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Total intravenous anesthesia using a midazolam-ketamine-xylazine infusion in horses: 46 cases (2011–2014)

Bovine respiratory syncytial virus-specific IgG-1 in nasal secretions of colostrum-fed neonatal calves

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Spontaneous resolution of bilateral congenital patellar luxation in an alpaca cria

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Letters to the Editor  Courrier des lecteurs

Question 3 of the March Quiz — A comment

Dear Editor,

I wish to bring to your attention an error in the Quiz Corner in the March issue of The CVJ, (Can Vet J 2018;59:229). Question 3 posed the following clinical scenario: An apparently healthy 7-year-old Doberman pinscher has echocardiographic findings of left ventricular enlargement and reduced ventricular contractility consistent with pre-clinical dilated cardiomyopathy. Which of the following is the most appropriate therapy? Subsequently providing furosemide, enalapril, hydralazine, diltiazem, and amlodipine as answer options. Enalapril was given as the correct answer based on the rationale that angiotensin-converting enzyme inhibitors may delay the progression of dilated cardiomyopathy to development of clinical signs.

While there is 1 retrospective study that supports the rationale for ACEi use in pre-clinical DCM, the authors caution that prospective studies are required to confirm these findings and these have, as yet, not been published (1). The most appropriate treatment in this case was not even included as an answer selection — pimobendan (Vetmedin; Boehringer Ingelheim). This is supported by the recently published PROTECT study, which demonstrated in a blinded, placebo-controlled, prospective study in Doberman pinchers that the use of pimobendan in pre-clinical DCM delayed the onset of CHF by a median of 277 days compared to placebo, a finding that was statistically significant (P = 0.008; 2). This approximately 9 months extension of being symptom-free translates into not only enhanced quality of life but survival time as well (also a study finding), particularly relevant considering Doberman dogs that go into CHF have a 4- to 5-month median survival time despite aggressive treatment (3). These findings have been supported with similar findings in other large-breed dogs (4). This has also translated to a label claim extension for Vetmedin in Canada and elsewhere, which reads to delay the time of onset of congestive heart failure or sudden death in Doberman pinchers with clinically asymptomatic dilated cardiomyopathy.

Vetmedin is the first and only therapeutic with a licensed pre-clinical use claim in acquired canine heart disease.

Walt Ingwersen, DVM, DVSc, DACVIM, Specialist, Pet, Boehringer Ingelheim Animal Health (Operational Unit), Burlington, Ontario.

References

Editor’s Comment

We thank Dr. Ingwersen for his valuable commentary on the cardiology question in the quiz in the March issue of the CVJ. This appears to be a case in which new information has become available since the question in the quiz was written. We can depend on CVJ readers to update us when new information becomes available.

Carlton Gyles

Constructive and professional comments made in the spirit of intellectual debate are welcomed by the Editor. Writers are expected to be respectful of others and to ensure that letters are considerate and courteous. The Editor reserves the right to remove comments deemed to be inflammatory or disrespectful.
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Toward a harmonized approach to animal welfare law in Canada — A comment

Dear Editor,
I wish to commend David Fraser, Katherine Koralesky, and Geoff Urton, the authors of “Toward a harmonized approach to animal welfare law in Canada” (Can Vet J 2018;59:293–302) for accomplishing a truly herculean task in summarizing the plethora of animal welfare laws and regulations in Canada. They have captured the essence of the regulatory and legislative challenges, namely: the lack of standardization of terms, the multiplicity of stakeholders, and the absence of a national template to guide provincial legislation. As someone who was formerly responsible for enforcing provincial animal welfare standards, I understand the complexity of creating and modifying legislation and then shepherding it through the legislative agenda within the context of shifting provincial priorities. Nevertheless, I am encouraged by the progress that I have witnessed over the last number of years. As public interest in animal welfare has increased, provincial and territorial statutes have been modified to address gaps that have come to light. This might have been a somewhat ad hoc process, but I think that over the years there will be a gradual movement towards a more standardized legislative approach as statutes come up for review. A national consultation as suggested by the authors would facilitate this process. However, there is another important component of animal welfare outside the scope of the paper that also needs to be addressed — the separation of advocacy from enforcement. I see a real conflict of interest when the enforcement of animal welfare laws is delegated to animal welfare advocacy groups, especially those that rely on public donations for their funding. The temptation to create high profile “busts” and then cash in on the resulting public outcry leaves little room for the due process of justice. It is time to end this practice and ensure that animal welfare enforcement is delegated only to government-funded departments and agencies. This will be one of the next major advancements in harmonizing animal welfare outcomes across Canada.

Wayne Lees, DVM, Former Chief Veterinary Officer for Manitoba, Oak Lake, Manitoba.

Veterinary school admission — A response

Dear Editor,
It is interesting to note the amount of response to my short note several months ago, (Can Vet J 2017;58:1145–1146), regarding OVC. To clarify the comment made in the March 2018 issue (Can Vet J 2018;59:217), a second career person is not a student who has completed an undergrad degree, or MSc, or PhD; it is an individual who has been out in the real world working. I had several classmates with advanced degrees who progressed through OVC and have had wonderful careers. However, people try to justify the admissions process using neuro-research and behavioural studies, it does not address the concerns many practise owners across Canada have. Why is the Multiple Mini interview format being used with final year students involved in the selection process? It seems unlikely the process will change as long as prefrontal cortex comes into the discussion about veterinary school admissions.

Paul Francis, DVM, OVC graduate, 1983.

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New technologies and the challenges they present
Les nouvelles technologies et les défis qu’elles suscitent

What challenges do new technologies present to veterinary medicine? In the last couple of years there has been much discussion around telemedicine; how it is done, how to have the necessary valid veterinary client patient relationship (VCPR), and who can provide the service. For years our human health care system has utilized telemedicine in remote communities. A person can speak to a nurse on the phone to get advice or to see if they need to seek further medical care. So, just what is telehealth and how do we use it in veterinary medicine?

According to the American Veterinary Medical Association (AVMA) website, telehealth is a term that covers all uses of technology to help the veterinary profession to provide remote access to health information, education and/or care. Telehealth includes teleconsulting, telemedicine, telemonitoring, teletriage, mobile health and electronic prescribing.

Teleconsulting occurs when one veterinarian consults with a veterinary specialist to garner opinions and advice on a patient; for example, sending digital X-rays to a board-certified veterinarian for advice on the X-rays.

Telemedicine involves the use of electronic means to improve a patient’s health status by exchanging information with a client; a valid VCPR is required in such a situation. It could be a follow-up appointment performed on-line, client education, or the scheduling of diagnostic procedures, to name a few.

Telemonitoring involves the use of wearable monitors, for example, the use of a Holter monitor to detect arrhythmia and allow remote monitoring of patients.

Mobile health involves the use of wearable monitors that help the veterinarian make decisions for the pet’s health care. For some of these wearable monitors a valid VCPR would likely be needed. Some wearable monitors are marketed directly to clients for their education and of course do not require a VCPR.

Teletriage is the giving of general medical advice or guidance that is not specific to a patient’s health, injury, or illness. The advice does not diagnose, prognose, or treat.

Wuels sont les défis inhérents aux nouvelles technologies en médecine vétérinaire? Au cours des dernières années, beaucoup de discussions ont eu cours à propos de la télémédecine : sa mise en œuvre, la mise en place d’une relation vétérinaire-client-patient (RVCP) valide et les personnes autorisées à fournir le service. Notre système de soins de santé des humains a recours à la télémédecine depuis plusieurs années déjà. Une personne peut parler à une infirmière au téléphone pour obtenir des conseils ou s’informer du besoin de solliciter des services médicaux plus poussés. Donc, en quoi consiste la télésanté et comment y a-t-on recours en médecine vétérinaire?

Selon le site Web de l’American Veterinary Medical Association (AVMA), la télésanté est un terme qui englobe toutes les utilisations de la technologie pour aider la profession vétérinaire à fournir l’accès à distance à des renseignements sur la santé, à l’éducation et/ou à des soins. La télésanté comprend la télésurveillance, la télémédecine, la santé mobile et la prescription électronique.

La télésurveillance comprend l’usage de moniteurs prêts à porter, pour exemple, le moniteur Holter qui permet la surveillance à distance des patients.

La télémédecine comprend l’usage de dispositifs électroniques afin d’améliorer l’état de santé d’un patient en échangeant des renseignements avec un client et une RVCP valide est requise dans une telle situation. Il pourrait notamment s’agir d’un rendez-vous de suivi réalisé en ligne, de l’éducation des clients ou de la prise d’un rendez-vous pour des interventions diagnostiques.

La santé mobile comprend l’usage de dispositifs prêts à porter qui aident le médecin vétérinaire à prendre des décisions.
Last March, the College of Veterinarians of Ontario (CVO) stated that if human pediatric telemedicine can be performed, then why not veterinary telemedicine? Telehealth providers field phone calls after hours, they don’t diagnose or prescribe, but instead offer advice about whether the animal’s owner should seek further veterinary help. There is a pilot study underway wherein some veterinary practices are working with telehealth providers on weekends and after hours to provide their clients with service during those hours.

The telehealth provider keeps records and provides a report to the regular veterinarian. One of the arguments for allowing veterinarians to do this is the concern that if we don’t do this, someone not involved in our profession will.

Obviously there are many benefits to telehealth especially for people and animals in remote areas where they may not have any other access to veterinary care, or in 3rd world countries where access to veterinary care is challenging or non-existent. There are also challenges such as establishing a valid VCPR, the value of teledadvice versus diagnosis, and the possibility that a 3rd party who isn’t in the veterinary profession becomes the telehealth provider.

The Canadian Veterinary Medical Association’s current position statement on telemedicine was established in 2014 and is currently being reviewed and revamped by our National Issues Committee with the aim to have a new position statement available in 2019. The National Issues Committee has been liaising with the AVMA on this issue. You can find the 2014 position statement on our website, but note that since it came into effect there have been many changes to the meaning and practice of telemedicine, thus an update is necessary.

With new technologies come new challenges for our profession. I believe we need to embrace the technology and take the lead on these challenges and changes. If we don’t, then someone else might. Who better than us to embrace new technologies and develop the ways and means of using them for the benefit of our patients.

Troye McPherson
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Ethical question of the month — May 2018

A 6-month-old crossbred dog is presented to you early one morning with unusual central nervous system signs. The husband and wife are new clients and appear “edgy.” They are there with their two young children. It is difficult for you to obtain a clear history regarding the onset or progression of the clinical signs. Due to the reluctance of the couple to provide an adequate history, you assure them that anything they tell you will be kept confidential within the veterinary-client-patient relationship. They then admit that the dog consumed some of their recreational opioids. The dog responds well to treatment with naloxone. The couple and their children are relieved and grateful. You are not comfortable lecturing these people about the dangers of recreational narcotics; however, with two young children and the dog as evidence that these drugs are not always stored in a secure manner, it does not seem right to register this as a successful treatment outcome and get on with your day. You have a professional obligation to report animal abuse. What are your professional obligations in this situation?

Submitted by Roy Lewis, Calgary, Alberta

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.
Ethical question of the month – February 2018

The average sow mortality on North American swine farms is estimated to be approximately 10%. The average prevalence of lameness in freestall dairy barns in Canada is approximately 25%. These and other average production values on livestock farms are considered by some to be unacceptably high and indicative of substandard animal welfare. University herds and flocks strive to be representative of industry practices so that the teaching and research done on university farms can be effectively extended to commercial herds.

Knowing this, is it right to insist that university herds and flocks achieve above industry production averages? Should welfare parameters on university farms be held to a higher standard than purely production parameters such as feed efficiency?

Question de déontologie du mois – Février 2018

En Amérique du Nord, la mortalité moyenne des truies dans les fermes d’élevage de porcs est d’environ 10%. La prévalence moyenne de la boiterie dans les fermes laitières à logettes au Canada est d’environ 25%. Ces valeurs, et d’autres valeurs moyennes de production, observées dans les fermes d’élevage sont considérées par certains comme étant inacceptablement élevées et indicitrices d’un bien-être animal inférieur aux normes. Les troupeaux des universités s’efforcent de représenter les pratiques de l’industrie afin que l’enseignement et la recherche effectués dans les fermes universitaires puissent être efficacement mis en œuvre dans les troupeaux commerciaux. En sachant cela, est-il approprié d’insister que les troupeaux universitaires atteignent des moyennes de production supérieures à celles obtenues dans l’industrie? Les paramètres de bien-être des fermes universitaires devraient-ils répondre à une norme supérieure au lieu de satisfaire simplement à des paramètres de production comme l’efficacité de l’alimentation?

An ethicist’s commentary on University standards for agricultural operations

Often, in order to respond to issues raised in this column, I have harked back to wisdom provided by Plato in his dialogues. In this case, we may begin by looking to Plato’s student, Aristotle, for guidance. At one point, Aristotle is discussing the absolute necessity of ideals in ethics, and makes the point that an ethic is a yardstick, a measure of where we are deficient. As Aristotle put it, stressing the need for an ethical ideal:

“Will not the knowledge of it, then, have a great influence on life? Shall we not, like an archer who has a mark to aim at, be more likely to hit upon what is right?” As I argued in my first book on animal ethics, “Without an ideal, we confuse the way things are with the way things ought to be, and we are smug and complacent. Only by having an ideal to move toward can we progress beyond the status quo.”

One major role of universities is the promulgation and dissemination of ideals, sometimes without realizing that is what they are doing. These ideals are ubiquitous, be they the ideal gas laws in chemistry; the ideal descriptions of ecosystems; the teaching of democratic political ideals in philosophy and political science classes; or the ideal components of a suspension bridge in civil engineering. In all cases, it is understood that reality will inevitably deviate from the ideal. As my friend and colleague Temple Grandin often remarks, the ideal is necessary “to prevent bad from becoming normal.”

Obviously, agriculture does the same thing. Universities should be setting up state-of-the-art systems for animals, while at the same time realizing that reality will fall short of these ideals. For example, animal agriculture must realize that sustainability is currently a major demand for agricultural systems. And it is sometimes forgotten that sustainability has numerous parameters. Certainly animal agriculture must be environmentally sustainable, for example utilizing water resources wisely and disposing of wastes in manners that come as close as possible to avoiding environmental despoliation. And it obviously must be economically sustainable and not expend more resources than it brings in. What is sometimes forgotten is that such systems must be socially sustainable as well. If citizens reject a way of producing animal products on moral grounds, such as is ever-increasingly the case regarding gestation crates in swine production, producers are ill-advised to ignore such concerns. That is why Smithfield Farms has commendably continued to eliminate gestation crates, despite the major costs involved in doing so.

Given human nature, producers will strive to maximize short-term productivity and economic payoff, even at the cost of animal welfare, a result that has led to societal rejection of many of the most severe components of industrialized agriculture. It is thus perfectly appropriate for university farms to build systems that satisfy societal animal welfare demands, even if this is accomplished at the cost of short-term profits. Just as universities are chartered to determine for industry the optimal genetics for farm animals; the optimal feeding protocols for maximizing efficiency while minimizing disease; the optimal methods for disposing of waste while preserving environmental values; so too are they obliged to press forward systems that maximize animal welfare, and thus social sustainability of animal agriculture, while being mindful of the correlative need for economic sustainability.

Bernard E. Rollin, PhD
1. Which of the following statements is true regarding acromegaly?
   A. Acromegaly in dogs is usually due to a pituitary tumor.
   B. Acromegaly in cats is often associated with diabetes mellitus.
   C. Acromegaly in dogs is often associated with diabetes mellitus.
   D. Acromegaly in cats is easily cured with medical therapy.
   E. Acromegaly in cats is often associated with an adrenal tumor.

2. Which of the following is NOT a characteristic of hyperadrenocorticism in dogs?
   A. Increased concentration of corticosteroid-induced alkaline phosphatase (ciALP)
   B. Seizures
   C. Urinary tract infections
   D. Polyuria and polydipsia
   E. Pot-bellied appearance

3. Which of the following statements is NOT correct regarding persistent right aortic arch?
   A. It is the most common vascular ring anomaly in dogs.
   B. The esophagus is compressed between the ligamentum arteriosum, the aorta, the pulmonary trunk, and the base of the heart.
   C. Signs (regurgitation) are usually present from birth.
   D. Esophageal dilation cranial to the heart may be apparent on survey thoracic radiography.

4. Acute onset of posterior ataxia and/or paresis in the horse is associated with which of the following?
   A. Tetanus
   B. Rabies
   C. Herpesvirus 1 myelitis
   D. Equine protozoal myelitis

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1. Lequel des énoncés suivants est vrai à propos de l’acromégalie?
   A. Chez les chiens, l’acromégalie est habituellement due à une tumeur de l’hypophyse.
   B. Chez les chats, l’acromégalie est souvent associée au diabète sucré.
   C. Chez les chiens, l’acromégalie est souvent associée au diabète sucré.
   D. Chez les chats, l’acromégalie est facilement guérie par traitement médical.
   E. Chez les chats, l’acromégalie est souvent associée à une tumeur de la surrénale.

2. Lequel des problèmes suivants N’EST PAS une caractéristique de l’hyperadrénocorticisme chez le chien?
   A. augmentation de la concentration de la phosphatase alcaline induite par les corticostéroïdes;
   B. convulsions;
   C. infections du tractus urinaire;
   D. polyurie et polydipsie;
   E. apparence d’abdomen distendu.

3. Lequel des énoncés suivants N’EST PAS correct à propos de la persistance de l’arc aortique?
   A. C’est l’anomalie vasculaire la plus commune chez le chien.
   B. L’œsophage est comprimé entre le ligament artériel, l’aorte, le tronc pulmonaire et la base du cœur.
   C. Les signes (régurgitation) sont habituellement présents à la naissance.
   D. La dilatation de l’œsophage cranial au cœur peut être apparente sur les radiographies thoraciques.

4. Chez le cheval, l’apparition soudaine d’ataxie et/ou de parésie est associée à laquelle des affections suivantes?
   A. tétanos;
   B. rage;
   C. myélite à herpès virus 1;
   D. myélite à protozoaire des équidés.
5. Which of the following is an appropriate herd plan after the first laboratory diagnosis of *Streptococcus agalactiae* in ongoing clinical mastitis case culturing?
A. Continuation of clinical case culturing alone.
B. Rapid removal of this case from the herd.
C. California mastitis testing (CMT) of all other cows.
D. Review of manure removal and stall bedding procedures.
E. Review of pre-milking teat hygiene.

(See p. 524 for answers./Voir les réponses à la page 524.)

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.
Treating Honey Bees: What Veterinary Medical Professionals Need to Know

**Traitement des abeilles domestiques : ce que les professionnels médicaux vétérinaires doivent savoir**

Apiculture, including pollination services and the production of honey, is a significant component of Canadian agricultural production. Often overlooked is the fact that honey bees are a food-producing animal. In 2015 there were 8500 recorded honey producers in Canada. This represents over 720 000 colonies of bees. Canada produced 95 million pounds of honey with a market value of 250 million Canadian dollars.

At that time, 68% of the Canadian production was in Alberta, Saskatchewan, and Manitoba with 41% coming from Alberta. Ontario had the highest number of producers, 2562.

Generally, bee keepers will have many apiaries, each consisting of a series of colonies/hives with several boxes or supers in each hive, containing frames, where the honey is produced. The distribution of the industry is quite diverse, including some large commercial producers with many colonies, part-time producers with as few as 10 colonies, and many hobbyists with as little as 1 hive. Honey production occurs in remote rural areas, suburban settings, and even in some urban environments.
Frequently Asked Questions:

What is a veterinary prescription?
A prescription is a direction issued by a registered veterinarian that an animal or group of animals be treated with a specified drug, at a specified dose, for a specified period of time, for treatment of a specified condition.

When is a veterinary prescription required?
A prescription is required for any prescription product including medically important antimicrobial for use in an animal, including honey bees. A prescription is required to dispense prescription products.

When can a veterinary prescription be issued?
A veterinary prescription can only be issued by a registered veterinarian once they have established medical need for a product and within the confines of a veterinarian-client-patient relationship (VCPR).

Necessary steps:
1. Establish and meet conditions of a valid VCPR regarding the bee keeper, their operation and their bees.
2. Make an evidence-based determination of medical need,
3. Complete appropriate documentation in a medical record, and
4. Provide oversight of use and follow-up.

What is required to establish a VCPR?
A VCPR exists when the following conditions have been met:
1. The veterinarian has assumed the responsibility for making clinical assessments and recommendations regarding the health of the animal(s) and the need for medical treatment.
2. The veterinarian has sufficient knowledge of the animal(s) on which to base the assessment, diagnosis and treatment of the medical condition of the animal(s). This means that the veterinarian has recently seen and is personally acquainted with the keeping and care of the animal(s) by virtue of an examination of the animal(s) or by medically appropriate and timely visits to the premises where the animal(s) are kept.
3. The client has agreed to follow the veterinarian’s recommendations and prescription.
4. The veterinarian is available or has arranged for follow-up evaluation, especially in the event of adverse reactions or failure of the treatment regimen.

How does the VCPR relate to treating honey bees and pollinators?
While the overarching principles of the VCPR apply to bees, the process of establishing legitimate medical need for treatment may not necessarily require the specific “examination of an animal” (bee).

What information is required for a VCPR with a bee keeper to be legitimate?
There must be a medical record indicating that the veterinarian has assumed the responsibility for making clinical assessments and recommendations regarding the health of the animals (bees) and the need for medical treatment and the producer has agreed to follow these recommendations. The veterinarian and bee keeper must be shown to have developed a working relationship.

Information in the medical record might include some or all of the following, along with whatever relevant information is available in regard to the specific circumstance.
- Producer name
- Address and location of production sites

The industry is well organized with producer organizations in all provinces and a national Canadian Honey Council. This is supported by Apiary Acts and regulations in most provinces and federal regulation under Agriculture and Agri-food Canada (AAFC) and the Canadian Food Inspection Agency (CFIA). Professional support is available in the form of provincial apiculturists and other staff, as well as tech transfer teams and federal specialists with AAFC and CFIA.

Like any livestock production system, bees are afflicted by many disease threats, including bacteria, fungi, viruses, and parasites. These health situations have historically been managed by bee keepers with guidance from provincial and federal employees engaged in the field. The engagement of private veterinarians has been minimal.

American Foulbrood (AFB) is a bacterial disease with significant impact on the industry. It is widespread with as many as 25% of colonies showing the presence of spores in some areas. The prevalence varies widely across Canada. In areas of high incidence, AFB is preventively treated with tetracycline fed to the colony in fall and spring (most of the time, it is mixed with sugar and placed as a dust on top of the frames), even in unaffected colonies. Normally, the antibiotics work on the vegetative stage but not on the spore forming stage. Consequently, it hides the presence of the disease and AFB cannot be eliminated by antibiotic treatment (because the spore forming stage is not affected). As a result of this systematic preventive use, tetracycline resistance has developed and management is further complicated. Tylosin is also registered in Canada for AFB therapy and is only recommended when AFB has been confirmed and tetracycline resistance has been documented. In these situations, tylosin is used in the fall. In addition to the risk of developing resistance, both products are problematic in that there is a risk of contamination of commercial honey with antibiotics. Consequently, their use must be carefully controlled and limited to a timeframe when commercial honey is not being produced.

Health Canada has directed that the use of Medically Important Antimicrobials (MIA) in food producing animals shall be under veterinary oversight. This will be achieved by moving all MIA to the prescription-only drug list, to be fully implemented by the end of 2018.

This change will have a significant impact on the apiculture industry. To access tetracycline, tylosin or any other medically important antimicrobial for use in their operation, producers must have a veterinary prescription.

It is necessary that Canadian veterinarians become familiar with apiculture and the specific treatment requirements of honey bees. This is essential to develop legitimate veterinarian-client-patient relationships (VCPR), establish evidence-based medical need, and subsequently prescribe and dispense antimicrobial treatment for patients in this industry.

Given the wide distribution of honey operations, it should be anticipated that as a practicing veterinarian, you may be approached to serve this industry. The need for veterinary participation will not be confined to traditional food animal veterinary practices but will also engage companion animal practitioners in suburban and urban locations.

(by the CVMA Veterinary Pharmaceutical Advisory Group)
des producteurs à temps partiel possédant quelques dizaines de colonies et beaucoup d'amateurs qui peuvent parfois posséder une seule ruche. La production de miel s'effectue dans des régions rurales éloignées, des banlieues et même dans certains milieux urbains.

L'industrie est bien organisée et elle compte des organisations de producteurs dans toutes les provinces ainsi qu'un Conseil canadien du miel à l'échelle nationale. Ces organisations sont soutenues par des lois et des règlements sur les ruchers dans la plupart des provinces et une réglementation fédérale sous l'égide d'Agriculture et Agroalimentaire Canada (AAC) et de l'Agence canadienne d'inspection des aliments (ACIA). Du soutien professionnel est offert par les apiculteurs provinciaux et d'autres employés provinciaux ainsi que des équipes de transfert technologique et des spécialistes fédéraux d'ACIA et de l'ACIA.

Comme tous les systèmes de production de bétail, les abeilles sont exposées à de nombreuses menaces de maladies, dont des bactéries, des champignons, des virus et des parasites. Ces situations de santé ont été jusqu'à maintenant gérées par les apiculteurs avec des conseils des employés provinciaux et fédéraux travaillant dans le domaine. La participation des médecins vétérinaires a été minimale.

La loque américaine est une maladie bactérienne qui a un impact important au sein de l'industrie. C'est une maladie répandue et, dans certaines régions, on peut trouver la présence de spores dans jusqu'à 25 % des colonies. La prévalence varie grandement au Canada. Dans les régions à forte incidence, la loque américaine est traitée de façon préventive en administrant de la tétracycline à la colonie à l'automne et au printemps (la plupart du temps, on la mélangé avec du sucre et on la place sur le haut des cadres sous forme de poussière), même dans les colonies non affectées. Normalement, les antibiotiques agissent sur le stade végétatif mais non sur le stade de formation des spores et cette mesure masque donc la présence de la maladie. Signalons que la logue américaine ne peut pas être éliminée par un traitement antibiotique (parce que le stade de formation des spores n'est pas affecté). En raison de cette utilisation préventive systématique, la résistance à la tétracycline s'est développée et la gestion est devenue plus complexe. La tylosine est aussi enregistrée au Canada pour le traitement de la loque américaine et est seulement recommandée lorsque la logue américaine a été confirmée et que la résistance à la tétracycline a été documentée. Dans ces situations, la tylosine est utilisée à l'automne. En plus du risque de développer une résistance, les deux produits sont problématiques car il existe la possibilité de contamination du miel commercial avec des antibiotiques. Par conséquent, leur utilisation doit être minutieusement contrôlée et limitée à une période de non-production du miel commercial.

Santé Canada a stipulé que l'utilisation des antimicrobiens importants sur le plan médical (AIM) chez les animaux destinés à l'alimentation doit se faire sous surveillance vétérinaire. Cette surveillance s'effectuera en ajoutant tous les AIM à la liste des médicaments sur ordonnance et elle sera mise en œuvre d'ici la fin de 2018.

Ce changement aura un impact important sur l'industrie de l'apiculture. Pour accéder à la tétracycline, à la tylosine ou à d'autres antimicrobiens importants sur le plan médical pour la production de miel, il faudra faire une prescription vétérinaire.

### Foire aux questions :

**En quoi consiste une prescription vétérinaire ?**

Une prescription est une directive émise par un médecin vétérinaire autorisé pour le traitement d'un animal ou d'un groupe d'animaux avec un médicament particulier selon une dose spécifiée et pendant une durée déterminée afin de traiter une affection particulière.

**À quel moment une prescription vétérinaire est-elle requise ?**

Une prescription est requise pour tout produit sur ordonnance qui inclut un antimicrobien important sur le plan médical pour utilisation chez un animal, y compris les abeilles domestiques. Une prescription est requise pour la distribution des produits sur ordonnance.

**Quand peut-on émettre une prescription vétérinaire ?**

Une prescription vétérinaire peut seulement être émise par un médecin vétérinaire une fois qu'il a établi le besoin médical d'un produit dans le contexte d'une relation vétérinaire-client-patient (RVCP).

**Étapes nécessaires :**

1. Établir les conditions d'une relation vétérinaire-client-patient valide (RVCP) à l'égard de l'apiculteur, de son exploitation et de ses abeilles et y satisfaire.
2. Effectuer une détermination du besoin médical en se basant sur des données probantes.
3. Verser les documents appropriés au dossier médical.
4. Assurer la supervision de l'utilisation et du suivi.

**Quels sont les éléments requis pour établir une «RVCP» ?**

Une RVCP existe lorsque toutes les conditions suivantes ont été satisfaites :

1. Le médecin vétérinaire a assumé la responsabilité de la réalisation des évaluations cliniques et des recommandations concernant la santé de l'animal et le besoin de traitement médical.
2. Le médecin vétérinaire connaît suffisamment l'animal pour la réalisation d'une évaluation, d'un diagnostic et du traitement de l'affection médicale de l'animal. Cela signifie que le médecin vétérinaire a récemment vu l'animal et qu'il s'est personnellement rendu compte des conditions d'élevage et des soins prodigués à l'animal lors d'un examen de l'animal ou de visites médicales appropriées et opportunes sur les lieux d'hébergement de l'animal.
3. Le client a accepté de suivre les recommandations et la prescription du médecin vétérinaire.
4. Le médecin vétérinaire est disponible pour un suivi ou il a pris les dispositions nécessaires pour une évaluation de suivi, particulièrement en cas de réaction indésirable ou d'échec du programme de traitement.

**Comment la RVCP s'applique-t-elle au traitement des abeilles domestiques et des pollinisateurs ?**

Même si les principes fondamentaux de la RVCP s'appliquent aussi aux abeilles, le processus d'établissement d'un besoin médical légitime pour le traitement n'exigera pas nécessairement «l'examen d'un animal» (abeille).
**What patient specific information must a veterinarian have to issue a prescription for treatment?**

Some or all of the following information may provide sufficient knowledge of the animal(s) on which to base the assessment and diagnosis, necessary for treatment or prevention recommendations of specific medical conditions.

- Records of colony health
- Previous disease history
- Treatment history for all diseases
- Documentation of site visits by provincial apiculturists, including report and recommendations
- Clinical evidence of disease based on visual inspection by the veterinarian or qualified provincial apiculturist
- Laboratory reports from all submitted samples, confirming the presence of disease/spores
- Culture results regarding resistance to American foul brood
- Results of antibiotic residue testing
- Evidence of disease in the specific region or province that may potentially spread to the colony in question.

**What other information needs to be in the record?**

A veterinarian is required to document all relevant information gathered about a client and patient. This will include, but not limited to, history, diagnosis, treatment and outcomes.

**Where can I obtain more information about treating honey bees?**

- Canadian Association of Professional Apiculturists (www.capa bees.org)
- Canadian Honey Council (www.honeycouncil.ca)
- Various provincial honey producer associations
- Participate in continuing education activities currently available
- Veterinary Information Network (VIN) (www.vin.com), Bees 2018
- Establish a good working relationship with the provincial apiculturist working in your province.
- Consult diagnostic laboratories and veterinary colleges.

**Quels sont les renseignements requis pour que la RVCP avec l'apiculteur soit légitime?**

Il doit y avoir un dossier médical indiquant que le médecin vétérinaire a assumé la responsabilité des évaluations cliniques et des recommandations concernant la santé des animaux (abeilles), qu'il existe un besoin médical et que le producteur a consenti à suivre ces recommandations. On doit pouvoir démontrer que le médecin vétérinaire et l'apiculteur ont établi une relation de travail. Les renseignements dans le dossier médical pourraient inclure une partie ou la totalité des renseignements suivants ainsi que tous les renseignements pertinents disponibles concernant la situation particulière.

- Nom du producteur
- Adresse et emplacement des lieux de production
- Confirmation de l'inscription de l'exploitation auprès de la province lorsque cela est requis en vertu de la loi
- Numéro d'identification de l'établissement (le cas échéant)
- Nombre de ruchers
- Nombre de colonies ou de ruches
- Production annuelle
- Facilité de l'accès aux unités de production par le médecin vétérinaire
- Preuve d'une consultation en personne avec l'apiculteur
- Preuve de la connaissance de l'exploitation soit par des visites en personne dans les lieux de production ou lors d'une consultation par communication vidéo en temps réel
- Historique des pratiques de gestion de la santé de l'exploitation.

**Quels sont les renseignements spécifiques au patient que doit posséder un médecin vétérinaire afin d'émettre une prescription de traitement?**

Une partie ou la totalité des renseignements suivants pourraient fournir une connaissance suffisante de l'animal afin de réaliser l'évaluation et le diagnostic nécessaires pour les recommandations de traitement ou de prévention en lien avec les affections médicales particulières.

- Dossiers de santé de la colonie
- Historique des maladies
- Antécédents de traitement pour toutes les maladies
- Documentation des visites sur les lieux par les apiculteurs provinciaux, y compris les rapports et les recommandations
- Données probantes cliniques de la présence d'une maladie en se basant sur l'inspection visuelle par le médecin vétérinaire ou l'apiculteur provincial qualifié
- Rapports de laboratoire pour tous les échantillons soumis qui confirment la présence de la maladie ou de spores
- Résultats de cultures concernant la résistance à la roque américaine
- Résultats des tests de résidus d'antibiotiques
- Données probantes confirmant la présence de la maladie dans une région ou une province particulière qui peut potentiellement se propager dans la colonie en question.

**Quels autres renseignements devrait-on verser au dossier?**

Un médecin vétérinaire doit documenter tous les renseignements pertinents recueillis à propos d’un client et d’un patient. Cela inclura, entre autres, l’anamnèse, le diagnostic, le traitement et les résultats.
utilisation dans leur exploitation, les apiculteurs devront maintenant se procurer une prescription vétérinaire dans tous les territoires canadiens.

Il est nécessaire que les médecins vétérinaires canadiens se familiarisent avec l’apiculture et les exigences des traitements particuliers aux abeilles, car ces connaissances sont essentielles afin de développer des relations vétérinaire-client-patient (RVCP) légitimes, d’établir des besoins médicaux basés sur des données probantes et d’ensuite prescrire et distribuer le traitement antimicrobien pour les patients dans cette industrie.

Compte tenu de la vaste distribution des exploitations d’apiculture, il faut prévoir que cette industrie pourrait faire appel à vos services à titre de médecin vétérinaire praticien. La participation vétérinaire ne se limitera pas aux pratiques vétérinaires traditionnelles pour animaux destinés à l’alimentation, car les services des praticiens pour animaux de compagnie des banlieues et des milieux urbains seront aussi sollicités.

(par le Groupe consultatif sur la gouvernance des produits pharmaceutiques vétérinaires de l’ACMV)

Le présent article a pour but de servir de point de départ pour les médecins vétérinaires qui désirent participer à la pratique vétérinaire pour les abeilles. Les obligations professionnelles sont déterminées par l’organisme provincial de réglementation de la médecine vétérinaire. Les commentaires présentés dans cette discussion ne visent pas à remplacer ou à insinuer une contradiction aux normes d’exercice établies dans chaque province.

On conseille aux professionnels médicaux vétérinaires de contacter leur organisme de réglementation afin d’obtenir des renseignements sur les exigences provinciales particulières.

Où puis-je obtenir de plus amples renseignements sur le traitement des abeilles?

- Association canadienne des apiculteurs professionnels : www.capabees.org
- Conseil canadien du miel : www.honeycouncil.ca
- Diverses associations provinciales de producteurs de miel
- Participer à des activités de formation continue actuellement offertes
- Veterinary Information Network (VIN) : www.vin.com, Bees 2018
- Établir une bonne relation de travail avec l’apiculteur provincial travaillant dans votre province.
- Consulter les laboratoires de diagnostic et les écoles de médecine vétérinaire.

À tous les membres de l’Association canadienne des médecins vétérinaires (ACMV)

Avis de l’Assemblée générale annuelle de l'ACMV

Tous les membres de l’ACMV sont invités à participer à l’Assemblée générale annuelle (AGA) qui aura lieu le jeudi 5 juillet de 12 h à 14 h 30 dans le salon Kitsilano de l’hôtel J.W. Marriott Parq Vancouver (39 Smithe Street) à Vancouver, en Colombie-Britannique, durant le congrès 2018 de l’ACMV. Immédiatement après l’AGA, l’ACMV tiendra sa cérémonie annuelle de remise des prix.

NOTE : Même si tous les membres de l’ACMV ont accès à des sièges dans l’ amphithéâtre à l’AGA, un repas sera servi uniquement aux personnes possédant un billet de repas. Pour obtenir un billet de repas, veuillez vous rendre au site d’inscription en ligne au congrès (www.veterinairesaucanada.net/science-knowledge/annual-convention-registration) et vous inscrire à l’AGA.

To All Members of the Canadian Veterinary Medical Association (CVMA)

Notice of the Annual General Meeting of the CVMA

All members of the CVMA are invited to participate in the Annual General Meeting (AGM), taking place in the Kitsilano Ballroom at the J.W. Marriott Parq Vancouver Hotel (39 Smithe Street) in Vancouver, British Columbia on Thursday, July 5 from 12:00 am to 2:30 pm, during the 2018 CVMA Convention. Immediately following the AGM, the CVMA will hold its annual Awards Ceremony.

NOTE: Although all CVMA members have access to theater seating at the AGM, only those with a meal ticket can be provided with a lunch. To obtain a meal ticket, please go to our online convention registration site (www.canadianveterinarians.net/science-knowledge/annual-convention-registration) and sign up for the AGM.
2018 CVMA Convention
July 5 to 8, 2018
Ignite Your Passion!

The 2018 CVMA Convention is less than 2 months away, but you can still take advantage of the early bird savings up until May 31. The Convention offers over 113 RACE-approved continuing education (CE) credits, allowing you to earn up to 27 credits. Top-notch speakers from Canada and the United States have been invited to speak.

Dr. Kevin Stepaniuk, a diplomate of the American Veterinary Dental College, previous faculty and section chief of dentistry and oral surgery at the University of Minnesota, and scientific journal and textbook author and reviewer, will present 6 lectures on companion animal dentistry on Friday, July 6. Dr. Stepaniuk will address Clandestine Oral Pathology — Captured with Intraoral Dental Radiography; Oral Masses in the Dog and Cat, as well as Feline Oral Inflammation Differentiation and Treatment Updates.

Dr. Anthony Carr, a diplomate of the American College of Veterinary Internal Medicine and professor of small animal clinical sciences at the Ludwig Maximilians University in Munich, Germany will discuss Cushing’s disease: Something New, Something Old and Something Blue; Addison’s disease: Keep it in Mind; and Hyperthyroidism during the companion animal endocrinology sessions. Dr. Carr will also be discussing Gastroenterology in the afternoon.

Dr. Marie Holowaychuk, small animal emergency and critical care specialist, along with Ms. Jolene Watson, president of Clarity Coaching and Development, will speak on Workplace Wellness on Saturday, July 7. Dr. Holowaychuk will present effective team communication, and practical options for workplace wellness. Ms. Watson will share her experience on understanding personality styles, managing team conflict, and appreciation styles in the workplace.

For more information on the speakers mentioned above, or more speaker and session information, be sure to download the CVMA Convention App. To download, simply enter eventmobi.com/app/cvma18 into your smart phone and click “Get the App.” Don’t have a smart phone? You can still view the app in your web browser (eventmobi.com/cvma18).

Visit the CVMA website (www.canadianveterinarians.net) to register before the early bird May 31, 2018 deadline to receive the discounted registration fees. See you in Vancouver!

(by Sarah Cunningham, Manager, Conventions, CVMA)

Congrès 2018 de l’ACMV
Du 5 au 8 juillet 2018
Éveillez votre passion!

Le congrès 2018 de l’ACMV aura lieu dans moins de deux mois, mais vous pouvez toujours profiter du rabais de l’inscription hâtive jusqu’au 31 mai. Le congrès offre plus de 113 crédits de formation continue approuvés par RACE et vous permet d’accumuler jusqu’à 27 crédits. Des conférenciers de haut calibre provenant du Canada et des États-Unis ont été invités à prendre la parole.

Le Dr’ Kevin Stepaniuk, diplomate de l’American Veterinary Dental College, ancien professeur et chef de section de dentisterie et chirurgie buccale à l’Université du Minnesota et auteur et lecteur de revues scientifiques et de manuels, présentera six conférences sur la dentisterie des animaux de compagnie le vendredi 6 juillet. Le Dr’ Stepaniuk abordera la pathologie buccale clandestine observée à l’aide de radiographies dentaires intra-buccales; les masses orales chez le chien et le chat ainsi que la différenciation de l’inflammation orale feline et les mises à jour sur le traitement.

Le Dr’ Anthony Carr, diplomate de l’American College of Veterinary Internal Medicine et professeur de sciences cliniques des petits animaux à l’Université Ludwig Maximilians à Munich, en Allemagne, discutera de la maladie de Cushing’s : Du neuf, du vieux et du bleu; de la Maladie d’Addison : pensez-y; et de l’hyperthyroïdisme durant les ateliers sur l’endocrinologie des animaux de compagnie. Le Dr’ Carr parlera aussi de la gastro-entérologie en après-midi.

La Dme Marie Holowaychuk, spécialiste en soins d’urgence et en soins critiques pour les petits animaux, de même que Mme Jolene Watson, présidente de Clarity Coaching and Development, aborderont le sujet du bien-être au travail le samedi 7 juillet. La Dme Holowaychuk fera une présentation sur la communication efficace au sein de l’équipe et les options pratiques pour le bien-être au travail. Mme Watson partagera ses expériences sur la compréhension des styles de personnalité, la gestion des conflits au sein de l’équipe et les styles d’appréciation au travail.


Visitez le site Web de l’ACMV (www.veterinairesaucanada.net) pour vous inscrire avant la date d’inscription hâtive du 31 mai 2018 afin de vous prévaloir des tarifs d’inscription réduits. Au plaisir de vous rencontrer à Vancouver!

(par Sarah Cunningham, gestionnaire, Congrès, ACMV)
The CVMA Welcomes Dr. Ted Kilpatrick to the Animal Welfare Committee

The Canadian Veterinary Medical Association (CVMA) is delighted to welcome Dr. Ted Kilpatrick, representing the Ontario Veterinary Medical Association (OVMA) as ex-officio, to the Animal Welfare Committee.

After graduating with Honors from the Ontario Veterinary College in 1979, Dr. Kilpatrick joined a mixed animal practice in St. Paul, Alberta where he practiced until 1980. He then moved to Ontario, where he worked in a number of small animal practices and an emergency hospital, including the Ottawa Veterinary Hospital and the Bells Corners Animal Hospital. In 1991, Dr. Kilpatrick purchased the Bowmanville Veterinary Clinic, where he worked until he sold his share of the practice in July 2009. Dr. Kilpatrick now lives on Manitoulin Island and recently retired.

In 1996, Dr. Kilpatrick joined the OVMA Board of Directors as the South Durham Veterinary Association representative. Since then, he has held a number of different positions with the OVMA. He is currently the chair of the Small Animal Issues Committee, sits on the Focus editorial committee and in the past, chaired the Small Animal Program and Conference Committee, and was a member of the Nominations Committee. At these tables, he has been a strong voice for improved animal welfare and has been instrumental in the adoption of multiple OVMA position statements, as well as a key voice that encouraged the College of Veterinarians of Ontario to adopt a position statement that compels veterinarians to institute appropriate pain management and to not withhold analgesic therapy in order to reduce costs.

When he manages to find some time for himself, Dr. Kilpatrick enjoys the wilderness and white-water canoeing, cross-country skiing, mountain biking, cycling, travelling, and keeping an eye on environmental issues. In recent years, he completed the construction of a straw bale house on Manitoulin Island.

L’ACMV accueille le Dr Ted Kilpatrick au sein du Comité sur le bien-être animal

L’Association canadienne des médecins vétérinaires (ACMV) est ravie d’accueillir le Dr Ted Kilpatrick, qui représente l’OVMA en tant que membre d’office, au sein du Comité sur le bien-être animal.

Après avoir obtenu un diplôme spécialisé de l’Ontario Veterinary College en 1979, le Dr Kilpatrick s’est joint à une pratique mixte à St. Paul, en Alberta, où il a exercé jusqu’en 1980. Il est ensuite déménagé en Ontario, où il a travaillé dans plusieurs pratiques pour petits animaux et une clinique d’urgence, dont l’Ottawa Veterinary Hospital et la clinique Bells Corners Animal Hospital. En 1991, le Dr Kilpatrick a acheté la Bowmanville Veterinary Clinic, où il a travaillé jusqu’à la vente de ses intérêts dans la pratique en juillet 2009. Le Dr Kilpatrick habite maintenant dans l’Île Manitoulin et il a récemment pris sa retraite.

En 1996, le Dr Kilpatrick s’est joint au conseil d’administration de l’OVMA à titre de représentant de la South Durham Veterinary Association. Depuis ce temps, il a occupé plusieurs postes différents auprès de l’OVMA. Il est actuellement président du Comité des enjeux pour les petits animaux, siège au comité éditorial de Focus et a déjà présidé le Programme pour petits animaux et le Comité des conférences et été membre du Comité des mises en candidature. À ces réunions, il a défendu l’amélioration du bien-être animal et a joué un rôle crucial dans l’adoption de nombreux énoncés de position de l’OVMA. De plus, il a été l’un des principaux intervenants qui ont encouragé le College of Veterinarians of Ontario à adopter un énoncé de position qui oblige les médecins vétérinaires à établir une gestion de la douleur appropriée et à ne pas s’abstenir d’administrer la thérapie analgésique afin de réduire les coûts.

Lorsqu’il trouve du temps pour lui-même, le Dr Kilpatrick aime la nature et le canot en eaux vives, le ski de fond, le vélo de montagne, les voyages et les actualités environnementales. Au cours des dernières années, il a terminé la construction d’une maison en ballots de paille dans l’Île Manitoulin.
The CVMA Cares About You and Wants to Contribute to Your Overall Wellness

There has been a wealth of discussion on the topic of wellness in veterinary medicine the past few years and it is important we keep this issue a priority. In 2012, the Canadian Veterinary Medical Association (CVMA) surveyed 769 veterinarians and found 19% of respondents had seriously thought about suicide. Nine percent of respondents had previously made an attempt on their life, and 27% took anti-depressants.

The CVMA is continuously looking at ways to support Canadian veterinarians on their wellness journey and contribute to their success in achieving a work-life balance. Two of CVMA’s wellness initiatives are highlighted on the next page.

CVMA Creates Reference Tool

Opioids: Risk Evaluation/Mitigation Strategies in Veterinary Medicine

L’ACMV se soucie de vous et elle désire contribuer à votre bien-être général

Les opioides sont utilisés en médecine vétérinaire depuis de nombreuses années et ils demeurent un élément important de l’arsenal dont dispose notre profession afin de lutter contre la douleur. Les opioides fonctionnent comme des analgésiques efficaces soit seuls ou en combinaison avec d’autres catégories d’analgésiques. Ils sont importants pour la gestion de la douleur intense qui se produit lors d’affections chroniques comme le cancer ou pour les patients en phase périopératoire ou postopératoire afin d’assurer le confort du patient.

L’Association canadienne des médecins vétérinaires (ACMV) a conçu un document intitulé Opioïdes : Évaluation des risques et stratégies d’atténuation en médecine vétérinaire qui peut servir de bref sommaire des connaissances et des meilleures pratiques actuelles, d’outil de référence potentiel pour l’équipe de soins vétérinaires et de ressource à utiliser lors de discussions. Le but du présent document n’est pas de servir de document stratégique, d’énoncé de position ni de norme pour une utilisation légale. Vous pourrez trouver le document sous l’onglet Pratique et finances sur le site Web de l’ACMV (www.veterinairesaucanada.net).

The CVMA Cares About You and Wants to Contribute to Your Overall Wellness

Opioïdes : Évaluation des risques et stratégies d’atténuation en médecine vétérinaire

Opoid-class medications have been used in veterinary medicine for many years and remain an important part of the arsenal that our profession can call upon to fight pain. Opioids function as effective analgesics either alone or in combination with other classes of analgesics. They are important for management of significant pain occurring in chronic conditions such as cancer or for perioperative and postoperative patients, producing patient comfort.

The Canadian Veterinary Medical Association (CVMA) created a document called Opioids: Risk Evaluation/Mitigation Strategies in Veterinary Medicine to be used as a brief summary of current knowledge and best practices, as a potential reference for the veterinary health care team, and as a resource for further discussions. The document is not intended to be a policy paper, a position statement nor a standard for legal use. Find the document under the Practice & Economics tab on the CVMA website (www.canadianveterinarians.net).

Carrefour des ressources sur la santé et le bien-être des vétérinaires

Dans la profession vétérinaire, le stress et le danger de l’épuisement à long terme sont importants tandis que risque de suicide est inquiétant parmi les vétérinaires. Que vous soyez étudiant, professeur, propriétaire de pratique ou vétérinaire salarié, les longues heures, la lourde charge de travail et un mauvais équilibre travail-vie peuvent menacer votre bien-être. C’est pourquoi l’ACMV accorde la priorité à cet enjeu et a conçu une section du site Web afin de fournir l’accès facile à des ressources et à des renseignements pertinents et d’appuyer les vétérinaires et les étudiants en médecine.
Veterinarian Health and Wellness Resource Hub

In the veterinary profession, stress and the danger of long-term exhaustion are significant, and the risk of suicide among veterinarians is disturbing. Whether you're a student, faculty, practice owner, practice manager or associate veterinarian, the long hours, heavy workload, and poor work-life balance can threaten your health and well-being. This is why the CVMA is keeping this issue at the forefront and created a website section to provide easy access to pertinent resources and information from numerous sources to help support veterinarians and veterinary students. Within the 3 sections focussing on emotional and mental health, physical health and veterinarian wellness, you can find modules, video lectures, personalized self-help programs, guides, tips, calculators, and more.

To access the Veterinarian Health and Wellness Resource Hub, visit the CVMA website (www.canadianveterinarians.net) and click on the Practice & Economics tab.

CVMA members receive discounted gym memberships through GoodLife Fitness

Another CVMA Health and Wellness initiative is the CVMA-GoodLife Fitness Corporate Discount Program for CVMA members.

Why it's important to have regular physical activity:
• Weight control
• Prevention or management of health conditions and diseases
• Mood and mental health improvement
• Increasing energy
• Sleep improvement

Why it's important for you and your employees to be active and healthy:
• 60% of Canadians are overweight and 23% are clinically obese. These factors could inhibit work performance and contribute to increased employer costs related to absenteeism, benefit costs and short- and long-term disability leaves.
• Work-related stress — the #1 health risk affecting Canadian employees — is linked to poor health.

A healthier, happier life is one step away. The CVMA corporate membership can save you up to 40% of regular individual membership rates. To view the GoodLife flyer or FAQs or to join now, visit the CVMA website's Member Benefits and Services section (www.canadianveterinarians.net/membership/benefits-services). You will need your CVMA ID number to register. If you do not have or forget your ID number or have additional questions, please contact the CVMA (admin@cvma-acmv.org).
CVMA Welcomes Dr. Marie-Claude Blais to Council

The Canadian Veterinary Medical Association (CVMA) is pleased to welcome Dr. Marie-Claude Blais to Council, as the FMV/AVC representative. Dr. Blais replaces Dr. Kathleen MacMillan whose term ended December 31, 2017. We thank Dr. MacMillan for her work in this role.

Dr. Blais graduated from the Faculté de médecine vétérinaire of the Université de Montréal in 2002. Following an internship at the Centre Vétérinaire DMV in Montreal and an additional year as an emergency clinician, she pursued a specialization at the University of Pennsylvania (2005) with a Fellowship in Transfusion Medicine under Dr. Urs Giger. Dr. Blais subsequently completed a residency in Small Animal Internal Medicine at Tufts University (2008) and became a Diplomate of the American College of Veterinary Internal Medicine that same year.

In August 2008, Dr. Blais returned to the Université de Montréal where she is currently an associate professor in Small Animal Internal Medicine. She is in charge of the Small Animal Blood Bank of the Centre Hospitalier Vétérinaire Universitaire, reflecting her main research interest, all aspects of transfusion medicine. Most recently, Dr. Blais concluded a collaboration agreement with the Canadian Animal Blood Bank, a not-for-profit organization based in Winnipeg, which was founded through the efforts of the Manitoba Veterinary Medical Association (MVMA) and Red River College. This collaboration helps provide high quality blood products to veterinarians throughout Canada.

Dr. Blais is also passionate about the quality of DMV programs and continuing education for veterinarians, reflected by her participation in numerous committees. She is the proud recipient of the Canadian Association of Veterinary Medicine Teaching Award (2010–2011; 2015–2016).
Christine Theoret nommée pour diriger la Faculté de médecine vétérinaire

Le Conseil de l'Université de Montréal a nommé la Dʳ Christine Theoret comme nouvelle doyenne de la Faculté de médecine vétérinaire (FMV) de l'Université de Montréal et elle entamera un mandat de cinq ans dès le 1er juin 2018. Elle remplace le Dʳ Michel Carrier qui occupe le poste de doyen depuis 2010.

«Christine Theoret possède un bagage où se mêlent, de façon assez unique en milieu universitaire, charisme, rigueur scientifique, talent de pédagogue, capacité d'écoute et sens des perspectives organisationnelles», estime le recteur de l'Université, Guy Breton. «Ces traits de personnalité, conjugés à un parcours universitaire impeccable qui lui a acquis l'estime de ses pairs, nous ont convaincus qu'elle était la personne qu'il fallait pour assurer la direction de la seule faculté de médecine vétérinaire francophone d'Amérique et un moteur de l'innovation biotechnologique de la région maskoutaine.»

Diplômée en médecine vétérinaire de l'Université de Montréal et de l'Université de la Saskatchewan, Christine Theoret est professeure titulaire au Département de biomédecine vétérinaire de la FMV depuis 2009. Elle est à la tête du Laboratoire de guérison tissulaire et chercheuse au Groupe de recherche en médecine équine du Québec (GREMEQ). Experte reconnue à l'international dans le traitement des plaies et la régénérescence tissulaire chez le cheval, la Dʳ Theoret a siégé aux conseils consultatifs d'une variété d'entreprises de biotechnologies et d'associations nationales et internationales. Sa contribution exceptionnelle à l'enseignement de la médecine vétérinaire a été récompensée notamment par le prix Carl J. Norden d'excellence en enseignement, qu'elle a reçu à quatre reprises, et par un prix d'excellence en enseignement de l'UdeM.

Le Dʳ Breton a également salué le travail du doyen sortant, Michel Carrier. «Depuis 2010, Michel Carrier a exercé les fonctions de doyen avec aplomb. C'est un gestionnaire chevronné qui a obtenu le renouvellement de l'agrément de la FMV par le Council on Education de l'American Veterinary Medical Association et qui a mené une solide campagne philanthropique. Au nom de la direction de l'Université et du corps professoral, je veux le remercier très chaleureusement du travail qu'il a accompli.»
Developing an evidence-based approach for antimicrobial resistance reporting for British Columbia diagnostic animal health laboratory data

Theresa Burns, Brian R. Radke, Tyler Stitt, Carl Ribble

Abstract — Antimicrobial resistance (AMR) data generated by diagnostic animal health laboratories are underutilized for AMR reporting in Canada. Data assessment, review of practices in other jurisdictions, and expert interviews were used to develop an evidence-guided plan to generate AMR reports from British Columbia Animal Health Centre (AHC) data that would provide transparent, timely, and useful information to public health practitioners, the food animal sector, and the general public. Using the Canadian Animal Health Surveillance Network (CAHSN) platform was the most efficient method of data retrieval. Project outputs included 2 publicly available reports. The public health report included AMR information for methicillin-resistant Staphylococcus aureus, Escherichia coli, and Salmonella. The animal health report included AMR information for Aeromonas salmonicida and Yersinia ruckeri from Atlantic salmon, bacteria from bovine milk samples, and staphylococci from broiler chickens. A preliminary comparison was conducted between selected AHC data and publicly available Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) reports.

Introduction

Antimicrobial resistance (AMR) in bacteria is an increasing concern for both public health and animal agriculture (1,2). Recent Canadian policy prioritizes monitoring and reducing antimicrobial use in animal agriculture as a means to reduce AMR in human pathogens (3). Transfer of genetic determinants of AMR from bacteria in food-producing animals to bacteria in humans has been reported (4,5). For example, recently Escherichia coli isolated from human extraintestinal infections have been shown to be indistinguishable from E. coli in chicken meat, and similarities have been reported in AMR in E. coli from humans and poultry products (6,7).

In Canada, the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) is the primary source of AMR data from food-producing animals. Active sampling from farms, abattoirs, and meat retailers is conducted...
through CIPARS across Canada and CIPARS reports on AMR for *E. coli*, *Salmonella*, and *Campylobacter* (8). The program also reports on AMR in *Salmonella* isolated from sick livestock and horses.

There are 9 publicly funded diagnostic animal health laboratories in Canada. Veterinarians and farmers submit whole animals and tissue samples to these laboratories to identify the cause of illness and poor performance in livestock and poultry. Submissions are routinely subjected to bacterial culture, and antimicrobial susceptibility testing is routinely performed on bacterial isolates. The bacteriology and AMR data generated by animal health laboratories have been identified as another potential source of information about AMR in Canadian food-producing livestock (1,2,9); however, there have been few scientific publications generated from these data (10,11). The benefits of analyzing and reporting AMR data from diagnostic animal health laboratories include the new knowledge created from existing data, the potential for detecting emerging or changing AMR trends earlier and at lower cost than with active surveillance programs (12), and the provision of regional information that might demonstrate the cause/ effect of regional antimicrobial use (AMU) patterns. The capacity for providing regional context might be more useful for veterinarians in clinical practice making decisions on AMU. However, it has also been recognized that isolates from provincial laboratories are more likely to have originated from sick or unthrifty animals that might have already received antimicrobial treatment (12), and caution in extrapolating findings to the larger animal population in a region needs to be exercised (2).

The BC Animal Health Centre (AHC) is BC’s public diagnostic animal health laboratory. The BC AHC has reported AMR in bacterial isolates from milk samples since 2005 as part of the Animal Health Monitor quarterly publication. However, trends over time have not been evaluated, and there has not been routine reporting of AMR from other animal species. In response to a growing interest in establishing and strengthening AMR surveillance systems for animal agriculture (3), a project was initiated to develop an evidence-guided program for routine reporting of AMR from bacterial isolates from the AHC. The first purpose of the project was to use available, previously unutilized data to provide transparent information to public health officials and the general public about AMR in bacterial isolates from the AHC. The second was to provide information to the animal agriculture sector to guide regional AMU decisions, especially for pathogens of specific concern in the major food-producing species in BC. The third was to provide regional AMR data that could, in future, be combined with regional AMU data to assess the relationship between the two. The first task was to gather best-practices information to guide AMR reporting by the BC AHC. Three questions were focused on: i) what animal types, pathogens, and antimicrobials should be included in reports; ii) how data should be analyzed; and iii) how results should be reported. The second task was to select animal/bacteria/antimicrobial combinations to report, develop an acceptable report format, and generate and publish a first round of AMR reports. Results were compared to CIPARS reports to make a preliminary exploration of similarities and differences between the BC AHC and CIPARS data.

### Materials and methods

**Review of AMR reporting programs for isolates of animal origin in other jurisdictions**

A scoping review of the peer-reviewed and gray literature was carried out to examine existing AMR data reporting systems. Publications on systems that use passively acquired animal health data were reviewed, but because these publications did not provide all the information necessary to guide choosing best practices, the review was expanded to include publications that described active surveillance systems for AMR in isolates of animal origin. The methods used by programs to report AMR data were also examined, with a special focus on programs that used alternatives to print style reports, such as searchable webpages. Because only one of the animal health reporting programs identified used non-print style reporting, this portion of the search was expanded to include Canadian human AMR reporting programs.

A list of search strings and inclusion/exclusion criteria was used to retrieve relevant publications using the search engines PubMed, Science Direct, and Google Scholar (Table 1). These 3 electronic databases were chosen for their focus on agriculture, veterinary medicine, and life sciences, and they could be accessed through the Vancouver Island University holdings. If a search string(s) resulted in more than 200 “hits” in any electronic database, only the first 200 most relevant titles were examined for inclusion. Using a combination of researcher prior knowledge, the retrieved peer-reviewed literature, and Google

<table>
<thead>
<tr>
<th>Study type</th>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture system/Population</td>
<td>Livestock production, Aquaculture (finfish), Poultry, dairy, swine, beef, Bison, sheep, goat</td>
<td>Non-livestock</td>
</tr>
<tr>
<td>Time period</td>
<td>Last 5 years (unless key paper)</td>
<td>Prior to 2009</td>
</tr>
<tr>
<td>Language</td>
<td>English (at least abstract)</td>
<td>Non-English</td>
</tr>
<tr>
<td>Study type</td>
<td>Use of AMR Data, Review of AMR monitoring program(s), Review articles, AMR data reporting</td>
<td>General listserves, e-mail distribution lists, chat rooms, electronic versions of textbooks or websites that provide information without a moderator or peer-review process.</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Surveillance methods, AMR data reporting and use</td>
<td>Does not deal with surveillance or reporting of AMR data</td>
</tr>
</tbody>
</table>

### Table 1. Literature review methods.

Search strings for literature review:

(AMicrobial AND resistance AND surveillance); (AMicrobial AND resistance AND surveillance AND report); (AMicrobial resistance AND (review OR evaluate OR evaluation) AND surveillance); and [Reporting AND "AMR OR Antimicrobial resistance"]').

Inclusion and exclusion criteria for the literature review:

<table>
<thead>
<tr>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>English (at least abstract)</td>
<td>Non-English</td>
</tr>
<tr>
<td>Last 5 years (unless key paper)</td>
<td>Prior to 2009</td>
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<tr>
<td>Livestock production, Aquaculture (finfish), Poultry, dairy, swine, beef, Bison, sheep, goat</td>
<td>Non-livestock</td>
</tr>
<tr>
<td>Use of AMR Data, Review of AMR monitoring program(s), Review articles, AMR data reporting</td>
<td>General listserves, e-mail distribution lists, chat rooms, electronic versions of textbooks or websites that provide information without a moderator or peer-review process.</td>
</tr>
<tr>
<td>Surveillance methods, AMR data reporting and use</td>
<td>Does not deal with surveillance or reporting of AMR data</td>
</tr>
</tbody>
</table>
Table 2. Antibiotics included on British Columbia Animal Health Centre antimicrobial resistance testing panels for food-producing animals; and clinical importance of antimicrobials to veterinarians working with 4 major food-producing animal types.

<table>
<thead>
<tr>
<th>Antimicrobial</th>
<th>AHC AMR testing panels</th>
<th>Clinically important&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Swine, Poultry, Dairy, Fish</td>
<td>Swine, Poultry, Dairy, Fish</td>
</tr>
<tr>
<td>Aminoglycosides</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apramycin</td>
<td>MaGm&lt;sup&gt;+&lt;/sup&gt;, AvGm&lt;sup&gt;+&lt;/sup&gt;</td>
<td>Y, Y</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>MaGm&lt;sup&gt;-&lt;/sup&gt;, MaGm&lt;sup&gt;+&lt;/sup&gt;, AvGm&lt;sup&gt;-&lt;/sup&gt;</td>
<td>Y, Y, Y</td>
</tr>
<tr>
<td>Neomycin</td>
<td>MaGm&lt;sup&gt;-&lt;/sup&gt;, Swine, AvGm&lt;sup&gt;-&lt;/sup&gt;</td>
<td>Y, Y</td>
</tr>
<tr>
<td>Cephalosporin</td>
<td>MaGm&lt;sup&gt;-&lt;/sup&gt;, Swine, Milk, AvGm&lt;sup&gt;-&lt;/sup&gt;, AvGm&lt;sup&gt;+&lt;/sup&gt;</td>
<td>Y, Y</td>
</tr>
<tr>
<td>Cefotetor</td>
<td>Milk</td>
<td>Y</td>
</tr>
<tr>
<td>Cephalothin</td>
<td><em>Staphylococcus aureus</em> and <em>S. intermedius</em> isolates only</td>
<td></td>
</tr>
<tr>
<td>Fluoroquinolone</td>
<td>MaGm&lt;sup&gt;+&lt;/sup&gt;, MaGm&lt;sup&gt;-&lt;/sup&gt;, AvGm&lt;sup&gt;-&lt;/sup&gt;, AvGm&lt;sup&gt;+&lt;/sup&gt;</td>
<td>Y, Y</td>
</tr>
<tr>
<td>Folate Pathway Inhibitors</td>
<td>MaGm&lt;sup&gt;-&lt;/sup&gt;, MaGm&lt;sup&gt;-&lt;/sup&gt;, Swine, Milk, AvGm&lt;sup&gt;-&lt;/sup&gt;, AvGm&lt;sup&gt;+&lt;/sup&gt;, Fish</td>
<td>Y, Y, Y, Y</td>
</tr>
<tr>
<td>Triple-sulfas</td>
<td>AvGm&lt;sup&gt;-&lt;/sup&gt;, Fish</td>
<td></td>
</tr>
<tr>
<td>Lincomycydes</td>
<td>MaGm&lt;sup&gt;+&lt;/sup&gt;, Swine, AvGm&lt;sup&gt;+&lt;/sup&gt;</td>
<td>Y, Y, Y</td>
</tr>
<tr>
<td>Pirlimycin</td>
<td>Milk</td>
<td>Y</td>
</tr>
<tr>
<td>Macrolide</td>
<td>MaGm&lt;sup&gt;+&lt;/sup&gt;, Milk, AvGm&lt;sup&gt;+&lt;/sup&gt;, Fish</td>
<td>Y</td>
</tr>
<tr>
<td>Erythromycin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penicillins</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ampicillin</td>
<td>Milk</td>
<td>Y</td>
</tr>
<tr>
<td>Cloxacillin</td>
<td>Milk</td>
<td>Y</td>
</tr>
<tr>
<td>Penicillin</td>
<td>MaGm&lt;sup&gt;+&lt;/sup&gt;, Swine, Milk, AvGm&lt;sup&gt;+&lt;/sup&gt;</td>
<td>Y, Y, Y</td>
</tr>
<tr>
<td>Piperacillin</td>
<td>If requested by submitter only</td>
<td></td>
</tr>
<tr>
<td>Phenicols</td>
<td>MaGm&lt;sup&gt;+&lt;/sup&gt;, MaGm&lt;sup&gt;-&lt;/sup&gt;, Swine, Fish</td>
<td>Y, Y, Y</td>
</tr>
<tr>
<td>Florfenicol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetracyclines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxytetracycline</td>
<td>Fish</td>
<td>Y</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>MaGm&lt;sup&gt;-&lt;/sup&gt;, MaGm&lt;sup&gt;-&lt;/sup&gt;, Swine, Milk, AvGm&lt;sup&gt;-&lt;/sup&gt;, AvGm&lt;sup&gt;+&lt;/sup&gt;</td>
<td>Y, Y, Y</td>
</tr>
<tr>
<td>β-Lactamase/β-Lactamase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inhibitor Combinations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ampicillin-Sulbactam</td>
<td>MaGm&lt;sup&gt;-&lt;/sup&gt;</td>
<td>Y, Y</td>
</tr>
</tbody>
</table>

<sup>a</sup> Antimicrobials included in each testing panel are dependent on animal and bacteria type and include: avian Gram-negative (AvGm<sup>-</sup>); avian Gram-positive (AvGm<sup>+</sup>); mammalian Gram-positive (MaGm<sup>+</sup>); mammalian Gram-negative (MaGm<sup>-</sup>); fish, swine, and milk.

<sup>b</sup> Was the antimicrobial named as clinically important by interviewed veterinarians working in the sector (Y = yes).

searches, a list of existing AMR monitoring systems in North America and Europe that use animal health data was created. Online gray literature for these programs was reviewed and program staff were contacted if more information was needed.

**Stakeholder interviews**

A semi-structured interview tool (Figure 1) was used during in-person or telephone interviews. Researcher prior knowledge purposefully identified the initial interviewees, and a snowball strategy was used to identify subsequent interviewees. In total, 6 public health veterinarians working in AMR (national level, n = 3; provincial level, n = 2; private veterinary laboratory, n = 1) were interviewed; 5 veterinary pathologists and the laboratory director at the AHC; and 8 food or large animal veterinarians practicing in BC (cattle, n = 3; swine, n = 1; poultry, n = 2; fish, n = 1, large animal internal medicine, n = 1). In addition, veterinary pathologists and large animal veterinarians were asked to select the antibiotics they and others in their sector used most often from a list of 32 antimicrobials (Table 2). Responses were anonymized and analyzed descriptively.

**British Columbia AHC data assessment**

Bacteriology data generated by the AHC between January 1, 2007 and December 31, 2015 were reviewed. Sources of isolates included animals submitted for postmortem examination, fecal samples, environmental samples from animal-rearing facilities, and swabs collected by veterinarians in clinical practice. Bacterial isolates were tested for resistance to a panel of antimicrobials, with the specific antimicrobials in a panel determined by the animal type from which the isolate originated (Table 2). Classification of bacterial isolates as resistant or susceptible to antimicrobials was made in accordance with Clinical Laboratory Standards Institute (CLSI) protocols using Kirby-Bauer disk diffusion (13).

The Vetstar Animal Disease Diagnostic System (VADDS; Advanced Technology Corporation; Ramsey, New Jersey, USA) was used to retrieve data for submissions before August 1, 2014, and the Canadian Animal Health Surveillance Network (CAHSSN) data platform was used to retrieve data for submissions between August 1, 2014 and December 31, 2015. During data queries, an understanding was gained of the comparative
strengths and efficiencies of the platforms for obtaining AMR data for reporting.

Data were cleaned, transformed, and analyzed using Microsoft Excel (Microsoft, Redmond, Washington, USA) and Minitab Statistical Software (Minitab, State College, Pennsylvania, USA). A quantitative descriptive statistical analysis (tables and graphs) of the data was conducted to determine the number and types (e.g., tissue, milk, active surveillance) of samples from different animal types, the frequency with which different bacterial species were isolated, and the antimicrobial susceptibility patterns of isolates. Two authors (TB, CR) developed a document detailing multiple options for reporting BC AHC AMR data. Options were based on the characteristics of the AHC data, reporting methods used in other jurisdictions, and stakeholder interviews. Key options included graphical presentation of proportions with calculated 95% confidence intervals (CI), graphical presentation of rolling averages smoothed over various time periods, and regression analysis to look for statistically significant trends over time. The final option for reporting was selected by all authors in consultation with key experts and stakeholders.

Table 3. Summary of antimicrobial reporting programs identified in a literature review.

<table>
<thead>
<tr>
<th>Program name</th>
<th>Data sources</th>
<th>Performs statistical analysis for changing prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS)</td>
<td>Active surveillance along food chain</td>
<td>Yes</td>
</tr>
<tr>
<td>Programme québécois d’antibiosurveillance vétérinaire (Quebec) (MAPAQ)</td>
<td>Passive surveillance in isolates from sick animals</td>
<td>Yes</td>
</tr>
<tr>
<td>United States National Antimicrobial Resistance Monitoring System (NARMS)</td>
<td>Active surveillance along food chain</td>
<td>Yes</td>
</tr>
<tr>
<td>Réseau d’épidémiosurveillance de l’antibiorésistance des bactéries pathogènes animales (RESAPATH) (France)</td>
<td>Passive surveillance in isolates from sick animals</td>
<td>No</td>
</tr>
<tr>
<td>Swedish Veterinary Antimicrobial Resistance Monitoring Program (SVARM)</td>
<td>Passive surveillance in isolates from sick animals</td>
<td>No</td>
</tr>
<tr>
<td>Danish Integrated Antimicrobial Resistance Monitoring and Research Programme (DANMAP)</td>
<td>Active surveillance along food chain</td>
<td>No</td>
</tr>
<tr>
<td>Finnish Veterinary Antimicrobial Resistance Monitoring and Consumption of Antimicrobial Agents (FINRES-vet)</td>
<td>Active surveillance along food chain</td>
<td>No</td>
</tr>
<tr>
<td>Norwegian Surveillance System for Antimicrobial Drug Resistance (NORMVET)</td>
<td>Active surveillance along food chain</td>
<td>No</td>
</tr>
</tbody>
</table>

Comparison of AHC data with the 2013 CIPARS report

At the time of analysis, the 2013 CIPARS report was the most recent available. If information in the CIPARS report was relevant to the selected animal-bacteria-antimicrobial combinations, the proportion of resistant isolates in AHC data and the proportion of resistance isolates reported by CIPARS for isolates from various sources (retail meat, chick placement, preharvest, abattoir) were examined. Count data available in the CIPARS report were used to calculate the mean proportion of isolates resistant, and the 95% CI for the calculated proportion (Bonferroni method). These were then displayed graphically beside AHC proportions and confidence intervals. If multi-year AHC and BC specific CIPARS data were available, the 95% CIs were examined for how the proportions of isolates resistant to the selected antimicrobials overlapped between the 2 data sources.
Results

Review of AMR reporting programs for isolates of animal origin in other jurisdictions

Eight sources of AMR reports from across North America and Europe were found (Table 3). The CIPARS reports provide a quantitative descriptive statistical analysis of resistance in *E. coli*, *Salmonella*, and *Campylobacter* isolates obtained by active sampling from various sampling streams including on farms, at abattoirs, and at meat retailers across Canada. Results are presented by sampling stream, rather than by food chain value (i.e., farm through to retail meat). Sampling strategies used in the active surveillance program are designed to minimize clustering (8). A CIPARS report includes resistance and minimum inhibitory concentrations for a number of bacteria-antimicrobial combinations, as well as the proportion of multi-class-resistant isolates (8). Changes in proportion resistant are assessed by comparing current results to the previous year and the year surveillance began for each specific bacteria-antimicrobial combination using logistic regression models with year as an independent categorical variable and proportion resistant as the outcome variable. CIPARS also reports on resistance in *Salmonella* isolates from sick animals forwarded to the CIPARS laboratory from provincial diagnostic animal health laboratories. CIPARS does not perform statistical analyses for temporal changes in AMR from

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### Table 3. Results of AMR reporting programs for isolates of animal origin in other jurisdictions

<table>
<thead>
<tr>
<th>Source</th>
<th>Sampling Stream</th>
<th>2013</th>
<th>All years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Health Centre</td>
<td>CIPARS chick placement (BC)</td>
<td>366</td>
<td>2600</td>
</tr>
<tr>
<td></td>
<td>CIPARS preharvest (BC)</td>
<td>43</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>CIPARS abattoir (all Canada)</td>
<td>92</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>CIPARS retail meat (BC)</td>
<td>174</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>CIPARS reports ciprofloxacin, AHC reports enrofloxacin.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>Animal Health Centre</td>
<td>65</td>
<td>466</td>
</tr>
<tr>
<td></td>
<td>CIPARS chick placement (BC)</td>
<td>43</td>
<td>2600</td>
</tr>
<tr>
<td></td>
<td>CIPARS preharvest (BC)</td>
<td>92</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>CIPARS abattoir (all Canada)</td>
<td>174</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>CIPARS retail meat (BC)</td>
<td>65</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>CIPARS reports ciprofloxacin, AHC reports enrofloxacin.</td>
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</tr>
</tbody>
</table>

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**Figure 2.** Comparison of BC Animal Health Centre and CIPARS data for 2013 and all years for AMR in *E. coli* isolates from broiler chickens.
Salmonella acquired from sick animals, as the source population and number of samples per herd are unknown, and the forwarding of samples is voluntary.

The Ministère de l’Agriculture des Pêcheries et de l’Alimentation du Québec (MAPAQ) produces annual reports on AMR patterns from passively acquired diagnostic animal specimens in Quebec (14). For poultry, the report includes E. coli, Staphylococcus aureus, Salmonella spp. and Staphylococcus hyicus. For cattle, the report includes Salmonella spp., Mannheimia haemolytica, E. coli, Histophilus somni, and Pasteurella multocida, as well as for mastitis-specific S. aureus and coliforms. For swine, the report includes Streptococcus suis, E. coli, Salmonella spp., S. hyicus, Actinobacillus pleuropneumoniae, and P. multocida. For each animal and bacterial species combination, MAPAQ performs a weighted linear regression with proportion resistant as the dependent variable and year as the independent variable. The regression measures whether the slope of the predicted line is different from zero with a P-value of 0.10.

The United States National Antimicrobial Resistance Monitoring System (NARMS) includes active sampling from farms, abattoirs, and meat (15). The AMR pattern for a particular sample source (e.g., chicken, ground turkey, ground beef, or pork chop) is analyzed using a mixed logistic regression model with year (2002 through 2012) as a fixed effect to detect trend, and laboratory site as a random intercept. They do not report on passively acquired animal health data or resistance patterns in isolates from sick animals.

In France, the Réseau d’épidémiosurveillance de l’antibiorésistance des bactéries pathogènes animales (RESAPATH) network is made up of 63 public and private veterinary laboratories and is part of a larger network that includes human and animal laboratories. Their reports include all submissions from sick animals to diagnostic laboratories in France. Submissions include samples from a wide range of livestock, farmed fish, and small animals (16). Major animal species are broken down for reporting into animal type based on age, production class, and system affected. Antimicrobial resistance profiles (% resistance) for all bacteria with > 30 isolates per animal type are reported. Multi-drug resistance of E. coli isolates to 5 antibiotics is reported, namely cefotiofur, gentamicin, tetracycline, and trimethoprim-sulfonamide in combination, and either enrofloxacin or marbofloxacin.

The Swedish Veterinary Antimicrobial Resistance Monitoring group (SVARM) reports annually on resistance patterns from bacteria isolated from clinically ill livestock, salmon, and pets (17). Samples are submitted passively, with intermittent active, enhanced surveillance when findings support it. For swine, the report includes E. coli (virulent, gastrointestinal only), Brachyspira hyodysenteriae, Brachyspira pilosicoli, A. pleuropneumoniae, and Pasteurella spp. For cattle, the report includes E. coli from diarrheic calves and milk, as well as Klebsiella pneumoniae and S. aureus from milk samples. For farmed fish, the report includes Aeromonas salmonicida subsp. aeroemegenes, Flavobacterium columnare, and Flavobacterium psychrophilum. It also provides data from horses (E. coli, Streptococcus zooepidemicus, and S. aureus), dogs (E. coli, Staphylococcus pseudintermedius, Pseudomonas aeruginosa), and cats (E. coli).

In the Danish Integrated Antimicrobial Resistance Monitoring and Research Programme (DANMAP), isolates from diagnostic submissions are specifically collected for E. coli O149 from diarrheic pigs (18). DANMAP also monitors AMR in E. coli, Enterococcus, and Salmonella using active surveillance of meat and live cattle, swine, and broilers.

The Finnish Veterinary Antimicrobial Resistance Monitoring and Consumption of Antimicrobial Agents (FINRES-vet,
2011) group reports on AMR data from *E. coli* isolated from pigs with enteritis and *S. pseudintermedius* isolated from canine clinical infections (19). They also report on active surveillance of food-producing animals for *Salmonella*, *E. coli*, *Enterococcus*, and *Campylobacter*.

The Norwegian Surveillance System for Antimicrobial Drug Resistance (NORMVET) reports results for clinical isolates of *S. pseudintermedius* in dogs (20). In meat and food-producing animals, active surveillance is used to estimate the prevalence of resistance in *Salmonella*, *Campylobacter*, *Y. enterocolitica*, *E. coli*, *Enterococcus*, and *Shigella flexneri*.

Most systems produced online documents (primarily in PDF format) specific to data reporting that included a combination of text and graphs (e.g., CIPARS, NARMS). Reports generally included all bacterial species in 1 document (e.g., NARMS, SVARM, RESAPATH). Some reports integrated human and animal data (e.g., CIPARS, DANMAP), although most reported them separately. Two searchable webpages presented AMR data: the Canadian Antimicrobial Resistance Alliance (CARA) interactive data display CAN-R (www.can-r.ca) and the NARMS interactive data display. The CAN-R interactive data display allows users to access tables showing pathogens isolated, proportion of isolates resistant to various antibiotics, and antibiotic usage from a sample of Canadian tertiary care hospitals. The NARMS interactive data display allows users to see graphs of proportion resistant to various antibiotics for *Salmonella* and *Campylobacter* isolates from humans, retail meats, and food animals by year, and multidrug resistance among *Salmonella* isolates (21).

**Stakeholder interviews**

All public health veterinarians named CIPARS, MAPAQ, DANMAP, and NARMS reports as sources of veterinary AMR data and regularly reviewed 1 or more reports. Veterinary pathologists and veterinarians in private practice were less familiar with AMR reports (able to name 2 or fewer sources of veterinary AMR data), and none regularly reviewed AMR reports. Interviewees said that the ease of finding the information they needed would be the key factor in their decision to use AMR reports.

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**Figure 4.** Comparison of BC Animal Health Centre and CIPARS data for 2013 and all years for AMR in *E. coli* isolates from pigs.
*Figure 5.* Comparison of BC Animal Health Centre and CIPARS data for 2013 and all years for AMR in *Salmonella* isolates from broiler chickens.

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>All years&lt;sup&gt;g&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Ceftiofur</strong></td>
<td></td>
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<tr>
<td>Animal Health Centre</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>CIPARS chick placement (BC)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>CIPARS clinical isolates (all Canada)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>182</td>
<td></td>
</tr>
<tr>
<td>CIPARS preharvest (BC)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>CIPARS abattoir (all Canada)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>CIPARS retail meat (BC)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td><strong>Fluoroquinolone</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animal Health Centre</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>CIPARS chick placement (BC)&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>CIPARS clinical isolates (all Canada)&lt;sup&gt;b&lt;/sup&gt;</td>
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<td></td>
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<tr>
<td>CIPARS preharvest (BC)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>68</td>
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<td>CIPARS abattoir (all Canada)&lt;sup&gt;d&lt;/sup&gt;</td>
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<tr>
<td>CIPARS retail meat (BC)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>33</td>
<td></td>
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<tr>
<td><strong>Sulfamethoxazole</strong>&lt;sup&gt;f&lt;/sup&gt;</td>
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<td>Animal Health Centre</td>
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<td>CIPARS chick placement (BC)&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>CIPARS clinical isolates (all Canada)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>182</td>
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<tr>
<td>CIPARS preharvest (BC)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>68</td>
<td></td>
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<tr>
<td>CIPARS abattoir (all Canada)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>CIPARS retail meat (BC)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>33</td>
<td></td>
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<tr>
<td><strong>Trimethoprim</strong></td>
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<tr>
<td>Animal Health Centre</td>
<td>24</td>
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<td>CIPARS chick placement (BC)&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>CIPARS clinical isolates (all Canada)&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>CIPARS preharvest (BC)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>68</td>
<td></td>
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<tr>
<td>CIPARS abattoir (all Canada)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>CIPARS retail meat (BC)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>33</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> CIPARS (8) p. 85. Twelve isolates were *S. Enteritidis*, these were all pan-susceptible. The most frequently isolated serovar showing resistance was *S. Kennedy* (3).

<sup>b</sup> CIPARS (8) p. 108. Thirty-nine isolates were *S. Enteritidis*, these were all pan-susceptible. The most frequently isolated serovars showing resistance were *S. Heidelberg* (20), *S. Kentucky* (32) and *S. Serengeti* (4) and *S. Muenchen* (3).

<sup>c</sup> CIPARS (8) p. 88. Thirty-one isolates were *S. Enteritidis*, these were all pan-susceptible. The most frequently isolated serovars showing resistance were *S. Kentucky* (11) and *S. 4,5,12:i-ii* (3).

<sup>d</sup> CIPARS (8) p. 66. For 2013, 14 isolates were *S. Enteritidis*, these were all pan-susceptible. The most frequently isolated serovars showing resistance were *S. Kentucky* (31) and *S. Livingstone* (8).

<sup>e</sup> CIPARS (8) p. 40, 46. For 2013, fifteen isolates were *Salmonella* Enteritidis, these were all pan-susceptible. The most frequently isolated serovars showing resistance were *S. Kentucky* (8) and *S. Heidelberg* (5).

<sup>f</sup> CIPARS reports ciprofloxacin, AHC reports enrofloxacin.

<sup>g</sup> Data has been combined for all available years. For BC AHC, years included are 2007 through 2015. For CIPARS abattoir, years included are 2003 through 2013. For CIPARS Retail Meat, years included are 2007 through 2013.

Error bars show 95% confidence intervals for the mean (calculated using the Bonferroni method).

n/a — Not available.

**Figure 5.** Comparison of BC Animal Health Centre and CIPARS data for 2013 and all years for AMR in *Salmonella* isolates from broiler chickens.
use any AMR report. All interviewees expressed concern that AMR reports using data should contain appropriate context to allow users to understand that AMR in laboratory submissions may differ from that in source populations, and the drivers of change in prevalence for laboratory data.

For public health, highest priority was given to reporting AMR data for *Salmonella*, *E. coli*, *Campylobacter*, and methicillin-resistant *S. aureus* (MRSA).

For animal health, animal types of interest to veterinarians included Atlantic salmon, dairy cattle, and broiler chickens. These choices reflect the relatively large size of these sectors in BC’s animal agriculture, and the geographic concentration of these farm types near the AHC. Interest in specific pathogens was dependent on the type of animal. For aquaculture, veterinarians prioritized *A. salmonicida*, *Y. ruckeri*, and *Vibrio anguillarum*. For dairy cattle, mastitis causing bacteria were of highest interest. The Gram-positive bacteria of interest were *S. dysgalactiae*, *S. uberis*, *S. aureus*, and coagulase-negative staphylococci. *Escherichia coli* was the major Gram-negative bacterium of interest. For broiler chickens, veterinarians were interested in penicillin resistance in *Staphylococcal* spp.

**British Columbia AHC data assessment and AMR reports**

Data sufficient for AMR reporting could be obtained by querying both the VADDS and CAHSN systems. Retrieving AHC AMR data was more efficient using CAHSN than VADDS for 3 main reasons: i) it was simpler to design and edit queries using CAHSN, ii) CAHSN queries could be conducted remotely, so did not require use of limited AHC technology resources, and iii) the CAHSN system was able to retrieve data in ≤ 15 s in response to all data queries undertaken during the project.

Based on the review of food animal AMR reporting programs, stakeholder interviews, and preliminary analysis of AHC data, short, simple AMR reporting templates were developed, with one report targeted to public health and another to animal health. Tables present number of isolates tested and prevalence, and graphs present yearly prevalence data, with 95% CIs for prevalence calculated using the Clopper-Pearson exact binomial method. Reports also included brief descriptive commentaries to highlight data limitations and key findings.

**Public health**

Methicillin-resistant *Staphylococcus aureus*, *E. coli*, and *Salmonella* were selected for inclusion in public health reports. *Campylobacter* was excluded because routine aerobic culture methods used at AHC do not isolate *Campylobacter*, so there were no available data. Full results for these animal-bacteria-antimicrobial combinations for 2007 to 2015 are publicly available in the AHC Antimicrobial Resistance Report for Veterinary Public Health (22).

**Animal health**

For *A. salmonicida* and *Y. ruckeri* isolated from Atlantic salmon, resistance to florfenicol, oxytetracycline, and sulfathion-trimethoprim were selected for reporting because these antimicrobials are included in routine AMR testing protocols for fish samples at the AHC, and are licensed for aquaculture use in Canada. There were insufficient *V. anguillarum* isolates for reporting.

For dairy cattle, AMR results from *S. dysgalactiae*, *S. uberis*, *S. aureus*, coagulase-negative staphylococci and *E. coli* from milk were selected for reporting. For the Gram-positive bacteria, resistances to ceftiofur, cloxacinfl, penicillin G, and pirlimycin were chosen for reporting because they are clinically important.

**Figure 6.** Comparison of BC Animal Health Centre and CIPARS data for 2013 and all years for AMR in *Salmonella* isolates from turkeys.

\[\text{Table:} \]

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Ceftiofur</td>
<td>14</td>
<td>39</td>
</tr>
<tr>
<td>Fluoroquinolone</td>
<td>14</td>
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<td>Tetracycline</td>
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<td>36</td>
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</tbody>
</table>

\[\text{Figure 6:} \]

Comparison of BC Animal Health Centre and CIPARS data for 2013 and all years for AMR in *Salmonella* isolates from turkeys.
and are included in routine AMR testing protocols for milk samples. For *E. coli*, resistances to ceftiofur, sulfa-trimethoprim, and tetracycline were chosen for reporting for the same reasons.

Penicillin resistance in *Staphylococcus* spp. isolated from broiler chickens and broiler breeders was selected for reporting because there was a clinical impression that resistance might be increasing.

Full results for these animal-bacteria-antimicrobial combinations for 2007 to 2015 are publicly available in the AHC Antimicrobial Resistance Report for Animal Health (23).

**Comparison to CIPARS data**

Sufficient data were available to create graphs showing AHC and CIPARS AMR data for *E. coli* in broiler chickens (Figure 2), turkeys (Figure 3), and pigs (Figure 4) and for *Salmonella* in broiler chickens (Figure 5) and turkeys (Figure 6). No AHC fluoroquinolone data were available for pigs.

For *E. coli*, data on fluoroquinolone resistance in BC were available for chickens and turkeys for both AHC and CIPARS isolates. Overall, 2% (62/3202) of AHC isolates (chickens: *n* = 2600, all years; and turkeys: *n* = 602, all years), and zero (0/668) CIPARS isolates originating from BC (chickens: chick placement: *n* = 43, 2013 only), preharvest: *n* = 92, 2013 only), and retail meat: *n* = 466, all years, and turkeys: retail meat (67, 2013 only) were resistant to fluoroquinolones.

For ceftiofur, sulfa-trimethoprim (SMT) and tetracycline, multi-year CIPARS *E. coli* data specific to BC were available for chicken and pig retail meat samples. Sample sizes were larger for chickens than for pigs. For ceftiofur, the 95% CI of the proportion resistant overlapped for BC AHC and CIPARS BC retail meat samples for both species (chickens: AHC 95% CI: 0.34 to 0.38; CIPARS 95% CI: 0.38 to 0.48; and pigs: AHC 95% CI: 0.08 to 0.14; CIPARS 95% CI: 0.04 to 0.10). For SMT, the 95% CI overlapped for chickens (AHC 95% CI: 0.10 to 0.12; CIPARS 95% CI: 0.06 to 0.11), but not for pigs (AHC 95% CI: 0.23 to 0.32; CIPARS 95% CI: 0.02 to 0.07). For tetracycline, AHC isolates had higher resistance than CIPARS isolates for both species (chickens: AHC 95% CI: 0.53 to 0.57; CIPARS 95% CI: 0.39 to 0.49; and pigs: AHC 95% CI: 0.81 to 0.88; CIPARS 95% CI: 0.26 to 0.40).

For *Salmonella*, data on fluoroquinolone resistance in BC were available for chicken and turkeys for both AHC and CIPARS isolates. There was no fluoroquinolone resistance (0/481) in AHC isolates from poultry (chickens: *n* = 387, all years; and turkeys: *n* = 94, all years), or in CIPARS isolates from all available BC specific sampling streams (0/454, all years); chickens: chick placement (17, 2013 only), preharvest (68, 2013 only) and retail meat (330, all years); and turkeys: retail meat (39, 2013 only). For ceftiofur, SM, and tetracycline, multi-year CIPARS *Salmonella* data specific to BC were available for broiler chicken retail meat samples. Confidence intervals for resistance to ceftiofur and tetracycline were slightly lower in AHC than in CIPARS isolates (ceftiofur: BC AHC 95% CI: 0.13 to 0.20, CIPARS 95% CI: 0.26 to 0.36; and tetracycline: BC AHC 95% CI: 0.12 to 0.19; CIPARS 95% CI: 0.21 to 0.30). Resistance to SM was low in both data sources (BC AHC 95% CI: 0.00 to 0.01; CIPARS 95% CI: 0.00 to 0.01).

**Discussion**

The literature review showed that at least 5 European countries are reporting on AMR using diagnostic animal health laboratory data. In Canada, only Quebec is using diagnostic animal health laboratory data to generate routine AMR reports.

A triangulation technique, in which a review of reporting in other jurisdictions, stakeholder interviews, and the amount and type of BC AHC data was used to i) generate a specific list of animal, bacteria, and antimicrobial combinations that were best candidates for reporting using available AHC data, and ii) select a method to visually represent the yearly prevalence of AMR for the selected combinations. Tests for statistical significance were not included in reports because of concerns that users of reports might focus on statistically significant differences, and might fail to carefully review the data limitations section that detailed the possible drivers of apparent changes in AMR prevalence in passive surveillance data. A first round of reports was generated using data from 2007 to 2015. For public health, the report provides a transparent source of AMR information that can be accessed by public health and the general public. For animal health, the report provides information that directly addresses the needs for animal agriculture sectors of regional importance in BC. Data provided in these reports can be easily customized or expanded in the future to meet changing needs of public and animal health.

The time and technical challenges to retrieve data from the AHC laboratory information system (LIMS) were identified as barriers that had precluded previous analysis and reporting. These barriers might also exist in other provinces. CAHSN provided an easier to use alternative to the provincial LIMS system, and CAHSN could be quickly and reliably queried to retrieve real-time data (24). In addition, the CAHSN system allowed retrieval of anonymized data, eliminating the need for post-retrieval anonymization, thereby further reducing data security concerns.

Robust surveillance systems include multiple surveillance components. Examining passively acquired AHC data with actively and passively acquired CIPARS data provided a comparatively low-cost method to use existing data to increase AMR surveillance in BC. When interpreting the data obtained from the CIPARS and AHC components, it is important to note differences between CIPARS and AHC data, which include: i) CIPARS implements an active, random sampling strategy, while AHC relies on passive sample procurement; ii) CIPARS samples are obtained from a larger portion of the food production continuum (live animals through abattoir to retail meat); iii) some CIPARS results are national and not specific to BC; and iv) AHC isolates are more likely than CIPARS isolates to originate from individuals that are sick or unthrifty, and might be more likely to have received antimicrobial treatment.

Preliminary findings from examining the AHC and CIPARS components together by food chain value, provide new information, which might be valuable for future surveillance activities. For example, during the survey of experts, interviewees expressed a common concern that using data from sick animals might lead to erroneously high estimates of AMR. Given the limitation
of small sample sizes for some sample types, general similarities between AHC and CIPARS AMR for commodity chains indicate that this assumption warrants further examination. In humans, most AMR samples come from diagnostic samples. As another example, AHC data added evidence to support CIPARS data showing very low resistance to fluoroquinolones in Enterobacteriaceae. However, the lack of AHC AMR data for Campylobacter was an important limitation to interpretation. Improving capacity for assessing and reporting AMR in Campylobacter might add public health value to AHC’s work. As a final example, examining AHC and CIPARS data side-by-side graphically illustrates that cefotiofur resistance appears higher in AHC than in CIPARS Enterobacteriaceae isolates from turkeys, as well as that the CIPARS program was restricted to retail meat during 1 year (2013). The comparison suggests that if a detailed review of AHC data shows limited sampling bias (i.e., AHC data represent multiple premises over many years), increasing active surveillance for cefotiofur AMR in turkeys in BC might be of comparative priority.

In conclusion, a rational approach was developed to regularly report AMR in passively acquired bacterial isolates from a Canadian provincial diagnostic animal health laboratory. Reports were generated shortly after results were available, allowing ongoing and timely analysis of AMR. These reports accessed a previously untapped source of information about AMR in BC and provided the capacity to customize the reports to address specific regional issues.

Acknowledgments
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References
Reflections on the provision of veterinary services to underserved regions: A case example using northern Manitoba, Canada

Caroline Boissonneault, Tasha Epp

Abstract — Rural, remote, and Indigenous communities often contend with free-roaming dog populations, increasing the risk of aggressive dog encounters, particularly dog bites and fatal dog attacks. This qualitative survey gathered a range of perspectives to ascertain the current veterinary services available in rural, remote, and Indigenous communities of northern Manitoba, as well as needs, barriers to, and considerations for future veterinary care provision. Survey results indicated terminology such as “overpopulation” and “rescue” need to be carefully considered as they may have negative connotations for communities. While veterinary services such as vaccination and deworming are important for public health, most programs were focused on sterilization. There was consensus that conversations must begin with individual communities to determine what services are needed and how to fulfil those needs. Perceived barriers include the remoteness of communities, finances, and culturally different views of veterinary medicine. Recommendations for future delivery of services include increased frequency and funding of current models, while others focused on different methods of delivery; all of which will require further discussions within the veterinary community and with other stakeholders.

Introduction

In Canada, humans living in rural or remote communities, particularly Indigenous populations, are at increased risk of adverse health outcomes due to exposure to and infection with certain pathogens, including agents of tuberculosis, HIV/AIDS, and select zoonoses (1–4). Social determinants of health, such as poverty, poor nutrition, unemployment, and substandard housing contribute to the pronounced risk of adverse health outcomes seen in Indigenous, particularly on-reserve communities (5–8). These determinants also affect the health and welfare of animals that are kept as companions or for work (5). Since most of the population of Canada lives in the southern portion of the country, near the American border, it should be no surprise that services to more northern rural or remote communities are

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In the past, dogs were used as sled dogs within northern communities in the Canadian prairies (12). In 2007 fatal dog attacks were more common in rural and remote areas (24/28 deaths) compared to urban areas (4/28 deaths), with 11 of the 24 non-urban deaths happening in aboriginal reserve communities in the Canadian prairies (12).

In many communities, there is a large number of free-roaming dogs [defined as domesticated dogs that are not confined to an owner’s home or property (16)]. They may be owned, but allowed to roam freely, or may be strays (previously owned but lost or abandoned) (16). “Community dogs,” for which more than one individual or household in the community claims ownership, may be owned or strays but are dependent on humans for resources to ensure their survival and reproduction, and therefore, may be more willing to approach people in the community (14,16). A feral dog is defined as one that is born in the wild, lives and fends for itself with little to no socialization with humans; a state that is not common in communities in Canada (2,14,17). Free roaming and community dogs are more likely to form packs, threaten, injure, or kill children or adults (10,17), chase or kill livestock/wildlife, and are of primary importance for rabies control in about half of the countries in the world (14,16,18). This makes dog management in northern communities an important public health concern.

Several northern communities manage their dog issues by culling dogs at what are sometimes called “dog-shoot days” (10,16). This strategy is a short-term solution that “disturbs pack social order, creates empty ecological niches, and does nothing to promote dog health or welfare or community well-being” (10). In addition, it may have profound psychological impacts on community members, particularly those performing the culling. Reducing the number of sexually intact females does have a stabilizing effect on the dog population (if 70% to 85% of females in a population are spayed) and has been used in developing countries particularly as a component of rabies prevention plans (14,16,18). Research has found that education and communication are important to relay the significance of spaying/neutering in dog population management efforts (10,14). While many researchers feel that veterinary services, such as dog spaying and neutering, may help prevent dog attacks (14), no studies have proven that it is the surgical alteration alone that causes a decline in dog bites or fatal encounters within a community.

Veterinary services can be cost-prohibitive or unavailable in northern communities, and have decreased uptake because of distrust of outsiders or limited knowledge of the need for veterinary services (10,11). Also, because of different cultural views regarding deworming, vaccinating, and spaying/neutering dogs, veterinary services may not be acceptable for some Indigenous groups (10,11). Of note, Schurer et al (10) argued that improving access to veterinary service in northern (Indigenous) communities by offering subsidized spay/neuter clinics was a contentious issue, and unlikely to be the only solution to improving public health and animal welfare concerns. Other factors hindering veterinary service delivery in northern communities include logistical challenges such as housing, road access, specific buildings in which to operate community clinics, and veterinary staff’s perceptions of the physical and cultural environment (e.g., access to potable water, acceptance of veterinary team) (11,14). Further to this, some local veterinary clinics may be reluctant to provide free/low cost services as they don’t believe it addresses the underlying issues of dog husbandry and welfare and is unsustainable for their livelihood (10).

The purpose of this study was to conduct a qualitative survey focused on veterinary services for Manitoba northern communities. The objective was to gather various perspectives to fully ascertain the current veterinary services available to northern communities of northern Manitoba. In addition, perceived needs, perceived barriers to, and considerations for developing future veterinary care provision were explored.

Materials and methods

This study was designed to explore the range of current services, and opinions on the barriers to use of, and perceived veterinary service needs of northern communities. Qualitative interviewing methods were used to gain the broadest responses possible from a range of participants residing or working within communities in northern Manitoba, Canada (Figure 1). For the purposes of this paper, community includes the various residents, settings, and jurisdictions that exist between on- and off-reserve communities in the Prairie provinces, with particular reference to northern communities as defined by the Government of Manitoba (19,20). Ethics approval was obtained from the University of Saskatchewan’s Behavioral Research Ethics Board.

An initial list of contacts was obtained from Manitoba Health’s One Health committee, which has animal and public health representatives who work in, reside in or work with northern Manitoba communities. This pool of potential participants was collected based on whether contacts were working/residing in northern communities, or travelled to one of these communities in a professional capacity/volunteer basis. The remaining contacts were obtained through referrals by study participants.
participants, with particular emphasis on anyone who could provide context of residing in or working in northern communities, or travelling to provide health or veterinary services to northern communities. Each participant was either telephoned or e-mailed to ascertain their level of interest in participation. Participant contact was initiated on August 5, 2016 and continued until October 21, 2016.

Participants were asked to complete a semi-structured telephone interview governed by 4 basic areas of interest: community issues affecting animal health and use of services; current animal health services offered; barriers to veterinary or animal health services; and considerations for new programs for northern or underserved communities. However, participants were also offered the option of an e-mailed open-ended questionnaire covering the same topics. There were 2 versions of the interview/questionnaire: 1 designed for veterinarians (Veterinarian), and the other for participants working with or residing in northern communities (Non-veterinarian). Two attempts were made to contact a person. If the invitation to participate was sent out and no response was received 3 wk later, a follow-up e-mail or telephone call was made. Subsequently, if no response was received, no more attempts were made to contact the individual. Participants were not asked to self-identify as Indigenous and if this information was offered it was not included in the analysis due to confidentiality.

Telephone interviews were recorded, with the participant’s permission, and then transcribed. For e-mailed questionnaires, participants were e-mailed with follow-up questions in the

Figure 1. The geographical extent of northern Manitoba. A set of communities is indicated for visual reference. An inset is provided to orient readers to the location of the province in Canada.
case of unclear responses or ideas expressed. Once transcribed, all voice recordings were permanently deleted. All participant responses were kept as anonymous as possible by removing names or e-mail identification when data were analyzed. Both transcripts and emailed responses were coded using a coding key which was created using 5 sample participants’ responses to gather the major sub-themes within each main theme as determined by the objectives of the research as described. The sub-themes were determined by coalescing like ideas into 3 to 4 overarching concepts per theme. Quotes were used to highlight concepts and ideas as expressed by the participants.

Results
There was a total of 13 participants out of 34 persons contacted (response rate of 38%); 9 by telephone and 4 by e-mail. Veterinary participants included 6 veterinarians and 1 member of a veterinary regulatory body. Non-veterinarian participants included 2 Animal Protection Officers (APOs), 2 public health professionals, and 2 animal rescue organization members. Five of the seven veterinarians resided in southern Manitoba, and 2 resided in northern Manitoba. Of the 6 non-veterinarian participants, 3 were residents of northern Manitoba, and 3 had work-related or service provision connections to specific communities in the north. Unfortunately, no northern community residents without ties to public or animal health were interviewed in this survey.

Community issues affecting animal health and use of services
Socio-economic factors indirectly affecting animals
Participants mentioned many socio-economic factors they had seen within communities that they felt could act as barriers to animal owners seeking veterinary services, such as a lack of resources, poverty, inadequate infrastructure, and high cost of living. One non-veterinarian participant noted the impoverished and difficult life experiences, including addictions, stating it was no surprise that “once you get a segment that is so impoverished, the kids and animals will suffer.” It is evident that there may often be more pressing issues that must first be addressed to help improve the well-being of everyone.

Relationship/community involvement
Community involvement in new programs as well as relationship building were stated as critical by all to working specifically with Indigenous communities; this is particularly important as most participants were not residents of the north. One participant with several years of volunteer experience noted that just going to “do the preaching and the teaching….you won’t get anywhere…been there done that…” Rather, the approach taken to overcoming this “helicoptering in” mentality was to focus first and foremost on building strong relationships and trust within the communities.

Perceptions of dog over-population and animal welfare
Some participants were adamant that dog “over-population” was an irrefutable issue in communities with the lack of sterilization by animal owners as the cause. On the other hand, other participants believed that it may not be an issue of “over-population” but rather an issue of animal husbandry, namely free-roaming of dogs. Over-population was defined differently by different participants, ranging from too many dogs to too many free-roaming dogs. Non-veterinarian participants provided statements that included “free-roaming,” “stray,” and “not regularly fed,” which commented on the changing management and perceived cultural shift of the place of dogs within communities. Four non-veterinarian participants and 1 veterinary participant explained that dogs in northern communities were often very thin, had heavy parasite loads including lice, and did not appear to have adequate shelter according to the “world view” of how dogs should be kept. “Dog shoot days,” more aptly termed culling of problem free-roaming dogs, were mentioned by all non-veterinarian participants as common methods used for dog population management in northern communities. Such terminology should be used cautiously as it can be misinterpreted, resulting in condemnation for communities trying to humanely deal with a present danger.

Public health concerns
Four non-veterinarian participants and 1 veterinary participant had concerns with the potential for dogs forming packs that could become aggressive with one another or to humans. One non-veterinarian participant noted that there had been a recent dog attack incident on a human within a northern region which prompted community leaders to approve a “dog shoot day.” Further to this, another non-veterinarian participant stated that there are “a few cases every year that are caused by an attack by 1 or more dogs… where they have that pack-like, survivalist attitude.” There are also concerns with the level of rabies vaccination coverage among dogs in these northern communities, with the same participant stating that although most dogs “….were not immunized, it would be safer for everyone in the community if more animals were immunized for rabies.” Although most temporary clinics offered immunization against rabies, only 1 non-veterinarian and 1 veterinary participant responded that public health education on the risks of rabies was needed. As well, 1 non-veterinarian participant raised the concern for those children playing with the community dogs as there were severe parasite loads in animals within that community.

Current animal health services offered
When assessing the current services being offered to northern communities, 2 main types were considered: veterinary services being offered by veterinarians, often in conjunction with animal rescue organizations, and other health-related services provided to the community by public health professionals and Animal Protection Officers (APOs). It should be noted that Thompson, Manitoba has the northernmost fully equipped, permanently established veterinary clinic in Manitoba. Participants remarked that animals from many remote communities are sometimes driven or flown into Thompson for care. As well, owners can also opt to fly their animals to Winnipeg, Saskatoon, or Edmonton to receive veterinary care. It was difficult to separate the service providers, the services provided, and the reasons
<table>
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<th>Service provider</th>
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| Temporary veterinary clinics and animal rescue groups | Veterinary participants | • Immunization against rabies, parvovirus, distemper  
• Sterilization (spay/neuter or contraceptive implants)  
• Treatment of wounds and minor problems such as ear infections  
• Treatment for ectoparasites such as lice or mange, general deworming, and heartworm testing  
• Treatment of malnutrition | • Temporary clinics varied in length between 2 to 3 days, sometimes up to a week  
• Most veterinarians went to communities on average 1 to 2 times per year, with 1 example of an established mobile clinic operating within a community more regularly | • Veterinary participants offered their services on a volunteer basis  
• Procedures were done on a fee for service basis to try to offset the operational costs  
• Resources and planning required for these clinics were substantial, as all equipment had to be brought into the communities  
• A few communities covered the full costs of the clinics for all their community members |
| Animal rescue groups | | • “Save dogs” by providing low-cost, temporary veterinary clinics to remote communities, through conventional surgical means or contraceptive implants on females  
• Build long-lasting relationships with community members — “go-to person”  
• Bring resources such as dog food as the cost to purchase and have it shipped up north is considerable  
• Educate community members on basic animal husbandry by providing coloring books and other educational materials for children | • Frequency and length of time that rescue organizations operated were irregular and dependent on availability of funds | • Temporary clinics were in great part subsidized by fundraising by affiliated animal rescue organization(s), while community animal owners paid what they could  
• Other services were covered by fundraising efforts of the affiliated rescue groups |
| Other health-related service providers | Animal protection officers (APOs) | • APOs have authority to enforce the Animal Care Act anywhere throughout Manitoba including remote and northern communities  
• Investigate concerns of neglected or abused animals which might include inadequate food or water, lack of adequate shelter, lack of adequate medical attention if injured or ill, or abandonment | • APOs visit northern communities regularly but are also dispatched upon a complaint being submitted, at which time they could go and retrieve the animal if necessary | • APOs are a public good and are appointed by the Province of Manitoba  
• Costs incurred from seizing or treating an abused animal are the responsibility of the owner upon claiming |
| Communicable disease officers | | • Investigate all animal-related human exposure incidents (bites or disease transmission) for the northern region, beginning with a verification of whether the animal had previously received veterinary care (mobile or at the Thompson Veterinary Hospital) and was up-to-date on its rabies immunizations. This may be directly with a veterinary clinic or through the APOs  
• Animals with out-of-date rabies immunization are referred to the nearest veterinary clinic for follow-up | • If rabies was a concern in bite incident history, follow-up with the owner about any changes in the animal’s behavior or health preceding the incident or in the following 10 days. If there were difficulties in interpreting the animal’s health status, a veterinarian would be consulted; however, this was unlikely to happen as most incidents reported are considered at low risk for rabies | • This is a public good and is paid for through provincial health services |
behind providing those services, so the following is a summary of the motivations for and services currently provided by each provider group.

**Temporary veterinary clinics and animal rescue groups**

There was mention of many veterinary clinics and/or rescue organizations having gone to several specific communities in northern Manitoba as well as Nunavut, some only being accessed by winter road, airplane, or boat. All of the veterinary participants residing in southern Manitoba had gone to northern communities on several occasions to volunteer their services in addition to working in a private practice in southern Manitoba (Table 1). The veterinary services offered varied, with minimally resourced clinics often only providing immunizations/deworming while those with greater resources also offering sterilization services (Table 1). Telephone consultations were often provided to animal owners post-clinic visit and were also available on an as-needed basis for all community members, although this may not have been well-known among community animal owners.

According to both veterinary and non-veterinary participants, animal rescue organizations reportedly had similar objectives (Table 1). A main component of animal rescue work consisted of building rapport with the community’s Chief and Council to seek their permission for the temporary veterinary clinics, and to build strong relationships and reliable contacts within each community who could assist in the planning and gathering or act as resources for temporary clinics and as a “go-to person.” All the veterinarians who had participated in a temporary veterinary clinic said that without this contact person, planning these events would be nearly impossible. As 1 participant noted, “Our visits completely depend on a rescue group taking interest and raising funds to allow us to visit a community. They also establish rapport with the local Council and get the OK for the clinic.”

Overall, the main reasons behind these temporary clinics can be summed up as follows: “We try to fix as many animals as we can while up there … It’s 1 less source of dogs and puppies Winnipeg has to contend with because rescue organizations don’t have to bring them down to the city to have them fostered.” There were concerns raised by both veterinary and non-veterinary participants with how some of the animal rescue organizations may operate outside of the temporary veterinary clinic collaborations. For example, there was a perception (or perhaps a misconception) that rescue organisations go into northern communities and “just gather as many free-roaming dogs as they can” and bring them to Winnipeg to be spayed/neutered with the purpose of adopting them out. The concept of “rescuing” was contentious; if the animals are not voluntarily offered for rehoming this action could strain existing relationships formed with other communities or community members.

**Animal protection officers and public health professionals**

The Office of the Chief Veterinary Officer (CVO) oversees enforcement of provincial animal welfare legislation called The Animal Care Act (21) (Table 1). Any sick or injured animals could be brought by an APO to a location where they can receive veterinary care, and all other “stray” animals are housed in the local dog confinement facility (if the community has one) until they can be claimed by their owners. If the animal is not claimed within a set period of time (up to 3 mo), the animal is brought to the Winnipeg Humane Society or taken by an animal rescue group for adoption. In cases of an animal-related human exposure (bites or disease transmission), the Communicable Disease Coordinator for the north becomes involved (Table 1).

**Barriers to accessing services**

**Remote/ness/access**

All but 2 participants agreed that remoteness and poor access to some of the northern communities were barriers to both the community seeking veterinary services and veterinary services coming into the community. All participants noted how northern communities were often located far from the nearest veterinary clinic and could only be accessed by boat, plane or winter road. On the other hand, the 2 participants who did not agree thought that it was not an issue of accessibility, but rather a “lack of will of the animal owner to bring their pet in for veterinary care.” This showcases the different opinions that exist, some of which may need to be dispelled before trusting relationships between communities and providers of services can be cultivated.

**Perception of veterinary medicine/cultural differences**

All veterinary participants and some of the non-veterinarian participants perceived differences in cultural values of animals, specifically for Indigenous people, as a barrier to accessing veterinary services. “They are very uncomfortable with veterinary services like spaying and neutering their animals. Animals fit differently in their lives compared to non-Indigenous people.” Two veterinary participants felt that offering temporary veterinary clinics could be misconstrued as imposing Western values on Indigenous cultures, which was deemed to be worse if strong connections had not been made with community members. Finally, 3 participants who reside in northern Manitoba specifically commented that it may not have been well-known to animal owners that veterinary services could be accessed or how to access them. Focus should be made on identifying specific community member perceptions concerning veterinary medicine as these comments may not be truly representative. However, once perceptions are more concretely identified, a good communication plan that identifies services and the value that they provide to the animal would be prudent for all northern communities.

**Financial and logistic concerns**

The perceived financial barriers to accessing veterinary services in northern communities were two-fold. First, temporary veterinary clinics were resource-intensive and logistically difficult to plan. Subsequently, the costs associated with veterinary services were seen as a potential and significant barrier for individuals/communities to implement. However, there was some ambiguity by participants on who should bear the costs of providing veterinary services. About half of the participants said that the onus
should be on the animal owner to pay for veterinary services, while others put the onus on community leaders or community organizations and recommended that fundraising be done or resources put aside for regular temporary veterinary clinics. As 1 non-veterinarian participant said, “... these (veterinary services) shouldn't be free. They should be low-cost, yes, but not free. Otherwise, people won't see the value in what they're getting.” While all participants thought that more funding was needed to assist in offsetting the costs, 2 veterinary participants specifically stated that the provincial government should provide the grants.

Considerations for new programs
Veterinary services moving forward
All but 2 participants stated that veterinary services in northern Manitoba were inadequate and identified increased basic veterinary services as important needs within northern communities. In view of these needs, most participants (11/13) stated that the frequency of temporary veterinary clinics should be increased, i.e., quarterly or bi-annual visits by veterinary teams to some regions would be sufficient.

Responsibility for programs
One veterinary participant indicated it was first necessary to determine what community members perceived as their primary objective with the establishment of a new program, be it to reduce animal bite incidents, reduce the risk of rabies or manage a perceived dog ‘over-population’ issue. All participants stressed the importance of community involvement in these programs, from the initial needs identification to development, implementation, and finding of resources. One veterinary participant noted that what was lacking were veterinarians wanting to play a leadership role; veterinarians who could demonstrate initiative in providing services to northern communities.

Factors other than veterinary services
All participants said that community dog-related by-laws were also required to address concerns of animal husbandry, e.g., free-roaming dogs. Three non-veterinarian participants further elaborated, suggesting that restrictions be put on the number of dogs allowed, promotion of tethers and dogs on personal property, requirement of mandatory sterilization and immunizations, or even not allowing unvaccinated dogs into the community. It was also noted that either an APO or local by-law officer was needed to enforce any established by-laws.

All 6 veterinary and 4 non-veterinarian participants recommended education, which should include education on the benefits of veterinary services, especially sterilization; other topics could include basic animal husbandry, risk of rabies and other public health issues, animal training such as “puppy classes,” and workshops on how to safely interact with dogs. Such education would have to be done in a culturally sensitive manner due to the cultural differences present in different community settings. One non-veterinarian participant suggested that there should be more collaboration among public health professionals, veterinarians, and community members to address the variety of perceived needs.

Innovations for provision of veterinary services
One veterinary participant recommended that the Health of Animals Act should be modified to allow APOs, nurses, emergency medical services personnel, and other designated community members to vaccinate for rabies. Currently, the federal Health of Animals Act only allows licensed veterinarians to administer rabies immunizations to animals, with a provision for lay vaccinators who have undergone training by the Canadian Food Inspection Agency. It was stated that such provisions should also include immunizations for parvovirus and distemper, and administration of dewormers. Other suggestions included the promotion of telephone consultations with veterinarians in non-serious cases, which would help to build rapport and increase awareness of veterinary issues among community members.

One non-veterinarian participant suggested veterinary stations, very similar to nursing stations, could be established and operated in rotation by various veterinarians coming in from out of town. Another recommendation put forth by a veterinary participant, echoed by a non-veterinarian participant, was to have veterinary students and animal health technologists train and practice their skills in northern communities. Currently, there are a few learning opportunities available for veterinary students interested in working in northern communities; however, it is not a mandatory part of the curriculum. If integrated into the curriculum, it was felt that veterinary schools could help promote and build a sustained interest for northern community work among new veterinarians. Such programs would also raise awareness of the socio-economic situation in some of these northern communities and foster an appreciation for Indigenous cultures. It was noted that a similar endeavor has proven successful among medical residents in Manitoba, whereby the medical school has promoted the rewards of working in northern community early on in their academic training.

Discussion
This qualitative survey provided an overview of the current range of veterinary services available to remote northern communities in Manitoba. It also highlighted the participants’ perceptions of barriers to accessing veterinary services, and of community issues that might influence access to veterinary services. Although the sample size was small, it did represent a variety of public health and animal health individuals working, residing, or travelling on a frequent basis into these northern communities. It unfortunately is lacking the perspectives of the potential service users who reside in the communities.

It is evident that terminology used by groups visiting communities will need to be addressed and defined. There was no consensus among participants on whether dogs need to be “rescued” and whether there is an “over-population” issue in northern communities. However, whether there is an “over-population” issue should not be determined by outsiders to the communities in the north but rather by the communities themselves. It is important for a community to define the dog-related issues that are present within its boundaries before committing resources to any new population management program (22). In addition, while reducing the number of dogs in a community...
may assist in decreasing the likelihood of fatal dog attacks or aggressive encounters, it is likely this will only be effective in conjunction with education, by-laws, and other community engagement (22,23). It was refreshing to find that participants sought and valued community participation in all aspects from defining the issues to determining the solutions.

Perceived community issues were mostly associated with existing socio-economic situations and the associated hardships faced by community members and their pets on a daily basis. Brook et al (11) identified animal welfare as a perceived issue in several northern Indigenous communities, of which the major sources of mortality for dogs in remote northern communities included being hit by vehicles, being shot (culled), exposure (often puppies), starvation, dehydration, and infectious diseases such as parvovirus infection and distemper; all of which are preventable (4,11). Several studies have also identified issues related to zoonotic parasites, for example *Echinococcus*, in northern communities with large free-roaming dog populations (2–4,10,11,24). Often, a fatality within the community stimulates an immediate desire to react. It is therefore important to find mechanisms for provision of services in areas lacking veterinary services; however, veterinary-based solutions may not be the best nor first course of action for all of these dog-related issues.

Veterinary services such as vaccination and deworming are important from a public health perspective. Routine vaccination of domestic dogs began in 1940, making wild animal reservoirs and unvaccinated dogs in contact with rabid wildlife the greatest risk for rabies in Canada (25,26). The principle variant and vector of rabies in most of the prairies (Alberta, Saskatchewan, and Manitoba) is the skunk; however, the picture presented historically and by present day provincial rabies surveillance suggests that some northern Manitoba communities may be at relatively low risk (27). Although some human cases of rabies have been prevented with post-exposure treatment for animal bites, it costs a considerable amount of money for each high risk bite case, which would be reduced if the offending animal was immunized. Therefore, rabies vaccination should be considered as part of any community program as a form of public health protection even in low-risk areas.

Participants outlined the needs they believed northern communities had and provided recommendations and considerations for existing and new programs, all of which will require further discussions within the veterinary community. Based on the current method of delivery, given the issues of logistics and finances mentioned by participants, it is highly unlikely (given the vastness of Canada’s north) that all communities lacking services could be serviced using the existing volunteer model. The idea of connecting veterinary services with a public health focus may lead to innovative ways to service all areas of the north effectively. It will be imperative that the veterinary community first works towards understanding the service needs and then explores the best methods available to meet those needs.

Throughout, participants voiced concerns that communities must have involvement in all phases of the program — needs identification, program development, implementation and evaluation — and that this was critical for the success of any endeavour. This is encouraging as it places the emphasis on community-driven management rather than an “imposed” plan of action. It was also evident when speaking to participants with several years’ experience working in northern communities that there were particular challenges; specifically, that it was a multi-faceted issue, requiring a collaborative, culturally sensitive approach involving community members, community leaders and all other stakeholders.

References

Chronic Disease Management for Small Animals, 1st edition


A first of its kind, this text serves as a handy desk reference to assist with chronic disease case management. What makes this book unique is that it provides not only a concise review of chronic diseases, but also an emphasis on the quality of life issues affecting both the patient and the caregiver.

The first section, in this author’s opinion, should be mandatory for all veterinarians, no matter how long they have been in practice. “Communication, Caregiving and Chronic Disease” highlights the importance of effective communication with clients and covers verbal and non-verbal cues.

The body of the text covers a multitude of specific chronic diseases from all body systems. Each chapter, written by a different specialist in their respective field, has a similar format and includes a succinct overview of the disease, including diagnosis and therapy, and ends with a quality of life evaluation. Most of the chapters are extremely well-written and easy to read. “Chronic Diseases of the Eye and Adnexa” and “Heart Disease” are notable for their thoroughness and inclusion of high quality photographs. “Managing Mobility” is especially helpful considering the importance of mobility in geriatric pets. It provides a thorough review of the emerging field of rehabilitation and sports medicine, including a look at the latest available diagnostics and integrative therapies.

The weakest chapter was, by far, “Chronic Kidney Disease.” Considering the prevalence of kidney disease in senior cats, this chapter was noticeably thin and dated compared to other topics in this text. For example, there is no mention of the implications of the renal biomarker symmetric dimethylarginine (SDMA) or the use of calcitriol. Lacking also is a chapter on feline cognitive dysfunction, although the canine topic is covered. Following editions will benefit from more stringent editing to round out some topics and correct grammar and spelling mistakes.

The final topic, “Hospice Care and End of Life,” takes an in-depth look at the challenges and benefits of hospice care and euthanasia. It includes information on how to guide and support not only patients but clients as well through difficult end-of-life issues.

So often as veterinarians we focus on the patient and the disease, neglecting the physical and emotional toll on the caretaker. This text focuses on using expert communication to support the human-animal bond and will be an invaluable guide for the recent graduate. The structured layout and comprehensive review make it a beneficial resource for the seasoned practitioner as well.

Reviewed by Kathy Kramer, DVM, Associate Veterinarian, Vancouver Animal Wellness Hospital, 105 East Broadway, Vancouver, British Columbia V5T 1W1.
Total intravenous anesthesia using a midazolam-ketamine-xylazine infusion in horses: 46 cases (2011–2014)

Turi K. Aarnes, Phillip Lerche, Richard M. Bednarski, John A.E. Hubbell

Abstract — This study evaluated use of midazolam, ketamine, and xylazine (MKX) for total intravenous (IV) anesthesia (TIVA) in horses. Medical records of 46 horses undergoing a clinical procedure using MKX for TIVA were reviewed. Age, breed, procedure, heart rate (HR), respiratory rate (RR), pre-anesthetic drugs, induction drugs, and total volume of MKX were recorded. Duration of anesthesia, time to standing, number of attempts to stand, and recovery score were also recorded. All horses were premedicated with an alpha-2 adrenoceptor agonist and anesthesia was induced with ketamine and midazolam. Duration of MKX infusion was 33 ± 14 min. Heart rate and RR decreased during the infusion of MKX. Time to endotracheal extubation was 19 ± 12 min. Horses stood at 33 ± 13 min. Median number of attempts to stand was 1. Maintenance of anesthesia of horses with MKX was useful for a variety of procedures and recovery from anesthesia was good.

Résumé — Anesthésie intraveineuse totale à l’aide d’une infusion de midazolam-kétamine-xylazine chez les chevaux : 46 cas (2011–2014). Cette étude a évalué l’usage du midazolam, de la kétamine et de la xylazine (MKX) pour l’anesthésie intraveineuse (IV) totale (AITT) chez les chevaux. Les dossiers médicaux de 46 chevaux subissant une intervention clinique à l’aide de MKX pour l’AITT ont été évalués. L’âge, la race, l’intervention, la fréquence cardiaque, la fréquence respiratoire, les médicaments pré-anesthésiques, les médicaments d’induction et le volume total de MKX ont été consignés. La durée de l’anesthésie, le délai pour se tenir debout, le nombre de tentatives pour se tenir debout et la note de rétablissement ont aussi été consignés. Tous les chevaux ont reçu une prémédication avec un agoniste alpha-2 adrénocepteur et l’anesthésie a été induite avec de la kétamine et du midazolam. La durée de l’infusion de MKX a été de 33 ± 14 min. La fréquence cardiaque et la fréquence respiratoire ont diminué durant l’infusion de MKX. Le délai jusqu’à l’extubation endotrachéale a été de 19 ± 12 min. Les chevaux se sont tenus debout à 33 ± 13 min. Le nombre médian de tentatives pour se tenir debout était de 1. Le maintien de l’anesthésie chez les chevaux avec MKX était utile pour une diversité d’interventions et le rétablissement de l’anesthésie a été bon.

Introduction

Total intravenous anesthesia (TIVA) is a common anesthetic technique used in horses for procedures such as castration and laceration repair. The use of TIVA is facilitated using drugs that minimally depress cardiovascular and respiratory function because advanced equipment such as ventilators and blood pressure monitors, and additional technical support are often not available in field situations.

Solutions of guaifenesin, ketamine, and alpha-2 adrenoceptor agonists are commonly used for TIVA in the horse (1). Guaifenesin-ketamine-xylazine combinations have been studied extensively (2–5). This combination produces acceptable arterial blood pressure, mild to moderate hypoventilation, and good quality of recovery to standing (2). Guaifenesin solutions are no longer commercially available in the United States, Canada, Australia, and New Zealand. Reconstitution of guaifenesin powder into solution is time consuming and problems of precipitation out of solution have been reported (6). Additionally, guaifenesin solutions may induce hemolysis and thrombosis (6,7).

The benzodiazepine-midazolam may be a suitable alternative for guaifenesin for TIVA in the horse. Midazolam is water-soluble and when combined with ketamine, both drugs maintained potency for up to 97 h (8). Midazolam was investigated for use in combination with ketamine and xylazine for TIVA in Thoroughbred mares undergoing palmar digital nerve surgery (9). Midazolam was administered at a rate of 0.002 mg/kg.
body weight (BW) per min, ketamine at a rate of 0.03 mg/kg BW per min, and xylazine at a rate of 0.016 mg/kg BW per min. Heart rate (HR), arterial blood pressures, cardiac output, and respiratory rate (RR) did not change from awake values during 70 min of anesthesia. Recovery from anesthesia was good with all horses standing on the first attempt (9). The combination appeared useful, but the study was limited in scope because of the homogenous population undergoing the same procedure. The objective of the present study was to describe the use of midazolam, ketamine, and xylazine (MKX) for maintenance of anesthesia in horses undergoing various clinical procedures and to evaluate its clinical suitability.

**Materials and methods**

Anesthetic records for all horses that underwent short-term anesthesia using MKX for TIVA between October 2011 and February 2014 were evaluated. Data obtained included age, breed weight, gender, procedure, pre-anesthetic drugs, anesthetic induction drugs, duration of infusion of MKX (defined as the start of infusion administration to cessation of infusion), duration of anesthesia (defined as time from administration of anesthetic induction drugs to cessation of MKX), and additional drugs administered. Heart rate and RR were recorded before anesthesia and at up to 5 time points (depending on duration of anesthesia): 10, 20, 30, 45, and 60 min. Time to standing (defined as the time from end of MKX infusion to standing), number of attempts to stand, and overall recovery score were also obtained.

Food, but not water, was withheld from horses for all planned procedures for approximately 6 h before anesthesia. All horses had a physical examination completed before anesthesia and an IV catheter was placed in a jugular vein using aseptic technique for drug administration. The horses’ mouths were washed with water using a dosing syringe before induction of anesthesia.

Horses were sedated and all horses weighing more than 200 kg were positioned behind a hinged restraining door in a padded induction/recovery stall for induction of anesthesia. Horses weighing less than 200 kg were guided to recumbency and incurs minor injury; 2 = several weak attempts to stand and marked instability once standing; 6 = several weak attempts to stand and marked instability once standing; 7 = several weak attempts to stand, horse resumes recumbency, and minor shifting is observed once standing; 8 = several weak attempts to stand, horse falls easily or resumes recumbency and incurs minor injury; 9 = several violent attempts to stand, horse falls or resumes recumbency and incurs minor injury; and 10 = several violent attempts to stand, horse resumes recumbency, and major injury is incurred by horse or personnel (9). Heart rate and RR were recorded after standing while the horse remained in the recovery stall.

As many of the surgical procedures were less than 45 min in duration the 45- and 60-minute periods for HR and RR data were not analyzed. Descriptive statistics were calculated for each time period. Heart and respiratory rates were analyzed using Friedman test with a Conover’s post-hoc test using MedCalc (MedCalc Statistical Software version 17.6, MedCalc Software, Ostend, Belgium). The 95% confidence intervals (CIs) for differences between medians were also calculated. Statistical significance was set at $P < 0.05$. 

**Anesthesia**

Anesthesia was maintained using MKX, which was made by adding midazolam (West-Ward, Eatontown, New Jersey, USA), 25 mg, ketamine (Vetakaet; Akorn, Decatur, Illinois, USA), 650 mg, and xylazine (Anased; Akorn), 325 mg, to a 500-mL bag of 0.9% saline. Administration began after the horse was positioned on the surgery table. The infusion was administered to effect using a 10 drop/mL drip set based on clinical signs of depth of anesthesia including palpebral reflex, corneal reflex, spontaneous blinking, lacrimation, muscle tension, horse movement, and change in respiratory rate, depth, or pattern. At the discretion of the anesthetist, additional drugs were administered as an IV bolus if the horse’s depth of anesthesia indicated movement was imminent or if spontaneous movement occurred.

A base-apex electrocardiogram (ECG) was used to determine heart rhythm. Heart rate was determined by palpation of a peripheral artery. Respiratory rate was determined by observing chest excursions.

The total volume of the infusion that was administered was recorded. The infusion rate of each drug was calculated based on the total volume administered, the weight of the horse, and the duration of infusion. Any local anesthetic technique performed was noted.

At the end of the procedure, horses were transported from the padded table to the padded induction/recovery stall and lowered to the floor with a hobble and hoist system. Horses were positioned in lateral recumbency and the lights were dimmed. Head and tail ropes were used and sedation for recovery was administered at the discretion of the attending anesthetist. The orotracheal tube was removed after the horse attempted to swallow.

The time at which the horses stood and the number of attempts to stand were recorded. The quality of recovery was assessed by the attending anesthetist and scored on a 10-point scale:

- 1 = stands on first attempt with clean effort and no body sway or weight shifting;
- 2 = stands on first attempt with little to moderate effort and slight body sway or shifting;
- 3 = stands on first or second attempt with great effort and marked shifting once standing;
- 4 = 2 or 3 attempts to stand, with a strong effort on the last attempt and slight shifting once standing;
- 5 = 2 or 3 attempts to stand and marked instability once standing;
- 6 = several weak attempts to stand and marked instability once standing;
- 7 = several weak attempts to stand, horse resumes recumbency, and minor shifting is observed once standing;
- 8 = several weak attempts to stand, horse falls easily or resumes recumbency and incurs minor injury;
- 9 = several violent attempts to stand, horse falls or resumes recumbency and incurs minor injury; and
- 10 = several violent attempts to stand, horse resumes recumbency, and major injury is incurred by horse or personnel (9).

Heart rate and RR were recorded after standing while the horse remained in the recovery stall.
Table 1. Median (range) cardiopulmonary variables for 46 healthy horses that underwent total intravenous anesthesia (TIVA) maintained with a midazolam-ketamine-xylazine (MKX) infusion.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Timea</th>
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<tbody>
<tr>
<td></td>
<td>Baseline</td>
</tr>
<tr>
<td>HR (beats/min)</td>
<td>40 (24 to 60)</td>
</tr>
<tr>
<td>RR (breaths/min)</td>
<td>20 (12 to 48)</td>
</tr>
<tr>
<td>Number of horses</td>
<td>46</td>
</tr>
</tbody>
</table>

a Baseline values were obtained the morning of the procedure. Remaining values were obtained from 10 to 60 min after the MKX infusion was started, and 10 min after horses stood during recovery. Times 45 and 60 min were not included in the analysis. 

b Value is significantly different from baseline value.

Table 2. Anesthesia and recovery variables for 46 healthy horses that underwent total intravenous anesthesia (TIVA) maintained with a midazolam-ketamine-xylazine (MKX) infusion.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± SD</th>
<th>Median (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midazolam infusion rate (mg/kg BW per minute)</td>
<td>0.002 ± 0.001</td>
<td>0.0017 (0.0003 to 0.0094)</td>
</tr>
<tr>
<td>Ketamine infusion rate (mg/kg BW per minute)</td>
<td>0.048 ± 0.033</td>
<td>0.042 (0.007 to 0.236)</td>
</tr>
<tr>
<td>Xylazine infusion rate (mg/kg BW per minute)</td>
<td>0.024 ± 0.016</td>
<td>0.021 (0.003 to 0.118)</td>
</tr>
<tr>
<td>Duration of infusion (min)</td>
<td>32 ± 14</td>
<td>30 (10 to 80)</td>
</tr>
<tr>
<td>Duration of anesthesia (min)</td>
<td>39 ± 15</td>
<td>36 (13 to 80)</td>
</tr>
<tr>
<td>Duration of procedure (min)</td>
<td>22 ± 14</td>
<td>19 (5 to 65)</td>
</tr>
<tr>
<td>Time to extubation (min)</td>
<td>18 ± 12</td>
<td>18 (0 to 38)</td>
</tr>
<tr>
<td>Time to standing (min)</td>
<td>33 ± 13</td>
<td>33 (12 to 59)</td>
</tr>
<tr>
<td>Number of attempts to stand</td>
<td>—</td>
<td>1 (1 to 5)</td>
</tr>
<tr>
<td>Recovery score</td>
<td>—</td>
<td>2 (1 to 8)</td>
</tr>
</tbody>
</table>

Ten horses received acepromazine (Vedco, St. Joseph, Missouri, USA), 0.02 ± 0.003 mg/kg BW, IM, morphine (Hospira, Lake Forest, Illinois, USA), 0.06 ± 0.005 mg/kg BW, IM, and xylazine, 0.72 ± 0.16 mg/kg BW, IV, and 1 horse received xylazine, 0.35 mg/kg BW, IV and 0.7 mg/kg BW, IM and acepromazine, 0.02 mg/kg BW, IM. One horse received xylazine, 0.7 mg/kg BW, IV and detomidine, 0.004 mg/kg BW, IV.

Results

Records from 46 horses were included in the study. Breeds included Thoroughbreds (n = 10), Quarter horses (n = 10), Warmbloods (n = 5), Arabs or Arabian crosses (n = 4), American Paint horses or Paint crosses (n = 4), Standardbreds (n = 2), American Saddlebreds (n = 2), Oldenburgs (n = 2), miniature horses (n = 2), Hanoverian (n = 1), Belgian (n = 1), Appaloosa (n = 1), and unknown breeds (n = 2). Age of the horses averaged 6.7 y with a range of 5 mo to 21 y of age. Weight of the horses averaged 430 kg with a range of 98 to 664 kg. Six mares, 15 geldings, and 25 stallions were included in the study. Horses were anesthetized by 5 different anesthetists.

Procedures performed included 19 castrations (1 with an abdominal testicle), 11 bone marrow aspirates, 5 wound/absciss debridement/joint flushing, 3 ophthalmic procedures [tissue plasminogen activation (TPA) factor injection or cyclosporine implants], 2 cast applications, 2 dental procedures, 1 umbilical hernia repair, 2 orthopedic procedures, and 1 myectomy.

All horses were premedicated with an alpha-2 adrenoceptor agonist. Xylazine was administered as the sole sedative in 23 horses at a mean ± SD dose of 0.92 ± 0.16 mg/kg BW, IV, and 1 horse received xylazine (1.05 mg/kg BW, IV) and butorphanol (Torbugesic, Zoetics, Kalamazoo, Michigan, USA), 0.02 mg/kg BW, IV, Romifidine (Sedivet; Boehringer Ingelheim Vetmedica, St. Joseph, Missouri, USA), 0.1 mg/kg BW, IV, was administered to 1 horse and detomidine (Dormosedan; Orion Corporation, Espoo, Finland), 0.01 mg/kg BW, IV, was given to 5 horses. Four horses were premedicated with detomidine, 0.01 ± 0.007 mg/kg BW, IV and 0.02 mg/kg BW, IM, and 1 of these horses also received butorphanol, 0.03 mg/kg BW, IV.

Summary statistics for heart rate and respiratory rate for all horses and for all study periods are reported in Table 1. Median heart rates were lower at times 10, 20, and 30 min compared to baseline (P < 0.05) but were not significantly different between baseline and standing periods. Median respiratory rate was lower at times 10, 20, and 30 min and standing compared with baseline (P < 0.05).

Orotracheal intubation was not performed in 3 horses. Orotracheal intubation was performed in the other 43 horses, but in 2 of these horses the extubation time was not noted on the record. Time to extubation was 18 ± 12 min in 41 horses. Fifteen horses (33%) received boluses of ketamine during the anesthetic period due to insufficient anesthetic depth: 2 (4%) of...
these horses received ketamine immediately after induction and 2 horses (4%) received ketamine during transfer to the recovery stall. Six horses (13%) received additional xylazine: 2 of these horses due to insufficient depth of anesthesia, and 5 of these horses received xylazine as the horse was being transferred to the recovery stall for sedation going into recovery. One horse (2%) received additional xylazine immediately after anesthetic induction. Seven (15%) of the horses being castrated received intratesticular lidocaine (MWI, Boise, Idaho, USA) bilaterally before orchiectomy. Three of these 7 horses also received additional ketamine due to insufficient depth of anesthesia.

Horses stood at 33 ± 13 min after discontinuation of MKX infusion. The median number of attempts to stand was 1. Thirty-eight horses stood on the 1st attempt, 3 horses stood on the 2nd attempt, 4 horses stood on their 3rd attempt, and 1 horse stood on the 5th attempt. The median and mode recovery score was 2. The range of recovery scores was 1 to 8. One horse received a recovery score of 7 and 1 received a recovery score of 8. The horse that received the recovery score of 8 was a 4-year-old Arabian cross undergoing hoof debridement. This horse was extubated 3 min after the infusion ended, received ketamine (200 mg) and xylazine (150 mg) IV while moving to the recovery stall due to assessment of the attending anesthetist that the horse was “too light” (rapid nystagmus, extension of forelimbs). The recovery notes indicate 3 attempts to stand and subjectively described recovery as “very stormy” and the horse as “excitable.” The horse with a recovery score of 7 was a 4-year-old Oldenburg anesthetized for a routine castration. The horse was extubated 17 min after cessation of the MKX infusion, made 4 weak attempts to stand and resumed recumbency until the last attempt to stand 5 min after extubation.

Discussion

Total IV anesthesia using MKX may be a useful alternative to combinations that included guaifenesin. The use of a skeletal muscle relaxant in combination with a dissociative anesthetic, and an alpha-2 adrenoceptor agonist has provided acceptable anesthesia for diagnostic and surgical procedures lasting less than 1 h and provided maintenance of arterial blood pressure, and acceptable respiratory and heart rates. Inclusion of a muscle relaxant reduces muscle rigidity associated with ketamine administration, and when given as a bolus extends the duration of ketamine-induced anesthesia (10). Guaifenesin-ketamine-xylazine (2), midazolam-ketamine-medetomidine (11), and guaifenesin-ketamine-romifidine (12) have been studied to provide TIVA in horses, and the combination of MKX was previously investigated for maintenance of anesthesia in horses undergoing digital nerve procedures (9). In the heterogeneous group of horses studied here, the infusion of MKX provided suitable anesthesia for various surgical procedures.

The duration of TIVA in horses is often limited to an approximately 1-hour duration due to concerns regarding drug accumulation (13). In this study, the mean duration of infusion administration was 33 ± 14 min and the approximate mean infusion rate of midazolam was 0.002 ± 0.001 mg/kg BW per min, of ketamine was 0.048 ± 0.033 mg/kg BW per min, and xylazine was 0.024 ± 0.016 mg/kg BW per min. The infusion rate was adjusted during the procedure by the anesthetist based on clinical evaluation of depth of anesthesia. These rates are similar to those initially investigated by Hubbell et al (9) who administered these drugs for 70 min with no adverse effects noted. Midazolam in the present study was administered during anesthetic induction at a dose of 0.05 ± 0.01 mg/kg BW and subsequently as an infusion. Pharmacokinetics of midazolam after a single bolus of 0.05 mg/kg BW resulted in no change in cardiorespiratory parameters, but did result in swaying and weakness in standing horses (14). Pharmacokinetics of midazolam administered as an infusion in horses have not been studied.

Different sedation protocols were used in the horses in this study and could have affected the results. Some horses received opioids (morphine or butorphanol) and/or acepromazine for sedation and pain, in addition to an alpha-2 agonist for premedication. Opioids may cause excitement in horses and acepromazine has been associated with ataxia (15). While these may have impacted recovery scores, the inclusion of these drugs is common in clinical anesthesia of horses.

Heart rate and RR remained within physiologic ranges for the duration of the infusion; however, heart rate and RR decreased during the infusion compared with baseline. Previous investigation of MKX resulted in no change in HR, cardiac output, or arterial blood pressures (9). Invasive blood pressure was not monitored in these clinical patients.

Total intravenous anesthesia techniques are frequently used in field situations due to the ease of administration and lower cost, and because anesthesia can be provided without the transport of anesthetic machines and oxygen sources. Producing anesthesia without the ability to ventilate the horse or supplement FiO\textsubscript{2} has the potential to compromise ventilation and decrease oxygenation, although reports on the use of TIVA suggest that the levels of hypoventilation and/or hypoxemia associated with TIVA do not compromise patient safety (13). Care should be taken in applying these results to the equine population as a whole because respiratory function was assessed as normal prior to anesthesia in the horses used in most of these studies. Horses with pre-existing disease would probably benefit from supplementation of FiO\textsubscript{2} and perhaps mechanical ventilation, although there is scant evidence that the presence of arterial oxygen tensions in anesthetized horses below values seen in standing horses affects mortality. The largest study on equine mortality associated with anesthesia reports that TIVA is associated with lower mortality rates than inhalant anesthesia (16).

Oxygenation and adequacy of ventilation were not evaluated in these clinical patients through arterial blood gas monitoring; however, in the previous study of MKX, partial pressures of arterial carbon dioxide (PaCO\textsubscript{2}) did not change from baseline values, indicating adequate ventilation while partial pressures of arterial oxygen (PaO\textsubscript{2}) decreased from baseline values during 60 min of anesthesia (9). Intubation was performed, but these horses breathed room air spontaneously (9). This is consistent with another study evaluating midazolam-ketamine-romifidine, in which normocarbia but impaired oxygenation occurred (17). Additionally, a previous study of xylazine, ketamine, and guaifenesin administration reported moderate hypoventilation...
with normal oxygenation in ponies spontaneously breathing oxygen (4). Although healthy anesthetized horses appear to be amazingly tolerant of variations in ventilation and oxygenation, consideration should be given to intubating and ventilating, or providing oxygen supplementation to horses anesthetized with MKX whenever possible.

The retrospective study design is a limitation of the study. Some data were incomplete, such as time of extubation. The lack of standardized anesthetic protocol is a confounding factor for determination of the effects of MKX on depth of anesthesia and recovery.

The clinical nature of the patients included in the study demonstrate that midazolam-ketamine-xylazine infusion is a suitable technique for anesthetizing horses for surgical and diagnostic procedures of 1 hour or less duration while utilizing a variety of anesthetic protocols.

Acknowledgments
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References
Bovine respiratory syncytial virus-specific IgG-1 in nasal secretions of colostrum-fed neonatal calves

John A. Ellis, Manuel F. Chamorro, Stacey Lacoste, Sheryl P. Gow, Deborah M. Haines

Abstract — In order to determine whether nasal secretions of young calves contain passively derived antibodies to bovine respiratory syncytial virus (BRSV) and if there are differences in presence and/or subclass of these antibodies between calves fed different colostrum replacement products, 17 Holstein calves were fed 150 g of IgG in either a sprayed-dried colostrum-based (CR; n = 8) or a plasma-based colostrum replacement product (PR; n = 9) within 6 h of birth. Venous blood and nasal secretions obtained before feeding and at 24 h of age were assayed for total IgG (serum) by radial immunodiffusion and for BRSV-specific total IgG, IgG-1, and IgG-2 by indirect enzyme-linked immunosorbent assay (ELISA). Calves that were fed a CR had higher concentrations of BRSV-specific IgG and IgG-1 in their serum and nasal secretions compared to calves fed product PR; calves fed the PR had higher levels of serum BRSV-specific IgG-2. The only subclass of antibodies detected in nasal secretions was IgG-1. Re-secretion of passive IgG with neutralizing activity, onto the nasal mucosa could contribute to BRSV-associated disease-sparing observed in the laboratory and in the field. Use of PR will result in lower nasal antibodies since IgG-2 is not re-secreted.

Résumé — IgG-1 spécifique au virus respiratoire syncytial bovin dans les sécrétions nasales des veaux néonaux nourris au colostrum. Afin de déterminer si les sécrétions nasales des jeunes veaux contenaient des anticorps dérivés passivement envers le virus respiratoire syncytial bovin (VRS) et s’il y a des différences dans la présence et/ou la sous-catégorie de ces anticorps entre les veaux nourris avec différents produits de remplacement du colostrum, 17 veaux Holstein ont été nourris avec 150 g d’IgG soit sous forme de produit vaporisé-séché à base de colostrum (CR; n = 8) ou d’un produit de remplacement de colostrum à base de plasma (PR; n = 9) au cours des 6 premières heures après la naissance. Du sang veineux et des sécrétions nasales obtenus avant le nourrissage et à l’âge de 24 h ont été analysés pour obtenir la quantité d’IgG totale (sérum) par immunodiffusion radiale et le total des quantités d’IgG, d’IgG-1 et d’IgG-2 spécifiques au VRS par ELISA indirecte. Les veaux qui avaient été nourris d’un CR avaient des concentrations supérieures d’IgG et dIgG-1 spécifiques au VRS dans leur sérum et les sécrétions nasales comparativement aux veaux nourris de produits PR; les veaux nourris d’un PR avaient des niveaux supérieurs d’IgG-2 sérique spécifique au VRS. La seule sous-catégorie d’anticorps détectée dans les sécrétions nasales était l’IgG-1. La re-secrétion passive d’IgG avec de l’activité neutralisante sur les muqueuses nasales pourrait contribuer à l’immunité associée au VRS observée en laboratoire et sur le terrain. L’usage de PR produira des anticorps nasaux inférieurs vu que l’IgG-2 n’est pas re-secrété.

(Traduit par Isabelle Vallières)
Introduction

It is generally accepted that successful passive transfer of maternal antibodies is necessary to avert disease or death in young domestic animals, including calves, which are reared in conventional environments with endemic pathogens (1). Supporting this concept are data indicative of higher morbidity and mortality in calves with failure of passive transfer (2,3).

Bovine respiratory syncytial virus (BRSV) and human RSV (HRSV) are the most important causes of calfhood and childhood pneumonia, respectively (4). Supporting the disease-sparing role of passive immunity in these infections are epidemiologic studies in cattle and humans that document an increasing incidence of RSV-associated pneumonia in individuals at the time when maternal antibodies have decayed (5,6). Moreover, prospective studies of experimental BRSV infections of calves or any species have further substantiated the disease-sparing role of maternally derived antibodies (7).

It is recognized that IgG-1 is the predominant immunoglobulin in the lower respiratory tract of cattle and that this antibody is derived from local production and systemic responses (8). This predominance of IgG subtypes in the secretions of the lower respiratory tract is similar to that in humans (9) and other domestic animal species (10). With regard to RSV’s, BRSV-specific IgG responses have been directly associated with disease-sparing in passively immune (6) and vaccinated calves (11,12). Relatedly, prophylactic systemically administered IgG protects against infection by HRSV in the human lung (13).

In recognition of the vital role of colostrum in protection of newborn calves from infectious disease, there is a large number of colostrum replacement products commercially available to assist producers in ensuring timely and sufficient delivery to calves. While some products are colostrum-based, others are based on whey and/or plasma harvested from slaughterhouse blood. Colostrum products are marketed based on total IgG content; however, the relative abundance of the subclass of antibodies present will differ depending on the source of the IgG used in the product. While colostral antibody is predominantly IgG-1, plasma-based products contain about equal amounts of IgG-1 and IgG-2 (1). While the re-secretion of IgG-1 passive antibodies to mucosal surfaces has been shown, there is no evidence for similar re-secretion for IgG-2 (1).

There is scant information concerning the presence and activity of passively derived pathogen-specific antibodies in the upper respiratory tract, specifically in nasal secretions of young calves or any species. This study was undertaken to examine re-secretion of passive antibodies in the upper respiratory tract of neonatal calves in the context of the most relevant cause of calfhood pneumonia, BRSV, and to compare IgG subclass in calves that had been fed a colostrum-based or plasma-based colostrum replacement product. While colostral antibody is predominantly IgG-1, plasma-based products contain about equal amounts of IgG-1 as a percentage of the mass of total IgG in the plasma-derived product was 47% and that of the colostrum-derived product was 87% (D. Haines unpublished data, 2009). These were the expected levels given the stated sources of the IgG mass in the products and are consistent with what is known about IgG subclass proportions in plasma and colostrum (1). Prior to feeding and at about 24 h of life, calves were sampled for venous blood and nasal secretions. The calves were maintained throughout the study according to the established guidelines of the Canadian Council on Animal Care.

Sample collection

Deep nasal swab specimens were taken from both nares (1 each) using cotton-tipped swabs, handled gently so as to avoid trauma and preclude contamination by blood. Swab specimens were placed in 2 mL of transport medium consisting of Dulbecco’s modified Eagle’s medium supplemented with 10% fetal bovine serum (Invitrogen, Burlington, Ontario), 0.5 M MgSO4, 50 mM HEPES, sodium penicillin G (200 U/mL), streptomycin sulfate (200 μg/mL), and amphotericin B (1 μg/mL), and frozen at −70°C. Serum samples were obtained from blood collected by jugular venipuncture, allowed to clot at room temperature, harvested following 5 min centrifugation at 1500 rpm and stored frozen until thawed for laboratory testing.

Single radial immunodiffusion (SRID)

Serum (diluted 1:4) was assayed for total IgG concentration by single radial immunodiffusion, as previously described (14,15). Antiserum against bovine IgG (H and L chain) was used (Jackson Laboratories, West Grove, Pennsylvania, USA). Previous studies using SRID demonstrated that anti-bovine IgG antibodies target immune-dominant epitopes of the heavy chain C structural regions specific for bovine IgG and different from IgA and IgM (16).

Antibody assays

The BRSV-specific IgG, IgG-1, and IgG-2 enzyme-linked immunosorbent assays (ELISAs) for serum (diluted 1:50) and nasal (diluted 1:2) antibodies were performed as previously described (11,17). Convalescent serum from an unvaccinated calf with naturally occurring BRSV infection was used as a positive standard. High optical density (OD) values (read at 405 nm), relative to a fetal bovine serum negative control,
were obtained with this serum. A pool of nasal secretions from 5 naturally exposed cattle was used as the standard for assays of nasal secretions. Optical density values were converted to ELISA units as previously described (11,17).

Data analysis
All statistics were calculated using a commercial statistics software program (SAS 9.3; SAS Institute, Cary, North Carolina, USA) with an alpha level of 0.05. To detect differences in total IgG in serum and BRSV-specific IgG-1 and IgG-2 antibody titers in serum and nasal secretions over time, the mean total IgG in serum, mean serum BRSV-specific IgG-1 and IgG-2, and mean nasal secretions specific BRSV-specific IgG-1 and IgG-2 antibody titers measured at 0 h (before feeding) were compared with those measured at 24 h of life by the use of repeated-measures analysis in a mixed generalized linear model. Since antibody data (ELISA units) were not normally distributed and variances were not homogeneous between groups, a non-parametric 1-way analysis of variance (ANOVA) (Kruskal-Wallis) test was performed to compare the medians of BRSV-specific IgG-1 and IgG-2 in serum and nasal secretions at each time point (0 h and 24 h, respectively) between treatment groups.

Results
As expected, before ingestion of colostrum or plasma-based colostrom replacements, newborn calves had negligible amounts of immunoglobulin in their sera (plasma-based — median: 0.2 g/L, range: 0.2 to 2.6 g/L versus colostrum-based — median: 0.25 g/L, range: 0.2 to 2.7 g/L) that were not significantly different between groups. At 24 h of age, calves which received 150 g IgG from the colostrum-based product had significantly (P = 0.0002) higher total serum immunoglobulin than the calves which received 150 g IgG from the plasma-based product (colostrum-based — median: 13.80 g/L, range: 12.4 to 19.4 g/L versus plasma-based — median: 9.30 g/L, range: 6.8 to 12.3 g/L).

There were no detectable BRSV-specific antibodies in the serum of calves fed either of the colostrum replacement products in samples taken before feeding. In samples collected at 24 h of life calves fed the colostrum-based product had higher total IgG BRSV-specific antibodies (median: 75.79 ELISA units, range: 60 to 88.35 ELISA units) than those fed the blood-based product (median: 38.0 ELISA units, range: 30 to 61.96 ELISA units) (P = 0.0002).

In samples collected 24 h after feeding, calves fed the colostrum-based replacement product had significantly (P = 0.0005) higher concentrations of circulating BRSV-specific IgG-1 compared to the calves fed the plasma-based replacement (colostrum-based — median: 96.18 ELISA units, range: 69 to 141.03 ELISA units versus plasma based — median: 50.0 ELISA units, range: 13.54 to 57 ELISA units). In contrast, 24 h after feeding, the calves fed the blood-based replacement had significantly higher serum concentrations of BRSV-specific IgG-2 compared with the calves fed the colostrum-based replacement product (blood-based — median: 46.0 ELISA units, range: 37 to 54 ELISA units versus colostrum-based — median: 1.0 ELISA units, range: 0 to 12 ELISA units).

There was negligible BRSV-specific IgG-1 or IgG-2 detected in the nasal secretions in the groups of calves before feeding the colostrum-based replacement product or the blood-based replacement product and no significant differences in these values. There was an increase in BRSV-specific IgG-1 detected in the nasal secretions of calves after feeding either colostrum-based (median: 29.86 ELISA units; range: 3 to 101 ELISA units) or plasma-based (median: 11.43 ELISA units; range: 0 to 25 ELISA units) replacement product; however, the concentrations in the calves fed the colostrum-based product were significantly (P = 0.0002) higher.

There was a negligible increase in BRSV-specific IgG-2 in the nasal secretions of calves after feeding either the colostrum-based (median: 0.0 ELISA units, range: 0 to 14 ELISA units) or the plasma-based (median: 0.0 ELISA units, range: 0 to 19 ELISA units) product, and there was no significant (P = 0.37) difference in these values.

Discussion
These results add to the small database of virus-specific antibody concentrations in nasal secretions of clinically normal passively immune neonatal animals, in the context of arguably the most important respiratory pathogen in calves, BRSV. These results are similar to the one most relevant study, performed over 40 y ago, that documented the presence of IgG in nasal secretions of neonatal lambs after colostrum intake and the inhibitory activity of these nasal secretions on the replication of parainfluenza virus (18).

The source of nasal immunoglobulins in neonates has been somewhat controversial (8). Aside from the exudation of proteins, including immunoglobulin, as a result of capillary permeability during inflammatory processes, there is little precise mechanistic information concerning the transport of immunoglobulin across intact mucosal surfaces in the respiratory tract in clinically normal animals. Ruminants are born essentially devoid of mucosal plasma cells in the nose (8), implying that the nasal immunoglobulin is derived from plasma. One study (19) documented the presence of Fc receptors for IgG in the neonatal bovine lung; however, these receptors were not observed in the trachea, and the nasal mucosa was not examined.

The present study clearly demonstrates the presence of IgG-1 as a result of re-secretion of passive antibody in neonatal calves. The negligible amounts of IgG-2 (compared to IgG-1) in nasal secretions, including calves fed plasma-based replacement product containing significant levels of BRSV-specific antibody, suggest that there is preferential transfer of IgG-1 into the nasal secretions as there is in the lower respiratory tract (8,10) and is further indicative of the predominant role of this subtype in providing immune protection in the respiratory tract.

Regardless of the mechanism of transport, the presence of BRSV-specific IgG-1 in the upper respiratory tract of young passively immune calves has at least 3 practical implications. First, antibody at the site of virus entry could act in concert with virus-specific antibody in the lower respiratory tract to mediate the disease-sparing effect that is associated with adequate transfer of passive immunity as demonstrated epidemiologically and experimentally (4,5,7). Secondly, the source of,
and by extension the subclass of IgG present in the colostrum product fed, is important. Although, as in the present study, equivalent amounts of IgG may be fed, if comparing colostrum and plasma-based replacement products, the latter contains about 50% IgG-2 and as such will fail to deliver the same levels of the most relevant immunoglobulin (IgG-1) to the mucosal surface. Thirdly and conversely, the presence of neutralizing IgG-1 antibody in the nose and pharynx could have an effect on mucosal (intranasal) vaccination of neonatal calves, a management practice that is increasing in popularity. In a recent study we demonstrated significant sparing of BRSV-associated disease in both BRSV seronegative and BRSV seropositive calves that had been vaccinated intranasally at 3 to 11 days of age (12), although the protective response was somewhat diminished in the seropositive calves compared to the seronegative cohort. Those results suggest that some level of inhibition of priming may occur in calves with passive nasal antibody; however, it is certainly less than what has been demonstrated with parenteral delivery of similar modified-live BRSV vaccines when compared to the same experimental model of virulent BRSV infection (20). All together, these results further support the well-established principle of ensuring successful passive transfer to confer disease-sparing in young animals and suggest that colostrum containing almost exclusively IgG-1 will have superior efficacy compared to products using other immunoglobulin sources.

References

NovaVive Inc., an animal health immuno-biology company, today announced that its anticancer immunotherapeutic for horses will be evaluated in a clinical study at Iowa State University (ISU) College of Veterinary Medicine.

Immunocidin® Equine has regulatory approval in the U.S. and Canada for the treatment of equine sarcoid tumors. The study at ISU is focused on standardizing treatment protocols and assessing the product’s efficacy and safety in the treatment of both sarcoids and squamous cell carcinoma. Dr. Stephanie S. Caston, DVM, DACVS-LA, Associate Professor, Equine Surgery, Lloyd Veterinary Medical Center, College of Veterinary Medicine, Iowa State University is the Principal Investigator. Sarcoid and squamous cell carcinoma are two of the three most commonly diagnosed tumors in horses (the third is melanoma).

Sarcoïds can occur in horses of any age. They are most common in adult Quarter Horses and other closely related breeds, but rare in Standardbreds. There are four different forms of sarcoïds and these tumors are often found around the eyes, head/face, neck, chest, and shoulder, and at the site of old scars. It is estimated that sarcoïds affect 1 in 100 horses in North America.

Squamous cell carcinoma is most commonly found in adult to geriatric horses of any breed. It can show up in the form of ulcerative or proliferative masses that look like proud flesh. It is common in un-pigmented (white or pink) areas, such as around the eye or third eyelid and urogenital structures.

Treatment for both types of cancer varies according to type, size, tumor location and economic concerns. Current treatments include surgical removal, chemotherapy, or herbal products however, the tumors often recur. Immunotherapy (with or without surgical de-bulking) is a safe and effective treatment option that is gaining interest in both human and veterinary oncology. Sixty horses will be enrolled in the ISU study.

“Equine skin tumors such as sarcoïds and squamous cell carcinoma can be difficult to treat, as they can reoccur after treatment,” said Dr. Caston. “Our team at ISU Veterinary College is interested in immunotherapy and we are investigating the success rates of new formulations of immunotherapies and novel immunotherapies as well as combination treatments. Performing clinical trials is essential to developing the most effective treatment protocols and understanding the response of different tumors to these therapies. We are looking forward to our collaboration with NovaVive and to testing their product, Immunocidin Equine, to potentially establish new treatment protocols for sarcoïds and squamous cell carcinoma.”

“We are pleased to be working with Dr. Caston and her research team on this project,” said Dr. Aleksandar Masic, Vice-President of Research & Development at NovaVive Inc. “Immunocidin Equine is a potent immunomodulator that we know has good efficacy in the treatment of sarcoïd tumors. We have also seen a handful of squamous cell carcinoma cases where the product has been successfully used which gives us confidence in this indication as well. The additional data generated by ISU Veterinary College may lead to further studies in equine tumors and we expect it will be helpful in providing equine veterinarians with safe and effective options for treating these difficult cancer cases.”

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Equine duodenitis-proximal jejunitis: A review
Luis G. Arroyo, Diego E. Gomez, Candace Martins

Abstract — Duodenitis-proximal jejunitis (DPJ) is an inflammatory process of the proximal part of the small intestine and occurs sporadically in horses. It is clinically characterized by an acute onset of ileus and nasogastric reflux leading to systemic signs of toxemia. This review discusses the definition of the disease, potential etiologic agents, clinical findings, epidemiological features, histopathologic and clinico-pathological findings, and medical management of this condition. Salmonella spp., mycotoxins, Clostridium perfringens, and Clostridium difficile have all been associated with the disease but there is limited supporting evidence for any agent other than C. difficile. Particular attention, however, was given to etiological investigations and the data available to support the proposed etiological agents. The potential role of C. difficile as the etiological agent of DPJ, possible pathogenesis, and recent efforts to support this hypothesis are highlighted, but it is recognized that there could be more than one agent that causes the disease.

Résumé — L’entérite proximale chez le cheval: revision. L’entérite proximale est un processus inflammatoire de la portion proximale du petit intestin qui se présente sporadiquement chez le cheval. Cliniquement, elle est caractérisée par un début soudain d’iléus et de reflux nasogastrique menant à des signes systémiques d’endotoxémie. Cet article discute de la définition de la maladie, des agents étiologiques potentiels, des signes cliniques, des caractéristiques épidémiologiques, des travaux histopathologique et clinique et du traitement médical de cette condition. Salmonella spp., les mycotoxines, Clostridium perfringens et Clostridium difficile ont tous été associés avec la maladie, mais les preuves sont limitées pour tout autre agent que C. difficile. Une attention particulière a été mise sur l’étude étiologique et sur les données disponibles pour supporter les agents étiologiques proposés. Le rôle potentiel de C. difficile comme étant l’agent étiologique de l’entérite proximale, la possible pathogénèse et les efforts récents pour supporter cette hypothèse sont soulignés, mais il est reconnu qu’il pourrait y avoir plus d’un agent causatif de la maladie.

Introduction
Equine duodenitis-proximal jejunitis (DPJ) is an acute intestinal disease characterized by inflammation of the duodenum and proximal jejunum (1–3). Equine practitioners commonly refer to these cases as anterior enteritis; other names in the literature include proximal enteritis, duodenitis, acute ileus syndrome, acute gastric dilatation, cranial enteritis, fibrinonecrotic duodenitis, enteritis or jejunitis, gastroduodenitis, and hemorrhagic fibrinonecrotic duodenitis-proximal enteritis. Some of these names are inaccurate because other parts of the gastrointestinal tract such as the pylorus, stomach, and esophagus can also be affected (2).

Clinically, horses present signs of abdominal pain, decreased or absent intestinal motility, and gastric reflux. The volume of gastric reflux produced by affected horses has been used as a criterion to define DPJ cases but this clinical parameter has not been standardized or agreed upon. For example, one study defined a horse as having DPJ if gastric reflux continued for > 24 h or the amount of reflux exceeded a rate of 3 L/h for > 8 h (4), while another study defined DPJ cases as horses that produced a net volume of > 20 L of gastric reflux/day (5).

Duodenitis-proximal jejunitis was first recognized in Georgia, USA in 1977 and a large number of cases were diagnosed by the early 1980’s. However, there were anecdotal reports of a similar condition described in other states including Florida, Louisiana, Ohio, Pennsylvania, Texas, Kentucky, and California (2,3). Also, a similar problem was reported in Germany around the same time as in the USA (6) and since those original reports, DPJ has been reported in Canada (7), Great Britain (8,9), Iran (10),...
Czech Republic (11), and Colombia and Brazil (12,13). An interesting note is that in 1932 a famous racehorse named Phar Lap died at 6 y of age from a colicky condition of unknown origin (4) and, based on the clinical description and postmortem report, some believe that Phar Lap suffered from and succumbed to DPJ (14,15).

Etiology
An elaborate description of the etiopathogenesis of DPJ has been published under the premise that this condition results from an inflammatory process of the small intestine (16). Clinical or experimental studies investigating the etiology of DPJ are scarce, however, and a causal microbiological agent has not been proved. The following are agents which have been associated with the disease.

Salmonella spp.
Merritt et al (17) proposed Salmonella spp. as the possible cause of DPJ. They describe 2 horses, which had clinical signs compatible with DPJ, hospitalized in a veterinary teaching hospital. In Case 1, a 12-year-old gelding Quarter horse was presented with gastrointestinal signs characterized by dehydration and gastric reflux. The horse was hospitalized and treated with intravenous fluids and stomach decompression. On day 6 of hospitalization, a gastric reflux and fecal sample were submitted for bacterial culture and tested positive for Salmonella group D. In Case 2, an 8-year-old gelding was referred for signs of colic. During hospitalization the horse displayed signs of abdominal discomfort, and had nasogastric reflux and soft feces. Feces (n = 6) and gastric reflux (n = 1) were submitted for bacterial culture. The fecal sample and gastric reflux collected on admission were negative, but subsequent fecal samples cultured positive for Salmonella group E. In Case 2, an 8-year-old gelding was referred for signs of colic. During hospitalization the horse displayed signs of abdominal discomfort, and had nasogastric reflux and soft feces. Neither gastric content nor fecal samples were submitted for culture in this case. The link between the DPJ and salmonellosis was based on the observation that another horse from the same farm had died 5 d earlier with signs of chronic weight loss and diarrhea, and voluminous gastric reflux and soft feces. Feces (n = 6) and gastric reflux (n = 1) were submitted for bacterial culture. The fecal sample and gastric reflux collected on admission were negative, but subsequent fecal samples cultured positive for Salmonella group C. In another study, Henninger (18) also proposed that Salmonella spp. was the cause of DPJ in a horse. The horse described in that report had signs of abdominal pain, ileus, and voluminous gastric reflux and soft feces. Neither gastric content nor fecal samples were submitted for culture in this case. The link between the DPJ and salmonellosis was based on the observation that another horse from the same farm had died 5 d earlier with signs of chronic weight loss and diarrhea, and was positive for Salmonella group C, in the microbial culture of colonic contents.

Experimental inoculation of horses with S. typhimurium and S. anatum has been described, but clinical signs or lesion compatible with DPJ were not reported in those trials (19,20). It has been reported, however, that salmonellosis may manifest as gastric dilation and ileus syndrome in horses (21), and gastric reflux was reported as one of the clinical signs in horses during a nosocomial salmonellosis outbreak (22). These publications did not refer to those horses as having DPJ and the clinical diagnosis is therefore undefined and subject to interpretation. Previous studies including a larger number of DPJ-affected horses did not indicate whether any microbiological investigation (including Salmonella culture) was carried out in those cases (2–4,23,24). Furthermore, Arroyo et al (7) found no Salmonella in DPJ-affected horses, neither did Griffiths et al (25). Thus, the suggestion that Salmonella spp. can be a cause of DPJ remains anecdotal and unproved. Currently, there is no good evidence in the literature to support the suggestion that Salmonella spp. are associated with DPJ.

Mycotoxins
A single study proposed mycotoxins as a potential cause of DPJ (26). In this study, 6 horses were challenged with low (n = 2), medium (n = 2), and high (n = 2) levels of fumonisins obtained from Fusarium moniliforme strains of various sources. One of the strains had been recovered from feed consumed by horses which developed clinicopathological signs consistent with DPJ (26). Control horses and horses fed low levels of mycotoxins remained normal, but horses on medium and high doses developed neurological signs and either died or were euthanatized within 24 h after the initial signs. None of the horses developed signs consistent with DPJ; however, horses fed high doses of mycotoxins developed catarhal inflammation of the duodenum and proximal jejunum with edematous mucosa. Interestingly, the F. moniliforme isolate recovered from the field DPJ case did not cause intestinal lesions. Based on these observations, the authors suggested mycotoxins as a potential etiological agent of DPJ. Hemorrhagic enteritis lesions similar to DPJ, however, have been described among horses that died from aflatoxicosis or fusariotoxicoisis (27,28). Fumonisins disrupt sphingolipid metabolism by inhibiting ceramide synthases, and sphingolipids play important roles in cellular regulation and intestinal wall base membrane function (26). However, other associations between mycotoxins and DPJ have not been reported in the literature.

Clostridium spp.
Clostridium spp. were suggested to be the cause of DPJ since the initial reports of DPJ because large numbers of Clostridium organisms were observed in Gram-stained smears of gastric reflux from those cases. The presence of Clostridium spp. by culture was investigated in affected intestines of 9/20 DPJ cases but Clostridium spp. was isolated in only 3 cases (2). Clostridium perfringens had been one of the most popular candidates, in particular because other intestinal diseases including typhlocolitis were suspected to have a clostridial origin (29–32). However, only a few studies investigated this hypothesis and such studies failed to repeatedly and consistently identify a particular Clostridium organism.

Clostridium perfringens
In one investigation, the gastric and/or small intestine contents collected before, during, or after surgery were cultured from 40 DPJ cases, 28 (70%) of which yielded C. perfringens (9). Another study by the same group reported the isolation of high numbers of C. perfringens from 5/5 DPJ cases versus significantly lower numbers in 55% of fecal samples from other horses with colic and in 75% of healthy horses (25). Interestingly, C. perfringens isolates from DPJ cases were predominantly type D, whereas the isolates from healthy horses were mostly type A. In another study, C. perfringens was also isolated from reflux samples of 4/10 DPJ cases and 12/16 control cases (7). No further characterization was performed on the isolates to
determine their toxin type. *Clostridium perfringens* is a common enteric commensal frequently isolated from healthy horses and horses with gastrointestinal disorders. This organism can produce up to 16 toxins in various combinations, and diseases caused by this bacterium are mediated by one or more of these toxins. Four of these toxins, alpha, beta, epsilon, and theta toxins are the major toxins and are used to type isolates. All types of *C. perfringens* produce alpha toxin, but *C. perfringens* type A produces large amounts of alpha toxin as the sole major toxin, which causes cell lysis by degradation of membrane phospholipids and activation of several other membrane and internal cell mechanisms. Additionally, alpha toxin activates the arachidonic cascade resulting in activation of the inflammatory cascade and vasoconstriction. *Clostridium perfringens* type D, on the other hand, produces alpha and epsilon toxins, the latter being one of the most potent *C. perfringens* toxins. This toxin causes elevation of blood pressure, increased contractility of smooth muscle, an increase in vascular permeability, as well as brain and lung edema in multiple animal species (33). However, the role of some of these virulence factors of *C. perfringens* in intestinal disease is controversial and poorly documented. The potential role of this organism or a particular member of this heterogeneous species remains to be determined.

**Clostridium difficile**

*Clostridium difficile* is known to affect the small intestine and causes disease in humans, horses, and other animals (33–38). Lesions in the small intestine were observed in foals with natural and experimental inoculation of a mixture of bacteria and crude toxins (39). *Clostridium difficile* toxins A and B are the most important virulence factors leading to cell damage and disease; therefore, toxin detection is considered the gold standard for the diagnosis of *C. difficile* disease in humans (40). Detection of toxins A or B or both in intestinal contents or feces is also considered the most reliable diagnostic criterion for *C. difficile*-associated disease in horses (41). However, there is no information on toxin detection in reflux samples of DPJ cases. Culture is considered essential for epidemiologic studies, but some argue that toxigenic culture is more sensitive than cytotoxicity assay alone (40).

Braun et al (34) cultured *C. difficile* from 9/17 horses with clinical conditions of the small intestine such as duodenjejunitis, jejunal infarctions, and ileus. In one study, *C. difficile* was isolated from the nasogastric reflux of 10/10 horses with signs of DPJ, thereby suggesting that *C. difficile* is a potential etiological agent for DPJ (7). The *C. difficile* isolates recovered from those DPJ cases were toxigenic, while the 1 isolate recovered from controls (1/16) was non-toxigenic (7). Non-toxigenic *C. difficile* strains lack the genes that encode for toxins A and B; these strains do not cause disease because they are not capable of producing the toxins which are essential virulence factors. *Clostridium difficile* has been isolated from other cases presented to the Ontario Veterinary College (OVC) and from a reflux sample from a DPJ case in upstate New York (unpublished data). However, *C. difficile* is not always isolated from DPJ cases from our clinic and studies including a larger number of cases with a wide geographical distribution have not been conducted. We are not aware of any other studies or researchers attempting to isolate *C. difficile* from DPJ cases elsewhere.

Recently, our research group investigated the effect of inoculating healthy horses with *C. difficile* toxins produced by a strain isolated from a naturally occurring DPJ case (42). All horses developed lesions in the small intestine and 2/6 horses developed clinical signs similar to those described for naturally occurring DPJ, suggesting a role of *C. difficile* toxins in the pathogenesis of DPJ in horses.

**Other clostridia**

There are many members of the clostridium family capable of producing exotoxins with a wide range of biological activities. It is often speculated that there could be many other enterocommensal clostridia potentially capable of causing damage to the gastrointestinal tract under certain conditions. In one study, the reflux samples of DPJ and control cases were selectively cultured in enrichment broth for spore-forming clostridia (7). Multiple clostridia, including *C. beijernickii*, *C. bifermentans*, *C. clostridiiforme*, *C. glycolicum*, *C. sporogenes*, and *C. cadaveris*, were recovered from both groups and deemed not clinically significant at that time (7). Despite considerable effort, a single particular clostridial organism has not been consistently isolated from horses with naturally occurring DPJ (2,7,25).

The etiology of DPJ remains elusive but some textbooks still mention *Salmonella* spp. and mycotoxins as potential etiologies; this is in our opinion dated. The clinical, microbiological, and pathological evidence to support those statements is weak and poorly investigated. Several published retrospective studies have focused on the clinico-pathologic findings of DPJ or factors associated with outcome; however, few studies have ventured to address the cause for this condition (23,24). Based on our current information, we propose that DPJ is a clinical condition with multiple causative organisms (including *C. perfringens*) and that *C. difficile* could be one of the causes.

**Pathogenesis**

The pathogenesis of DPJ is speculative at best, but has been hypothesized based on the clinico-pathological findings (16). The macroscopic and histologic lesions observed in the small intestine suggest an inflammatory process leading to gastrointestinal ileus, with accumulation of electrolyte-rich fluid and distension of the proximal part of the small intestine and stomach, and absorption of bacteria and bacterial products into the bloodstream. Macroscopically, the affected segments are distended, and the serosal surface appears bright to dark red and covered with petechial to ecchymotic hemorrhages. The contents are red-brown watery fluid and the mucosa dark red, with petechial hemorrhages and occasionally necrotic and ulcerated areas. Microscopically, lesions can range from mild to severe, characterized by hyperemia and edema of the mucosa and submucosa, sloughing of villus epithelium, hemorrhage, and neutrophil infiltration of mucosa, submucosa, tunica muscularis, and serosa (1,42). These lesions could cause the clinical signs displayed by horses with DPJ including abdominal discomfort, gastric reflux, dehydration, and endotoxemia.
As noted, the etiology of DPJ remains to be determined but a study suggested that toxins of *Clostridium difficile* may cause DPJ and, based on this etiologic agent, it can be hypothesized that the disease process most likely begins with the ingestion of spores of this organism (42). These spores are normally dormant and highly resistant to many types of environmental insults and when ingested, the normal microflora maintain these spores in a quiescent state. Certain conditions (i.e., antimicrobial therapy, abrupt changes in diets) that cause disruption of the gut microflora can lead to germination of *C. difficile* spores in the bile-rich environment of the intestine, where outgrowth of vegetative cells occurs, followed by bacterial multiplication and production of toxins (43). Bile is produced in the liver and stored in the gall bladder in most animal species, and helps in digestion by emulsifying fat and cholesterol, allowing their absorption in the small intestine. Horses, however, do not have a gall bladder; therefore, bile acids are secreted directly into the first portion of the duodenum during all phases of the digestive cycle (44). Some bile salts, such as cholate and taurocholate, are known to stimulate germination of spores and growth of vegetative cells. Interestingly, there are major differences in the composition of secreted bile acids between horses and other species. Taurocholate for example, a well-known germination stimulant, accounts for 23.9% ± 6.1% of the total bile acids in horses *versus* 3.5% ± 0.5% in humans. Conversely, the proportion of the secondary bile salt chenodeoxycholate, an inhibitor of sporulation, is low in horses (7.0% ± 3.8%) but high in humans (27.1% ± 5.3%) (45). Such differences could play a role in the risk factors associated with establishment of infection and disease susceptibility.

Upon production and release of *C. difficile* toxins A and B into the intestinal lumen, the toxins gain entry into the host cells through receptor-mediated endocytosis. These toxins are glucosyltransferases that inactivate small Rho GTPases irreversibly, leading to disruption of the cytoskeleton and tight junctions, causing cell rounding, detachment, and cell death (46). The toxins also cause damage and inflammation by disruption of the intestinal epithelial barrier and induction of proinflammatory mediators and cytokines that further contribute to mucosal damage (46). *In vitro* studies have shown that these toxins also can profoundly affect the motility of the small intestine. For instance, injection of *C. difficile* toxins into ligated rabbit small intestinal segments resulted in a transitory increase in intestinal motility followed by an absence of intestinal motility at 18 h after exposure to toxin A (47). This suggests that *C. difficile* toxins may alter small intestinal motility in horses leading to ileus and potentially contribute to subsequent development of clinical signs of DPJ (Figure 1).

The possibility that *C. difficile* toxins can affect small intestine function in horses, and perhaps play a role in the pathogenesis of DPJ was considered previously (16). It is important to highlight, however, that since an etiologic agent(s) and predisposing factors for DPJ have not been consistently and repeatedly proven, the suggested pathogenesis remains hypothetical. Many alternative pathogenesis pathways were previously suggested and elaborated in detail in another review, and interested readers are encouraged to refer to this review for more information (16).

**Epidemiology**

The prevalence and severity of DPJ cases appear to be influenced by geographical factors. For instance, cases of DPJ are commonly reported in the southeast regions of the United States and parts of Europe while low prevalence has been reported in California (16,26). In Brazil, the reported prevalence was 13% (26/205) amongst all colic cases and 1.7% among all horses admitted to a teaching hospital (13). A report that out of all cases of colic caused by small intestinal diseases, DPJ contributes to 3% to 22% suggests that DPJ is less common than small intestine obstruction (i.e., volvulus or ileal impaction) (16,48–50).

Risk factors predisposing to DPJ are unknown or poorly documented. Stress from recent foaling or changes in training routines have been proposed (14). Gender and breed predispositions have not been recognized; however, one study reported that females were overrepresented in cases of DPJ. The proportions of females, geldings, and male horses were 59% (41/70), 26% (18/70), and 16% (11/70) for DPJ cases, respectively, compared with 46% (50/108), 42% (45/108), and 12% (13/108), respectively for all colic cases (5). Regarding age, DPJ has been recognized in horses over 2 years of age, with an average age range of 5 to 10 y (3,16). Concentrated diets and pasture grazing appeared to be risk factors for DPJ compared with horses suffering from other causes of colic or horses evaluated for lameness (5,8). Similar results were reported in a retrospective study from Colombia in which 83% (15/18) of the horses with DPJ were fed highly concentrated diets (12).
### Table 1. Age, clinical parameters, and abdominal fluid values for horses with DPJ in 5 retrospective studies from North and South America.

<table>
<thead>
<tr>
<th>Number of horses (n)</th>
<th>Age (range in years)</th>
<th>Depression (%)</th>
<th>Rectal temperature (°C)</th>
<th>Heart rate (beats/min)</th>
<th>Colic signs (%)</th>
<th>Gastric reflux (L)</th>
<th>Borborygmi</th>
<th>Small intestinal distension</th>
<th>PF-WBC (× 10³ cells/µL)</th>
<th>PFP (g/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>NR</td>
<td>20% (&gt; 38.3)</td>
<td>Mean: 39.3 ± 0.5</td>
<td>Mean: 68 ± 18</td>
<td>100%</td>
<td>&gt; 12 (admission)</td>
<td>80% absent</td>
<td>80%</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>34</td>
<td>1.5 to 27</td>
<td>85% (&gt; 38.8)</td>
<td>Mean: 39.2 ± 0.6</td>
<td>Range: 40 to 120</td>
<td>NR</td>
<td>(85%)</td>
<td>Reduced or absent in most cases</td>
<td>NR</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>1 to 21</td>
<td>NR</td>
<td>Mean: 39.1 ± 1.1</td>
<td>Range: 36.9 to 41.1</td>
<td>NR</td>
<td>(100%)</td>
<td>Mean: 12 ± 8 (admission)</td>
<td>NR</td>
<td>55% decreased 3% motile</td>
<td>NR</td>
</tr>
<tr>
<td>12</td>
<td>2 to 13</td>
<td>NR</td>
<td>Mean: 39.2 ± 0.4</td>
<td>Range: 37 to 39.4</td>
<td>NR</td>
<td>(97%)</td>
<td>Mean: 12 to 144 (1st 24 h)</td>
<td>NR</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>3 to 18</td>
<td>NR</td>
<td>Mean: 39.0 ± 0.5</td>
<td>Range: 35.5 to 40.4</td>
<td>NR</td>
<td>(100%)</td>
<td>Mean: 12 to 144 (1st 24 h)</td>
<td>NR</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

*reference; detected by rectal palpation; NR — not reported; Number: 0 = absent, 1 = decreased, 2 = normal; PF-WBC — peritoneal fluid white blood cells; PFP — peritoneal fluid protein.

### Clinical signs

The clinical signs and abdominal fluid values for horses with DPJ included in 5 retrospective studies from North and South America are presented in Table 1. Duodenitis-proximal jejunitis occurs sporadically, typically causing copious amounts of gastric reflux and abdominal pain that often improves after gastric decompression; this is regarded as a hallmark of this condition (4,16,24). Approximately 25% to 30% of horses with DPJ had an elevated temperature > 38.6°C, with most these cases having an average temperature ranging from 38.3°C to 39.3°C (2–4). Tachycardia is also a consistent sign, with an average heart rate of 70 beats/min (bpm), with the lowest being around 40 bpm.

Ileus is the hallmark sign of the disease and a consistent finding. Profuse gastric reflux (> 48 L of gastric fluid in the first 24 h) was reported in 42/75 (56%) DPJ cases in 1 study (4); another study reported an average reflux volume of 11 L ± 7 L (range: 0 to 35 L) during the first 24 h of hospitalization (24). Although ileus and gastric reflux are typically associated with DPJ cases, these studies highlight the variability in the amount of reflux collected (2,3,4,51). The color of the reflux fluid can range from yellowish-green to reddish-brown, usually with a fetid smell, and often with an alkaline pH, but acidic reflux can be obtained early in the disease process (26).

Other major clinical signs are acute onset of mild to severe abdominal pain and variable degrees of dull demeanor (26,52). Signs of severe abdominal pain are rare, and some horses only present signs of inappetence, depression, and recumbency (16). Signs of dehydration, endotoxemia, decreased to absent borborygmi, and tachypnea can also be identified (16,26). Small intestinal distension detected by per rectal palpation is reported in approximately 80% of DPJ cases (2,3).

Other complications such as laminitis have been reported in 30% of the cases of DPJ. Laminitis can occur in both the early and late phases of the disease (23).

### Clinical pathology

Hemoconcentration and increased total plasma proteins are common and likely associated with dehydration and splenic contraction (3,4). These changes are not distinctly different from those reported in horses with small intestine strangulating obstruction (SISO). Complete blood cell counts vary greatly and consistent findings have not been reported.

On serum biochemistry profile, activity of the liver enzymes and total bilirubin are elevated when compared to healthy horses or horses with SISO (24). Most of the horses suffering from DPJ experience azotemia (80%, 70/87), hyponatremia, hypochloremia, hypokalemia, and hypocalcemia, but electrolyte abnormalities vary greatly amongst cases (23). Most of the horses had normal blood pH; hypochloremic metabolic alkalosis can also occur as a consequence of gastric chloride losses (16); however, metabolic acidosis and anion gap acidosis are common because of hypovolemia and decreased tissue perfusion (4). Furthermore, anion gap values > 15 mEq/L have been associated with increased risk of mortality in horses with DPJ [odds ratio (OR): 6.1; 95% confidence interval (CI): 1.06 to 18.2] (16).

The peritoneal fluid total protein (abd-TP) concentration is commonly increased without an elevation in the total nucleated cell count (abd-TNCC) (4,53). In one study, the abd-TNCC was significantly lower in horses with DPJ (10 214 cells/µL ± 15 945 cells/µL) than horses with SISO (46 257 cells/µL ± 51 079 cells/µL) (3), while abd-TP was significantly higher in...
horses with DPJ than horses with SISO. The aforementioned study failed to report the actual values of abd-TP in each cohort. However, increased abd-TP levels > 35 g/L have been associated with increased risk of death in horses with DPJ (OR: 4.03; 95% CI: 1.38 to 11.8 g/L) (4).

Pathology
Tyler et al (1) published a comprehensive description of the macro- and microscopic lesions of 14 horses with DPJ. The DPJ cases had lesions mostly restricted to the proximal half of the small intestine including the duodenum (in some cases also the pylorus) and various lengths of the jejunum. In some cases most of the small intestine (up to 90%) can be affected with mild distention (5 to 7 cm). Extending from the intestinal mucosa to the serosa, lesions in many DPJ cases begin with hyperemia due to congestion of intestinal vessels which, in turn, can lead to edema and then hemorrhage (1,16). Severe lesions are characterized by villus atrophy and epithelial cell loss concurrent with hemorrhage and neutrophil infiltration of intestinal wall layers and fibrinopurulent exudates (1). Mucosal necrosis also can occur which can promote peritonitis in the most severe cases (1).

Consistent lesions have not been detected in the liver, spleen, kidney, lung, heart, or adrenal glands of horses with DPJ (1). Described lesions in the liver include hepatocellular vacuolization and cholestasis, and infiltration of inflammatory cells of the centrolobular and periportal regions. Horses with histopathologic lesions in the liver had increased serum liver enzyme activity (24). It has been suggested that the liver lesions can occur secondary to small intestinal stasis, decreased blood flow, macrophage activation from endotoxemia, or ascending inflammation from duodenum to bile ducts, but these remain speculative (16).

Diagnosis
The clinical diagnosis of DPJ is based on typical clinical signs, response to medical treatment, and exclusion of other small intestinal conditions such as obstructive or strangulating lesions. Surgical, postmortem findings, or both are considered confirmatory for the diagnosis of DPJ, particularly when combined with the clinical history (9,26). The clinical differentiation between DPJ and SISO or simple small intestine obstructions (i.e., ileal impactions) can be a diagnostic challenge because the clinical signs can be indistinguishable. Some criteria typically used to discriminate between DPJ and SISO include degree of pain, presence of fever, hematologic and abdominal fluid analyses, and response to medical therapy (52). The level of abdominal pain experienced by horses with SISO tends to be more severe than that with DPJ. Horses with DPJ tend to show marked dullness and pain relief particularly after gastric decompression, while horses with SISO display little or no improvement (3,4). The degree of distension and wall thickness of the small intestine is also used to aid in the diagnosis. Subjectively, horses with SISO can have marked firm bowel distension upon rectal palpation, while there is less distension of the small intestine loops in DPJ cases. On ultrasonographic imaging, horses with SISO appear to have loops of the small intestine with larger diameter but thinner wall thickness compared to DPJ cases (52). Small intestinal motility is reduced but usually not absent in DPJ cases and small intestinal and gastric distension are variable (54); however, large numbers of turgid and amotile small intestinal loops have been reported (55). Ultrasonographic imaging is considered useful but yields inconsistent findings; however, when combined with a positive response to medical treatment, may aid in the diagnosis of DPJ.

The mean volume of nasogastric reflux recovered from horses with DPJ appears to be significantly greater than from those with SISO, but this finding is not consistent (3). However, some studies (4,5) have used the volume of reflux as a criterion for definition of DPJ, as noted earlier in this article. Several clinicopathological variables are different between horses with DPJ and SISO on admission, but none of them are of any value to differentiate both conditions (3). The peritoneal fluid has been considered of some value in distinguishing between these conditions, with minor changes consistent with DPJ, while marked changes suggest strangulating lesion (16).

Medical management
Since DPJ is an idiopathic condition, much of the treatment relies on intensive supportive therapy (52). The therapy is aimed to relieve gastric and intestinal distension, replace fluid and electrolyte losses, alleviate pain, and restore gastrointestinal motility (27,53). The repetitive siphoning of intestinal contents via gastric decompression (as often as every 2 h) is recommended because of the potential risk of gastric rupture and abdominal discomfort (16,26). Although it appears intuitive that gastric rupture is a risk in DPJ cases, there are no reports in the literature to support this argument.

Intravenous administration of polyionic isotonic electrolyte fluid solution is essential to maintain circulatory volume depleted by continuous enteric fluid losses (52,53). Hypokalemia, hypocalcemia, and hyperlactatemia are clinicopathological abnormalities that have been reported consistently in DPJ cases, but other electrolyte abnormalities are variable (26). Fluid losses in horses with DPJ can be substantial and can reach as much as 8 L/h. Constant monitoring is required to correct dehydration, always accounting for the ongoing losses (52). Prokinetic drugs including neostigmine, bethanechol, phenothiazine, metochlopramide, cisapride, and lidocaine have been advocated (16,56,57). The potential benefits of these drugs remain unknown and anecdotal at best. Randomized controlled clinical trials would be ideal to test whether prokinetics are beneficial in these cases, but the infrequent occurrence of these conditions and lack of an experimental model of DPJ are major limitations.

Other forms of supportive or interventional therapy for endotoxemia and ileus, laminitis, antimicrobial administration, and surgical decompression of distended intestine could be required (26). The use of antimicrobials remains controversial (57). Penicillin, alone or in combination with ampicillin or gentamicin, is often used (2,26). Metronidazole has been advocated based on the assumption that DPJ cases are associated with clostridial infection (57). Also due to the hepatic injury reported in these cases, use of antimicrobials has been recommended to reduce the possibility of ascending infections to the liver (24).
Prophylactic digital cryotherapy (PDC) ( icing the feet) can contribute to reducing the risk of development of laminitis. One study demonstrated that horses treated with PDC had 10 times less odds of developing laminitis compared with horses treated without PDC (OR: 0.11, 95% CI: 0.03 to 0.44) (58). Severe DPJ cases, without continuous or frequent gastric decompression and intensive fluid therapy can succumb to shock, severe dehydration, and respiratory problems from abdominal distension (4).

Management by surgery
Some DPJ cases undergo exploratory celiotomy when a mechanical lesion or obstruction cannot be definitively ruled out or if the horse fails to respond to therapy (16,52). Although surgical management is not commonly undertaken, there are reports of successful surgical treatment of DPJ cases (8,59). One study, however, documented significantly reduced survival rates, an increased likelihood of developing diarrhea, and a larger volume of gastric reflux in DPJ-affected horses treated surgically compared with those treated medically (60). However, the results of this study need to be evaluated cautiously as this was a retrospective rather than a randomized prospective study. It is also possible that horses more severely affected with a larger volume and/or longer duration of refluxing were more likely to undergo an abdominal exploration (60). Of interest, only 25% of horses that underwent abdominal surgery stopped refluxing after surgery, suggesting that surgical treatment failed, consistently, to resolve gastric reflux in horses with DPJ (60).

Complications
Laminitis was reported to occur secondary to DPJ in 30% of the cases. Suggested risk factors for the development of laminitis include endotoxemia, high body weight (i.e., draft horses), and hemorrhagic reflux (16,23). Cardiac arrhythmias have been reported in DPJ cases, which resolved while treating the primary condition (61). As mentioned, hepatic injury also occurs and is characterized by increased liver enzyme activities and structural changes observed in liver biopsies or postmortem examination (24). Other reported complications include septic peritonitis, myocardial and renal infarction, aspiration pneumonia, and adhesions of the proximal small intestine (52).

Prognosis
The overall survival rates for horses with DPJ range from 25% to 94% (2,23,24). The survival rates, defined as discharge from the hospital, were 87% (104/120), 67% (50/75), and 85% (56/66), in Pennsylvania, Texas, and North Carolina, respectively (3,23,24). Some studies have reported higher survival rates (63% to 96%) with surgical intervention (9,62,63); however, Underwood et al (60) reported a survival rate of 91% for medically treated versus 75% for surgically treated horses with DPJ (60).

The volume of gastric fluid in the first 24 h, anion gap (AG), and abd-TP values recorded on admission were considered clinically useful as indicators of prognosis for survival in DPJ cases (4). The volume of gastric reflux produced during the first 24 h (> 48 L/24 h) has been associated with increased risk of mortality (OR: 4.13; 95% CI: 1.20 to 14.1). Duodenitis-proximal jejunitis cases (n = 75) with an abd-TP concentration of > 3.5 g/L were approximately 4 times more likely to die (OR: 3.8; 95% CI: 1.18 to 12.08) compared with those with an abd-TP concentration < 3.5 g/L (4). Similarly, cases with AG > 15 mEq/L were 6 times more likely to die (OR: 6.43; 95% CI: 2.06 to 20) compared with cases with AG < 15 mEq/L. Reasons for euthanasia in DPJ cases include complications such as laminitis, appearance of the intestine at surgery, and treatment for several days with no apparent signs of improvement (23,52).

In conclusion, there is no consistent definition of a case of DPJ, but the main clinical features of the disease are well-recognized. The etiopathogenesis of DPJ remains to be determined but recent data showed experimental evidence for a role of C. difficile as a potential causal agent. The possibility that this condition can be caused by infection with various organisms that clinically manifest as DPJ should be considered and there is strong evidence that C. difficile could be part of such a repertoire of pathogens. Experimental reproduction of the disease is difficult, possibly because of a lack of knowledge of predisposing factors. Further investigations to elucidate risk factors that could lead to the development of DPJ are warranted.

References
Spontaneous resolution of bilateral congenital patellar luxation in an alpaca cria

Emily E. John, Laurent Viel

Abstract — An 8-day-old alpaca was presented for suspected meconium impaction and abnormal gait and posture. Physical examination revealed bilateral medial patellar luxation. In previous reports, medical treatment of patellar luxation in crias has been associated with a poor to grave prognosis; here we report a case of successful resolution.

Résumé — Résolution spontanée d’une luxation patellaire bilatérale congénitale chez un bébé alpaga. Un alpaga âgé de 8 jours a été présenté pour une impaction soupçonnée du méconium et une démarche et une posture anormales. L'examen physique a révélé une luxation patellaire médiale bilatérale. Dans des rapports antérieurs, le traitement médical de la luxation patellaire chez les bébés alpaga a été associé à un pronostic sombre ou grave; nous avons ici un rapport de cas d’une résolution réussie.

T he relatively recent introduction of alpaca farming in Canada, starting in the late 1980s, has been mostly for small hobby farm and small-scale fiber production purposes (1). The number of alpacas in Canada is relatively low compared with other livestock species, and clinical research involving alpacas is still in preliminary stages for many aspects of their anatomy and physiology. As such, there is little information relating to orthopedic abnormalities and/or defects in this species such as angular limb deformities, arthrogryposis, hemivertebrae, scoliosis, and luxation of the patella (2,3). Although lateral and medial luxations of the patella have been reported in South American camelids (SACs), the current limited literature reports a higher number of cases of lateral luxation (3,4). In general, untreated unilateral and bilateral patellar luxations are given a poor prognosis for long-term survival (2). However, surgical intervention was reported to be successful in a small number of cases (4–7). Conservative management generally seems to result in an unfavorable outcome (2). The case described herein demonstrates successful resolution of bilateral medial patellar luxation in an alpaca cria over a period of approximately 2 wk, without any noticeable conformational abnormalities observed over an 18-month follow-up period.

Case description

An 8-day-old male alpaca cria (Vicugna pacos) was presented to the Ontario Veterinary College Health Sciences Centre (OVC-HSC) Large Animal Hospital for evaluation of suspected persistent meconium impaction and constantly attempting to defecate. The cria was born at a normal gestational period, the birth had been unassisted and unobserved, and later that day the owner reported seeing the passing of some meconium, but then no feces were seen for 3 d. At that time, it was also noticed that the cria was walking with a hunched back and flexed hind legs; the owner suspected a meconium impaction and administered an enema which did not result in the passage of any feces. Upon examination by the referring veterinarian and digital examination of the rectum some meconium was expelled. Positive contrast radiography using a barium enema was performed to rule out meconium impaction, atresia coli, or a gastrointestinal stricture; no abnormalities were seen and so the cria was referred for further workup.

On presentation, the cria was bright, alert, and responsive, in good body condition, and weighed 12.5 kg. He was vocalizing normally. Vital parameters including heart rate [84 beats/min, reference range (RR): 70 to 100 beats/min] and temperature (38.6°C, RR: 37.8 to 38.9°C) were within normal limits. Moderate tachypnea was present (60 breaths/min, RR: 20 to 30 breaths/min), likely due to the new environment and manipulation during the physical examination (2). Throughout the examination the cria stood with an arched back and raised tail and appeared to be straining frequently to defecate; normal urination was observed. When ambulating, the cria did not fully extend either hind leg and walked with a hopping/bouncing-like
movement and continuously arched back (Figure 1). On palpa-
tion, the lumbar muscle mass was tense and firm. When walking
around the stall both hind limbs remained flexed at the tarsi and
stifles. Tail tone and anal tone were within normal limits. Based
on the history and clinical findings, the cria was sedated with
ketamine (Vetalar; Bioniche, Belleville, Ontario), 1.6 mg/kg
body weight (BW), IM, butorphanol (Torbugesic; Wyeth,
Guelph, Ontario), 0.1 mg/kg BW, IM, and xylazine (Rompun;
Bayer, Toronto, Ontario), 0.3 mg/kg BW, IM, for contrast
fluoroscopy of the distal gastrointestinal tract. A barium sulfate
(Liquid Polibar Plus; Therapex, Montreal, Quebec) enema was
administered for the contrast fluoroscopy, which revealed no
abnormalities. Right lateral and ventrodorsal radiographs of
the thoracolumbar vertebrae were taken to determine if a con-
genital or traumatic malformation of the thoracolumbar spine
was present but no radiographic abnormalities were identified.

As the spine and distal gastrointestinal tract had been ruled
out as the causes for the cria’s abnormal posture and gait, both
hind limbs were examined for abnormalities. It was noted that
when each stifle was extended, the patellas of both limbs were
deviated medially and could not be manipulated into the troch-
lear groove, and remained medial to the trochlear groove when
the limbs were in the flexed position. Using the grading scale
developed for patellar luxation in dogs (8), a grade of IV/IV was
assigned. The patellas also did not exhibit the normal range of
motion when the limbs were flexed and extended and remained
proximal and medial to their normal anatomical location. The
owner declined to have radiographs of the stifles taken following
the barium contrast study and thoracolumbar radiographs. Based
on the clinical findings as assessed by the internists and surgery
clinician, a diagnosis of bilateral congenital medial luxation of
the patellas was made. As per the literature recommendations
(2), the owner was given a poor prognosis for normal hind limb
function. Further, considering the potential genetic component
of the condition, the owner was encouraged not to keep this cria
for breeding stock. The owner elected to take the cria home and
monitor him, with the option of humane euthanasia should the
cria’s quality of life decline.

Follow-up conversation (weekly for 6 wk) with the owner
revealed that the cria had always nursed very well and main-
tained a good appetite. The cria continued to show the hopping-
like gait for approximately 10 d but during that time the owner
noticed that his gait improved gradually and steadily, with a
return to a completely normal walking and running stance
thereafter. The owner reported that he did not administer any
treatments or provide special management conditions. A photo-
graph taken approximately 8 mo following presentation to the
hospital showed the cria winning his class at a provincial alpaca
show (Figure 2). In the last follow-up 16 mo later, the male
alpaca was identified as a high quality fine fleece producer but
the owner elected not to use him as reproductive stock.

**Discussion**

To the authors’ knowledge, spontaneous resolution of patellar
luxation in a cria has not previously been reported. This case
suggests that in some instances a favorable prognosis could be
given, compared to previous reports (2). However, the under-
lying etiology, e.g., osseous compared to ligamentous abnormal-
ity, should be considered, as the degree of severity of any patellar
and femoral groove defect(s) could play a significant role in
spontaneous recovery versus surgical intervention.

Patellar luxation can be congenital or acquired, with acquired
patellar luxation being almost always traumatic in origin (9).
Congenital patellar luxation, in which the patella is located
in an abnormal position since the time of birth, can be due
to osseous abnormalities of the femoropatellar joint, soft tis-
sue abnormalities of the patellar tendon, collateral patellar
ligaments, or quadriceps muscle, or muscular weakness due to
prematurity (9). Traumatic events at the time of parturition,
including prolonged parturition or malpositioning of the fetus
during parturition, could result in rupture of the patellar reti-
nacula, damage to the patellar tendon, or femoral nerve deficit
with concurrent quadriceps dysfunction resulting in abnormal
patellar location (9). Due to the variety of causes, treatment
recommendations and prognosis vary. It is plausible that all of

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**Figure 1.** Typical stance adopted by the cria during
hospitalization, showing the “hunched” posture consisting
of bilaterally flexed stifle and tarsal joints.

**Figure 2.** Photograph showing the cria winning his class at an
alpaca show. Note the normal hind limb anatomy.
these causes could be present in SACs, although the current literature is quite limited. Anatomy of the stifle joint of SACs more closely resembles that of dogs and sheep than of horses or cattle, consisting of a single compartment with a single patellar ligament attaching the patella to the tibial tuberosity and tibial crest and a larger medial trochlear ridge compared to the lateral. In theory, this should make lateral patellar luxation more common than medial luxation (4, 10).

Although most published cases of patellar luxation in SACs are associated with suspected or known trauma to the stifle joint (4, 6), cases of congenital luxation with a suspected hereditary component have also been reported (2, 5). Patellar luxation has a higher prevalence in certain breeds of dog (11) and is thought to be inherited in the Dutch Kooiker breed (12). In a case series describing diagnosis and surgical repair of patellar luxation in sheep (13), all affected sheep came from 1 herd and were all traced back to a related ram and ewe that were purchased as foundation breeding stock; this is highly suggestive of an inherited component to the disease. In horses, while luxation in adults is generally due to a traumatic incident (14, 15), it is thought that there is a congenital hereditary form in miniature horses (16, 17) and monogenic autosomal recessive hereditary transmission is suspected in Shetland ponies (18). Based on inferences from other species, it is plausible that patellar luxation has a hereditary component in SACs despite the paucity of current literature.

Patellar luxation and its treatment have been described in beef and dairy calves (19–23), sheep (13), a goat (24), and various horse breeds (14–16, 18, 25, 26). While current recommendations in cattle indicate that surgery is required to correct patellar luxation in cases without femoral nerve injury that are grade III or IV/IV (9), the bilateral patellar dysfunction described in this cria appeared to fully resolve without any surgical intervention (Figure 2).

As the history was highly suggestive of meconium impaction, most of the initial diagnostic workup focussed on ruling out this condition, resulting in most of the client’s budget being spent on diagnostic tests for meconium impaction and radiographs of the lumbosacral vertebrae. This was partly due to the lack of general knowledge of congenital conditions of SACs, and illustrates the importance of performing a complete and thorough physical examination on all neonates regardless of species, including a complete musculoskeletal examination.

Limitations of this case report include the lack of stifle radiographs taken to confirm the bilateral patellar luxation or presence of other osseous abnormalities. Although palpation and observation of the cria’s stance and gait were highly suggestive of medial patellar luxation, radiographs were not performed due to the assumed poor prognosis and reluctance of the owner to financially invest in an animal that potentially would have to be euthanized in the near future. There was limited information available about the periparturient period and so trauma during or shortly after birth could not be ruled out. Also, there was no comprehensive neurological workup and so it was not possible to rule out femoral nerve dysfunction. Another limitation is the lack of regular veterinary rechecks of the cria and radiographic and/or ultrasonographic assessment of the stifle joint during its growing phase.

This is the first reported case of spontaneous resolution of bilateral medial patellar luxation in an alpaca cria. This suggests that some patellar luxations in SACs may be self-correcting, and that surgical correction should not necessarily be undertaken immediately. Although it is difficult to formulate recommendations based on an isolated case, the authors suggest any neonatal SAC exhibiting signs of patellar luxation, in the absence of any other congenital disorders or systemic disease, should be monitored for 3 to 4 wk and surgical correction only performed if there is no improvement during that time.

References

Diaphragmatic hernia in a pet chinchilla (Chinchilla lanigera)

Jessica Aymen, Isabelle Langlois, Isabelle Lanthier

Abstract — A 10-year-old pet chinchilla (Chinchilla lanigera) was referred for ultrasound investigation of a thoracic mass. The mass was initially believed to be a pulmonary abscess or tumor based on radiographs and ultrasound. Cytological examination suggested the presence of a gastrointestinal structure in the thorax, and necropsy revealed a true diaphragmatic hernia subdividing the stomach into thoracic and abdominal portions.

Résumé — Hernie diaphragmatique chez un chinchilla de compagnie (Chinchilla lanigera). Un chinchilla (Chinchilla lanigera) domestique mâle castré de 10 ans a été référé pour investigation échographique d’une masse thoracique. Basé sur les radiographies et l’échographie, il fut initialement pensé que la masse était un abcès ou une tumeur pulmonaire. L’analyse cytologique suggérait la présence d’une structure gastro-intestinale dans le thorax et la necropsie a révélé une vraie hernie diaphragmatique qui divisait l’estomac en une partie thoracique et une partie abdominale.

Diaphragmatic hernias occur when all or a portion of 1 or more abdominal organs enter the thoracic cavity through an abnormal opening involving a defect of the diaphragm (1). Diaphragmatic hernias may be congenital or occur secondary to trauma (2). Congenital hernias may be differentiated as peritoneopericardial or true diaphragmatic hernia. Peritoneopericardial diaphragmatic hernia (PPDH) is the most common congenital hernia, which occurs when a congenital communication exists between the abdomen and pericardial sac (2). True diaphragmatic hernias are distinct from PPDH. In a true diaphragmatic hernia, there is an incomplete diaphragmatic tear in which a direct communication between the pleural and peritoneal cavities is prevented by an intact serosa on the thoracic surface of the diaphragm (2).

This report describes the clinical presentation, diagnostic and therapeutic steps, and necropsy findings leading to the final diagnosis of a true diaphragmatic hernia in a pet chinchilla. To the authors’ knowledge, there is only 1 other reported case of diaphragmatic hernia in a pet chinchilla, which involved the herniation of a substantial length of colon through the aortic hiatus (3).

Case description

A 10-year-old, neutered male domestic pet chinchilla (Chinchilla lanigera) was referred to the Exotic Animal Clinic of the Université de Montréal because of a 2-day history of anorexia, lethargy, and respiratory difficulties. Husbandry and diet were adequate for the species. No recent trauma was reported by the owner. Radiographs from the referring veterinarian showed pleural effusion and a soft tissue density mass located in the caudal thorax, making it hard to distinguish the cardiac shadow (Figure 1). The chinchilla was referred for a thoracic ultrasound.

Initial physical examination revealed dyspnea and slightly elevated respiratory rate [96 breaths/min (bpm); reference range: 40 to 80 bpm (4)] with muffled respiratory sounds. The animal was immediately placed in an oxygen-enriched cage. Determination of oxygen saturation by pulse oximetry was attempted but was unsuccessful. The remainder of the physical examination showed 5% dehydration and a right head tilt that was presumed to be secondary to previous otitis. Likely differential diagnoses for the mass included abscessation, neoplasia, granuloma formation, or a consolidated pulmonary lobe.

The initial diagnostic plans included a complete blood (cell) count (CBC), plasma biochemical analysis, and thoracic ultrasound. Supportive care involved the administration of supplemental oxygen to assist breathing, warm sub-cutaneous fluids (Lactated Ringer’s Injection; USP, Baxter Corporation, Mississauga, Ontario), 65 mL/kg body weight (BW), q24h and syringe feeding (Herbivore Critical Care, Oxbow, Murdock, Nebraska), 15 mL, q8h to address dehydration and anorexia. The results of the CBC and biochemical analysis were unremarkable. The patient was anesthetized with 2% isoflurane (Isoflurane USP; Pharmaceutical Partners of Canada, Richmond Hill, Ontario) in oxygen (2.5 L/min) via facemask and placed...
in dorsal recumbency for ultrasonographic evaluation. The ultrasound showed a 2.5-cm mass within the thoracic cavity, near the right caudal pulmonary lobe. The mass had areas of mineralization and a hypoechoic center corresponding to air (Figure 2). Pleural fluid was present. The right dorsal and middle pulmonary lobes showed atelectasis, which may have been at least partially the result of positioning for the procedure as well as a lack of positive pressure ventilation during the period of anesthesia. At this stage, differential diagnoses were narrowed to either a pulmonary abscess or a tumor.

Fine-needle aspiration of the mass for cytological analysis was performed, and a granular background containing moderate numbers of erythrocytes and a slightly heterogeneous population of white blood cells consisting of 73% macrophages, 10% small lymphocytes, and 17% non-degenerate neutrophils was found. Rare unidentifiable basophilic elongated structures small lymphocytes, and 17% non-degenerate neutrophils was found. Rare unidentifiable basophilic elongated structures and showed nuclear rowing indicative of regeneration.

Histopathological findings showed moderate to severe multifocal atelectasis of the lungs. Intra-alveolar macrophages were present in moderate quantity. The herniated portion of the stomach showed moderate focal serosal fibrosis. Occasional yeasts were observed on the surface of the gastric mucosa. The diaphragm had a low number of degenerate myocytes as well as rare necrotic myocytes that were infiltrated by macrophages. In a few areas, muscular fibers were narrow, basophilic to amphophilic, and showed nuclear rowing indicative of regeneration.

**Discussion**

Diaphragmatic hernias may be congenital or acquired. Acquired diaphragmatic hernias are most common, typically as the result of trauma. Diaphragmatic hernias are reported in traumatized small mammalian herbivore patients. These types of thoracic injuries often result from blunt trauma such as falling from a height, or being kicked, stepped on, or crushed (5). In this case, there was no history of recent trauma reported by the owner. The histopathological finding of a focal area of fibrosis on the serosa of the herniated portion of stomach was consistent with chronicity, although normal anatomic variation for this species cannot be excluded. A traumatic origin to this patient’s hernia remains the main suspicion, although it is unknown if the animal had a diaphragmatic defect prior to the trauma. Interestingly, acquired diaphragmatic hernias occur in equine patients as a result of acute increased intra-abdominal pressure during digestive accidents (6). However, this has not been described in small herbivore mammals.

True diaphragmatic hernias may be asymptomatic (7) and 15% to 25% of diaphragmatic hernias resulting from trauma are diagnosed weeks after the injury (2). Clinical signs of chronic diaphragmatic hernia in dogs and cats usually involve...
the respiratory (i.e., dyspnea, exercise intolerance) or digestive system (i.e., vomiting, anorexia, diarrhea, weight loss, pain after ingestion of food). Nonspecific clinical signs such as depression might also be present (2). Clinical signs referable to the digestive system in chinchillas differ due to the fact they cannot vomit. In our case, syringe feeding did not result in palpable gastric dilatation. Anorexia and diminished fecal output were the first and main clinical signs observed. Absence of fecal output was noted on the day of euthanasia. The chinchilla also showed tachypnea and worsening respiratory difficulties with open mouth breathing during manipulations for syringe feeding.

In dogs and cats, true diaphragmatic hernias are frequently interpreted as pulmonary masses, especially when other radiographic signs of diaphragmatic herniation are absent (8). Radiographic signs caused by, or associated with, diaphragmatic rupture are well-documented and include loss of the diaphragmatic line, displacement or loss of the cardiac silhouette, lung lobe collapse, pleural effusion, and cranial displacement of abdominal organs into the chest (9). Radiographic imaging in small mammalian herbivore trauma patients is recommended to confirm diaphragmatic hernia (5). In our case, the stomach was visible in the abdomen, but positioning was not optimal, which may have altered radiographic interpretation.

Ultrasound examination of the thoracic and abdominal cavities may also help with the diagnosis. A study conducted on dogs and cats showed 2 key features when evaluating diaphragmatic ruptures with the aid of an ultrasound: an irregular or asymmetric cranial hepatic border when using a transhepatic window and visualization of abdominal viscera lateral to the heart from either abdominal or intercostal window (10). It is interesting to note that the ultrasonic findings of a thoracic mass were not interpreted as a diaphragmatic hernia. The features of a diaphragmatic hernia described in dogs and cats were not visualized in our case. Since the mass appeared to be completely within the thorax and on the right side, it was not suspected to be the stomach especially since the stomach was visible in the abdomen. Interpretation may have been more difficult due to the size of the animal and the content of the stomach at the time of examination.

Although imaging modalities such as radiology and ultrasonography are used in chinchillas, it appears neither could identify the nature of the mass. In this case, a hypothesis of a diaphragmatic hernia was only considered after analysis of the second aspirate revealed presence of plant material, yeasts, and bacteria.

If a diaphragmatic hernia is suspected, computed tomography or magnetic resonance imaging may confirm the presence of a hernia due to higher definition. In cats and dogs, differentiation between a PPDH and a true diaphragmatic hernia may be achieved with positive peritoneography. Positive peritoneography consists of injecting contrast medium within the peritoneal cavity to demonstrate leakage into the thoracic cavity or presence of an abnormal diaphragm (7). Pneumoperitoneography could have been considered to help rule out presence of a diaphragmatic hernia. Further studies are needed to validate if the use of this diagnostic modality is clinically applicable in pet chinchillas.

In our case, further investigations were not performed due to rapid clinical degradation and associated poor prognosis. Although rabbits and some rodents other than chinchillas have been used in human pediatric surgery as models for diaphragmatic hernia repairs, to the authors’ knowledge, there are no such surgeries described in a clinical context in these species or in the chinchilla (11–13). Given the advanced stage of the condition, the presence of fibrosis, and the major pulmonary involvement, surgical intervention was definitely high risk.

In conclusion, a true diaphragmatic hernia was diagnosed during necropsy of a 10-year-old male domestic chinchilla which had respiratory difficulties and no history of recent trauma. Diaphragmatic hernias should be included in the differential diagnosis for clinical signs of respiratory disease or thoracic masses in chinchillas and other small exotic mammals. Determination as to whether the hernia was congenital or acquired was not possible in this case. To the authors’ knowledge, this is the first report of gastric herniation through a diaphragmatic defect in this species.
1. Acromegaly in dogs is usually due to excess secretion of progesterone. In cats, acromegaly is associated with a pituitary tumor.

2. Seizures are not typically associated with hyperadrenocorticism. An increased concentration of cALP is commonly seen with hyperadrenocorticism. Urinary tract infections are common in dogs with hyperadrenocorticism, as are polyuria and polydipsia. Many dogs with hyperadrenocorticism have a pot-bellied appearance.

3. Signs usually begin at the time of weaning. All other statements are correct.

4. Clinical signs of equine herpesvirus 1 myelopathy include posterior ataxia and/or paresis and brain and spinal cord vasculitis.

5. *Streptococcus agalactiae* commonly causes subclinical infections, so identification of these infections by CMT or somatic cell counts and by culture is imperative. In some instances, culture of the entire herd is indicated. Response to antimicrobial therapy is good, so removal from the herd is not recommended, but isolation is. The source of the organism is other infected cows, not the environment, so although manure removal, stall bedding, and udder hygiene should always be optimized to prevent environmental organisms from causing mastitis, it is not specifically useful in preventing this infection.

C) Les signes cliniques de myélopathie à herpès-virus 1 des équidés comprennent l’ataxie postérieure et/ou la parésie, ainsi que la vasculite de l’encéphale et de la moelle épinière.

References

Reproductive failure associated with coinfection of porcine circovirus type 2 and porcine reproductive and respiratory syndrome virus

Chun Kuen Mak, Ching Yang, Chian-Ren Jeng, Victor Fei Pang, Kuang-Sheng Yeh

Abstract — An outbreak of reproductive failure in a pig farm in Taiwan was investigated. Coinfection with porcine circovirus type 2 (PCV2) and porcine reproductive and respiratory syndrome virus (PRRSV) was diagnosed in a stillborn pig by histopathology, polymerase chain reaction, and immunohistochemistry, and should be considered as a cause of reproductive failure.

Résumé — Échec de reproduction associé à la coinfection par le circovirus porcin de type 2 et le virus du syndrome dysgénésique et respiratoire du porc. On a fait enquête sur une écllosion d’échecs de reproduction dans une ferme porcine à Taiwan. La coinfection par le circovirus porcin de type 2 (PCV2) et le virus du syndrome dysgénésique respiratoire du porc (SDRP) a été diagnostiqué chez un porc mort-né par histopathologie, amplification en chaîne par polymérase et immunohistochimie et elle devrait être considérée comme la cause de l’échec de reproduction.

Porcine circovirus types 2 (PCV2) and porcine reproductive and respiratory syndrome virus (PRRSV) are economically significant pathogens in the swine industry worldwide. Both viruses are associated with reproductive failure characterized by mummified fetuses, late-term abortions, stillbirths, and premature farrowings (1,2). PCV2 may be associated with reproductive failure at all stages of gestation and may cause embryonic death (3). By contrast, PRRSV causes abortion or stillbirth during late gestation (2). Herds affected by PCV2-associated reproductive failure are typically composed of a high number of gilts which are probably PCV2-seronegative (4–6). The high seroprevalence of PCV2 in sows is believed to prevent most breeding herds from developing pronounced disease (1). In contrast to PRRSV, which is endemic at the global level and results in significant reproductive loss (2), the prevalence of PCV2-associated reproductive failure under field conditions is variable among studies, ranging from 1 to 25% (3,7,8). Also, some studies have stated that sows may be subclinically infected with PCV2 and may have given birth to viremic presuckling piglets (9,10). Whether transplacental infection occurs in the PCV2-seropositive sow population is still controversial (11–13).

The most common lesion observed in PCV2-infected fetuses is myocarditis (4,5). Lymphoid depletion, interstitial pneumonia, hepatic congestion with hepatocellular loss, and nonsuppurative hepatitis with periacinar necrosis have also been reported (14). Fetal lesions caused by PRRSV may include vasculitis, myocarditis, and encephalitis (15). The diagnostic criteria for PCV2-associated reproductive failure include clinical signs of late-term abortions and stillbirths, and the presence of heart lesions and high concentrations of PCV2 in the myocardial lesion and other fetal tissues (16). Regarding the diagnosis of PRRSV, 1 study suggested that the combination of pathological lesions and presence of PRRSV in the lesions is highly suggestive of PRRSV-associated fetal death (17); however, there is no gold standard for detecting PRRSV in fetuses (18). Both PCV2 and PRRSV are transmitted vertically and horizontally in utero (2,13). However, coinfections with these 2 viruses in fetuses from the same litter have rarely been reported and were only diagnosed by using polymerase chain reaction (PCR) (3,5,8). To date, no information is available regarding the association between the viruses and the corresponding lesions in the case of coinfection.

This case report describes reproductive failure associated with coinfection of PCV2 and PRRSV based on positive PCR and detection of both viral antigens in microscopic lesions by immunohistochemical (IHC) staining.
Table 1. Summary of clinical history, pathological lesions, and agents identified from 6 litters with abortion and stillbirth.

<table>
<thead>
<tr>
<th>Litter</th>
<th>Parity</th>
<th>Gestational age (days)</th>
<th>Number of fetuses/ mummies/ live piglets</th>
<th>Gross lesion</th>
<th>Microscopic lesion</th>
<th>Presence of protozoa-like organism in myocardiocytes</th>
<th>Agents identified by PCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>82</td>
<td>7 fetuses</td>
<td>Cardiomegaly, pleural and abdominal effusion</td>
<td>Endocardial hemorrhage, myocardial edema and fibrosis</td>
<td>Yes</td>
<td>PCV2</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>114</td>
<td>4 fetuses/ 7 mummies/ 3 live piglets</td>
<td>Mummification, pleural and abdominal effusion</td>
<td></td>
<td>d</td>
<td>PCV2 + PRRSV</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>98</td>
<td>10 fetuses</td>
<td>Cardiomegaly, congested meninges, pleural and abdominal effusion, pulmonary hemorrhage</td>
<td>Interstitial pneumonia, meningitis, myocardial edema and fibrosis</td>
<td>Yes</td>
<td>PCV2</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>113</td>
<td>7 fetuses/ 5 mummies</td>
<td>Cardiomegaly, congested liver, congested meninges, mummification, pleural and abdominal effusion, pulmonary hemorrhage</td>
<td>Choroid plexitis, interstitial pneumonia, meningitis, myocardial edema and fibrosis</td>
<td>Yes</td>
<td>PCV2 + PRRSV</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>103</td>
<td>11 fetuses</td>
<td>Cardiomegaly, congested liver, congested meninges, pleural and abdominal effusion, pulmonary hemorrhage</td>
<td>Interstitial pneumonia, meningitis, myocardial fibrosis</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>112</td>
<td>11 fetuses/ 2 mummies</td>
<td>Cardiomegaly, congested liver, mummification, pleural and abdominal effusion, pulmonary hemorrhage</td>
<td>Endocardial hemorrhage, meningitis, myocardial fibrosis</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

* Fetuses included abortuses, stillbirths, and dead neonatal piglets.
* Gross examination was performed on all fetuses.
* Histopathological examination was performed on 1 fetus from each litter which had the most prominent gross lesions.
* Histopathological examination was not performed due to severe autolysis and mummification of the fetuses.
* The antigen was also detected by immunohistochemical staining.

PCR — polymerase chain reaction; PCV2 — porcine circovirus type 2; PRRSV — porcine reproductive and respiratory syndrome virus.

Case description

The affected herd was from a 450-sow, farrow-to-finish, closed farm in Northern Taiwan, with a history of infections with PCV2, PRRSV, and *Mycoplasma hypopneumoniae*. The facility was under veterinary care, the housing was adequate, and the animals were humanely cared for. The farm consists of a breeding barn, a boar barn which also houses the gilts for acclimation, a gestation barn, 2 farrowing barns, a nursery barn, 2 growing-finishing barns, and a sales barn. This farm had 3 dogs, and a few feral dogs and cats were occasionally found on the farm. This farm operated on a continuous farrowing program on a weekly basis. All 3-week-old piglets were vaccinated for PCV2 (Fostera PCV; Zoetis, Madison, New Jersey, USA). For PRRSV vaccination (AMERVAC PRRS; Laboratorios Hipra, Amer, Spain), the replacement gilts were inoculated twice before breeding during acclimation, and the sows were inoculated after every farrowing. Other vaccines administered for reproductive management included the commercially available classical swine fever virus (CSFV; SUIGEN Hog Cholera Cell Cultured Live Vaccine; SBC Virbac Biotech, Kaohsiung City, Taiwan), Japanese encephalitis virus (JEV; NISSEIKEN Japanese Encephalitis Live Virus Vaccine; NISSEIKEN, Tokyo, Japan), porcine parvovirus (PPV; Suvaxyn P; Zoetis), and pseudorabies virus (PRV; SUIGEN Swine Pseudorabies Gene Deleted Live Vaccine; SBC Virbac Biotech) vaccines.

An increase in the incidence of late-term abortions, stillbirths, and premature farrowings was noted in this farm from November 2016 to February 2017. Abortion was defined as expulsion of fetuses before 110 d of gestation. Stillbirth indicated the delivery of a fully developed but nonviable offspring on or after 110 d of gestation. Expulsion of live piglets by gilts or sows between 110 and 113 d was considered premature farrowing. A month before this outbreak, the producer became aware that increased numbers of pigs in the herd were anorexic, lethargic, depressed, or pyrexic.

The abortion rate (i.e., number of abortions/number of females served) abruptly increased from 1.1% in October 2016 to the highest rate of 15.6% in December 2016. Subsequently, it decreased to 4.9% in February, although it was still unacceptable. Stillbirth rate (i.e., number of stillbirths/number of total pigs born) and mummy rate (i.e., number of mummified fetuses/number of total pigs born) were not available from the producer. During these 4 mo, records showed that only 8 of a total of 38 cases of abortions, stillbirths, and premature farrowings occurred in the gilts. The etiologies of 6 litters of 7 to 13 mummified fetuses, abortuses, and stillbirths, of varied crown-rump lengths from 3 gilts and 3 sows were investigated.
According to the breeding record, gestational ages ranged from 82 to 114 d. These gilts and sows showed no signs of illness other than having reproductive failure during the outbreak. Abortuses and stillbirths from these 6 litters were necropsied, and gross examination was performed on-site on every fetus from each litter on the same date the abortions occurred. The fetuses had variable crown-rump length ranging from 5 to 27 cm, which corresponded to approximate gestational ages of 40 to 110 d (19). No abnormal external appearances, except for meconium staining and mummification in some fetuses, were observed. The gross and microscopic lesions are summarized in Table 1. Excessive serosanguineous fluid was detected in the thoracic and abdominal cavities in fetuses of all 6 litters. Other gross lesions included marked cardiomegaly with ventricular dilatation, pale areas in the myocardium in cross-section, congested liver and meninges, and patchy pulmonary hemorrhage. Specimens of brain, gastrointestinal tract, heart, kidney, liver, lung, lymph node, placenta, spleen, thymus, tonsil, and umbilical cord were collected from 1 fetus of each litter, fixed in neutral buffered 10% formalin, and processed routinely for histopathological examination on the day after collection.

Histopathologically, the heart of 1 fetus from litter 4 had multifocal moderate mononuclear myocarditis (Figure 1A), edema, and fibrosis. In some areas, the myocardiocytes were reduced in size and exhibited cytoplasmic vacuolization. Vasculitis, characterized by infiltration of lymphocytes, macrophages, and plasma cells in the vessel wall (Figure 1B), and thrombus formation were sometimes noted in the same fetal heart. A few protozoa-like organisms were occasionally detected within the cytoplasm of myocardiocytes without associated inflammation in the same fetal heart and also in fetuses from another 2 litters (Figure 1C). Endocardial hemorrhage was observed in 2 other litters. Mononuclear choroid plexitis (Figure 1D) and meningitis, and cerebral edema were found in the brain from the fetus with myocarditis. Marked generalized hepatic lipidosis and congestion were also noted in most fetuses. Furthermore, hemorrhage was commonly observed in the cortex of the kidney and the lung. The IHC staining with Dako EnVision system using in-house anti-PCV2 antibody and anti-PRRSV antibody obtained from the Laboratory of Molecular Pathobiology, School of Veterinary Medicine, National Taiwan University, was performed on the fetus with prominent cardiac

**Figure 1.** Microscopic lesions of a fetus from litter 4 having concurrent infection of porcine circovirus type 2 (PCV2) and porcine reproductive and respiratory syndrome virus (PRRSV). A — The myocardium is infiltrated by mononuclear inflammatory cells [hematoxylin and eosin (H&E), 400×]. B — The vessel wall is infiltrated by mononuclear inflammatory cells, and perivascular fibrosis is apparent (H&E, 200×). C — A cluster of oval, basophilic tachyzoite-like structures (arrow) is observed in the cytoplasm of a myocardiocyte (H&E, 1000×). D — Mononuclear inflammatory cells infiltrate the choroid plexus (H&E, 400×).
lesions from litter 4. PCV2 antigen was detected within the cytoplasm of myocardiocytes and adjacent mononuclear inflammatory cells (Figure 2A), as well as in the mononuclear cells scattered in the lymphoid tissues (Figure 2B). PRRSV antigen was detected within the cytoplasm of the mononuclear inflammatory cells in the heart (Figure 2C), liver, lung, lymph node (Figure 2D), meninges, and spleen.

Body fluids, fetal tissues (brain, heart, kidney, liver, lung, lymph node, spleen, thymus, and tonsil), mummified fetuses from 6 litters, and the serum of 1 sow (the sow with litter 1) were also collected and frozen for laboratory tests. Multiplex PCR assays for detection of 6 swine abortifacient viruses, namely CSFV, JEV, PCV2, PPV, PRRSV, and PRV, and 2 additional PCR assays for detecting the encephalomyocarditis virus and Menangle virus were performed on pooled frozen fetal tissues, fetal body fluids, mummies from each litter, and serum from the sow, as previously described (20–22). Both positive and negative controls were included in each PCR assay of the multiplex PCR and worked appropriately. The samples were PCR-negative for all the tested viruses except for PCV2 and PRRSV. The fetal tissues from litters 2 and 4 were PCR-positive for both PCV2 and PRRSV, whereas PCV2 alone was detected in litters 1 and 3. The PCR amplicons with expected sizes for PCV2 and PRRSV were confirmed by sequencing. To detect protozoan pathogens, PCR assays were performed on the fetal hearts from the 3 affected litters by using self-designed primers for *Toxoplasma gondii* (obtained from the Laboratory of Molecular Pathobiology, School of Veterinary Medicine, National Taiwan University) and primers for *Neospora caninum* (23). The results were negative for both pathogens. Bacterial culture was performed on the fetal lungs, livers, stomach contents, and placenta from litter 1, and no pathogenic bacteria were isolated.

Coinfection of PCV2 and PRRSV was identified in 1 litter (litter 4). Coinfection of these 2 pathogens was suspected in another litter (litter 2); however, severe autolysis and mummification of the fetuses precluded histopathological examination and IHC. PCV2 infection alone was highly suspected in 2 other litters (litters 1 and 3) based on the presence of cardiac lesions and positive PCR result. However, IHC was not performed to validate the presence of PCV2 antigen in the lesion for these

Figure 2. Results of immunohistochemical staining (counterstained with hematoxylin) for porcine circovirus type 2 (PCV2) and porcine reproductive and respiratory syndrome virus (PRRSV) performed in a fetus from litter 4. A – PCV2 antigen is detected within the cytoplasm of myocardiocyte (arrow) and lymphocyte (inset, arrowhead) (400×). B – PCV2 antigen is detected in the mononuclear cells (arrows) scattered in the lymphoid tissue (1000×). C – PRRSV antigen is detected in the lymphocytes and macrophages scattered in the myocardium (1000×). D – PRRSV-positive mononuclear cells are present in the lymph node (400×).
2 litters. Specific lesions or pathogens were not identified in the remaining 2 litters.

**Discussion**

The first case of coinfection of PCV2 and PRRSV in stillborn pigs and nonviable neonates was reported in Canada by using PCR (5); however, only PCV2 antigen was associated with the lesions in the affected hearts by IHC staining. The PCR and IHC staining are the mainstay in routine diagnosis. In contrast to PCR, IHC staining also provides cellular detail and histological architecture while detecting the viral antigen in the same tissue section. In the present case, coinfection of PCV2 and PRRSV was diagnosed in stillborn pigs based on the clinical signs and the detection of both viral antigens in cardiac lesions and lymph node through IHC staining and PCR. Although the contributions of PCV2 and PRRSV to reproductive failure in this case are unknown, the concurrent presence of both viruses may reflect a possible interaction between these 2 pathogens. Whether PRRSV enhances the replication of PCV2 in utero or vice versa remains to be investigated.

In this case, the lesions found in different organs may be induced by 1 or both viruses. While mononuclear meningitis, choroid plexitis, vasculitis and interstitial pneumonia are all consistent with previously reported fetal lesions induced by PRRSV (14,24), cardiomegaly with myocarditis is more consistent with previously reported fetal lesions induced by PCV2 (13). However, a recent study showed that even though sows had high PCV2-specific antibody titers, including both total antibody and neutralizing antibody, they still delivered viremic viable piglets (12). In addition, the concept of cell-associated PCV2 viremia has been suggested (13), which may explain the failure of antibody to prevent the disease. Additional studies are required to clarify the roles of humoral and cellular immune responses against PCV2 in fetal infection and the effect of PCV2 on the reproductive performance of multiparous sows.

The identity of the protozoa-like organism was not confirmed in this case. *Toxoplasma gondii* is the primary differential diagnosis because it is the most commonly reported protozoan that causes reproductive failure in pigs (31). PCR and histopathology are insensitive methods to detect *Toxoplasma* because the concentration of protozoal cysts in tissues from pigs is very low (32), which correlates with the histopathological findings in this case and possibly explains the negative PCR results. Nevertheless, other diagnostic techniques were not available at the time of investigation, and the identity of the protozoa-like organism and its role as a cofactor in reproductive failure remain unknown.

This study has several limitations. Serum was only collected from the sow of the first litter because all dams showed no clinical signs during this outbreak of reproductive failure. Moreover, only 1 set of PCR primers was used to detect PRRSV; therefore, false negative results may have occurred due to PRRSV strain variation. Owing to the lack of gross and microscopic evidence supporting bacterial infection, routine bacterial culture was only performed for the first litter. Further testing for abortifacient bacteria, such as *Brucella* spp. and *Leptospira* spp., was not performed. *Toxoplasma gondii* tachyzoite antigen ELISA may increase the likelihood of diagnosing the protozoa-like organism in this case. Noninfectious causes including mycotoxin and environmental and nutritional factors were not investigated in the present case.

Based on the history of late-term pregnancy losses, pathological lesions, and positive results of PCR and IHC, stillbirth in this case appeared to be caused by coinfection with both PCV2 and PRRSV. Multiplex PCR with sample pooling is a useful tool for detecting coinfections, and reduces the cost and effort for initial screening during an outbreak of abortion and stillbirth. Immunohistochemistry further characterizes the role of each pathogen in different histopathological lesions in cases of reproductive failure with coinfections. As for the control strategies implemented as a result of the diagnostic investigation, a batch farrowing program with an all-in-all-out system could potentially decrease the chance of disease transmission during the outbreak. The presence of PCV2-associated reproductive failure in this conventional pig farm may stimulate the producer’s interest in implementing a vaccination program against this agent; however, a comprehensive and peer-reviewed study is warranted to elucidate the effect of vaccination against PCV2-associated reproductive failure.
Acknowledgments

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Feline hepatobiliary neoplasia and mistaken age
Kathryn M. Hotke

Abstract — A cat, thought to be 5 years old, and with reduced appetite and weight loss, was presented for dental cleaning and extractions. Bile duct origin hepatic carcinoma was diagnosed. The progression of iris degeneration, dental disease, histological renal lesions, spondylosis, and hepatobiliary neoplasia suggest this cat was closer to 10 years old.

Résumé — Néoplasie hépatobiliaire féline et âge erroné. Un chat, que l’on croyait âgé de 5 ans et qui souffrait d’une diminution d’appétit et d’une perte de poids, a été présenté pour un nettoyage des dents et une extraction dentaire. Un carcinome hépatique de la voie biliaire principale a été diagnostiqué. La progression de la dégénérescence de l’iris, la maladie dentaire, les lésions rénales histologiques, la spondylose et la néoplasie hépatobiliaire suggèrent que ce chat était probablement âgé d’environ 10 ans.

A spayed female domestic shorthaired cat, presented as a 5-year-old, with severe gingivitis, mild-moderate calculus buildup, and severe resorptive tooth lesions was admitted for routine dental surgery. According to the patient’s history, for the past month the patient had begun drinking and eating less. On pre-anesthetic physical examination, the patient was painful around her mouth; her gums were inflamed, and several teeth were missing. The hair coat and eyes were dull and the irises had a moth-eaten appearance (Figure 1A). The patient was cachectic, mildly depressed, and moderately dehydrated (~8%) with a prolonged capillary refill, tacky gums, and a prolonged skin tent. The gums and skin at the base of the cat’s ears appeared pale. On palpation, the patient was painful in both the abdomen and the hind-end. The patient’s abdomen was mildly distended; however, no fluid wave was detected. A large hard mass was felt in the right cranial abdomen which appeared to be continuous with the liver and could be pushed medially on palpation. After we described these physical findings, the owner revealed that the cat had been losing weight for the last 2 mo and had developed a dull hair coat. The cat was lethargic, spending most of her time sleeping. For the last 2 wk there had been an increased frequency of daily vomiting, decreased urination, and fewer bowel movements.

Due to these physical examination results and history, surgery was postponed, and further diagnostics were pursued. A complete blood (cell) count (CBC) revealed a mild normochromic normocytic regenerative anemia and a leukocytosis with neutrophilia and monocytosis. Serum biochemistry showed an increased alanine aminotransferase, low urea, and high lipase. Urinalysis revealed normal concentration, proteinuria, and hematuria. A right lateral radiograph revealed hepatomegaly with an irregular margin, loss of serosal detail, severe spondylosis of the lumbo-sacral spine especially at L13 (Figure 1B), an enlarged duodenum with a gas opacity, and a cranial dorsally displaced stomach. On a dorsal-ventral view, there was loss of detail in the right cranial abdomen with the stomach displaced laterally to the left. With these diagnostic results, the patient’s rapid decline and grave prognosis, the owner opted for euthanasia and allowed a postmortem examination.

Postmortem examination revealed approximately 250 mL of hemorrhagic fluid in the abdominal cavity. The omentum had formed adhesions to multiple organ surfaces and the body wall. The liver had a generalized zonal pattern, later revealed by histology to be hepatic lipidosis, and contained a large ~6 cm diameter mottled white hard mass encompassing 40% of the base of the liver lobes where the gall bladder should have been (Figure 2A). Organ biopsies were sent for histology (Animal Health Laboratory, Ontario Veterinary College), which showed the primary liver mass to be hepatic carcinoma of bile duct origin (Figure 2B). The tumor had localized areas of necrosis, inflammation with metastasis to the lung. Postmortem pancreatic samples revealed mild suppurative pancreatitis. Histology of postmortem kidney samples revealed lymphocytic and plasma cell infiltrates, and mild interstitial necrosis and tubule atrophy with mild amyloid deposition and < 5% of medullary collecting ducts containing luminal protein consistent with the proteinuria seen on urinalysis.
Discussion

The cat in this report had been adopted 2 y earlier and at the time was thought to be 3 y old. Nonetheless, the patient never wanted to jump and walked with a hunched spine. Since adoption the patient vomited daily, which was attributed to eating her food too quickly. However, iris atrophy, the degree of dental disease, radiographic evidence of spondylosis, histological kidney lesions, and the type of hepatic neoplasia, all suggest that this patient was closer to 10 y of age.

The patient was displaying senile iris atrophy, a condition commonly found in senior cats and considered age-related (1). As a cat ages, the iris tissues become thinner, resulting in reduced luster and a moth-eaten appearance. This atrophy may continue, resulting in a scalloped or irregular pupillary margin. Although iris atrophy does not appear to affect vision, these senile changes progress with age and result in a slower pupillary response to light (2).

Similarly, the severe progression of dental disease in this patient also suggests that she was of advanced age. Periodontal diseases, which include several plaque-inducing inflammatory lesions of the periodontium, are common in cats. Without preventative care, cats as young as 3 y of age may require intervention (3). According to 1 report (4), 68% of cats over 3 y of age are affected by dental disease. Increasing age positively correlates with the severity of periodontal disease. Feline odontoclastic resorptive lesions (FORLs) occur in the tooth root, eventually leading to the crown resorbing, or fracturing (5). Ingham et al (6) found FORLs to occur at a mean age of 4.9 y, and although FORLs can occur at any age they are mostly seen in senior patients (7).

The patient also presented with renal lesions of mild multifocal chronic tubulointerstitial nephritis, amyloid deposition, and luminal protein; all of which are common presentations among senior cats (8,9). These lesions are normal in an aging cat, with up to 35% of geriatric cats having some degree of chronic kidney disease (CKD) (10). This patient had not yet developed renal disease according to IRIS staging. However, proteinuria is a risk factor for progression of CKD (11). One study of feline CKD (2) found cats > 7 y to be over-represented (52.9% of cats with CKD). Morphological diagnoses of these senior cats included chronic tubulointerstitial nephritis (52.7%) and renal amyloidosis (9.5%), similar to the patient in this case (2).

Another condition present in this patient and common in aging cats is spondylosis deformans or spondylosis (12). Spondylosis is a non-inflammatory degenerative skeletal disease characterized by production of osteophytes along the ventral and lateral aspects of the vertebral bodies, resulting in the formation of bony spurs (13). These bony spurs can cause stiffness, restricted range of motion or pain consistent with the patient’s clinical signs of hunching and unwillingness to jump (14). Spondylosis is most common in the lumbosacral region of the vertebral column as was seen in this patient with the largest bone spurs present at the L13 vertebra (Figure 2) (12–14). The prevalence of spondylosis increases with age and average age of presentation is 10.5 y, thus suggesting that the patient was closer to 10 y old (12–14).

In this case, the patient’s primary problem was a single localized malignant hepatic tumor with histological characteristics of bile duct origin and metastasis to the lung. Primary feline hepatobiliary neoplasia of liver, gall bladder, or bile duct origin is uncommon, comprising 1.5% to 2.3% of all feline neoplasia (15). A study by Patnaik (16), found that neoplasms of the biliary system, such as that found in this patient, are more malignant than those of hepatocellular carcinoma with 80% of biliary tumors having metastasis. Malignant hepatobiliary tumors often spread diffusely intraperitoneally, to the lungs, lymph nodes, and spleen (16).

Cases of hepatobiliary neoplasia are more common in older cats, generally older than 10 y (17,18). These patients will generally have non-specific clinical signs including anorexia, weight loss, lethargy, polydipsia, polyuria, ascites, vomiting, and diarrhea (16–18). These clinical signs are more likely to be present if there is malignant disease. Lethargy, weakness, and ataxia could result from hemoperitoneum owing to rupture of the liver mass (19), such as seen in this case. The vomiting seen herein was likely due to the space-occupying liver tumor causing

Figure 1. Degenerative changes in this patient indicating advanced age. A — Photograph displaying degeneration of the iris. The iris has a moth-eaten appearance with black spots of the anterior chamber showing through. B — A right lateral radiograph of the patient displaying significant spondylosis of lumbar vertebrae L13 (arrow).
compression of the stomach and esophagus and of the pancreatic duct resulting in pancreatic inflammation. Hematologic abnormalities such as mild, nonregenerative anemia may be present and leukocytosis with neutrophilia is found in 28% of cats (17). The leukocytosis seen in this case was likely the result of inflammation and necrosis present in the large liver tumor. Liver enzymes are increased frequently at presentation but are not specific for hepatobiliary neoplasia (15,17). These findings support the diagnosis of hepatobiliary neoplasia of bile duct origin in this patient and are consistent with increased age.

In cats, it is often difficult to determine if an animal is displaying changes that are appropriate for age or if they reflect an abnormal condition. This case demonstrates the necessity to properly age feline patients who come from uncertain circumstances. This practice will help veterinarians to pre-emptively screen for diseases of geriatric animals and provide owners with guidance regarding optimal care. Better knowledge of the cat’s approximate age will also help clients prepare for diseases commonly associated with old age and to make difficult decisions related to this stage of life.

Acknowledgments
I thank Dr. Dorothea Kanter for her support and mentorship with this case, Catherine Ypma for her help with this case, and the staff at Edward’s Veterinary Clinic for a warm environment and wonderful experience throughout the externship program.

References

Figure 2. A – Gross pathology of the patient’s liver with the hepatobiliary tumor located at the base of the liver lobes. B – Histopathologic slide of the hepatobiliary tumor; the normal liver architecture is completely obliterated by the tumor mass. Tumor cells have 3- to 4-fold anisokaryosis, marginned chromatin, and 1 or more central nucleoli. Cytoplasm is eosinophilic with distinct cytoplasmic borders with a moderate nucleus:cytoplasm ratio.
Country veterinarian buys clinic after completing Massey University postgraduate degree

Veterinarian Nicola Pattison signed up for a distance orthopaedics course at Massey, and liked it so much that she tackled an MVM. The experience opened up her eyes - and a new opportunity.

AN OPPORTUNITY TO step into her boss’ shoes led Nicola Pattison to Massey University’s online Master of Veterinary Medicine (MVM) and she’s never looked back.

The New Zealander signed up for an MVM course at Massey when the owner of the vet clinic in Victoria, Australia, asked Pattison to take over while she was overseas.

“When my boss went to the UK for three months and asked me to cover for her while she was gone, I thought I’d better do an orthopaedics course so I could fix broken bones,” says Pattison.

She initially chose the orthopaedics course at Massey as it appeared to offer the best value and gave her the opportunity to return to her Kiwi homeland, but ended up enjoying the experience so much, she went on to complete the MVM.

“I did the soft tissue surgery course, followed by neurology and an epidemiology course. With an interest in farm dogs, I then did a dissertation on working farm dogs so I could complete the whole thing.

“With Massey, you’re actually working towards a degree, not just a certificate, which increases the course’s value.

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You can do one of the courses for about the same cost as attending a conference, and you get a lot more out of it,” says Pattison.

As a busy working mother with a young family, she appreciated the flexibility Massey University offered. “I gave birth to two children while doing it, already had a two-year-old and was working part-time.

“When my third child came along, my husband was working as a fly-in fly-out oil field worker and I ended up in hospital. It was a fairly hectic time in my life, but I was able to work through it with Massey’s help, and complete the course without too much drama” says Pattison.

The educators and support team at Massey University were another plus. “All of the admin staff are really good and I couldn’t say enough great things about my supervisor. “She was always available to me during my dissertation, and made extra time towards the end of the year so we could analyse the data and work on statistics together. They really do go above and beyond,” she says.

Pattison also valued the hands-on nature of what the Massey MVM offers and says, “This is for real world vets, you’ll learn stuff you can take into your practice and use straight away on a daily basis.”

She has since gone on to buy the country vet clinic in Casterton in January 2017 and attributes the postgraduate degree in helping to give her the confidence to do so.

“Without question, I wouldn’t be doing what I’m doing now without the MVM. It gives you the confidence to step outside your comfort zone. “It’s made me a better vet. The MVM has been brilliant and even though I’ve finished the degree I’m probably going to do more courses in the future, just for fun,” says Pattison.

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What Can’t Be Taught

Ce qui ne s’enseigne pas

Dr. Michelle Oakley shares poignant lessons

Alexandra Schlesiger

On January 13, 2018, Dr. Michelle Oakley, Canadian Veterinary Medical Association (CVMA) member and star of National Geographic Wild’s reality show Dr. Oakley: Yukon Vet, addressed the Students of the CVMA (SCVMA) as the annual SCVMA Symposium’s keynote speaker.

In a packed lecture hall at the Atlantic Veterinary College (AVC), Dr. Oakley’s alma mater, eager veterinary students hailing from every Canadian veterinary college listened intently to Dr. Oakley’s captivating 2-hour lecture titled, Yukon Vet: Will Film for Food.

Dr. Oakley spoke fondly of her time pursuing a doctorate in veterinary medicine at AVC, while simultaneously raising 2 of her 3 daughters. She regaled students with the story of surprising one of her mentors, Dr. Jeanne Lofstedt, AVC professor and CVMA Life Member, by carrying her 6-week-old baby into school one day, an occurrence that never happened back then, at least not to her knowledge. Dr. Oakley couldn’t hide the tears in her eyes as she told students that after Dr. Lofstedt saw Shane, her husband, carrying their baby into the college so she could feed her multiple times a day in a corner, she created a private nursing room for her; fully equipped with toys, a comfortable chair, and a soft light, as opposed to the fluorescent overhead ceiling lights in the college. “I can’t thank Dr. Lofstedt enough and I’ll always be grateful,” said Dr. Oakley.

When asked how she cultivates a good work-life balance with such a demanding career, Dr. Oakley said that, although ways to cultivate a good work-life balance are personal and depend on the individual; one thing she recommends is not taking on too much. “Veterinary students are perfectionists, many have Type A personalities and think they have to do everything to the max, but learning to let some things go and delegating and sharing work with coworkers is something we all need to work on,” advises Dr. Oakley. “And when you do have time off, take the time off; I remember reading articles during my time off when I should have been out with my kids. Of course, you have to find ways to keep up, but really, completely getting away from work when you do have off time is important.”

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I know it is tough because you don’t want to seem unprofessional, but while working in a couple of clinics, we laugh a lot,” says Dr. Oakley. “You have to be careful because you don’t want to be overheard and have the context misunderstood, but while still being concerned about the health and pain management of our patients, we laugh and we joke and if our patients could, they would be laughing with us also. Working in a clinic can be an emotional rollercoaster every day, so it is really important to laugh or find what works for you because an hour later you may feel like crying. Laughing and joking a bit while still focussing and being cautious so I’m not misunderstood, is what keeps me going or else I find it’s too easy to let things get to you and become too serious.”

Given the chance to go back and do some things differently in her career, Dr. Oakley said she would change 2 things: i) she would go back and give her husband more time to do things he would have liked to do, and ii) she would have found better ways to deal with issues. “I had a lot of fantastic mentors, but I also had a difficult one,” says Dr. Oakley. “When I became pregnant during a caribou project with my third daughter, he basically told me I wasn’t committed to the work, even though I started the project, came up with the idea, proposed it, and went out in the field and did it, and he said he couldn’t believe I got pregnant with 2 more years left on the project. It was a really difficult time for me and the next year, when he was the lead, he basically said, ‘You can’t come out in the field with your baby,’ (we had set it up so my husband could bring the baby because I didn’t want to wean her). So my choice was either wean the baby at 6 months old and go to work or don’t. I chose not to wean her, thank God, but I didn’t handle the situation well. I just gave up and said, ‘fine,’ but was angry about it for a long time and I should have found reasonable ways to discuss it and speak up. A lot of my past issues or mistakes have been from lacking the people skills needed to find ways to speak up in a non-combative or argumentative way and I feel I’ve learned them now, but I had to learn them through hard lessons. I have had so many wonderful mentors and great supporters, starting here at AVC and all the way throughout my career, but sometimes, it is still tough as a woman in male dominated fields.”

Dr. Oakley went on to speak about the positive mentors she has had throughout her career, such as Dr. Sandie Black, who is now the Calgary Zoo’s head veterinarian. She feels their patience and belief in knowing she could do something, be it a small project or little procedure, and standing back and supporting her not only while she did it, but also if she did something incorrectly, was instrumental in her career. Dr. Oakley is still in contact with many of her mentors and urges students to seek out their own mentors and take advantage of as many learning opportunities as possible.

Dr. Oakley provided great advice for students to remember when transitioning into their careers. “We all make mistakes, that’s what liability insurance is for — be as honest and open as possible with your clients; that is always the best policy,” she explains. “When you make a mistake, protect your heart, accept that mistakes will happen, and move on knowing you went into it with the best intentions. And love your clients, even the quirky ones, because they’re all teaching you.” Dr. Oakley also urged students not to stress about remembering everything at the beginning of their careers. “Even with so many things to remember, you still think you will remember them and the sad truth is you won’t. But you need to learn it all in school anyway, so you’ll have the general concept later and in your career, when you come across a case you’re unsure of, you’ll look up what you need to know and it will come back to you. And once you do it 5 to 10 times, you’ll remember it.”

Although Dr. Oakley would never describe herself as a “badass” and told students it’s hilarious and a little awkward when she is portrayed as one in her show, in fact, she is a perfect embodiment of just that. Dr. Oakley does not try to look tough, she just is tough, she stays true to herself, and she does not give up. She pushes herself to be better despite hardships, she shows kindness to the weak, and she realizes her limits and that is the true definition of a badass.
Burnout: Prescription for a happier healthier you

Debbie L. Stoewen

D
o you love your job? Do you feel energized, happy, and fulfilled, even when the work is demanding, and the conditions, at times, less than ideal? Are you devoted to, and impassioned by your work, and filled with ambition, ideals, and high objectives? If not, you may be at risk for, or experiencing, occupational burnout. As Dr. Michael Kaufmann, Medical Director of the OMA Physician Health Program and Physician Workplace Support Program, warns, “Burnout looms as one of the greatest challenges to the veterinary profession” (1). Although our work can offer an extremely rewarding professional life, it can also offer countless challenges, impacting health, happiness, and performance — and risking burnout. With the right “prescription,” however, the challenges can be managed, and you can stay happy and healthy, perform at your best — and love your job!

What is burnout?
According to psychologist Christina Maslach (2), a prominent pioneering researcher on the topic, occupational burnout is “a psychological syndrome of emotional exhaustion, depersonalization, and sense of low personal accomplishment” (2). It has been described as “a state of physical, emotional or mental exhaustion combined with doubts about one’s competence and the value of one’s work” (3) and “the process by which a person, in response to prolonged stress and physical, mental and emotional strain, detaches from work” (4). In sum, burnout is seen as a three-dimensional syndrome, with the salient features of exhaustion, cynicism and inefficacy, and is considered both “a state” and “a process.”

What causes burnout?
Burnout is the result of long-term, unresolvable work-related stress (5). Stress is recognized as a common occupational health concern in the veterinary profession (6). In fact, studies in the profession have identified the rate of work-related stress to be high (7) or moderately high (8), making the risk for burnout real.

Worldwide, a growing body of research has accumulated on stress in the veterinary workplace. The results have been unsurprisingly consistent (9), given the global nature of clinical veterinary practice. According to the literature (6,8,9–14) the list of veterinary workplace stressors seems nearly endless and includes:
- long work hours; excessive workload;
- emergency on-call;
- working time problems (e.g., not enough time per patient or rest breaks per day);
- work-home interference;
- under-staffing;
- inadequate professional support;
- unclear job descriptions;
- a mismatch between the person’s and the organization’s expectations;
- a difference in values or practice philosophy;
- hospital policies and procedures that lead to difficulties;
- the pressure to over-service or over-prescribe;
- unexpected outcomes of clinical cases;
- difficult relationships with managers, colleagues, and clients;
- high and unreasonable client expectations;
- recovery of amounts of money not paid by clients;
- lack of control over treatments due to clients’ cost constraints;
- lack of recognition from the public;
- lack of resources to do the job properly; immoral or unethical practices;
- ethical problems and performance of euthanasia;
- low remuneration;
- financial pressures and low profit margins;
- not having enough holidays;
- administrative duties;
- high levels of job complexity and concern about maintaining skills and expertise;
- insecurity of work; and
- career path concerns.

Workplace factors aside, person-level factors, such as personality and coping styles, may also contribute to the risk of burnout. Those with perfectionist tendencies, who have unrealistic standards and expectations of themselves, their job and others (15), and/or who feel overly responsible for the welfare of others (16) may be at greater risk. Likewise, the risk may be higher for those who lack the necessary skills to fulfill their work responsibilities, coupled with insecurity, the inability to relax, and Type A personalities (15).

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How does burnout arise?

Burnout arises insidiously. It is easy to miss the warning signs. As a process, burnout has been described as a set of stages (4) that blur together so that one rarely realizes what is happening:

**Physical, mental, and emotional exhaustion:** You start to feel differently about the job you loved and had boundless enthusiasm and energy for. You thought it would meet all your expectations, but you're starting to sense that something is wrong. You can't seem to put a finger on it, but you feel increasingly drained — physically, mentally, and emotionally.

**Shame and doubt:** Over time, you begin to feel disappointed and disillusioned. The job isn't working out the way you expected, and the more you try to fix things, working even harder, the more exhausted and frustrated you become. You start to question your abilities and competence, and feel your confidence waning. You may even start to question your achievements, and even discount them.

**Cynicism and callousness:** With a growing sense of inadequacy and insecurity, you start to blame those around you for your difficulties, and detach yourself, taking on a “look out for #1” kind of attitude. As your negativity increases you may start to openly criticize the practice, or management, or coworkers. To cope with the worry, powerlessness, and disillusionment, you may resort to escapism (i.e., drinking, eating, shopping).

**Failure, helplessness, and crisis:** You feel overwhelmed, unable to cope, and like a total failure. You may adopt a “damned if I do, damned if I don’t” kind of attitude, with a sense of helplessness and despair. You have reached a crisis point.

Could you be burning out?

If you sense, by the description above, that you may be burning out, know that you're unlikely to be alone. The CVMA conducted a national survey on the wellness of veterinarians, with a specific focus on burnout, to obtain data on the status of veterinarians in Canada (17). According to this study, 51% of veterinarians believed that they had suffered from burnout, and of these, 68% felt they were at risk of relapse. Of those who believed they had never experienced burnout, 75% believed they could be at risk. To know if you may be burning out, ask yourself the following questions:

1. Do you dread going to work?
2. Do you drag yourself in and have trouble getting started once you arrive?
3. Do you see work as a chore?
4. Do you feel constantly overwhelmed?
5. Are you no longer laughing or having fun at work?
6. Are your work relationships changing?
7. Are you less flexible, less of a team player?
8. Have you become cynical or critical at work?
9. Have you become irritable or impatient with co-workers or clients?
10. Are you feeling lethargic and empty in your work?
11. Do you lack the energy to be consistently productive?
12. Are you having trouble focusing and concentrating on your work?
13. Are you less able to complete tasks, follow guidelines, and meet deadlines?
14. Are you unconcerned about the quality of your work?
15. Do you lack satisfaction from your achievements?
16. Do you feel disillusioned about your job?
17. Do you chronically worry about your job?
18. Are you using food, drugs, or alcohol to feel better or to simply not feel?
19. Have your sleep habits or appetite changed?
20. Are you troubled by unexplained headaches, backaches, or other physical complaints? (18–20).

The higher the number of affirmatives, the higher the chance that you may, indeed, be burning out. While this may be the case, it's advisable to consult a doctor or mental health professional, as some of these symptoms can also indicate certain health conditions, such as hypothyroidism and clinical depression (18).

What are the consequences?

Ignored or left unaddressed, occupational burnout can have significant personal, professional, and organizational consequences. At the personal level, burnout can lead to a plethora of physical and mental health concerns including cardiovascular disease, high cholesterol, Type 2 diabetes, stroke, obesity, increased vulnerability to illnesses, chronic fatigue, insomnia, depression, anxiety, alcohol or substance abuse, and suicidal ideation (18,21). These concerns not only affect one's personal life, but spill over into one's professional life.

At the professional level, performance suffers, and careers become jeopardized. The declines in efficiency, productivity, and professional competence, so typical of burnout, along with the concerning risk of medical errors, seriously impact career direction and development (22,23). Burnout can lead to sick days, disability leave, quitting, dismissal, and even career loss (24).

At the organizational level, burnout contributes to increased staff turnover, absenteeism, presenteeism, reduced productivity, reduced morale, incivility, conflict, toxicity, dysfunctional teamwork, job dissatisfaction, and workplace unhappiness, all of which prevent hospitals from achieving their goals and directives (12,20,22,23). Incapacitating individuals to organizations, the consequences of burnout are far-reaching.

As Gardner and Hini (12) highlight, “There is a need for a wide range of strategies to manage work-related stress among veterinarians.” (p. 119) In fact, a “prescription” may be in order, to help us better manage the stresses of veterinary practice that impact health, happiness, and performance — and risk burnout and its many consequences. The risk is related to who you are, what your job is, and where you work, so the prescription to sustain a happy, healthy you needs to address all three.

Prescription for a happier, healthier you!

**Your personal self:** The prescription starts with you. The more resilient you are, the greater the chance you’ll thrive despite the challenges. How do you sustain resilience? Make a commitment
to ongoing self-preservation and renewal (25). This means you make your "own" health a priority! Think of this as creating a "personal stewardship program." Eat right, get enough sleep, and exercise so you'll have the stamina to cope with the stresses. Have fun on a regular basis; enjoyable activities are freeing and rejuvenating. Turn to nature; the great outdoors can be a great stress reliever. Focus on your spiritual side; it enables perspective-taking and provides a sense of guidance. Engage in activities that bring relaxation; while deep-breathing exercises, yoga, and meditation work for some, knitting, painting, carpentry, or playing the piano works for others. Practice self-compassion; this is a potent form of self-care that transforms our relationship with ourselves (26). Seek social support; sharing with co-workers, friends, and family can help you cope with the stress and feelings of burnout (18,27,28). Another aspect of self-care is to mind your mindset. If you can't change the stressors, change your perspective (18,25). When your thoughts turn negative, try to shift your attention to the positive. If you've become cynical, consider ways to improve your outlook. Spread optimism. Expect the best. Rediscover enjoyable aspects of your work. There are endless ways to adjust one's perspective. Lastly, know when to ask for help. When the bad days outnumber the good ones, and the symptoms of burnout are obvious, it's time to seek professional help (25).

**Your professional self:** The prescription continues with you. As Socrates (469–399 B.C.E.) wisely stated, "The unexamined life is not worth living." So take time to reflect on your professional self. This could include journaling, spending time in nature, meditating, praying, or whatever will help you settle into moments of quiet contemplation and introspection (29). Identify what's fueling your feelings of burnout so you can address the issues (18). Talk to colleagues and ask for help (30). Consider whether you (and your colleagues) may benefit from improving skills that help manage stress, such as mobilizing social support; problem-solving; decision-making; communication skills (including empathy, negotiation and mediation); conflict prevention and resolution; and grief management (12). Assess your interests, skills, and passions (18). How good is the fit between you, what you're doing, and where you're doing it? An honest assessment can help you decide whether you should consider other options in your practice or new career opportunities (31). As Fishell-Rowan (31) says, "Change may be daunting, but the cost of burnout's long-term effects may far exceed the price of pursuing a new position or career."

**Your practice:** The prescription ends with your practice. But in truth, this is where the prescription should begin! According to Maslach (32), "we need to pay greater attention to the social and organizational environment in which individuals work, and to be more creative about solutions at those levels, rather than just at the individual one." We have the greatest potential to avert burnout when we identify and manage the stressors in the workplace. Although the sources of stress vary from practice to practice, there are several strategies to consider. To start, make sure the tasks, technologies, and work environments are appropriate (12,30,33). Identify how tasks might be done with greater ease by attending to priorities, workflow, equipment needs, ergonomics, and other safety concerns. Attend to workloads, working hours, and work processes (12,33–35). This includes reviewing scheduling, staffing, breaks taken, hours worked, overtime policy, on-call duties, vacation, job-sharing, and administrative support. Ensure that demands are reasonable and manageable. Offer flexible work schedules. Create opportunities for variety with tasks, skills, caseload and/or location. Support work-life balance in whatever ways you can. Empower people by embracing a participative management style, increasing their control over their work, and providing discretion and decision latitude consistent with roles and responsibilities (12,33–36). Provide supportive and considerate supervision and build cohesive teams (26). Address communication practices to identify areas of stress and misunderstanding and make concerted efforts to reduce negative communication (31,35). Develop procedures for handling difficult clients. Coach and guide, blending support with appropriate levels of challenge, and be sure to conduct performance appraisals (12,33–35). Provide clear job expectations, develop equitable reward systems, and provide a sense of job security, all of which contribute to a culture of equity (12,33–35). Promote ongoing professional development, especially in work-related skills where the lack thereof is contributing to stress (12); continuing education is integral to job endurance. Ensure that confidential and relevant support resources are available for those experiencing stress (12). And lastly, each person can ask the question, "How do we make our hospital a great place to work, and a 'workplace of choice'?") Then go do it. Many of the stressors in the veterinary workplace are in our control.

**In closing...**

Every occupation has its burden of stress, but as the research indicates, the burden is sizable in our profession. Stress can additively impact health, happiness, and performance, and ultimately lead to burnout. As captured by Shanafelt et al (37), burnout manifests as "emotional exhaustion that affects a person's passion for work; ability to relate to others; sense of accomplishment or purpose; judgment; productivity; emotions; and overall health."

Burnout does not have to be the "undesired endpoint of a career that began with the noblest of intentions" (16). It is a difficult phenomenon to pinpoint, but with awareness and proactivity, a welcomed future can not only be envisioned, but achieved.

**References**

Associate veterinarians in Canada had cause to celebrate in 2017, with the national weighted average compensation climbing by 2.8%; this outpaces Statistics Canada’s December 2017 inflation figure of 1.9%.

Data for this investigation are provided through the CVMA sponsored 2017 Provincial Surveys of Compensation and Benefits for Associate Veterinarians. All figures presented are for full-time associate veterinarians employed in private practice.

Measuring pay growth against Statistics Canada Consumer Price Index (CPI), a common assessment of inflation, sheds light on changes in purchasing power of veterinarians. If, for example, a veterinarian’s salary grows by 1% and inflation climbs by 2% (as the cost of shelter, food, gas, and other goods and services increases) over the same period, the veterinarian’s purchasing power has declined. If this continues, it may eventually necessitate a reduction in their standard of living.

This acceleration of compensation growth will come as a relief to many Canadian associate veterinarians, particularly on the heels of 2 lackluster years. Incomes declined in 2015, but rose nearly in step with inflation in 2016, while the CPI continued its upwards march (Figure 1).

With compensation climbing by 2.8% in 2017, while inflation ticked upwards by only 1.9%, associate veterinarian compensation is now only a hair below where it would have been had it kept pace with inflation over the past 5 years.

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Grâce à une hausse de 2,8 % de la rémunération en 2017, tandis que l’inflation affichait seulement une légère hausse de 1,9 %, la rémunération des vétérinaires salariés se situe maintenant légèrement en deçà de ce qu’elle aurait été si elle avait suivi l’inflation au cours des cinq dernières années.

Avec deux autres années de croissance salariale soutenue au-dessus du niveau d’inflation, les vétérinaires salariés pourront reprendre le terrain perdu en 2015 et observer une progression de leur pouvoir d’achat.

Même si la rémunération médiane nationale globale pondérée des vétérinaires a grimpé à 82 548 $, il y avait, comme d’habitude, une variation importante du revenu entre les provinces.

Figure 2 montre la rémunération médiane annuelle des vétérinaires salariés à temps plein dans chacune des provinces.

Figure 3 illustre la rémunération médiane annuelle ajustée au CDV pour les vétérinaires à temps plein dans chacune des provinces.

Après l’ajustement au CDV, le classement est modifié de façon significative. L’Alberta devient la plus basse au pays, avec une rémunération ajustée au CDV de 71 390 $. Terre-Neuve-et-Labrador conserve la première place,

With a couple more years of sustained pay growth above the level of inflation, associate veterinarians will be able to make up all the ground that was lost in 2015 and see their purchasing power expand.

While the overall national weighted average associate veterinarian compensation climbed to 82 548, there was, as usual, wide variation in incomes across the provinces.

Figure 2 shows the median annual compensation for full-time associate veterinarians in each of the provinces.

Similar to last year, the provinces with the highest median compensation were Newfoundland and Labrador, Alberta, and Ontario, at $101 500, $90 000, and $85 000, respectively. Quebec, by contrast, had a median compensation of $74 000, the lowest in Canada.

As always, a meaningful comparison among provinces requires adjusting for the variations in cost of living (COL). This accounts for differences in how much it costs to reside in each province, while maintaining a similar standard of living. For example, a typical family in British Columbia is likely to have higher expenses when measured against one in New Brunswick, without significantly different living standards.

Figure 3 shows COL-adjusted median annual compensation for full-time veterinarians in each of the provinces.

Once adjusting for COL, the rankings are dramatically altered. Alberta falls to become the lowest paying province in the nation, with a COL-adjusted median compensation of $71 390. Newfoundland and Labrador retains top spot, but Prince Edward Island leapfrogs into second, with a median of $104 096.

In determining where to live and practice, it is important that a veterinarian consider COL-adjusted compensation. After all, if a veterinarian earns a high salary, but is paying significantly more for everyday expenses, they may wind up further behind a colleague who takes a lower salary in an area with lower expenses.
in 2017 was a good news story for associate veterinarians. Most provinces enjoyed compensation growth above inflation, no provinces saw median compensation decrease, and the overall national weighted average outpaced the consumer price index. With luck, Canada’s economy continues on its recent positive path, and there is more good news to come.

Notes: Median annual compensation was determined using the 2017 Provincial Surveys of Compensation and Benefits for Associate Veterinarians. Cost of living-adjusted median annual
compensation was determined through use of the most recent Statistics Canada data on average household expenditures, by province. The average household expenditure in each province was divided by the average household expenditure of the country as a whole, to determine the province-to-country ratio. This ratio was then multiplied by the median annual compensation in each province (as determined by the results of each respective provincial survey of compensation and benefits for associate veterinarians), to determine the cost of living-adjusted median annual compensation in each province. Information regarding inflation was taken from Statistics Canada data on consumer price index.

http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/famil130a-eng.htm
https://www.statcan.gc.ca/daily-quotidien/180126/dq180126a-eng.htm

Notes: La rémunération médiane annuelle a été déterminée en utilisant les sondages provinciaux 2017 sur la rémunération et les avantages sociaux des vétérinaires salariés. La rémunération médiane annuelle ajustée au coût de la vie a été déterminée en utilisant les plus récentes données de Statistique Canada sur les dépenses moyennes des ménages, par province. Les dépenses moyennes par ménage dans chaque province ont été divisées par

Les dépenses moyennes par ménage pour le pays en entier afin de déterminer le ratio de la province par rapport au pays. Ce ratio a ensuite été multiplié par la rémunération médiane annuelle dans chaque province (déterminée par les résultats des sondages provinciaux respectifs sur la rémunération et les avantages sociaux des vétérinaires salariés), afin de déterminer la rémunération médiane annuelle ajustée au coût de la vie dans chaque province. Les renseignements concernant l’inflation ont été tirés des données de Statistique Canada sur l’indice des prix à la consommation.

http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/famil130a-fra.htm
https://www.statcan.gc.ca/daily-quotidien/180126/dq180126a-fra.htm

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The treatment of demodicosis took a major step forward 2 years ago when a study demonstrated that fluralaner (Bravecto; Intervet-Merck Animal Health, Kirkland, Quebec), was very effective in the successful resolution of generalized demodicosis in 8 dogs over 1 year of age (1). The study did not indicate how many dogs had juvenile-onset or adult-onset demodicosis. All dogs were treated once with a minimum oral dosage of 25 mg/kg body weight (BW). The single treatment resulted in all 8 dogs being mite-free on skin scraping on day 56 and day 84. All but 1 dog showed > 90% hair regrowth by 12 weeks after the initial treatment (1).

A second study (2) involved treatment of 4 dogs with generalized demodicosis orally with 2.5 mg/kg BW afoxolaner (NexGard; Merial, Duluth, Georgia, USA) at monthly intervals for 3 consecutive months. Two dogs had juvenile onset and the other 2 dogs had adult onset generalized demodicosis. All 4 dogs were mite-free at 8 and 12 weeks based on skin scrapings (2). Afoxolaner (NexGard, Merial) was also used successfully in another group of 8 dogs with generalized demodicosis (3). They were treated with a minimum of 2.5 mg/kg BW on days 0, 14, 28, and 56. The bi-weekly treatments with NexGard were based on pharmacokinetic properties of afoxolaner, in order to rapidly achieve a steady-state concentration in the blood and this was considered safe based on target animals' safety studies. The percentages reduction in mite counts were 99.2%, 99.9%, and 100% on days 28, 56, and 84, respectively (3).

In another study (4), 16 dogs over the age of 6 mo with generalized demodicosis were all successfully treated orally with 2 mg/kg BW of sarolaner (Simparica; Zoetis, Patsippany, New Jersey, USA) at monthly intervals for 3 months. Skin scrapings were negative in all 16 dogs by day 44 and thereafter.

All 3 drugs are systemic insecticides and acaricides belonging to the isoxazoline class of parasiticides with selective inhibition of arthropod gamma-aminobutyric acid and L-glutamate-gated chloride channels. Fluralaner and sarolaner can be used in dogs as young as 6 months and afoxolaner can be used in dogs as young as 8 weeks of age. These drugs are not labelled for use for demodicosis (5).

These drugs are considered safe with rare adverse effects including vomiting, diarrhea, anorexia, lethargy, and flatulence. Specific considerations include:
- Afoxolaner should be used with caution in dogs with a history of seizures. It does not have to be given with food for adequate absorption.
- Sarolaner may cause neurologic signs, including tremors, ataxia, and seizures (4).
- Fluralaner must be given with food for adequate absorption (3).

Demodicosis: New treatment, common misdiagnosis

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The CAVD is a not-for-profit organization that promotes veterinary dermatology in Canada and provides continuing education for veterinarians, animal health technicians/technologists and veterinary students. The CAVD welcomes applications for membership (www.cavd.ca).
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We have used Bravecto on many occasions over the last 1 1/2 years and have not seen any treatment failures. Only 1 dog vomited after taking the drug, and the manufacturer stated that if vomiting occurs after 3 hours of taking the drug, adequate absorption has occurred and re-administration is not necessary. The manufacturer recommends repeating the medication if vomiting occurs within 3 hours of administration. The client, therefore, should record the time at which the drug is given in the rare event that vomiting does occur. The manufacturer will consider giving a free replacement, if this happens. The high degree of efficacy, low cost, relative safety, and ease of use, mean better owner compliance and make the isoxazoline class of drugs the therapy of choice for demodicosis.

The best treatment is of no use if one doesn’t make a correct diagnosis of demodicosis. Unfortunately the misdiagnosis of demodicosis is too common. The consequences of missing a diagnosis of demodicosis can be devastating to the patient and the client. Dogs may suffer from severe deep pyodermas that worsen over months of antibiotic treatment that fail because of lack of treatment for Demodex. The patient is often subjected to a number of symptomatic therapies to no avail. To make matters worse these patients may receive systemic or topical corticosteroids that will cause the demodicosis and pyoderma to become worse.

There are 2 main causes of misdiagnoses. The minority stem from the skin scraping test failing to reveal the presence of mites. It is imperative that a false negative be avoided by squeezing the skin before scraping to expel the mites from the follicle. Another way to retrieve the mites from the follicle is to epilate some hairs from the follicles and view the base of the hairs. Multiple scrapings, especially from the face, paws, and legs are essential. The skin scraping test is very reliable, as long as these techniques are used. Deep pyoderma of the paws with the associated swelling may make it more difficult to extrude the mites to the surface, so multiple scrapings or a biopsy may be necessary to make the diagnosis, although this is rare. We have seen cases in which a patient had negative scrape tests done by multiple veterinarians, followed by failure of the patient to respond to antibiotics; we then examined skin scrapings and found them positive (6). It’s always beneficial to re-scrape dogs that are not responding to antibiotics.

A major source of misdiagnosis of demodicosis is simply not including it on the list of differential diagnoses, so skin scrapings are not performed. Veterinarians appear to be generally effective at diagnosing juvenile onset demodicosis (JOD), but not as effective diagnosing adult onset demodicosis (AOD). This is the area in which we see the most misdiagnoses. A number of underlying diseases and treatments (Table 1) may suppress the immune system predisposing the patient to demodicosis. The use of corticosteroids and hyperadrenocorticism are 2 major sources (7–9). Once the likely cause of adult-onset demodicosis has been diagnosed, eliminating the cause of immunosuppression is essential for a positive outcome.

Neoplasia in very old dogs may be asymptomatic, such as in patients with small occult tumors and demodicosis as a paraneoplastic syndrome (8). This association may be under-reported as the malignancy may not become clinical for many months after the demodicosis is diagnosed. Therefore older dogs with Demodex may be classified as “unidentified” (Table 1). Some of the “hypothyroid” dogs that have demodicosis may have euthyroid sick syndrome due to occult tumors rather than having the hypothyroidism as the reason that demodicosis developed.

Of 431 dogs with demodicosis presented to a teaching hospital from 2000 to 2016, 225 (< 18 months) had JOD, 139 (> 48 months) had AOD and 67 could not be classified. The English bull dog and Staffordshire terrier were at increased odds of developing JOD. The JOD group had superficial pyoderma (n = 107), deep pyoderma (n = 22), or yeast dermatitis (n = 15, 6/15 had concurrent allergic disease) as secondary issues. Allergic disease was diagnosed before the JOD in 50 dogs, 17 of which had received corticosteroids. The AOD group had superficial pyoderma (n = 73), deep pyoderma (n = 36), and yeast dermatitis (n = 30, 20 with concurrent allergic disease). At the time of diagnosis of AOD, 59% (82 of 139) had been diagnosed

### Table 1. Causes of adult onset demodicosis in 41 dogs (3).

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug-induced</td>
<td>39%</td>
</tr>
<tr>
<td>Corticosteroids in allergy patients</td>
<td>24%</td>
</tr>
<tr>
<td>Chemotherapy/neoplasia immune-mediated disease</td>
<td>15%</td>
</tr>
<tr>
<td>Endocrine disorder</td>
<td>31%</td>
</tr>
<tr>
<td>Hyperadrenocorticism</td>
<td>19%</td>
</tr>
<tr>
<td>Hypothyroidism</td>
<td>12%</td>
</tr>
<tr>
<td>Unidentified</td>
<td>30%</td>
</tr>
</tbody>
</table>

We have used Bravecto on many occasions over the last 1 1/2 years and have not seen any treatment failures. Only 1 dog vomited after taking the drug, and the manufacturer stated that if vomiting occurs after 3 hours of taking the drug, adequate absorption has occurred and re-administration is not necessary. The manufacturer recommends repeating the medication if vomiting occurs within 3 hours of administration. The client, therefore, should record the time at which the drug is given in the rare event that vomiting does occur. The manufacturer will consider giving a free replacement, if this happens. The high degree of efficacy, low cost, relative safety, and ease of use, mean better owner compliance and make the isoxazoline class of drugs the therapy of choice for demodicosis.

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with a concurrent disease and 39% (55 of 139) had been treated with immunosuppressive therapy. The diseases most commonly identified concurrently with AOD (n = 139) were allergic disease (n = 57), hypothyroidism (n = 15), neoplasia (n = 14) and hyperadrenocorticism (n = 6). Of the 57 allergic dogs, 29 had received immunosuppressive therapy (systemic (n = 26), topical (n = 3) corticosteroids and 2 had received ocicatlinit maleate (Apoquel, Zoetis)]. The remaining dogs with allergic disease (28 of 57) had not received immunosuppressive medications (10).

Relapse or recurrence of demodicosis that were followed long-term and treated with various miticidal medications occurred in 11% (22 of 194). Incurable infestations occurred in just 5.2% (10 of 194), requiring long-term continuous therapy.

The clinical presentation of generalized demodicosis is highly variable (Figure 1). Usually, patchy, regional, multifocal, or diffuse alopecia is seen with variable erythema, silvery grayish scaling, and papules. Follicular hyperkeratosis is often marked; follicular openings are usually accentuated and plugged resulting in follicular casts or comedones. Some dogs may only manifest seborrheic changes. The skin may become hyperpigmented, lichenified, pustular, eroded, crusty, or ulcerated from secondary superficial and deep pyoderma. Pododemodicosis may appear through interdigital pruritus, pain, erythema, alopecia, hyperpigmentation, lichenification, scaling, swelling, crust papules, bullae, and draining tracts. Peripheral lymphadenopathy is common. Systemic signs (fever, depression, anorexia) may be seen if secondary sepsis develops (8,9). It should be stressed that demodicosis is one of the most common causes, if not the most common cause of deep pyoderma, especially of the paws and face of dogs of any age. Every dog showing any of these signs should be thoroughly screened for Demodex mites. With a skin scraping, the treatment of canine generalized demodicosis. Parasite 2016;23:14. doi: 10.11051/parasite/2016014.

Uncomplicated demodicosis is not considered very pruritic. Secondary pyoderma will contribute to pruritus. Secondary Malassezia has been seen as causing more intense pruritus in some demodicosis patients. Cytology would be helpful in the very pruritic Demodex cases that may also have Malassezia dermatitis. If the patient had been treated for allergies with corticosteroids then some of the pruritus might still be due to an underlying allergy.

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