, separating it from a maxillary sinus reduced in size along its short axis, and by soft tissues laterally (Figure 1).

The left nasolacrimal duct (NLD) was missing in its lacrimal bone portion, and present within the medial aspect of the maxillary bone (B). The left nasolacrimal duct continues rostrally in concert with the right nasolacrimal duct (arrows), although with a thinner medial wall (C).

Figure 1. Plain computed tomography (CT), transverse plane: right to left. Adjacent frontal, maxillary, and zygomatic bones had smoothly thickened edges that were mildly convex in cross section perpendicular to the skull surface. Due to the lack of lacrimal bone (arrowheads) there is no defined course of the left lacrimal duct while the right lacrimal duct is present and normal (arrow) (A), until the canal appears (arrow) within the medial aspect of the left maxillary bone (B). The left nasolacrimal duct continues rostrally in concert with the right nasolacrimal duct (arrows), although with a thinner medial wall (C).

Figure 2. Plain computed tomography (CT), transverse plane. Temporal (arrowhead) and parietal (arrow) bone asymmetries were also present.
normograde direction. A 2.5-mL volume of contrast medium was injected in each of the left and right NLD, in order to compare each side. No resistance was observed on either side during the procedure. The scan was performed as soon as the contrast medium was detected at the nares (2).

Computed tomographic dacryocystography (CTDCG) revealed a normal right lacrimal system, whereas on the left it demonstrated absence of the lacrimal sac and the lacrimal bone portion of the NLD. The contrast medium collected in the ventral part of the gas-filled cavity and continued along a soft tissue fold medially; then funneled down to communicate with the maxillary sinus, where it pooled dependently. The left lacrimal canal, although present, did not show any contrast filling. The contrast instead flowed medially to the canal, along the lateral mucosal surface of the medial nasal meatus, and then runs rostrally within the lacrimal and maxillary bones until the conchal crest, where it continues deep to the nasal mucosa, along the nasal face of the maxilla. It then opens onto the ventrolateral floor of the nasal vestibule ventral to the alar fold, and, in about 50% of dogs, also at the level of the root of the canine tooth (5). The nasolacrimal secretions flow along the canaliculi, helped by eyelid movements together with active contractions of the NLD; this mechanism prevents reflux at the level of the nasolacrimal sac (6).

Congenital causes of swelling of the medial canthus of the eye include nasolacrimal cysts, dysplasia, supernumerary openings, and atresia of the proximal and/or distal components of the NLS (3,6–9). Acquired conditions include trauma, dacryocyst, foreign body, masses invading/compressing, canaliculocoele, peribortal epidermoid cyst, maxillary bone cyst, cyst of the frontal and nasal sinuses, salivary mucocele, dilation of the peribortal glandular and duct tissue (zygomatic, lacrimal salivary gland, and 3rd eyelid gland), and cholesterol granuloma (3,6–9). Older patients are less likely to have congenital abnormalities, but they are more prone to neoplasia affecting the NLS or nearby structures, whereas traumatic injuries or foreign bodies may be more common in outdoor or active animals.

Active transport is directly involved in cyst formation. If an obstruction in the distal NLD occurs, followed by a proximal obstruction, active transport leads to accumulation of tears with a consequent dilation of the duct. If this does not resolve, a cyst can form and may then result in compression or obstruction of underlying structures including sinuses, nasal cavities, turbinates, and pressure necrosis of the surrounding bone can also occur. Chronic inflammation followed by secretion of osteolytic mediators such as prostaglandins and collagenases produced by the cyst lining can contribute to adjacent bone necrosis (6).

Plain and contrast digital radiography can be used as the first imaging approach; however, the small components of the lacrimal system, together with superimposition of multiple structures present in this area, are important limitations (10). Thanks to their superior spatial resolution, plain CT and CTDCG are the imaging procedures of choice for evaluation of this area. Both have been extensively used in human medicine and in the last few years they have been applied in veterinary medicine. Rached et al (2), for example, used this technique to describe the normal anatomy of the NLS, whereas Nykamp et al (1) explored some pathological conditions. Magnetic resonance imaging, often used in human medicine, is less favored in veterinary medicine due to the greater length of the NLS, its smaller diameter, and the greater presence of bone (1).

Benign cyst-like lesions such as dacryocoele and mucocoele typically have smooth, well-defined thin walls with anechoic content, whereas lesions such as abscesses and neoplasia are more likely to be characterized by irregular, less defined margins,
Compared to the previous literature, our case has 2 main and fundamental differences: the first is the absence of a defined cyst, and the disruption of the nearby anatomical structures (e.g., turbinates). The second difference is in the margins of the bone defect: in our case these are smooth and thickened with a convex cross-sectional appearance perpendicular to the surface; all characteristics suggestive of a congenital defect rather than of a compressive force arising from the inside of the nasal cavities. The presence of other ipsilateral bone deformities, as well as the young age of the patient, supports a congenital etiology. Also, in our case the CTDCG detected the contrast medium freely pooling in the left nasal cavity, excluding any obstructive phenomenon at the time of the evaluation; a very unusual scenario and, to the authors’ knowledge, never described before.

It is possible that the presumed traumatic incident ruptured a focal dilation due to acute obstruction or the presence of a cyst of the NLD where it should have been passing through the lacrimal bone. The absence of the lacrimal bone would then allow a sudden protrusion subdermally at the medial canthus rather than compression and distortion of the underlying finer bone structures. This possible rupture would explain the ease of cannulation and flushing at the time of the imaging procedure; this was not achievable when the swelling was present.

Although we cannot know the NLD anatomy at the time of the swelling, ultimately, the young age of the patient, the imaging findings, and the presence of concomitant skull asymmetries are suggestive of congenital abnormality with the most striking feature being the left lacrimal bone agenesis.

References

Initiative vétérinaire pour l’usage judicieux des antimicrobiens

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**References**

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Abstract — The use of computer-aided lung auscultation (CALA, Whisper Veterinary Stethoscope; Merck Animal Health, Madison, New Jersey, USA) is a relatively new approach to assist in confirming the diagnosis of bovine respiratory disease (BRD). For this prospective cohort study at 1 feedlot in the United States, a CALA score was generated for 2726 feeder cattle (calf-fed Holsteins and mixed-breed beef animals) at the time of the first BRD diagnosis and treatment. All cattle were treated according to the same BRD protocol prescribed for that facility and the protocol was not influenced by the CALA score. Data were collected for 120 d after enrollment. In this study, the risk of BRD retreatment and the risk of BRD mortality were each significantly (P < 0.05) associated with the CALA score at the time of first BRD diagnosis and treatment, and those risks increased (numerically and in some cases statistically) as the CALA score increased.

Résumé — Association entre l’auscultation pulmonaire assistée par ordinateur et le risque d’échec du traitement chez les veaux traités pour une maladie respiratoire. L’utilisation de l’auscultation pulmonaire assistée par ordinateur (CALA, Whisper Veterinary Stethoscope; Merck Animal Health, Madison, New Jersey, USA) est une approche relativement nouvelle pour aider à confirmer le diagnostic de maladie respiratoire bovine (BRD). Pour cette étude de cohorte prospective dans un parc d’engraissement aux États-Unis, un score CALA a été généré pour 2726 bovins d’engraissement (veau Holstein et bovins de race mixte) au moment du premier diagnostic et traitement de la BRD. Tous les bovins ont été traités selon le même protocole BRD prescrit pour ce site et le protocole n’a pas été influencé par le score CALA. Les données ont été collectées pendant 120 jours après l’inscription. Dans cette étude, le risque de retraitement pour BRD et le risque de mortalité associé au BRD étaient chacun significativement (P < 0.05) associés au score CALA au moment du premier diagnostic et traitement BRD, et ces risques augmentaient (numériquement et dans certains cas statistiquement) à mesure que le score CALA augmentait.

(Traduit par Dr Serge Messier)
treated according to the same BRD protocol prescribed for that facility and the protocol was not influenced by the CALA score. Data were collected for 120 d after enrollment. In this study, the risk of BRD retreatment and the risk of BRD mortality were each significantly ($P < 0.05$) associated with the CALA score captured at the time of first BRD diagnosis and treatment. In addition, those risks increased (numerically and in some cases statistically) as the CALA score increased.

The Whisper Veterinary Stethoscope is a computer-aided lung auscultation (CALA) system that records thoracic sounds; processes those sounds with a proprietary, machine-learning algorithm; and generates a score from 1 to 5 that reflects the overall severity of pulmonary disease. A score of 1 reflects lung tissue that is relatively healthy, whereas score 5 indicates severely compromised lung health.

The study was performed at 1 feedlot in the United States from July 29, 2015 to April 15, 2017, during which time 2726 cattle were evaluated. The experimental population was composed of calf-fed Holsteins ($n = 2023$) and mixed-breed, auction market-derived, beef steers and heifers ($n = 703$) that were enrolled in the study at the time of the initial BRD diagnosis and treatment. Body weight at the time of enrollment ranged from 71 to 699 kg. When observed in their feedlot pen, a tentative diagnosis of BRD was assigned based on subjective criteria (general appearance, attitude, gauntness, reluctance to move). Those animals were then individually separated from pen-mates and moved to the hospital facility. Animals with clinical signs not attributable to BRD were excluded from the study. During physical examination of each animal at the time of initial BRD diagnosis and treatment, a CALA score and rectal temperature were recorded for each animal by feedlot personnel. As per normal feedlot operating procedure, cattle were subsequently categorized with rectal temperatures $\leq 40.5^\circ$C or $> 40.5^\circ$C. Criteria for diagnosis and the respective treatment protocol were based on prescribed standard operating procedures for the feedlot. The CALA score was not used to determine diagnosis or treatment.

Animals were monitored for 120 d after enrollment. Similar to initial assessment for respiratory disease, when animals were observed in their feedlot pen, a tentative diagnosis of BRD relapse was assigned based on the subjective criteria. Those animals were then individually separated from pen-mates and moved to the hospital facility where animals with no abnormal clinical signs referable to body systems other than the respiratory tract were diagnosed and treated for BRD a second time.

### Table 1. Backward elimination model-building sequence using fixed effect of CALA score (1 to 5), breed ("B" = Holstein or beef), and rectal temperature ("Temp" $\leq 40.5^\circ$C or $> 40.5^\circ$C); and their association with the risk of BRD retreatment. The sequence began with the 3-way interaction (Model 1); terms were sequentially removed until the Final model contained variables that met $P < 0.05$ for each subsequent model, the variable with the largest $P$-value was removed.

<table>
<thead>
<tr>
<th>Classification variables</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Final model</th>
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<td>P-value</td>
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$^a$ A random effect was implemented to account for clustering within the month of enrollment. Models 1 through 3 did not converge with the stated random effect and do not reflect adjustment for clustering within the month of enrollment. Model 4 and the Final model reflect adjustment for the random effect of enrollment month.

$^b$ The inclusion of breed in the Final model (despite a non-statistically significant outcome) reflects the likely confounding effect on the CALA estimate. When breed was removed from the model, the F-statistic for CALA was reduced by 45%, which was greater than the threshold of 30% determined $a priori$ to the study to be considered as a possible confounding variable. Therefore, breed was considered to be a potential confounder and remained in the model to properly adjust the CALA estimate. NA — not applicable.

### Table 2. Backward elimination model-building sequence using fixed effect of CALA score (1 to 5), breed ("B" = Holstein or beef), and rectal temperature ("Temp" $\leq 40.5^\circ$C or $> 40.5^\circ$C); and, their association with the risk of BRD mortality. The sequence began with the 3-way interaction (Model 1); terms were sequentially removed until the Final model contained variables that met $P < 0.05$ for each subsequent model, the variable with the largest $P$-value was removed.

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<td>P-value</td>
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<td>0.41</td>
<td>0.21</td>
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</table>

$^a$ A random effect was implemented to account for clustering within the month of enrollment. Models 1 through 3 did not converge with the stated random effect; and, do not reflect adjustment for clustering within the month of enrollment. Model 4 and the Final model reflect adjustment for the random effect of enrollment month.

NA — not applicable.
examination was completed on all animals that died. In some instances, a veterinarian from Feedlot Health Management Services (Feedlot Health – Okotoks, Alberta) conducted the post-mortem examination on site and determined the cause of death based on clinical history and a gross post-mortem examination. In other instances, trained personnel prosected the dead animals using a standardized method to capture appropriate digital images as outlined in the written necropsy protocol provided by Feedlot Health. Subsequently, all digital images were electronically transferred to Feedlot Health and the cause of death for each animal was determined based on the clinical history and the gross post-mortem examination by a Feedlot Health veterinarian. Mortality due to BRD was defined as mortality due to bronchopneumonia, bronchointerstitial pneumonia, bronchopneumonia and arthritis, chronic bronchopneumonia, chronic mycoplasma-like bronchopneumonia, fibrinous pneumonia, chronic fibrictic pleuritis, infectious bovine rhinotracheitis, lung abscess, or viral interstitial pneumonia.

Data analyses were performed using generalized linear mixed models (GLIMMIX procedure; SAS, Cary, North Carolina, USA) with the animal as the experimental unit. Within each model, a binomial distribution was assumed, and a logit link was used. All necessary clustering effects were accounted for in all models. A backwards step-wise model building procedure was implemented to determine a final multivariable model. The fixed effects in the model statement included CALA score, breed (i.e., Holstein or beef), and rectal temperature (≥ 40.5°C or > 40.5°C). The denominator degrees of freedom were adjusted by the Kenward-Rogers method. Based on the available data, cattle were clustered at 2 levels: the lot and the time frame of enrollment. The lot was first evaluated as a random effect; however, subsequent analysis revealed that numerous lots contained only 1 calf that was enrolled in the study which created model convergence challenges. Therefore, a random effect was implemented to account for clustering among animals enrolled within the same month. Utilizing these 3 main effect variables (CALA score, breed, and rectal temperature), all biologically plausible 2- and 3-way interactions were assessed. An alpha level of 0.05 was used for inclusion of all parameters (main effects and interactions) in the final model statement. Confounding and col-linearity among the variables in the final model were evaluated by standard methods (3). Least-square means were generated for CALA score estimates. Multiple comparisons among CALA scores were adjusted by the Tukey-Kramer method.

Across the sample population (N = 2726), the proportion of calves requiring BRD retreatment was 36.9% (n = 1005) and the BRD case-fatality was 15% (n = 410).

An overview of the model building procedures for the BRD retreatment and mortality outcomes is displayed in Tables 1 and 2, respectively. The risk of BRD retreatment was significantly (P < 0.05) associated with the CALA score at the time of initial BRD diagnosis and treatment (Table 1). The model-adjusted means reflecting the risk of BRD retreatment and associated 95% confidence interval (CI) for each of the 5 CALA scores are shown in Figure 1.

The risk of BRD mortality was significantly (P < 0.05) associated with the CALA score collected at the time of initial BRD diagnosis and treatment (Table 2). Model-adjusted estimates of BRD mortality risk and associated 95% CI for each of the 5 CALA scores are shown in Figure 2.

Under the conditions of this study using the Whisper Veterinary Stethoscope, the CALA score (scale of 1 to 5) collected at the time of initial BRD diagnosis and treatment was significantly associated with the risks of BRD retreatment and mortality. These respective risks increased most notably as the CALA score increased from 3 to 5. Findings of this study were similar to those of previous research evaluating the relationship of the CALA score and the risk of BRD retreatment and mortality (2). DeDonder et al (2) observed a significant association between a greater Whisper score, collected at the time of initial BRD treatment, and the risks of requiring BRD retreatment and BRD mortality. In that study, cattle were followed to closeout. Further analyses revealed a strong correlation (R² = 0.89; P < 0.0001) between the ante-mortem CALA score and the magnitude of post-mortem lung lesions observed at slaughter (2).

Application of this technology at the time of BRD treatment is typically performed by feedlot lay staff. Findings from this study indicated that CALA scores generated by the Whisper Veterinary Stethoscope at the time of initial BRD diagnosis
and treatment are associated with the risks of subsequent BRD retreatment and BRD mortality. More research is necessary to identify the value proposition of implementing this technology in commercial feedlot production systems.

Acknowledgment

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References

Swine veterinarians – Key players in the pork production chain

Jessica Law

In 2020, Canada was ranked as the seventh highest pork producer in the world. Swine veterinarians are responsible for overseeing the health, welfare, and care of the sows, boars, and growing pigs from birth to processing. In doing so, Canadian swine veterinarians are contributing to the safe production of over 13 billion meals each year.

Swine veterinarians are known for their dedication and for constantly striving for improved welfare and innovation. Currently, swine veterinarians have a critical role in on-farm food safety, infectious disease prevention and control, biosecurity program design and implementation, and on-farm medication use oversight that obviously includes prudent antimicrobial use. Swine veterinarians are also involved in more global issues such as disease surveillance, welfare code development and implementation, education to prevent farm animal contamination by foreign animal diseases and increasing animal owners’ awareness of the issues related to antimicrobial resistance (AMR).

Before diving into the activities of swine veterinarians across Canada, it is helpful to understand the spaces that swine veterinarians occupy. There are numerous veterinary practices specialized in swine medicine across Canada. Swine practitioners working in these clinics are considered private practitioners. Corporate companies that are vertically integrated (integrated from birth to processing) often employ staff veterinarians. Both corporate and private practitioners are often involved in veterinary associations, sit on various community working groups that are involved in disease surveillance, animal welfare and biosecurity issues, as well as volunteer in various roles in veterinary medicine and the pork industry.

Swine veterinarians have diverse backgrounds, whether they started as a mixed practitioner that had an acumen for pigs, or a veterinarian that became involved in swine practice right out of school. Regardless of their path, swine practitioners are committed to the health and welfare of their clients’ pigs.

Swine practitioners are working in collaboration with swine-focused specialists from various organizations such as provincial and federal government institutions, universities, diagnostic laboratories, pharmaceutical companies, and producer pork boards. One of the major roles of swine veterinarians is to simplify complex information and data into usable working processes at the farm level, in efforts to maintain and improve animal health and welfare. This information comes from involvement in research, academia, laboratory diagnostics and surveillance.

The day-to-day practice of swine veterinarians is surprisingly varied. When it comes to health management, veterinarians could be walking the barn with producers, identifying improvement areas such as hygiene and pig handling. These veterinarians could also be involved in helping with a vaccination trial or implementing a new treatment protocol on farm, all while educating the producer and staff on the rationale and justification for these changes. When unexpected health challenges arise, veterinarians and their support staff are on-call to visit the farms, walk the barns and identify disease, as well as collect and submit samples. Following through on these findings can vary from a one-time disease diagnosis and treatment to a long-term management, diagnostic, and treatment plan to deal with a disease. This can involve thousands of dollars of diagnostics, numerous telephone calls to colleagues, multiple follow-up visits, and dozens of hours communicating and implementing the next steps.

Swine veterinarians are also involved in the design and delivery of food quality assurance and animal welfare certification programs. Canadian Pork Excellence (CPE) is the new national platform that covers 3 major components of on-farm programs: traceability, food safety, and animal care. The CPE program is intended to be a key component of international trade. The program helps Canadian pork producers demonstrate their production of safe pork from pigs raised in compliance with the Hazard Analysis Critical Control Points principles, national biosecurity standards, and the Code of Practice requirements.

Many swine veterinarians are involved in the improvement and auditing of the swine producer on-farm food safety and animal care programs.

The 2016 Code of Practice for swine brought forward significant changes to requirements in the care and handling of pigs. Compared to historical working processes, major changes are

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focused on implementation of group housing for gestating sows, enriched environment for growing pigs, and improved pain management during castration. Another key working process reviewed in this Code of Practice was how to humanely euthanize pigs. These new pig code requirements are now integrated in the CPE PigCARE program.

One of the main challenges of swine veterinarians is to work with the swine producers to help them to integrate new working processes at the farm level. Swine veterinarians have an important role to increase compliance of swine producers when new regulations are being implemented.

In addition to on-farm food safety, welfare, and health management, many Canadian swine veterinarians have critical roles on national committees involved in the development and improvement of national policies on animal health and welfare issues. Having swine veterinarians involved in policy and decision-making at a national level has resulted in an effective framework to protect Canada from foreign animal diseases. For example, Canada implemented import restrictions on high-risk feed components, including the requirement of import permits for feedstuffs originating from certain countries with African Swine Fever (ASF). Canada has also implemented quarantine requirements for livestock feed ingredients imported into Canada from these countries.

Importers are required to heat treat high-risk feed components or hold them for specific intervals at certain temperatures; these conditions were determined by veterinarians involved in swine research. Furthermore, these requirements are the result of industry and swine veterinarians pushing to take critical leaps forward in protecting the national swine herd. The progress made in import regulations and holding of imported feed ingredients has been praised internationally.

Judicious use of antimicrobials and antimicrobial surveillance has been in the public eye and at the forefront of veterinary medicine for the past decade. Historically, many antibiotics were sold over the counter in most Canadian provinces. This has now changed and, as of December 2018, a veterinarian prescription is required to sell all Medically Important Antibiotics (MIA) to Canadian farmers in all provinces. Moreover, the dispensing of antibiotics in Canada has also changed because MIA can no longer be purchased over the counter in the local agricultural supply store.

The modifications on MIA prescriptions and dispensing practices have had a significant impact on day-to-day use of antimicrobials at the farm level. Pig producers and swine veterinarians seem to have adapted extremely well, with more targeted disease management and antimicrobial use occurring on farm.

Swine veterinarians have key roles in on-farm antimicrobial use oversight in 4 ways:

i) they ensure that there are adequate diagnostics to prevent unnecessary antibiotic use;

ii) if the animals require antimicrobial treatments, they prepare the required prescriptions;

iii) they prepare specific indications for swine owners and farm workers to ensure antibiotics are used appropriately (right product with the proper dose for the right duration); and,

iv) swine veterinarians are responsible for defining the withdrawal period, to ensure the absence of drug residues in the final product.

Finally, swine veterinarians are also involved in antimicrobial use and antimicrobial resistance surveillance in Canada. For example, swine veterinarians have participated in the collection of samples for the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS). Swine veterinarians have a critical role in the forum of AMR discussion through advisory roles, research, and surveillance. In the last 5 years, antimicrobial usage and resistance has been a topic of discussion in almost every swine-focused, continuing education event.

Swine veterinarians are contributing toward the health of the national swine herd in Canada and ultimately to the food safety of pork through the many activities listed above. Through each of these roles, swine veterinarians continue to commit their expertise and time to the furthering of the health and welfare of pigs.
History and clinical signs

A 10-month-old female golden retriever dog was referred to the ophthalmology service at the Pulse Veterinary Specialists and Emergency clinic with bilateral exophthalmos and mild exotropia (Figure 1). The referring veterinarian had tentatively diagnosed bilateral orbital disease and referred the dog for a complete diagnostic evaluation. The menace responses, direct and consensual pupillary light, palpebral and oculocephalic reflexes were present in both eyes. However, the dorsal, ventral, lateral, and medial ocular movements were all markedly reduced. Schirmer tear tests (Schirmer Tear Test Strips; Alcon Canada, Mississauga, Ontario) were 25 mm/min bilaterally. The intraocular pressures were estimated with a rebound tonometer (Tonovet; Tiolat Oy, Helsinki, Finland), and were 13 mmHg bilaterally. Topical ophthalmic tropicamide (Mydriacyl; Alcon Canada, Mississauga, Ontario) was applied to both corneas and both pupils dilated within 20 min. Biomicroscopic (Osram 64222; Carl Zeiss Canada, Don Mills, Ontario) and indirect ophthalmoscopic (Heine Omega 200; Heine Instruments Canada, Kitchener, Ontario) examinations were completed and no abnormalities were detected. Fluorescein stain (Fluorets; Bausch & Lomb Canada, Markham, Ontario) was applied and rinsed from the corneal surfaces and the eyes were examined under cobalt blue filtered light; staining was not evident. What are your tentative clinical diagnoses, diagnostic and therapeutic plans, and prognosis?

Our tentative clinical diagnosis was extraocular polymyositis. We advised and conducted a routine complete blood cell count, serum biochemical profile, a serum toxoplasmosis titer, and urinalysis. The database was within normal reference ranges and the serum toxoplasmosis titer was negative. We completed a routine sedation, general anesthetic induction, intubation and maintenance, were carried out while a computed tomography (CT) scan of the skull was completed. Bilateral enlargement and moderate contrast enhancement of all extraocular muscles were confirmed (Figure 2). The medial and ventral rectus muscles were most affected, followed by the ventral oblique, with the right ventral oblique slightly larger than the left. The remaining structures of the skull were normal. A routine bilateral presurgical ocular surgical preparation was completed with dilute betadine solution and bilateral superior rectus muscle biopsies were harvested and fixed in formalin and submitted for routine histologic examination.

Discussion

The clinical signs and signalment are very typical of previous reports of an uncommon condition that predominates in young golden retrievers, extraocular polymyositis (1–5). The myositis is limited to the extraocular muscles and appears to be immune-mediated, based on the T-lymphocyte driven reaction (3,5). The differential diagnostic considerations are limited and include *Toxoplasma gondii* orbital myositis/cellulitis and infiltrative orbital round cell neoplasia such as lymphosarcoma (5,6). *Toxoplasma* extraocular myositis and orbital cellulitis and neoplasia were ruled out with serologic testing and histologic examination of the biopsy. The CT scan confirmed marked enlargement of all the extraocular muscles and no other abnormalities. The diagnosis was confirmed histologically as a bilateral lymphocytic extraocular myositis (3).

This condition was first reported in 1989 by Carpenter et al (3). The bilateral exophthalmos without 3rd eyelid prolapse in the dog is consistent with the intraconal swelling (5). There are no reports of this condition with involvement of other muscles or organ systems. Some have reported that diagnostic testing beyond clinical examination is not required and even considered unethical (6). Although infiltrative neoplastic orbital disease or *Toxoplasma gondii* myositis are rare conditions, both

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**Figure 1.** A 10-month-old golden retriever with bilateral exophthalmos and exotropia.
have the potential to respond at least partially to many months of immune suppressive therapy. In our opinion, this warrants, at a minimum, extraocular muscle biopsies to confirm the diagnosis before initiation of immunosuppressive therapy. In the ideal situation, cross-sectional imaging (computed tomography or magnetic resonance imaging) should also be used to screen for other causes of retrobulbar intraconal disease.

Extraocular myositis in dogs is treated by systemic immune suppression for many months (5,6). Relapses and progressive extraocular muscle inflammation are to be avoided as enophthalmos and strabismus are known complications due to extraocular muscle fibrosis. These complications are difficult if not impossible to treat effectively. Systemic administration of corticosteroids, azathioprine, cyclosporine have been reported (5,6). After discussion with Dr. David Ramsey, oral cyclosporine was chosen in this case as it is an excellent T-lymphocyte suppressor with minimal systemic complications. A recheck at approximately 5 mo revealed marked improvement (Figure 3). Prolonged therapy is planned for 6 to 12 mo, with gradual reduction and careful follow-up evaluations. If recurrence of exophthalmos or enophthalmos and strabismus are noted, extension of the therapy is planned. At the time of publication, this dog remains on oral cyclosporine therapy, which is steadily being reduced; relapses have not been encountered.

References
Shrugging off the pandemic: Results of the 2020 CVMA Practice Owners Economic Survey

Échapper à la pandémie : résultats du sondage économique de l’ACMV de 2020 auprès des propriétaires d’établissements vétérinaires

Chris Doherty

To borrow a popular refrain from our politicians, 2020 was an unprecedented year for Canada and the entire world. Yet, despite all the disruptions brought about by the COVID-19 pandemic, the veterinary industry proved once again to be remarkably resilient, with many key metrics continuing their climb to new record levels.

Companion animal hospitals

Canadian companion animal hospitals benefitted from a combination of increased revenues and prudent expense control, resulting in net income growth. The national weighted average revenue climbed by 2.4% year-over-year, to $646,893 per full-time equivalent (FTE) DVM; yet expenses only ticked up by 2.1%, to $439,880 per FTE DVM (Figure 1). This escalation of revenues outpacing expenses led to net income pushing up by 3.2%, to a national weighted average of $207,013 per FTE DVM.

Although the Canada-wide average figures are a good news story, there were individual variations between provinces, with some falling behind the average and others far exceeding it. Alberta and Manitoba companion animal hospitals posted revenue and net income growth well above the national weighted average. The Canada-wide average figures are a good news story, there were individual variations between provinces, with some falling behind the average and others far exceeding it. Alberta and Manitoba companion animal hospitals posted revenue and net income growth well above the national weighted average.

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average. By comparison, British Columbia and Nova Scotia suffered declines in gross revenues and net incomes. Saskatchewan companion animal hospitals were faced with shrinking revenues, but by trimming expenses by more than enough to offset this, had net income growth even in these difficult conditions.

Assessing non-DVM expenses as a percentage of revenue, Canadian companion animal hospitals shrunk this figure from 68.3% back down to 68%, a substantial decline from the highs of 69.6% witnessed in 2016. This budgeting and managing of expenses have been key contributors to net income growth over the past 5 y (Figure 2).

Comparing expenses as a percentage of gross revenue permits comparison between practices of various sizes in different areas. As a simple example, consider a 2-DVM practice and a 2-DVM practice; the larger hospital will invariably have a much higher dollar figure expended on drugs and supplies, utilities, non-DVM wages, etc., compared to the smaller hospital that generates less revenue. However, by expressing expenses as a percentage of revenue generated, it is possible to compare these 2 practices and assess their efficiency against national and provincial benchmarks.

Another positive development for companion animal hospitals over the past year were client numbers. After 4 straight years of decline, the number of current clients rebounded by 8.7%, to 887 per FTE DVM, while new clients also climbed, to 226 per FTE DVM, a 6.1% increase from 2019 (Figure 3).

In recent years, much of the revenue growth in the typical Canadian companion animal veterinary hospital has come even

![Figure 1. National weighted average revenue, expenses, and net income per full-time equivalent DVM for companion animal hospitals in Canada from 2016 to 2020.](image1)

![Figure 2. National weighted average non-DVM expenses as a percentage of gross revenue for companion animal hospitals in Canada from 2016 to 2020.](image2)

![Figure 3. National weighted average current and new clients per full-time equivalent DVM for companion animal hospitals in Canada from 2016 to 2020.](image3)
as client numbers decreased, suggesting that veterinarians had been doing more with each client. Although greater compliance and higher spending from each pet owner is still a strategy worth pursuing, it is encouraging to see revenue increases supported by client numbers ticking back upwards, providing a solid foundation for continued future growth.

Moving forward, one substantial risk to hospitals is the acceleration of expenses, particularly as suppliers raise their prices to offset pandemic costs (e.g., PPE, physical distancing, etc.), and non-DVM and DVM compensation climbs due to a very tight labor market and high demand for these employees. Veterinary hospitals should consider robust fee rises, in tandem with regular budgeting, to both expand revenues further and ensure that expenses are monitored and kept under control.

**Mixed and large animal hospitals**

Canadian mixed and large animal hospitals outstripped their companion animal colleagues in revenue growth, with the national weighted average climbing by 4.2%, to $567,336 per FTE DVM. Unfortunately, this was eclipsed by expenses advancing by 8.6%. This culminated in net incomes slipping to $185,760 per FTE DVM, a decline of 3.8% from 2019’s figure. Last year, mixed and large animal veterinarians had almost completely closed the gap in net income to companion animal veterinarians; these results see them fall back to over $21,000 behind the companion animal average net income (Figure 4).

As was the case with companion animal veterinarians, looking province-by-province, there were those that outperformed the national averages. British Columbia enjoyed robust growth in both revenues and net incomes, whereas Alberta and Saskatchewan saw both metrics decline by double-digit percentages. Ontario had stronger-than-average revenue growth, yet surging expenses drove net income growth into negative territory.

After fastidious budgeting in 2019 resulted in a decline in non-DVM expenses as a percentage of revenue, 2020 brought a significant rebound, with expenses climbing to their highest point in the past 5 y, at 67.1% of gross revenue (Figure 5).

Mixed and large animal veterinarians did a commendable job growing revenues in 2020, yet moving forward, equal attention will need to be directed towards staunching augmenting expenses, lest their hard work in bringing in more dollars simply flow out the door, rather than to the bottom line.

with each client. Bien que viser une meilleure observance des recommandations et des sommes déboursées plus élevées pour chaque propriétaire d’animal soit une stratégie qui mérite d’être poursuivie, il est encourageant de voir une progression du revenu brut soutenue également par la hausse du nombre de clients, ce qui fournit une base solide pour une croissance future continue.

**Pratiques mixtes et des grands animaux**

Les pratiques mixtes et des grands animaux ont devancé leurs collègues du secteur des animaux de compagnie au chapitre de la croissance du revenu brut, la moyenne nationale pondérée ayant augmenté de 4,2 % pour atteindre 567 336 $ par médecin vétérinaire ETP. Toutefois, cette hausse est malheureusement éclipsée par une augmentation des dépenses de 8,6 %. Ainsi, le revenu net a diminué à 185 760 $ par médecin vétérinaire ETP, ce qui représente une baisse de 3,8 % par rapport à 2019. L’année dernière, les médecins vétérinaires en pratique mixte et des grands animaux avaient presque complètement comblé l’écart par rapport aux médecins vétérinaires pour animaux de compagnie au chapitre du revenu net, mais les résultats de cette année les ont retomber à une différence de plus de 21 000 $ par rapport au revenu net moyen dans les établissements vétérinaires pour animaux de compagnie (figure 4).

Comme c’était le cas dans le secteur des animaux de compagnie, les résultats dans certaines provinces ont été supérieurs aux moyennes nationales. La Colombie-Britannique a connu une bonne croissance à la fois du revenu brut et du revenu net, tandis que l’Alberta et la Saskatchewan ont vu ces deux paramètres chuter de façon significative. L’Ontario a enregistré une croissance du revenu brut supérieure à la moyenne, mais la hausse des dépenses a fait en sorte que le revenu net a diminué.
Five years of strong and solid growth, as a pandemic raged, and the economy contracted, have proven veterinary medicine to be a surprisingly irrepressible industry. By continuing to expand their clientele, raising fees to keep up with costs, and controlling expenses through budgeting, Canadian veterinarians are well placed to keep this winning streak going, regardless of the economic conditions that are around the corner.

Notes: Data for the CVMA Practice Owners Economic Survey are derived from the 2020 Provincial Practice Owners Economic Surveys. Provincial averages are weighted based on relative population size to calculate a national weighted average for all metrics. For the purposes of this research, a full-time equivalent veterinarian is assumed to work 1750 h annually. Note that due to data gaps, Quebec is omitted from the calculation of the national averages for all years presented.

Après une surveillance assidue des budgets en 2019 qui a entraîné une baisse du pourcentage du revenu brut consacré aux dépenses non liées aux DMV, l’année 2020 a apporté un rebond important avec des dépenses qui ont atteint leur point culminant des cinq dernières années, à 67,1 % du revenu brut (figure 5).

Les médecins vétérinaires en pratique mixte et des grands animaux ont réussi à augmenter les revenus bruts en 2020, mais à l’avenir, ils devront aussi veiller à freiner l’augmentation des dépenses pour éviter que leur travail acharné visant à générer plus de revenus ne serve qu’à absorption les coûts et non à accroître les profits.

Cinq années de croissance forte et solide, qui se poursuit alors qu’une pandémie fait rage et que l’économie se contracte, prouvent que la médecine vétérinaire est une industrie étonnamment irrépressible. En continuant d’élargir leur clientèle, en haussant les tarifs pour suivre les coûts et en contrôlant les dépenses grâce à la budgétisation, les médecins vétérinaires canadiens pourront maintenir cette progression fructueuse, peu importe les conditions économiques qui prévaudront dans les mois et les années à venir.

Remarques : Les données de l’analyse économique de l’ACMV proviennent des sondages économiques provinciaux menés en 2020 auprès des propriétaires d’établissements et de pratiques vétérinaires. Les moyennes provinciales sont pondérées en fonction de la taille relative de la population pour calculer une moyenne nationale pondérée pour tous les paramètres. Aux fins de cette recherche, on considère qu’un médecin vétérinaire équivalent temps plein (ETP) travaille 1750 heures par année. Précisons qu’en raison de données manquantes, le Québec est omis du calcul des moyennes nationales pour toutes les années présentées.

Erratum

Clinical outcomes of dogs with transitional cell carcinoma receiving medical therapy, with and without partial cystectomy

Marcus L. Bradbury, Christine M. Mullin, Shaban D. Gillian, Chick Weisse, Philip J. Bergman, Michelle A. Morges, Lauren R. May, David M. Vail, Craig A. Clifford

Author Shaban D. Gillian would like her name changed to Gillian Dank.
If you are anything like me, a knot forms in your stomach when you find out that today's appointments include a pruritic cat!

These cases can be very frustrating for everyone. That includes the patient, pet owner, all of your staff, and you, the veterinarian.

Almost everything in itchy cats presents looking the same, and as soon as they start to improve, they relapse. Treatment starts all over again and you are trapped in a vicious cycle of never-ending steroids that fuel the fires of discontent.

I think the heart of the problem lies in treating cats... they are amazing animals that simply live to perplex we lowly humans! They don't read any of our textbooks and refuse to follow all the usual rules that apply to seemingly every other animal on Earth... especially when it comes to dermatology.

There is some hope though, and it lies in a well-oiled veterinary care team.

This starts with your receptionist. When booking an appointment for any itchy cat, or one with reported hair loss/overgrooming, your receptionist should offer to book a double time slot. Dermatology cases can be convoluted at the best of times, but when you throw in an itchy cat, things can spiral quickly out of control. The usual 20- to 30-minute appointment will not allow enough time to work up this patient.

In a perfect world, a thorough history questionnaire would be sent out to the owner with their appointment confirmation. The plan is to have this completed and returned before the appointment. Next up on your team is your Registered Veterinary Technician. Better known as the “Jack of all trades,” an RVT is the ace up your sleeve when it comes to veterinary dermatology.

Registered Veterinary Technicians love a good mystery to solve and can sift through that history questionnaire to pull out the clues that help you formulate differentials. A thorough history is the biggest part of the puzzle in veterinary dermatology. It's important to include:

1. What is the problem?
2. When did this first start?
3. What did lesions look like?
4. Where were lesions located?
5. How have lesions progressed?
6. Are there any other animals in the home or in contact with affected animal? Are any other animals affected?

Pruritic cats — from a technician's point of view

Jennie Tait

Jennie is a member of the health care team at the Veterinary Allergy Dermatology Ear Referral (VADER) Clinic in Morriston, Ontario. She is a charter member of the Academy of Dermatology Veterinary Technicians, is one of their Regents, and is currently the only VTS (Dermatology) in Canada. Jennie is also the only technician on the Executive Committee for the Canadian Academy of Veterinary Dermatology. She has over 24 years experience teaching veterinary students at the Ontario Veterinary College and 21 years experience working in veterinary dermatology. Jennie is an accomplished author and international speaker in her area of expertise. She graduated as an Animal Health Technician from Centralia College of Agricultural Technology in 1986 and is the proud owner of RVT certificate #4. Any spare time is enjoyed with family, which includes two bouncy German shepherds.

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7. Are any humans affected?
8. Is your cat an indoor or outdoor cat?
9. Is your pet on any preventative parasiticide?
10. Is this a problem year-round, or is it seasonal? What time of year is your pet more affected? What time of year is your pet least affected?
11. Is there any area of the body that your pet will focus on?
12. If licking, chewing, biting, scratching, and rubbing are considered itchy, where would you rate your pet on a scale of 1 to 10, if 1 is normal and 10 is extremely itchy?
13. Is your pet eating and drinking normally?
14. What is their current diet? How long have they been eating this? Any treats?
15. Any other supplements, flavored medications, pill pockets, or toothpaste?
16. Which proteins have they eaten in the past? Chicken, Turkey, Duck, Other fowl, Beef, Lamb, Venison, Pork, Salmon, White fish, Rabbit, Kangaroo, Hydrolyzed diet, Other.
17. Have any particular foods caused an adverse reaction?
18. How many bowel movements a day are they passing? What consistency are they?
19. Any vomiting, halitosis, burping, borborygms (grumbly tummy), flatulence, anal gland issues, anal pruritus?
20. Is their activity level normal?
21. Any other symptoms?
22. Any medications that have been helpful for this condition?
23. What medications is your pet currently being given, and the dose?
24. Any other medical conditions we should know about?

Having a technician go through the questionnaire with an owner will often tease out other important bits of information that may otherwise go undisclosed. The answers to these questions, along with a patient's signalment, will have your team already zeroing in on a list of differentials, before even seeing the cat.

Next up is the dermatologic examination. Use your technicians for this! This can be done while you are otherwise occupied with another patient. By empowering your team to collect samples for in-house diagnostics (cytology, trichograms, and skin scrapings) and evaluating them, you have almost all the pieces of the puzzle together and waiting for you when you walk into the examination room. This not only frees you up to do other things, like see other patients, but it also allows your clients to bond with your technicians and value their expertise. This helps them to appreciate that they have an entire care team working to improve your cat's comfort and health.

If you are not using your technicians in this manner, you are missing the boat and might want to check out the Ontario Association of Veterinary Technicians report on Exploring the Value that Registered Veterinary Technicians Bring to Ontario Companion Animal Practices, available on the CVMA website (1). The bottom line is that for every additional RVT utilized in clinic, gross revenues per vet increased by over $78,000.

But I digress… many owners of pruritic cats don’t even realize that their furry friend is itchy and bring them in for hair loss. That’s because many of these wily creatures prefer privacy and are “closet lickers.” Years ago, we would often diagnose psychogenic alopecia for these patients, but we now realize that is actually quite a rare disease (2), and that we were missing other reasons for overgrooming, such as underlying allergies.

On the upside, there aren’t that many reasons to be itchy: infestation; infection (bacterial or fungal, including malassezia); adverse reaction to either environmental allergens, insect bites, food, drugs, or vaccines; neoplasia.

Pruritic cats present with 3 main lesion patterns: hair loss with non-lesional skin; eosinophilic granuloma complex; and miliary dermatitis.

Unfortunately, we are dealing with cats, which means we never really know what we are going to get, so there is overlap between those lesion patterns and their respective lists of differentials (3).

This brings us back to having technicians perform dermatologic examinations and collect samples for in-house diagnostics.
Virtually every dermatology patient should have cytology done to check for bacterial or fungal infections. You can’t know for sure what you are dealing with until you look under the microscope. Even after 21 years of working in a dermatology referral practice, I am still surprised by what I see when reading cytology! This is something that can be done quickly, is high yield, generates income, keeps your technicians interested, and gives you answers on which to base your treatment protocol. It’s a quintuple win and should be a no-brainer.

Dermatology cases are notorious for being convoluted, with most being managed using multimodal treatment protocols, rather than cured. Often, this includes lifelong management of underlying allergies that will have flares. Technicians have a vital role in client education and can free up a clinician even further by discharging patients. It’s imperative to take the time to be sure clients understand why their cat is being worked up in the manner it is and what condition is suspected. Your technicians should also be explaining to the owner what each part of the treatment protocol is meant to do, possible side effects to watch for, what an anticipated positive response will look like, and the time line associated with it. This is part of managing realistic expectations for owners and helps to make our pet parents more aware of when things aren’t going according to plan, so that they can nip any worsening of a condition in the bud. This also highlights the perceived value a client receives for their money.

Technicians should be used to follow up with clients to make sure things are still on track, triage anything unexpected, and answer any further questions that may arise. If they don’t know the answer, or it isn’t appropriate for a technician to answer a particular question, then that gets passed on to a clinician. It’s also extremely helpful to send your clients home with a written visit summary. Yes, this takes more time (another things technicians can help with!) but it is invaluable for everyone, including other clinicians in a multi-vet practice.

When it comes to working up a pruritic cat, it’s pretty straightforward.

Start with a thorough history (send out that questionnaire in advance and have a technician comb through the responses).

Next is your dermatologic examination, looking for inflammation, alopecia, lesions, evidence of parasites, and/or infections and collect the appropriate samples to rule things in or out.

If your patient has lesions consistent with eosinophilic granuloma complex (eosinophilic plaques, pouty lower lip, indolent eosinophilic ulcer of the upper lip, or oral eosinophilic granulomas) cytology results should include eosinophils. If a suspected eosinophilic plaque sample does not have any eosinophils, it’s possible that you may be dealing with epitheliotrophic lymphoma and a biopsy should be your next step. It’s nearly impossible to tell the difference between these two lesions and both will respond with decreased pruritus when given corticosteroids. This is just one more reason to have your technicians doing cytology to help you narrow in on a diagnosis.

If infections are found, then appropriate treatment can begin, but prophylactic and imperic parasitcides should be administered. With cats you never know what you’re going to get and that includes asymptomatic infestations. Cats excel at grooming and often remove any evidence of parasites, so treatment should be a staple. If you cure your patient as a result, then it’s time for a happy dance!

You may also want to consider a culture and sensitivity if a bacterial infection is refractory. Fungal cultures or samples for polymerase chain reaction testing may be appropriate depending on examination findings, but dermatophytosis is not usually pruritic. Then again… with cats you just never know, so a Wood’s lamp examination is a great place to start.

If infestations and infections have been ruled out but your patient is still pruritic, then you continue to work up any underlying allergies. In general, a good response to steroids will lean towards environmental allergies playing a role. Poor or partial response will put an underlying food sensitivity on your radar. Just to keep things interesting, we often have both conditions occurring at the same time.

It’s not possible to tell environmental allergies from adverse food reactions (food allergies) since they can look identical, but there are a couple of things to bear in mind that may be helpful. Symptoms of environmental allergies start somewhere between 1 to 3 years of age, whereas adverse food reactions can be seen in older animals (2), and occasionally, very young animals. One study helped to map out hypersensitivity lesion distribution patterns in cats, but keep in mind — we are dealing with cats! (Figure 1).

Because environmental and food allergies present so similarly, a restricted diet trial should be done. This is yet another area in which technicians excel.

To date in veterinary medicine, we do not have a reliable, accurate test for food allergies (4) and are left with restricted diet trials. Performing a meaningful, restricted diet trial is no small task and can be a huge time-waster if not done properly. Most clinicians are more than happy to have a veterinary technici-explain diet trials to owners. Emphasis should be placed on being very strict, with a very gradual transition over 10 to 14 days to a new diet, to avoid our feline friends declining to participate in the venture.

Should an appropriate, minimum 6- to 8-week strict diet trial make no difference to your patient, then it’s time to declare them atopc and go through treatment options that will work best for that individual patient. If you are dealing with an adverse food reaction, we will typically see approximately 50% improvement by 4 weeks into trial, and should continue for at least another 4 weeks to see full effect.

Unfortunately for us, there is no “one size fits all” when it comes to pruritic cats. Most likely because we are dealing with cats! I really can’t stress enough though, how you can increase owner compliance and success with your dermatology cases by effectively using the RVTs in your practice. These highly trained individuals allow you to see more patients, improve the quality of more lives, increase your revenue, and improve bonds between clients and your practice. Using your technicians also increases their job satisfaction and showcases them to your clients as valuable members of your health care team. After all, veterinary dermatology, and dealing with pruritic cats, is a team sport.
References

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1. **C)** A typical reference range is based on the mean ± 2 standard deviations, which includes 95% of the population.

2. **E)** The external rectus fascia is the strongest layer of the abdominal wall.

3. **D)** The average time required for L3 to develop into L6 is 6 months.

4. **B)** Grass tetany is associated with decreased serum magnesium.

5. **C)** In horses, an increase in ALT usually indicates muscle damage.

**Answers to Quiz Corner**

Les réponses du test éclair

1. **C)** Une étendue de référence caractéristique est basée sur la moyenne ± 2 écarts-types, ce qui comprend 95% de la population.

2. **E)** Le fascia du muscle droit externe de l’abdomen est la couche la plus résistante de la paroi abdominale.

3. **D)** Le temps moyen nécessaire pour que les larves L3 se développent en larves L6 est de 6 mois.

4. **B)** La tétanie d’herbage est associée à une diminution du magnésium sérique.

5. **C)** Chez les chevaux, une augmentation de l’alanine aminotransférase indique un dommage musculaire.
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