An observational study of mortality on bison farms in Saskatchewan with special emphasis on malignant catarrhal fever

Factors associated with development of Canine Infectious Respiratory Disease Complex (CIRDC) in dogs in 5 Canadian small animal clinics

Characterizing 1341 cases of veterinary toxicoses confirmed in western Canada: A 16-year retrospective study


Antimicrobial susceptibility of Staphylococcus pseudintermedius colonizing healthy dogs in Saskatoon, Canada

The use of dexmedetomidine continuous rate infusion for horses undergoing transvenous electrical cardioversion — A case series

Aberrant heartworm migration to the abdominal aorta and systemic arteriolitis in a dog presenting with vomiting and hemorrhagic diarrhea

Poorly differentiated cutaneous carcinoma of non-sebaceous origin in a 3-year-old Mongolian gerbil (Meriones unguiculatus)

Outbreak investigation of porcine epidemic diarrhea in swine in Ontario
As a veterinarian, having the right insurance is essential to surviving and thriving in today’s business world. Available exclusively to members of the Canadian Veterinary Medical Association, the specialized CVMA Insurance Program offers the most comprehensive and cost-effective insurance protection for you and your practice.

**Employee Benefits**
Nolan Friesen  
1-800-665-8990 ext. 7215  
nolan.friesen@westernfgis.ca

**Commercial Insurance**
Thom Proch  
1-800-665-8990 ext. 7313  
thom.proch@westernfgis.ca

201-600 Empress St  
Winnipeg, MB R3G 0R5
Why compromise? You can have it all.

What makes Virox Animal Health™ disinfectants so different? Formulating a disinfectant that kills pathogens is easy, formulating a disinfectant that kills AND is less toxic is difficult. Our Accelerated Hydrogen Peroxide® (AHP)® surface disinfectants were deliberately designed to be effective against a broad-spectrum of hard to kill pathogens while remaining gentle for users, animals, materials and the environment. Using AHP® improves both animal and human health while protecting your assets by reducing the risk of exposure to harsh chemicals and deadly pathogens.

That’s why we are not just different from what you’re currently using, we are Deliberately Different™.
KNOWING MAKES ALL THE DIFFERENCE
An early diagnosis could save my life.

You can be the difference between “I wish we could have done something” and “I’m so glad we caught this soon enough...”

Visit IDEXX.ca/preventivecare to learn more
<table>
<thead>
<tr>
<th>ARTICLES</th>
<th>CASE REPORTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>70</td>
</tr>
<tr>
<td>An observational study of mortality on bison farms in Saskatchewan with special emphasis on malignant catarrhal fever</td>
<td>The use of dexmedetomidine continuous rate infusion for horses undergoing transvenous electrical cardioversion — A case series</td>
</tr>
<tr>
<td>Tasha Epp, Cheryl Waldner, Murray Woodbury</td>
<td>Charlotte Marly-Voquer, Colin C. Schwarzwald, Regula Bettschart-Wolfensberger</td>
</tr>
<tr>
<td>46</td>
<td>76</td>
</tr>
<tr>
<td>Factors associated with development of Canine Infectious Respiratory Disease Complex (CIRDC) in dogs in 5 Canadian small animal clinics</td>
<td>Aberrant heartworm migration to the abdominal aorta and systemic arteriolitis in a dog presenting with vomiting and hemorrhagic diarrhea</td>
</tr>
<tr>
<td>53</td>
<td>80</td>
</tr>
<tr>
<td>Characterizing 1341 cases of veterinary toxicoses confirmed in western Canada: A 16-year retrospective study</td>
<td>Poorly differentiated cutaneous carcinoma of non-sebaceous origin in a 3-year-old Mongolian gerbil (Meriones unguiculatus)</td>
</tr>
<tr>
<td>Vanessa Cowan, Barry Blakley</td>
<td>Heather Fenton, María J. Forzán, Marion Desmarchelier, Meghan Woodland, Soraya Sayi, Cornelia V. Gilroy</td>
</tr>
<tr>
<td>59</td>
<td>84</td>
</tr>
<tr>
<td>Benjamin W. Brunson, J. Brad Case, Gary W. Ellison, W. Alexander Fox-Alvarez, Stanley E. Kim, Matthew Winter, Fernando L. Garcia-Pereira, Lisa L. Farina</td>
<td>Tim Pasma, Mary Catherine Furness, David Alves, Pascale Aubry</td>
</tr>
<tr>
<td>65</td>
<td>15</td>
</tr>
<tr>
<td>Antimicrobial susceptibility of <em>Staphylococcus pseudintermedius</em> colonizing healthy dogs in Saskatoon, Canada</td>
<td>QUIZ CORNER</td>
</tr>
<tr>
<td>Roshan Priyantha, Mathew C. Gaunt, Joseph E. Rubin</td>
<td>TEST ÉCLAIR</td>
</tr>
</tbody>
</table>
myRad
The ideal solution for a faster, more streamlined approach to direct, high-quality digital radiography.

myRad Equine
The freedom of a fully wireless system incorporating AED Technology to remove the need for generator synchronization.

The Complete Digital Radiography Solution only from Universal Imaging
More than a Flat Panel Detector, only myRad offers a complete Digital Flat Panel Radiography solution that integrates premium hardware, efficiency optimized software, and comprehensive Cloud integration, allowing image acquisition and viewing to be fast, seamless and productive.

ADVANCED FEATURES
AED Technology: Image acquisition is initiated automatically upon the panel sensing x-ray photons. This technology enhances generator compatibility by removing the need for synchronization between the x-ray generator and the panel.
Crystal Clear Images: Only myRad incorporates our exclusive software configuration for the best Canon image quality on the market.
Immediate Results: Images are available approximately 3 seconds after capture and can be immediately transmitted over the network and Cloud for fast and easy data sharing.
Single Click Protocol: Powerful exam auto-sequence software enables a single click selection of a set of protocols required for a specific examination, thus streamlining study order creation.

FLEXIBLE FINANCING
Up to 6 months of no payments on approved credit.

Speak with a product specialist today: 800.842.0607
Ask About Our Digital Radiography & Ultrasound Bundles
Contents  Table des matières

FEATURES  RUBRIQUES SPÉCIALES

PRESIDENT’S MESSAGE  MOT DU PRÉSIDENT
9  Antibiotic use: Let’s be ready for the change! / Utilisation des antibiotiques — préparons-nous au changement!
Nicole Gallant

VETERINARY MEDICAL ETHICS  DÉONTOLOGIE VÉTÉRINAIRE
11

CROSS-CANADA DISEASE REPORT  RAPPORT DES MALADIES DIAGNOSTIQUÉES AU CANADA
29  Canine parvovirus type 2b is the most prevalent genomic variant strain found in parvovirus antigen positive diarrheic dog feces samples across Canada
Carl A. Gagnon, Véronique Allard, Guillaume Cloutier

VETERINARY HISTORY  HISTOIRE VÉTÉRINAIRE
32  Together we build: The OVC Student Wives’ Auxiliary
Lisa Cox, Katie Anderson, Elizabeth A. Stone

VETERINARY PRACTICE MANAGEMENT  GESTION D’UNE CLINIQUE VÉTÉRINAIRE
91  Minimizing the cost of your veterinary education: Saving through expedited student debt repayment / Minimiser le coût des études vétérinaires : économiser en accélérant le remboursement de la dette étudiante
Chris Doherty

DIAGNOSTIC OPHTHALMOLOGY  OPHTALMOLOGIE DIAGNOSTIQUE
95  Lynne S. Sandmeyer, Bianca S. Bauer, Bruce H. Grahn

BOOK REVIEW  COMPTE RENDU DE LIVRE
75  Seizures in Dogs and Cats
Lisa Watt

NOTICES  ANNONCES

52  Industry News
Nouvelles de l’industrie

64  Erratum

93  New Products
Nouveaux produits

58  Index of Advertisers
Index des annonceurs

97  Classifieds
Petites annonces

Contributors

“Instructions for authors” are available online
(www.canadianveterinarians.net).
Les «Directives à l’intention des auteurs» sont disponibles en ligne
(www.veterinaresaucanada.net).
The Canadian Veterinary Journal
La Revue vétérinaire canadienne

339 rue Booth Street
Ottawa, Ontario K1R 7K1
Telephone: (613) 236-1162
Fax: (613) 236-9681
E-mail: hbroughton@cvma-acmv.org
Website/Site Web: www.canadianveterinarians.net
www.veterinairescanada.net

© Canadian Veterinary Medical Association 2016
L’Association canadienne des médecins vétérinaires 2016

The Canadian Veterinary Journal is indexed or abstracted in: La Revue vétérinaire canadienne est indexée ou ses articles sont résumés dans :
AGRICOL, Biological Abstracts, Capsule Report, Current Contents — Agriculture, Environment, and Natural Resources, Current Veterinary Therapy, Current Veterinary Practice, Derwent Veterinary Drug File, EMBASE/Excerpta Medica, Index Veterinarius, Index Medicus, Quarterly Index, Science Citation Index, Small Animal Practice, Veterinary Bulletin, Veterinary Reference Service, Veterinary Update.

STUDENT SUBSCRIPTIONS/ABONNEMENTS DES ÉTUDIANTS

The editors and staff of The Canadian Veterinary Journal are pleased to have as readers student veterinarians at Canadian veterinary colleges! The production and distribution of student subscriptions is made possible through the generous sponsorship of Scotiabank

Les rédacteurs et le personnel de La Revue vétérinaire canadienne sont heureux de compter les étudiants en médecine vétérinaire des collèges vétérinaires au Canada au nombre de leurs lecteurs. La production et la distribution des abonnements des étudiants ont été rendues possible grâce au généreux soutien de Banque Scotia

Editorial policy: All published articles including editorials and letters reflect the opinions of the authors and do not necessarily reflect the opinion of the publisher. Publication of an advertisement does not necessarily imply that the publisher agrees with or supports the claims therein.

Politique de la Rédaction : Tous les articles publiés, y compris les éditoriaux et les lettres, représentent l’opinion de l’auteur et non pas nécessairement la position de l’éditeur.

La publication d’une annonce ne signifie pas nécessairement que l’éditeur est d’accord avec son contenu ou qu’il l’appuie.

Scotiabank

Banque Scotia
YOUR CVMA MEMBERSHIP MEANS MORE...
The CVMA Convention offers exclusive, signature events such as the CVMA Summit, Emerging Leaders Program and the AGM and Awards Luncheon. New this year — National Issues Forum allowing attendees to engage in interactive discussion on an emerging topic.
Antibiotic use: Let’s be ready for the change!

Utilisation des antibiotiques – préparons-nous au changement!

As I reflect on numerous meetings and discussions over the last year, one pivotal issue is the coming major changes in the oversight of the use of antibiotics in North America. These changes are a result of many years of discussion with different stakeholders. These include the Canadian Food Inspection Agency (CFIA), the Council of Chief Veterinary Officers (CCVO) the Public Health Agency of Canada (PHAC), the Veterinary Drug Directorate (VDD), the National Farmed Animal Health and Welfare Council (NFAHWC), and the Canadian Veterinary Medical Association (CVMA). These changes are in response to the growing concern about antimicrobial resistance and all its repercussions in both human and veterinary medicine.

These changes are not in the distant future but are upon us now! They will occur by December 2016 as Canada aligns itself with the changes that are being implemented in the United States. From that date forward, all antibiotics used in food or water for food-producing animals are to be administered with veterinary oversight.

As a profession, we should be very aware of these changes and be ready to advise our clients and answer their questions. Producer groups are on board with these changes but those of us in contact with individual producers should be ready to do our part to educate them on how to deal with these changes.

Those of us who engage in little or no large animal practice will be less affected in our daily work, but we all must be more selective and aware of the impact of our usage of antibiotics on the world. Having said that, I find it very difficult when faced with a financially restricted client to make choices about which diagnostic tools can be used as well as which treatment to pursue. It's a different world from the one I graduated into over 30 years ago, but what has not changed is that veterinarians have the intelligence, training, and flexibility to advise clients on appropriate choices for diagnosis and treatment.

Use of this article is limited to a single copy for personal study. Anyone interested in obtaining reprints should contact the CVMA office (hbroughton@cvma-acmv.org) for additional copies or permission to use this material elsewhere.

L’usage du présent article se limite à un seul exemplaire pour étude personnelle. Les personnes intéressées à se procurer des réimpressions devraient communiquer avec le bureau de l’ACMV (hbroughton@cvma-acmv.org) pour obtenir des exemplaires additionnels ou la permission d’utiliser cet article ailleurs.
When you get a chance in your busy veterinary life, please have a look at the CVMA website homepage (www.canadianveterinarians.net) under the news and events banner to find the October 26th 2015 news release entitled, “Change is Coming; Veterinary Oversight of Antimicrobial Use in Animals in Canada.” It should be referred to as the changes come closer to being instituted, as it has a wealth of links to pertinent documents on the topic. Of course this is only one source of information and keeping up-to-date on what is happening nationally and internationally concerning antibiotic use is important. This is truly one of the topics that can really fit into the “One Health” concept, to which we as a profession are committed.

It’s a changing world and we need to stay current with the changes and be part of the solution. I have every confidence that Canadian veterinarians are up to the challenge!

Nicole Gallant

Have Another Look at CJVR

Avez-vous consulté la RCRV dernièrement?

Members of the CVMA are entitled to receive the Canadian Journal of Veterinary Research (CJVR) at no additional charge. The CJVR, in the form of an interactive (portable document format) pdf, can be found on the CVMA member-only website (www.canadianveterinarians.net/publications-research-issue.aspx).

Published by the CVMA, this quarterly, peer-reviewed journal is Canada’s only national veterinary research publication.

Articles from the October 2015 issue of CJVR that might be of interest to practitioners include:

Descriptive analysis and spatial epidemiology of porcine reproductive and respiratory syndrome (PRRS) for swine sites participating in area regional control and elimination programs from 3 regions of Ontario on page 268

Use of ImageJ software for histomorphometric evaluation of normal and severely affected canine ear canals on page 316

The CJVR, along with the monthly Canadian Veterinary Journal, is also archived on PubMed Central (www.pubmedcentral.com) 6 months after publication.

An interactive pdf of The CVJ is also available on the member-only section of the CVMA website.


Publiée par l’ACMV, cette revue trimestrielle évaluée par les pairs est la seule publication nationale de recherche vétérinaire au Canada.

Les articles suivants du numéro d’octobre 2015 de la RCRV pourraient intéresser les praticiens :

Descriptive analysis and spatial epidemiology of porcine reproductive and respiratory syndrome (PRRS) for swine sites participating in area regional control and elimination programs from 3 regions of Ontario à la page 268

Use of ImageJ software for histomorphometric evaluation of normal and severely affected canine ear canals à la page 316

La RCRV, avec La Revue vétérinaire canadienne qui est publiée mensuellement, est aussi archivée sur PubMed Central (www.pubmedcentral.com) six mois après la publication.

Un pdf interactif de La RVC est aussi disponible dans la section réservée aux membres du site Web de l’ACMV.
Ethical question of the month — January 2016

The most fundamental requirements of adequate animal care include the provision of food and water. There is little sympathy for a livestock producer who does not provide feed and water for his or her animals. However federal livestock transportation regulations in Canada state that cattle may be transported for up to 52 hours without access to feed or water. Does the geographic size of the country and the limited number of slaughter plants justify this dichotomy between the acceptable standards of care expected from livestock producers and transporters?

Question de déontologie du mois — Janvier 2016

Les exigences les plus fondamentales des soins adéquats aux animaux incluent la fourniture des aliments et de l’eau. On éprouve peu de sympathie pour un éleveur de bétail qui ne fournit pas d’eau ni d’aliments à ses animaux. Cependant, les règlements fédéraux sur le transport du bétail au Canada stipulent que le bétail peut être transporté jusqu’à 52 heures sans avoir accès à des aliments ou à de l’eau. L’étendue géographique du pays et le nombre limité d’abattoirs justifient-ils cette dichotomie en matière de normes de soins acceptables que doivent respecter les éleveurs et les transporteurs de bétail?

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.

Comments/Commentaires:

Name/Nom:

Address/Adresse:

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.

Use of this article is limited to a single copy for personal study. Anyone interested in obtaining reprints should contact the CVMA office (hbroughton@cvma-acmv.org) for additional copies or permission to use this material elsewhere.

L’usage du présent article se limite à un seul exemplaire pour étude personnelle. Les personnes intéressées à se procurer des réimpressions devraient communiquer avec le bureau de l’ACMV (hbroughton@cvma-acmv.org) pour obtenir des exemplaires additionnels ou la permission d’utiliser cet article ailleurs.
Ethical question of the month — November 2015

Commercial fisheries and most aquaculture farms harvest fish by removing them from the water thus suffocating them. There appears to be little outrage regarding this practice by animal rights organizations. Some vegetarians switch to eating fish in place of more traditional meat sources believing it to be more humane. There is an increasing focus on monitoring humane slaughter practices for commercial livestock. Is there a rational or scientific basis for treating fish differently than mammals in this regard?

Les pêcheries commerciales et la plupart des entreprises aquacoles procèdent à la récolte des poissons en les retirant de l’eau, ce qui les suffoque. Il semble y avoir peu d’indignation concernant cette pratique de la part des organismes de défense des droits des animaux. Pour remplacer les sources de viande traditionnelles, certains végétariens se tournent vers le poisson parce qu’ils croient que ces animaux sont traités de façon moins cruelle. En outre, on réclame une surveillance accrue des pratiques d’abattage sans cruauté pour le bétail commercial. Y a-t-il une justification rationnelle ou scientifique pour traiter les poissons différemment des mammifères à cet égard?

Treatment of fish — a comment

Pure and simple: No. The issue is really no longer debatable.

The overriding principle is that “the only legitimate boundary to our concern for the interests of other beings is the point at which it is no longer accurate to say that the other being has interests,” (1) in other words, is not capable of suffering.

Fish have centrally organized nervous systems which are structurally and chemically comparable to those of mammals, and they demonstrate pain behavior and distress in similar ways, even if they cannot vocalize such. A considerable time ago an expert panel came to the unequivocal conclusion that the evidence for pain in fish is as strong as the evidence for pain in other vertebrate animals (2).

Intensive aquaculture practices can be even more harmful to the environment, to humans, and to fish than intensive agriculture practices involving mammals and birds. This is no more evident than in the sorry history of British Columbia’s salmon farms. But that is a topic for another day.

John B. Delack, PhD, DVM, Saskatoon SK

References


An ethicist’s commentary on treatment of fish

When my son was 6 years old, he expressed a desire to go fishing, as some of his friends did. Although I myself did not fish, I always raised him to make his own decisions. He went along with the group and, as luck would have it, he caught his limit within a half hour. Since he was happily excited throughout the entire activity, I assumed he had enjoyed himself, so I asked him if he wanted to go again. “No daddy, never again!” Surprised, I asked him why not. “Because I don’t think it is right to get pleasure from something else’s pain.” Thirty years later, he remains true to his dictum.

A short while later, one of my colleagues, ironically an anatomist, was commenting on my efforts to alleviate pain and suffering in laboratory and farm animals. “Well,” he said, “At least I don’t have to worry about your going after fishing.” Attendant on those two incidents, I felt it obligatory to investigate the question of whether fish felt pain. I discovered that from an anatomical point-of-view, fish possessed the requisite neurologically entailed by feeling pain. Furthermore I learned that fish could be conditioned by the use of electric shock. And finally, I realized that the “exciting fight” a fish hooked by an angler provided to fishermen was very likely a result of pain and something resembling fear in higher animals, eventuating in the struggle to escape. Five years later, while preparing an anthology on proper use of laboratory animals, I received a chapter on fish from well-known fish veterinarian Michael Stoskopf; eloquently arguing that fish felt pain.

A moment’s reflection reveals that from an evolutionary point-of-view, there is every reason to believe that pain is a very successful mechanism to ensure survival. In 2010, researcher Victoria Braithwaite published a seminal book entitled “Do Fish Feel Pain?” a question she unequivocally answers in the affirmative. Since breathing is essential to survival, one can assume that the same sort of very horrific experience all vertebrates have when deprived of air is replicated in fish.

To be sure, Braithwaite’s work is not universally accepted among scientists. But, from a moral point-of-view, it unequivocally militates in favor of giving fish the benefit of the doubt, if only from consideration of cost/benefit. If they do experience pain, fear, etc., death by suffocation is a major harm.

The key point relevant to our question is that there are alternative ways to kill fish. Many fishermen carry a billy club that they use to kill fish as soon as the animal is landed. From the point-of-view of commercially farmed fish, there are a variety of other methods that could assure a humane death.

Let the industry recall that concern for animal welfare can make or break a product as far as consumers are concerned —
Leba III is on your side, tartar will tap out.

Cleans Teeth with the Ease of a Spray

The LebaLab difference:

Leba III stimulates the good flora in the saliva. The longer Leba III is used, the cleaner the teeth and the healthier the chemistry of the mouth becomes. Antibacterial products kill the good bacteria in the mouth leading to imbalance and repeated dental procedures.

Pets ingest dental products, they cannot rinse. They can become subject to the side effects of the components, that’s why Leba III contains no Grapefruit Seed Extract, no chlorides or chemical agents.

Used by veterinarians since 1994.

TO ORDER, CALL 1.866.532.2522

Questions? Call 1.519.542.4236 | www.lebalab.com | tellus@lebalab.com
witness the public opposition to eggs from battery cages, pork from facilities using sow stalls, and veal from anemic, tethered, isolated calves. There is a serious chance of major controversy regarding farmed fish if it becomes widely known that these animals die by suffocation. Such controversy can decimate an industry. More than 20 years ago, there was a sharp reduction in the sale of live lobsters in Britain, as consumers refused to drop them in boiling water, believing that lobsters felt pain. The previous level of lobster purchase was more or less restored only when the industry developed stunners rendering the animals insensate, analogous to the way cattle are slaughtered.

Bernard E. Rollin, PhD

While you’re taking care of them, we’re looking out for you.

Specialized insurance programs and risk management services for CVMA members

• Professional liability insurance
• Commercial insurance
• Employee benefits
• Individual life and disability
• Student and graduate insurance
• Personal auto and home insurance

CVMA INSURANCE PROGRAM

1-866-860-2862 • cvmainurance.com
1. A 5-year-old boxer presents with a left basilar systolic and diastolic (to-and-fro) murmur, bounding femoral pulses, fever, and weakness. Which of the following is the most likely cause of the bounding femoral pulses?
   A. Mitral regurgitation
   B. Aortic regurgitation
   C. Tricuspid regurgitation
   D. Pulmonic regurgitation

2. A 2-year-old Alaskan malamute is presented for pruritic facial skin lesions. Examination reveals crusts, ulcers affecting the mouth and chin and around the eyes. Purulent exudate is present below some of the more adherent crusts. Which of the following is the most appropriate diagnostic test to confirm the most likely diagnosis?
   A. Skin scrapings
   B. Microscopic examination of purulent exudate
   C. Fungal culture of purulent exudate
   D. Skin biopsy
   E. Bacterial culture of purulent exudate

3. Which of the following is the most appropriate treatment plan for a cat with a mass in the left second mammary gland and a second mass in the right third mammary gland?
   A. No direct intervention is needed; measure the masses monthly to monitor for changes
   B. Simple lumpectomy
   C. Chemotherapy with a cisplatin-based protocol
   D. Mammectomy of the affected glands
   E. Bilateral radical mastectomy of both mammary chains

4. Bruxism in foals is usually associated with which of the following?
   A. Tail rubbing
   B. Pawing
   C. Gastroduodenal ulceration
   D. Buccostomy

1. Un chien Boxer âgé de 5 ans présente un souffle systolique basilaire gauche et un autre souffle diastolique (bruit de va-et-vient), des pouls fémoraux bondissants, de la fièvre et de la faiblesse. Laquelle des causes suivantes est la plus probable pour expliquer les pouls fémoraux bondissants?
   A. régurgitation mitrale;
   B. régurgitation aortique;
   C. régurgitation tricuspidale;
   D. régurgitation pulmonaire.

2. Un malamute d’Alaska âgé de 2 ans présente des lésions cutanées prurigineuses de la face. L’examen révèle des croûtes, des ulcères affectant la gueule et le menton ainsi que le tour des yeux. Un exsudat purulent est présent sous les croûtes les plus adhérentes. Lequel des tests de diagnostic suivants est le plus approprié pour confirmer le diagnostic le plus probable?
   A. raclage cutané;
   B. examen microscopique de l’exsudat purulent;
   C. culture fongique de l’exsudat purulent;
   D. biopsie cutanée;
   E. culture bactérienne de l’exsudat purulent.

3. Lequel des traitements suivants est le plus approprié pour un chat présentant une masse dans la deuxième glande mammaire gauche et une seconde masse dans la troisième glande mammaire droite?
   A. Aucune intervention directe n’est nécessaire; on mesurera les masses à tous les mois pour vérifier les changements.
   B. Ablation simple.
   C. Chimiothérapie accompagnée d’un protocole à base de cisplatine.
   D. Mammectomie des glandes mammaires atteintes.
   E. Mammectomie radicale bilatérale des deux chaînes de glandes mammaires.
“The Best CE Value in Canada”
April 22 – 24, 2016
Halifax Marriott Harbourfront Hotel
Halifax, NS
www.apvc.ca

**Veterinarians**

**Dr. Liz O’Brien**
- Feline CKD in 2016 – Can We Finally Make a Difference?
- Early Disease Detection in the Feline – Screen Early, Screen Often
- Feline Pain – A silent Epidemic We Need to Prevent, Recognize and Treat
- What are Those Blood Results Telling Me? A Case-based Approach to Those Lab Reports

**Dr. Anthony Fischetti**
*Radiography*
- The Heart and Lungs of the Matter
- Bones
- Guts
- Case Studies

**Dr. Michael Stone**
- Heartworm in the Maritimes. Can We Ignore It?
- Emerging Tick-Borne Infections: Anaplasmosis and Ehrlichiosis
- Lyme Disease: Facts and Fiction
- High Calcium? Low Calcium? Why? And What to Do
- When the Immune System Goes Awry: Immune-mediated Diseases.
- Urinary Tract Infections, Treatments and Controversies
- New Developments in the Management of Canine and Feline Diabetes
- Diagnosis and Management of Hyperadrenocorticism
- Hyperthyroidism: What’s New in Diagnosis and Treatment
- Hypothyroidism: Are Diagnostic Tests Accurate?

**Dr. Pierre Amsellem**
- Exploratory Laparotomy: Time to Open it up and Take a Look!
- Be Ready for Anything! Common GI Surgical Procedures
- When in Doubt, Cut it Out? Fatty Lumps, Mass Excisions and Closure Options
- Does Upper Airway Surgery Leave You Breathless?

**Dr. David Wilkie**
- Diagnostic Evaluation: Ophthalmology for Idiots
- Eyelids, Conjunctiva and Third Eyelids: Keeping it Simple
- Cornea – 0.5mm is All You Get
- Keratoconjunctivitis Sicca
- Retina – What the Heck am I Looking at?
- Anterior Segment: Uveitis, Glaucoma and Lens Diseases

**Dr. Steve Noonan**
- Prescription for Happiness

**Charlotte Lacroix**
- Full Day Succession Planning, the Transition to and from Ownership

**Wet Labs (Veterinarians):**

**Dr. David Wilkie** – Full Day
- Ophthalmic surgery: Eyelid, Adnexa and Corneal Surgery

**Dr. Pierre Amsellem** – Half Day
- Gastrointestinal Surgery; Resection and Anastomosis

*Join more than 850 other delegates, exhibiting companies and a world class list of speakers in an environment of true maritime hospitality*
A COMPLETE PACKAGE FOR THE ENTIRE VETERINARY TEAM

Animal Health Technicians

Amy Breton Newfield, RVT
- Caring for the Blue Patient: Respiratory Distress
- Evans Syndrome: Breaking Down ITP/IMHA
- Surviving Sepsis
- Too Hot, Too Cold: Hyper- and Hypothermia
- Bad Veins: Venous Access to Naughty Veins
- Seizures: Stopping the Twitching
- Love Your Face: How to Avoid Bites
- When Your HBC Tries to Die
- How to Survive as a Vet Tech

Dr. Liz O’Brien
- A Pain Free Feline in the Clinic and in the Home
- It’s All About Quality of Life: Your Senior Feline Patients Deserve It

Support Staff

Dr. Liz O’Brien
- Understanding the Feline Patient and Their Subtle Signs of Illness
- The Cat – Understanding How and Why They Hide Disease

Shelley Johnson
- Getting to the Heart of the Matter: Connecting with Clients
- Managing Your Own Stress and Fatigue

Business Management

Brian Conrad
- Avoid Preventing Preventative Care
- Change is Good: How to Build Innovation at Your Practice
- TRUST – Where Did it Go and Do We Get it Back?

Charlotte Lacroix
- Full Day Succession Planning, the Transition to and from Ownership
- Bullying in the Workplace
- Accountability
- Employee Motivation

Martin Traub-Werner
- Practice Data: Appreciate It, Learn to Use It and How You Will Benefit
- Lapsing Patients: How to Bring Them Back into the Practice

Fees

<table>
<thead>
<tr>
<th>Role</th>
<th>Full</th>
<th>(3 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veterinarians</td>
<td>$400</td>
<td></td>
</tr>
<tr>
<td>Technicians &amp; Vet’s Assistant’s</td>
<td>$200</td>
<td></td>
</tr>
<tr>
<td>Managers</td>
<td>$300</td>
<td></td>
</tr>
<tr>
<td>Support Staff</td>
<td>$150</td>
<td>(2 days)</td>
</tr>
</tbody>
</table>

For further information contact:
Dr. Courtney Sherlock, Chair
APVC Committee on Arrangements
PO Box 310
Eastern Passage, NS, B3G 1M6
902-483-2034
Email: cgsherlock@hotmail.com
5. Concerning umbilical hernias in calves, which of the following is true?
   A. They should not be repaired because of genetic predisposition.
   B. Abdominal bandaging is a useful method for correction.
   C. They are best repaired after the diet has become forage-based.
   D. Sonography is required before repair.
   E. They are a leading cause of losses on dairies.

(See p. 94 for answers./Voir les réponses à la page 94.)

Editors Wanted

The Canadian Journal of Veterinary Research (CJVR) is looking for a new editor. After a long and successful time at the helm, the current CJVR editor, Dr. Éva Nagy, is leaving. The Editorial Committee of the CVMA is seeking an individual responsible for the peer-review process for scientific articles in the CJVR. A job description is available by request (hbroughton@cvma-acmv.org).

The Editorial Committee is also seeking individuals interested in the position of associate editor for CJVR. An associate editor has a key role in allocating to peer reviewers various articles submitted to the journals for potential publication and in participating in policy development as a member of the Editorial Committee. The success of the peer-review process and, thus, the credibility of a journal are in large measure dependent on the selection of appropriate individuals to review manuscripts. There is a vast number of individuals with specialized knowledge in private practice, research, academia and industry — the challenge is in tapping into these resources for the peer review process.

If interested in these positions please contact the Journals’ staff at 339 Booth St., Ottawa, Ontario K1R 7K1; tel: 613-236-1162 or 800-567-2862, ext. 124; or e-mail (hbroughton@cvma-acmv.org).

Rédacteurs recherchés

La Revue canadienne de recherche vétérinaire (RCRV) est à la recherche d’un nouveau rédacteur. Après avoir occupé ses fonctions pendant longtemps et avec grand succès, la rédactrice actuelle de la RCRV, Dr. Éva Nagy, quitte son poste. Le Comité de la rédaction de l’ACMV est à la recherche d’une personne responsable du processus d’évaluation par les pairs pour la lecture des articles scientifiques de la RCRV. Une description de poste est disponible sur demande (hbroughton@cvma-acmv.org).

Le Comité de la rédaction est aussi à la recherche de personnes intéressées au poste de rédacteur associé pour la RCRV. Le rédacteur associé joue un rôle clé lors la distribution, aux examinateurs, des divers articles soumis aux revues aux fins de publication potentielle et il participe à l’élaboration de politiques en tant que membre du Comité de la rédaction. Le succès du processus d’évaluation par les pairs et, en conséquence, la crédibilité d’une revue dépendent en grande partie du choix des personnes appropriées pour réviser les manuscrits. Il y a un grand nombre de personnes possédant des connaissances spécialisées en pratique privée et en recherche ainsi que dans les universités et l’industrie, et le défi consiste à mettre ces ressources à contribution lors du processus d’évaluation par les pairs.

Si l’un de ces postes vous intéresse, veuillez communiquer avec le personnel des Revues au 339, rue Booth, Ottawa (Ontario) K1R 7K1; tél. : 613-236-1162 ou 800-567-2862, poste 124; ou par courriel (hbroughton@cvma-acmv.org).
Welcome to the Profession!

The annual lab coat ceremonies took place last fall. Each year, as first-year students enter into the profession, they receive a laboratory coat and personalized name badge on behalf of the Canadian Veterinary Medical Association (CVMA). Please join us in welcoming these future veterinarians to the profession!

Bienvenue à la profession!

La cérémonie annuelle de remise des sarraus s’est déroulée à l’automne. Chaque année, les étudiants de première année qui entrent dans la profession reçoivent un sarrau et un insigne d’identité personnalisés de la part de l’Association canadienne des médecins vétérinaires (ACMV). Veuillez vous joindre à nous pour accueillir ces futurs vétérinaires à la profession!
International Volunteer Placements Available

Veterinarians without Borders/Vétérinaires sans frontières is actively seeking 13 Canadian professionals for international volunteer assignments as part of the Volunteers for Healthy Animals and Healthy Communities project. Three of those positions are for veterinarians, but the other 10 cover a wide range of skills and professions including dairy management, public health, financial management, food safety policy, laboratory operations, monitoring and evaluation, planning, and rural development project design. In 2015–16, placements will be in Kenya, Tanzania, Laos, and Vietnam. Depending on the assignment, the placements are from 4 weeks to as much as 2 years in duration. For more information, or to submit an application, visit the website (www.vetswithoutborders.ca/volunteer/volunteering-with-vwb).

Postes volontaires internationaux disponibles

WVC Year-Round
Quality CE

WVC is dedicated to providing quality year-round continuing education to the veterinary community through an array of learning styles and environments. Our courses provide comprehensive, progressive and practical knowledge that can be applied immediately to your veterinary practice.

To register and see the full year’s calendar of events, visit wvc.org

Knowledge You Can Use Now

©2016 Western Veterinary Conference. All rights reserved.

wvc.org
Start Your Year Off By Going Green!

Entamez la nouvelle année en vous mettant au vert!


Veterinarians historically have fostered community health by being stewards of the link between human and animal health. Considerations for our profession’s impact on the environment are part of that concept. It is our obligation as veterinarians to minimize the detrimental impact of veterinary medicine on our environment, and we can all play a part! Through this web-based source of information, discover how to improve the environmental impact of your veterinary practice and infrastructure by learning more about concepts such as:

- Establishing an environmental policy for your practice
- Government funding incentives for going green
- Water and energy efficiency considerations
- Waste management decisions
- Careful selection of chemical and medical products
- Environmentally sustainable building construction and renovations
- Evaluating the eco-responsibility of your suppliers

Use the CVMA Green Veterinary Practice self-audit tool to determine how green your practice really is. Then consider the list of top 10 changes you can make to reduce your impact on the environment. Any change, no matter how simple or complex, will make a difference! Visit the Practice Tools page found under the Practice and Economics section of CVMA’s website (www.canadianveterinarians.net) and learn more today.

Start Your Year Off By Going Green!

Entamez la nouvelle année en vous mettant au vert!

Le Groupe consultatif environnemental de l’Association canadienne des médecins vétérinaires (ACMV) désire vous aider à améliorer l’empreinte écologique de votre pratique vétérinaire à l’aide d’une collection de ressources écoresponsables pour les pratiques vétérinaires.

Les vétérinaires ont traditionnellement favorisé la santé communautaire en raison de leur rôle de gardien du lien entre la santé humaine et animale. L’évaluation de l’impact de notre profession sur l’environnement fait partie de ce concept. Nous avons l’obligation, en tant que vétérinaires, de minimiser l’impact néfaste de la médecine vétérinaire sur notre environnement et nous pouvons tous jouer un rôle! Cette source d’information sur le Web vous fera découvrir la façon dont vous pouvez atténuer l’impact environnemental de votre pratique et de vos infrastructures vétérinaires en vous communiquant des renseignements sur les différents concepts, notamment :

- L’élaboration d’une politique environnementale pour votre pratique
- Les incitatifs financiers du gouvernement en vue de favoriser l’écoresponsabilité
- L’efficacité énergétique et la conservation de l’eau
- Les décisions liées à la gestion des déchets
- Le choix prudent des produits chimiques et médicaux
- Les travaux de construction et de rénovation durables
- L’évaluation de l’écoresponsabilité de vos fournisseurs

Servez-vous de l’Outil d’autovérification d’une pratique vétérinaire écoresponsable de l’ACMV pour déterminer le degré d’écoresponsabilité de votre pratique. Puis, considérez la liste des 10 changements les plus importants que vous pouvez apporter pour réduire votre impact sur l’environnement. Tout changement compte, peu importe son ampleur! Visitez la section des Outils pour la pratique du site Web de l’ACMV (www.veterinairesaucanada.net) et apprenez-en davantage dès aujourd’hui.
2016 CVMA Awards
Last Call! Nominations Close
January 31, 2016

E ach year, through CVMA’s national veterinary awards program, veterinarians are honored for their exceptional contributions to veterinary medicine. We encourage you to nominate deserving colleagues for their hard work and dedication to the profession.

Please note that some changes have been made to the nomination process: Award nominees (excluding those nominated for Honorary Membership) must be current CVMA members to be eligible for nomination; however, they can be nominated by non-CVMA members.

CVMA Awards will be presented during the CVMA Convention, which takes place in Niagara Falls, Ontario from July 7 to 10, 2016. Nominations will be accepted until January 31, 2016 for the following awards:

- CVMA Humane Award
  (Sponsored by Merck Animal Health)
- Merck Veterinary Award
  (Sponsored by Merck Animal Health)
- Small Animal Practitioner Award
  (Sponsored by Petsecure Pet Health Insurance)
- CVMA Practice of the Year Award
  (Sponsored by Scotiabank)
- CVMA Industry Award
- CVMA Life Membership
- CVMA Honorary Membership

Nomination packages must be submitted by January 31, 2016 via e-mail (communications@cvma-acmv.org), by fax to 613-236-9681, or by mail to the CVMA office at 339 Booth Street, Ottawa, ON K1R 7K1. Nomination packages must include a completed nomination form, an outline of the nominee’s key professional accomplishments, and letters of support.

For additional information, including updated award nomination guidelines, complete award descriptions, nomination forms, and a listing of past award recipients, please visit the CVMA Awards section of CVMA's website under About CVMA (www.canadianveterinarians.net).

Prix 2016 de l'ACMV
Dernier avis! Clôture des mises en candidature le 31 janvier 2016

Chaque année, dans le cadre du programme des prix vétérinaires nationaux de l'ACMV, des vétérinaires sont honorés pour leurs contributions exceptionnelles à la médecine vétérinaire. Nous vous encourageons à mettre en candidature des collègues méritants pour leur travail ardu et leur dévouement envers la profession.

Veuillez noter que certains changements ont été apportés au processus de mise en candidature : les candidats (sauf ceux mis en candidature pour le titre de membre honoraire) doivent être des membres en règle de l'ACMV pour être admissibles à la mise en candidature. Cependant, ils peuvent être mis en candidature par des non-membres de l'ACMV.

Les prix de l'ACMV seront décernés durant le congrès de l'ACMV, qui se déroulera du 7 au 10 juillet 2016 à Niagara Falls, en Ontario. Des mises en candidature seront acceptées jusqu'au 31 janvier 2016 pour les prix suivants :

- Prix humanitaire de l'ACMV
  (Commandité par Merck Santé Animale)
- Prix vétérinaire Merck
  (Commandité par Merck Santé Animale)
- Prix du praticien des petits animaux
  (Commandité par Petsecure assurance maladie pour animaux)
- Prix de la pratique de l’année de l'ACMV
  (Commandité par la Banque Scotia)
- Prix de l’industrie de l’ACMV
- Membre à vie de l’ACMV
- Membre honoraire de l’ACMV

Les trousses de mise en candidature doivent être soumises d’ici le 31 janvier 2016 par courriel (communications@cvma-acmv.org), par télecopieur au 613-236-9681 ou par la poste au bureau de l’ACMV, 339, rue Booth, Ottawa (Ontario) K1R 7K1. Les trousses de mise en candidature doivent inclure un formulaire de mise en candidature rempli, une description sommaire des principales réalisations professionnelles du candidat et des lettres d’appui.

Pour obtenir des renseignements supplémentaires, y compris des descriptions complètes de chaque prix, des formulaires de mise en candidature et une liste des récipiendaires antérieurs, veuillez visiter la section des Prix de l’ACMV sur le site Web de l’ACMV sous À propos de l’ACMV (www.veterinairesaucanada.net).
Spotlight on Emerging Leaders in Canadian Veterinary Medicine — Emerging Leaders Program

The CVMA Emerging Leaders Program (ELP) started in 2010 as a small, full-day workshop with the objective of supporting and developing leadership skills within Canadian veterinarians and to inspire leadership within the veterinary profession.

The CVMA is pleased to announce the Emerging Leaders Program will be exclusively sponsored by Virox Animal Health as of 2016. If you would like to learn more about the Emerging Leaders Program and how to participate please contact Sarah Cunningham via e-mail (scunningham@cvma-acmv.org).

The spotlight on ELP series will highlight the experience of some past participants in the program. Our first spotlight is on Dr. Erin Heck.

Dr. Heck grew up in Olds, Alberta with her 4 siblings as a “wanna be” farm girl. Dr. Heck started volunteering at a veterinary clinic at 14 and ended up going to Olds College a few years later. She loved being an animal health technician but really felt the yearning to get more involved in the client relationship side of veterinary medicine, which for her meant embarking on the path to become a veterinarian.

After moving to Lethbridge, Alberta and completing 2 years of undergraduate studies in science she applied to vet school; Dr. Heck received an amazing phone call from Dr. Alistair Cribb, the dean of the University of Calgary, Faculty of Veterinarian Medicine telling her she had been accepted into the inaugural class. Dr. Heck spent 4 memorable years at the University of Calgary developing her skills in medicine, communication and business. Graduation was exciting as she was unleashed into the world ready to start her chosen career.

Dr. Heck first went to a busy emergency and primary care clinic where she quickly learned all the things that you cannot be taught in a classroom. Dr. Heck then opted to try house-call visits to homes of animals.

La Dre Heck a grandi à Olds, en Alberta, avec ses quatre frères et sœurs, en tant que fermière «en devenir». La Dʳ Heck a commencé à faire du bénévolat dans une clinique vétérinaire à l’âge de 14 ans et, quelques années plus tard, elle a fréquenté Olds College. Elle adorait le métier de technicien en santé animale, mais elle ressentait le besoin de participer davantage dans les relations avec les clients en médecine vétérinaire et, pour elle, cela signifiait entamer le parcours pour devenir vétérinaire.

Après avoir déménagé à Lethbridge, en Alberta, et avoir terminé deux années d’études de premier cycle en sciences, elle a présenté une demande d’admission à l’école de médecine vétérinaire. La Dʳ Heck a reçu un appel incroyable du Dʳ Alistair Cribb, le doyen de la Faculté de médecine vétérinaire de l’Université de Calgary, lui annonçant qu’elle avait été acceptée à la promotion inaugurale. La Dʳ Heck a passé quatre années mémorables à l’Université de Calgary pour développer ses compétences en médecine, en communication et en affaires. L’obtention du diplôme s’est avérée une étape excitante, car elle se lançait dans le monde prête à entamer la carrière qu’elle avait choisie.

La Dʳ Heck a d’abord travaillé dans une clinique d’urgence et de soins primaires achalandée où elle a rapidement appris toutes les choses que l’on ne peut pas enseigner dans une salle de classe. La Dʳ Heck a ensuite choisi d’essayer la pratique des visites à domicile, où elle a appris beaucoup à propos du travail autonome et de la résilience du lien animal-humain en se basant sur ses observations dans les foyers des animaux de compagnie. Ensuite, elle a décidé de faire le saut et de devenir propriétaire de pratique et elle a lancé la Happy Paws Veterinary Clinic à Airdrie, en Alberta. Au moment où la Dʳ Heck écrivait ses lignes, sa clinique s’était ouverte dans moins d’une semaine et elle était exciée à propos de l’avenir!

1. Pourquoi désirez-vous participer au PFL de l’ACMV?

Je désirais y participer parce que je voulais m’équiper de tous les outils qui me permettront d’opérer les changements que je désire voir dans cette profession incroyable. Je suis en train de bâtir ma propre nouvelle pratique pour petits animaux à Airdrie, en Alberta, qui s’appelle Happy Paws Veterinary Clinic. La courbe d’apprentissage a été raide et j’ai vué beaucoup de hauts et de...
Another Province Bans Ear Cropping

Dog owners and breeders in British Columbia will no longer be able to get their animals’ ears cropped by veterinarians, after the College of Veterinarians of British Columbia voted to ban the cosmetic procedure earlier this week. The procedure is also banned by veterinary regulators in Manitoba, Saskatchewan, Prince Edward Island, New Brunswick, and Nova Scotia, while Newfoundland and Labrador has a legal prohibition against ear cropping.

The CVMA holds a position on cosmetic alteration, which includes tail docking in canines or equine and ear cropping in canines. It “opposes the alteration of any animal by surgical or other invasive methods for cosmetic or competitive purposes.” Read the full position statement on the website (www.canadianveterinarians.net).

UNE AUTRE PROVINCE INTERDIT LA COUPE D’OREILLES

Les propriétaires et les éleveurs de chiens de la Colombie-Britannique ne pourront plus demander à leur vétérinaire d’effectuer la coupe des oreilles de leurs animaux, car le Collège des vétérinaires de la Colombie-Britannique a décidé d’interdire cette intervention esthétique. L’intervention est déjà interdite par les organismes de réglementation du Manitoba, de la Saskatchewan, de l’Île-du-Prince-Édouard, du Nouveau-Brunswick et de la Nouvelle-Écosse, tandis que Terre-Neuve-et-Labrador a adopté une loi interdisant cette pratique.

L’ACMV a publié une position sur l’altération esthétique qui fait mention de l’amputation de la queue chez les chiens et les chevaux ainsi que la coupe d’oreilles chez les chiens. Elle «s’oppose à l’altération de tout animal par la chirurgie ou une autre méthode invasive à des fins esthétiques ou pour des concours». On peut consulter la version intégrale de l’énoncé de position sur le site Web (www.veterinairesaucanada.net).

Why did you want to participate in the CVMA ELP?

I wanted to participate because I want to equip myself with all tools in order to make the changes I want to see take place in this amazing profession. I am in the process of building my own brand new small animal practice in Airdrie, Alberta called Happy Paws Veterinary Clinic. It has been a steep learning curve filled with many ups and downs. The ELP was my opportunity to focus on my personal development.

What was the highlight of the program for you?

I loved that we were encouraged to develop our personal core values and that these were shared with the group. It allowed me to really put down on paper the deeply rooted philosophy that should always guide every decision, business or personal.

Describe one specific action that you are doing differently after participating in the ELP?

I have been able to categorize my time better. Dr. Rick DeBowes described 4 ways you can spend your time and freedom: problem solving, building the future, feeling busy, and passing the time. I have actively set aside time in my week for the often under-rated category of building the future.

Do you think it is important for others within the veterinary community to become more active in leadership training? Why?

The message to other veterinarians is to absolutely consider leadership training, it will help you manage the stressors that we all face at work or at home. As veterinarians we spend a lot of time in our own heads. The ELP teaches you how to start managing yourself before you manage others. It is an investment in you.

Dr. Rick DeBowes

I have been capable of mieux organiser mon emploi du temps. Le Dr Rick DeBowes a décrit quatre façons dont vous pouvez passer votre temps et vos moments libres : régler des problèmes, planifier l’avenir, se sentir occupé et occuper son temps. J’ai activement réservé du temps pendant la semaine pour la catégorie souvent oubliée de «planifier l’avenir».

Croyez-vous qu’il est important pour les autres membres de la collectivité vétérinaire de s’impliquer plus activement dans la formation en leadership ? Pourquoi ?

Mon message aux autres vétérinaires est qu’ils doivent absolument considérer la formation en leadership, car cela les aidera à gérer les facteurs de stress auxquels nous sommes confrontés au travail ou à la maison. En tant que vétérinaires, nous passons beaucoup de temps dans nos propres têtes. Le PFL nous enseigne comment commencer à se gérer soi-même avant de de gérer les autres. C’est un investissement que l’on fait pour soi-même.
2016 CVMA Convention
Exciting! Inspiring! Motivating!

Be dazzled by the beauty and adrenalin-rushing excitement of Niagara Falls during the 2016 Canadian Veterinary Medical Association (CVMA) Annual Convention, July 7–10, presented in collaboration with the Registered Veterinary Technicians and Technologists of Canada (RVTTC).

If you haven’t been to Niagara Falls in recent years, you won’t recognize the cityscape. It’s no longer a honeymoon capital, or a street lined with tacky souvenir shops. Towering 4- and 5-star hotels and spas line the skyline of the Falls and you will find award-winning cuisine, first-class service and attention to detail rivaling any world-class destination.

The CVMA Convention will be based at the Sheraton on the Falls Hotel; one of the largest and most luxurious Falls view hotels. It’s a modern 4-diamond/5-star hotel at the corner of Clifton Hill and Falls Avenue, on the 20-acre Falls Avenue Resort.

Continuing education (CE) sessions and the Exhibit Hall will be held at the Scotiabank Convention Centre. With diverse meeting and exhibit space, the Centre prides itself on the seasonal and regional field-to-table food offerings, created by Centerplate (the Centre’s exclusive Food & Beverage provider) in partnership with the Centre’s Celebrity Chef Anna Olson (Food Network Canada TV host and author).

Lots of reasons to be in Niagara this July, but the most important is to experience the 2016 CVMA Convention. Top-notch speakers from the United States and Canada will be sharing their knowledge and expertise on topics such as dentistry, soft tissue

Congrès 2016 de l’ACMV
Excitant! Inspiring! Motivating!

Admirez la beauté de la région et vivez les sensations fortes offertes par Niagara Falls durant le congrès annuel 2016 de l’Association canadienne des médecins vétérinaires (ACMV), qui aura lieu du 7 au 10 juillet et sera présenté en collaboration avec Technologues et techniciens vétérinaires enregistrés du Canada (TTVEC).

Si vous n’avez pas visité Niagara Falls dernièrement, vous serez étonné par son nouveau paysage urbain. Ce n’est plus la capitale des lunes de miel ni une rue où s’alignent les boutiques de souvenirs bon marché. Des tours d’hôtels à quatre et cinq étoiles ainsi que des spas se dressent à l’horizon près des chutes et vous y trouverez une gastronomie primée, un service de première classe et l’attention aux détails qui peuvent rivaliser avec toutes les destinations de calibre mondial.

Le siège du congrès sera situé à l’hôtel Sheraton on the Falls, l’un des plus grands et des plus luxueux hôtels offrant une vue sur les chutes. C’est un hôtel moderne à 4 diamants et 5 étoiles situé à l’angle de Clifton Hill et de Falls Avenue, dans le Falls Avenue Resort d’une superficie de 20 acres.

Les ateliers de formation continue et le Salon des exposants se tiendront au Scotiabank Convention Centre. Grâce à une diversité de locaux pour les réunions et les expositions, le Centre est fier de ses choix gastronomiques de la ferme à la table qui sont créés par Centerplate (le traiteur exclusif du Centre) en partenariat avec Anna Olson, la chef réputée du Centre (auteure et animatrice d’une émission au Food Network Canada).

Il existe une foule de raisons de visiter Niagara Falls en juillet, mais la plus importante sera l’expérience du congrès 2016 de l’ACMV. Des conférentiers de haut calibre provenant des États-Unis et du Canada partageront leurs connaissances et leur expertise sur des sujets comme la dentisterie, la chirurgie des tissus mous, l’imagerie diagnostique, la dermatologie, l’ophthalmologie et la gastro-entérologie pour les animaux de compagnie. Les autres ateliers inclureront la pharmacologie de la boiterie bovine, la mammite bovine et la vache péri-parturiente. Une série de six ateliers discutera l’intégration et la médecine corps et esprit afin d’améliorer la pratique vétérinaire et la vie quotidienne. Des crédits additionnels de formation continue pourront être accumulés durant des laboratoires spécialisés sur les interventions de dentisterie et de diagnostic pour les patients félins.

Durant vos temps libres, vous pourrez vous émerveiller devant les eaux rugissantes des chutes en fer à cheval, des
surgery, diagnostic imaging, dermatology, ophthalmology, and gastroenterology for companion animals. Other sessions include equine pharmacology lameness, bovine mastitis, and the periparturient cow. A series of 6 sessions will discuss the integration of mind/body medicine to improve your veterinary practice and daily life. Additional CE credits can be earned during specialized labs in dentistry and diagnostic procedures for feline patients.

During spare time, be dazzled by the thundering waters of the Horseshoe, American and Bridal Veil Falls, which have been the star attraction for centuries. The Niagara Park Commission provides plenty of sight-seeing opportunities including the Journey Behind the Falls and the Hornblower Niagara Cruises. For cyclists, the Commission’s bike trail runs the length of the picturesque Niagara River and cyclists can climb the Niagara Escarpment alongside 300-foot lakers as they navigate the locks that connect Lake Ontario and Lake Erie.

The vibrant restaurant sector in the falls attracts some of the best chefs in the country. Celebrity chef Massimo Capra, author and TV host, runs the Rainbow Room in the Crowne Plaza hotel. Jamie Kennedy has the Windows restaurant in the Sheraton on the Falls hotel combining local cuisine with a spectacular view of the falls.

Niagara-on-the-Lake is home to the modern Ontario wine industry, and has been named Canada’s #1 Food and Wine Destination by Trip Advisor. Each winery is unique and each bottle of wine offers a different taste profile. Large estate wineries, medium-sized operations, and small boutique wineries provide visitors the perfect opportunity to mix it up and explore all the offerings the regions has; you also won’t be disappointed with the dishes some of the Niagara chefs dream up. Many chefs are engaging the farm-to-table trend.

The Shaw Festival, a theatre company inspired by the works of Bernard Shaw, is located in Niagara-on-the-Lake. The plays are presented in 4 different theatres, all with their own unique features. The festival runs from April to October.

If you’re planning to bring the family along, the Fallsview Indoor waterpark offers over 3 acres of indoor water fun. Thrills include a 1000-gallon tipping bucket, 16 water slides up to 6-stories high, massive indoor wave pool, giant plunge pool, jungle beach dry playland and more. And it is conveniently connected to the Sheraton on the Falls hotel.

One of the newest shopping attractions is the Outlet Collection at Niagara, just off the QEW in Niagara-on-the-Lake, and a 10-minute drive from the heart of the Falls, with over 100 retailers. The Fallsview Casino and Resort Gallerias has unique boutiques for gift-shopping and other special activities. The Canada One Brand Name outlets on Lundy’s Lane is a popular spot for shopping for deals on popular brands like Nike, Roots, Coach and others.

Niagara is just over an hour’s drive from Toronto Pearson International Airport and just over 30 minutes from the Buffalo/ Niagara Falls International Airport. A shuttle service will be available at reduced pricing for convenient booking.

Visit the website (www.canadianveterinarians.net) for more information about the Convention, local attractions, accommodations and more. Online registration opens in March 2016.

chutes américaines et des chutes Bridal Veil qui constituent une attraction courue depuis des siècles. De plus, la Commission des parcs du Niagara offre une foule d’excursions, dont Journey Behind the Falls et les croisières Hornblower Niagara Cruises. Pour les amateurs de vélo, signalons que la piste cyclable de la Commission longe le pittoresque fleuve Niagara et que les cyclistes peuvent grimper l’escarpement du Niagara aux côtés des cargos des lacs de 300 pieds tandis qu’ils franchissent les écluses qui relient le lac Ontario au lac Érié.

Le quartier animé des restaurants près des chutes attire les meilleurs chefs au pays. Le célèbre chef Massimo Capra, auteur et animateur de télévision, gère la salle Rainbow à l’hôtel Crowne Plaza. Quant à lui, Jamie Kennedy est installé au restaurant Windows de l’hôtel Sheraton on the Falls où il marie la cuisine locale à une vue spectaculaire sur les chutes.

C’est à Niagara-on-the-Lake que se trouve l’industrie vinicole moderne de l’Ontario et la localité a été nommée la Destination n° 1 du Canada pour les vins et la gastronomie par Trip Advisor. Chaque établissement vinicole est unique et chaque bouteille de vin présente un profil différent. Les grands domaines vinicoles, les établissements de taille moyenne et les petites exploitations boutique permettent aux visiteurs de voir un peu de tout et d’explorer les attraits de la région. Vous ne serez pas déçu lorsque vous dégusterez les créations gastronomiques des chefs de la région du Niagara. Bon nombre de chefs se sont d’ailleurs ralliés à la tendance de la ferme à la table.

Le Festival Shaw, une compagnie théâtrale s’inspirant des œuvres de Bernard Shaw, a pignon sur rue à Niagara-on-the-Lake. Des pièces sont présentées dans quatre salles différentes, qui comportent toutes des caractéristiques uniques. Le festival se déroule d’avril à octobre.

Si vous prévoyez emmener la famille, le parc aquatique intérieur Fallsview offre plus de 3 acres d’attractions aquatiques intérieures. Pour ceux qui aiment les sensations fortes, il y a un auge basculeur de 1000 gallons, 16 toboggans aquatiques pouvant atteindre une hauteur de 6 étages, une énorme piscine à vagues intérieure, une piscine de plongeon géante, le terrain de jeu sans eau Jungle Beach et plus encore. Et ce parc est relié à l’hôtel Sheraton on the Falls pour plus de commodité.

L’une des plus récentes attractions de magasinage est le centre Outlet Collection at Niagara, qui offre plus de 100 détaillants et se trouve à la sortie de l’autoroute QEW à Niagara-on-the-Lake et à 10 minutes de route du centre de Niagara Falls. Les boutiques des Fallsview Casino and Resort Gallerias proposent des articles uniques pour l’achat de souvenirs et d’autres activités spéciales. Les magasins de liquidation de Canada One Brand Name, sur Lundy’s Lane, représentent aussi un endroit populaire pour les chasseurs d’aubaines pour des marques populaires comme Nike, Roots, Coach et autres.

Niagara Falls est situé à un peu plus d’une heure de l’Aéroport international de Toronto — Pearson et à un peu plus de 30 minutes de l’Aéroport international de Buffalo/Niagara Falls. Un service de navette sera offert à un prix réduit et pourra être réservé facilement.

Visitez le site Web (www.veterinairesaucanada.net) pour obtenir de plus amples renseignements à propos du congrès, des attractions locales, de l’hébergement et plus encore. L’inscription en ligne ouvrira en mars 2016.
Obituary

Dr. Carol Morgan

It is with great sadness we share the news of the recent passing of a veterinary colleague, Dr. Carol Morgan, after a long and courageous battle with cancer; she was 51.

Dr. Morgan was very much involved in the CVMA’s Animal Welfare Committee and will be remembered for her “tenacious spirit and passion for animal welfare.”

Dr. Morgan’s passion for animal welfare began with her education when she completed an interdisciplinary PhD at the University of British Columbia Animal Welfare Program and Centre for Applied Ethics, with a focus on moral decision-making in veterinary medicine with specific interest in the welfare of animals. She also graduated from the Western College of Veterinary Medicine in 1988.

She was involved in a number of other animal welfare organizations and committees including the British Columbia Veterinary Medical Association Animal Welfare Committee, the British Columbia Society for the Prevention of Cruelty to Animals, the Canadian Council on Animal Care, the Code Development Committees for the National Farm Animal Care Council Codes of Practice for Sheep and for Pigs, and the Society for Veterinary Medical Ethics.

She was awarded the Frederic McGrand Award for Excellence in Animal Welfare by the Canadian Federation of Humane Societies in 2011. She was also the recipient of the 2012 CVMA Humane Award for her leadership in the care and well-being of animals.

Nécrologie

Drs. Carol Morgan

C’est avec une grande tristesse que nous vous annonçons le décès d’une collègue vétérinaire, Drs. Carol Morgan, qui nous a quitté après une longue lutte courageuse contre le cancer — elle avait 51 ans.

Drs. Morgan était très active au sein du Comité sur le bien-être des animaux de l’ACMV et demeurera dans nos souvenirs pour «son esprit tenace et sa passion pour le bien-être des animaux».


Elle était membre de plusieurs autres organisations et comités sur la protection des animaux, y compris le Comité sur le bien-être animal de la British Columbia Veterinary Medical Association, la Société pour la prévention de la cruauté envers les animaux de la Colombie-Britannique, le Conseil canadien de protection des animaux, les comités d’élaboration des codes de pratiques pour le soin et la manipulation des moutons et des porcs du Conseil national pour les soins aux animaux d’élevage et la Society for Veterinary Medical Ethics.


World Congress of Veterinary Dermatology

The 8th World Congress of Veterinary Dermatology (WCVD8) will take place in Bordeaux, France, May 31–June 4, 2016. To encourage Canadian veterinarians, veterinary students and animal health technicians to attend the congress, the Canadian Academy of Veterinary Dermatology (CAVD), Royal Canin Canada and Vétoquinol Canada have jointly agreed to fund up to 20 grants of $600 each for the first 20 CAVD members registering to WCVD8.

For more information, please visit the “News” section of the website (www.cavd.ca/news) or contact the CAVD administrator, Phyllis Mierau at (cavd@sasktel.net) or 306-955-4832.

Congrès mondial de la dermatologie vétérinaire

Le 8e Congrès mondial de la dermatologie vétérinaire (World Congress of Veterinary Dermatology ou WCVD8) se déroulera du 31 mai au 4 juin 2016 à Bordeaux, en France. Afin d’encourager la participation au congrès par les vétérinaires, les étudiants en médecine vétérinaire et les techniciens en santé animale du Canada, l’Académie canadienne de dermatologie vétérinaire (ACDV), Royal Canin Canada et Vétoquinol Canada ont conjointement accepté de financer jusqu’à 20 subventions de 600 $ chacune pour les premiers membres de l’ACDV à s’inscrire au WCVD8.

Pour en savoir davantage, veuillez visiter la section des «Nouvelles» du site Web (www.cavd.ca/news) ou contactez l’administratrice de l’ACDV, Phyllis Mierau à (cavd@sasktel.net) ou au 306-955-4832.
Canine parvovirus type 2b is the most prevalent genomic variant strain found in parvovirus antigen positive diarrheic dog feces samples across Canada

Carl A. Gagnon, Véronique Allard, Guillaume Cloutier

In 1978 an emerging virus, called canine parvovirus (CPV) was identified in the dog population; this virus was subsequently named CPV type 2 (CPV-2). The CPV-2 was distinct from the well-known parvovirus, canine minute virus (CnMV), which was formerly known as canine parvovirus type 1 (1). The CPV-2 virus induced hemorrhagic enteritis, severe diarrhea, vomiting, and leukopenia associated with a high mortality in infected dogs and spread into non-immune dog populations worldwide causing a pandemic. Furthermore, CPV-2 was responsible for myocarditis in puppies. Today, the prevalence of CPV antibodies in adult dogs is high due to vaccination and/or natural infection causing a high protective immunity status. Nevertheless, non-immune puppies that are 6 wk to 6 mo old are susceptible to CPV infection when there is loss of passive protection from maternal-derived antibodies (MDA), which are able to protect puppies against myocarditis (2).

The CPV-2 virus belongs to the virus family Parvoviridae, subfamily Parovirinae (which infect vertebrates) and genus Parovirus (3). A small non-enveloped single-stranded DNA virus, COV-2 is about 25 nm in size (1). The CPV-2 genome is 5.2 kilo bases (kb) long and possesses at least 2 major open reading frames (ORFs) (4). In the conventional orientation, the right-hand ORF encodes the viral capsid proteins VP1 and VP2, which are the main antigens that induce protective antibodies (5–7). The left-hand ORF encodes the non-structural proteins NS1 and NS2 (8). Since the emergence of CPV-2, several viral genomic variants have emerged due to a surprisingly high substitution rate in the CPV genome, similar to those of RNA viruses (1,9). At least 4 genomic variants have been described and officially recognized: the initial emerging CPV was named CPV-2, and was followed shortly after by CPV-2a in 1979, CPV-2b in 1984, and CPV-2c in 2000 (1). These CPV variants are differentiated through single nucleotide polymorphism (SNP) located at the VP2 gene (10). The prevalence of CPV variants is geographically restricted and has evolved over time (1,10). To our knowledge, the prevalence of CPV genomic variants in Canada is not known. Thus, the main objective of the present study was to determine the prevalence of CPV genomic variants within the Canadian diarrheic dog population.

Canadian veterinarian volunteers submitted feces from diarrheic animals that were previously confirmed to be positive for CPV antigen after local testing by any commercially available capture antigen assay such as the SNAP® Parvo Test (IDEXX Laboratories, Westbrook, Maine, USA). The CPV vaccination status of diarrheic animals was requested and fecal samples of dogs that were known to be recently vaccinated (within the last 30 d) were excluded from the study. It has been recently reported that animals that are vaccinated with a live attenuated vaccine may shed the vaccine strain for up to 21 d post-vaccination, as established by CPV real-time polymerase chain reaction (qPCR) (11). Thus, a delay of 30 d post-vaccination for CPV genotyping was sufficient to circumvent the effects of vaccine strains.

Samples from 49 cases were included in this study. These samples were submitted over a 3-year period (from September 27, 2012 until August 21, 2015) and originated from 7 provinces (Table 1). Genotyping of CPV variants was performed by the concomitant analysis of 3 multiplex qPCR assays using minor groove binder (MGB) probes technology as previously described (12,13) but with minor modifications. These MGB probes allow SNP discrimination of the ORF encoding the VP2 protein and therefore allow genotyping of strains. Briefly, about 1 g of feces was suspended in 5 mL of phosphate-buffered saline (PBS). Nucleic acid extraction was performed on supernatants or directly on vaccine formulations (Duramune®Max Pv and Nobivac®Canine 3-DAPv which contain the CPV-2b and CPV-2 variants, respectively, as positive controls) with either the QIAmp cador Pathogen Mini Kit (Qiagen,Toronto, Ontario) or the BioSprint 96 One-For-All vet kit (Qiagen) according...
to the manufacturer’s instructions. Thereafter, the 3 multiplex qPCR assays were carried out in a 25-µL volume containing 5 µL template or control DNA, 12.5 µL of QuantiTect Probe PCR buffer 2× (Qiagen), 3 pmol of TET-labeled probe, and 1.25 µL of a 20× mixture consisting of forward and reverse primers and the FAM-labeled probe. The qPCR assays were performed on either a SmartCycler (Cepheid, Sunnyvale, California, USA) or a Rotor-Gene (Qiagen) thermal cycler. The first multiplex qPCR assay targeted the change from adenine to guanine at position 4062 (SNP A4062G in GenBank reference strain M38245) that distinguishes between CPV-2a and 2b variants, while the second multiplex qPCR assay targeted the thymine to adenine change at position 4064 (SNP T4064A) that differentiates CPV-2b and 2c variants. As previously reported, the first multiplex qPCR assay could not properly discriminate CPV-2 and 2a variants. Thus, a third multiplex qPCR assay targeting SNP T3088C was developed to ensure discrimination between the CPV-2 variant and all 3 other variants. Taken together, these 3 multiplex qPCR assays allow reliable and fast CPV genotyping results.

As shown in Table 1, the CPV-2b variant was the most prevalent in all 7 provinces from which the samples were obtained. The prevalence of CPV-2b between the different provinces varied from 85.7% to 100%. Overall, the Canadian CPV-2b prevalence was 89.8%. This finding was surprising because CPV-2c was reported to be the most prevalent variant in the United States (US) since 2007, varying between 48.1 and 73.5% (14,15). In contrast, only 1 sample (originating from Ontario) was positive for CPV-2c variant in the current study (Table 1). The CPV-2c virus has an overall Canadian prevalence of 2%, which is much lower than its prevalence in the United States. Four samples were positive for the CPV-2a variant and originated from 3 provinces: Alberta, British Columbia, and Quebec. Thus, CPV-2a has an overall Canadian prevalence of 8.2% (Table 1). As expected, no CPV-2 variant was detected, as it is considered to be extinct (Table 1).

Vaccination could significantly affect the genotyping of CPV as attenuated vaccine strains could be shed in feces (11); information on vaccination status was therefore requested for the submitted samples. Unfortunately, the vaccination status of 7 animals (i.e., 14.3% of the fecal samples) was unknown (data not shown). Even if those 7 cases are excluded from our analyses, the CPV-2b variant remained the most prevalent variant found in diarrheic dogs with a value of 90.5% (data not shown). Interestingly, 19 diarrheic animals were reported by veterinarians to be vaccinated and at least 3 different commercial vaccines had been used to vaccinate these animals (data not shown). Only 1 of these animals (5.3%), however, seems to have been vaccinated according to the equivalent guidelines of the American Animal Hospital Association (AAHA) and the World Small Animal Veterinary Association (WSAVA). These guidelines are: “Puppies with poor MDA may be vulnerable (and capable of responding to vaccination) at an earlier age, while others may possess MDA at such high titres that they are incapable of responding to vaccination until 12 weeks of age. No single primary vaccination policy will therefore cover all possible situations. Thus, puppies should be vaccinated every 3–4 weeks between the ages of 6 and 16 weeks (e.g., at 6, 10, and 14 weeks, or 8, 12, and 16 weeks). To minimize the risk of MDA interference with vaccination, the final dose of the initial series should be administered between 14 and 16 weeks of age, regardless of the product used” (16,17). Thus, at least 83.7% (n = 41) of the diarrheal animals of this study were not or were improperly vaccinated (data not shown) because they received only 1 or 2 doses or the last puppy booster was given before 14 wk of age. Three of the vaccinated animals received 3 injections of vaccine as recommended by AAHA and WSAVA but surprisingly, the last booster injection was given before 14 wk of age (data not shown).

Canadian veterinarians should encourage pet owners to allow vaccination of their puppies following the AAHA and WSAVA guidelines. Several reports have demonstrated a very good efficacy of CPV vaccines in the context of homologous and heterologous challenges (10,17). Our results may have indicated a vaccination failure in 1 vaccinated animal but it might be explained by errors included in the clinical data that were reported by the owner and/or the veterinarian. Moreover, other co-infecting microorganisms (bacteria, parasites, viruses) could have contributed to the diarrhea in the clinical cases that were submitted (18). Unfortunately, the intestinal microbiota of diarrheic animals was not part of this study and, therefore, it was not investigated. In conclusion, by far the most prevalent CPV variant found in the feces of Canadian diarrheic dogs is CPV-2b.

<table>
<thead>
<tr>
<th>Province</th>
<th>Number of submitted feces samples</th>
<th>Genomic variants % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nova Scotia</td>
<td>3</td>
<td>0.0 (0) 0.0 (0) 100.0 (3) 0.0 (0)</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>1</td>
<td>0.0 (0) 0.0 (0) 100.0 (1) 0.0 (0)</td>
</tr>
<tr>
<td>Quebec</td>
<td>10</td>
<td>0.0 (0) 10.0 (1) 90.0 (9) 0.0 (0)</td>
</tr>
<tr>
<td>Ontario</td>
<td>13</td>
<td>0.0 (0) 0.0 (0) 92.3 (12) 7.7 (1)</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>1</td>
<td>0.0 (0) 0.0 (0) 100.0 (1) 0.0 (0)</td>
</tr>
<tr>
<td>Alberta</td>
<td>7</td>
<td>0.0 (0) 14.3 (1) 85.7 (6) 0.0 (0)</td>
</tr>
<tr>
<td>British Columbia</td>
<td>14</td>
<td>0.0 (0) 14.3 (2) 85.7 (12) 0.0 (0)</td>
</tr>
<tr>
<td>Total</td>
<td>49</td>
<td>0.0 (0) 8.2 (4) 89.8 (44) 2.0 (1)</td>
</tr>
</tbody>
</table>

a Samples were submitted from CPV antigen positive diarrheic animals starting September 27, 2012 to August 21, 2015.
Acknowledgments

This project was sponsored by Boehringer Ingelheim (Canada) Ltd. Dr. Carl Gagnon was supported by a Natural Sciences and Engineering Research Council of Canada (NSERC) discovery grant. The authors thank all the Canadian veterinarians who voluntarily participated in this project by submitting diarrheic dog fecal samples. Nucleic acids of CPV-2a and 2c variants were kindly provided by Dr. Nicola Decaro (University of Bari, Italy) and were used as positive controls to validate our qPCR multiplex assays.

References

Together we build: The OVC Student Wives’ Auxiliary

Lisa Cox, Katie Anderson, Elizabeth A. Stone

This paper examines the Ontario Veterinary College (OVC) Student Wives’ Auxiliary from 1951 to the early 1990s. The formation and function of the auxiliary is explored by creating a context of other relevant auxiliaries and organizations during the time period and through archival resources housed at the OVC along with oral interviews of past Auxiliary members. The Auxiliary was formed following World War II as a social and support network for the many women whose husbands were OVC students. Meetings were held twice a month and were filled with fellowship, fundraising, and a variety of other events for families and their children. Beyond the social aspects of the group, the auxiliary organized practical veterinary, financial, and business demonstrations for its members. This practical experience was essential for many women who went on to work with their husbands in their veterinary practices, performing pre- and post-operative care and managing the finances and scheduling. The changing demographics of the veterinary profession and the broader world led to the dissolution of the auxiliary by the early 1990s.

If you walk as a friend You will find a friend Wherever you choose to go If you go with mirth to a far strange land You will find that mirth is there, For the strangest part of this old world Is that like will join with like; And he who walks with love for his Fellow man An answering love will strike (1)

Tucked in among the thousands of historical artifacts and rare books in the C.A.V. Barker Museum of Canadian Veterinary History at the Ontario Veterinary College (OVC), University of Guelph, is a large red scrapbook. Leafing through its pages reveals the history of a little-known community within the college, the OVC Student Wives’ Auxiliary. Founded in 1951, the Auxiliary provided a venue of support, fellowship, education, and involvement for the women whose husbands were OVC students. This paper analyzes the history of the Auxiliary from its founding to its eventual dissolution by the early 1990s through the use of archival sources as well as interviews of former Auxiliary members and their family members. The Auxiliary made significant contributions, not only within the OVC, but also to the wider veterinary profession in Canada.

Women’s auxiliaries and social groups have been a regular fixture within veterinary medicine since the mid-twentieth century. However, recognition of these groups in the history of veterinary medicine is minimal. In their history of the Ontario Veterinary Association (OVA), for example, Margaret Evans and Dr. C.A.V. Barker make only brief references to the women’s auxiliary to the OVA, noting their positive role in supporting and promoting the veterinary profession, and the publication by the OVA Women’s Auxiliary of Profile of the Veterinary Profession, which outlined the various roles of veterinarians (2). Similarly, Dr. Terry Crowley and Dr. C.A.V. Barker make passing references to the Women’s Auxiliary of the Canadian Veterinary Medical Association in their book, One Voice (3).

The auxiliaries of the American Veterinary Medical Association (AVMA), Canadian Veterinary Medical Association (CVMA), and OVA provided broader networking opportunities for the wives of veterinarians and veterinary faculty members. Their yearly meetings, held mainly during the annual meetings of the larger organizations, also provided opportunities for fundraising and fellowship for various projects as well as opportunities for wives to take in lectures on various aspects of veterinary medicine. For example, at an annual meeting of the OVA in 1946, Mrs. Jay Barker, wife of OVC faculty member Dr. C.A.V. Barker, made a motion during the annual meeting of the OVA Women’s Auxiliary to ask the conference organizers if “…permission could be granted to the ladies to listen in on lectures and discussion of the men at the convention” (4). Permission was granted and so even at these larger conferences, wives participated in lectures as they did in the smaller auxiliaries like the OVC’s and were thus kept current on the latest developments in veterinary medicine, a profession in which they participated.

The formation of veterinary wives’ auxiliaries reflects a much larger presence of formally organized women’s networks in the early to mid-20th century. Women’s Institutes, for example, were a regular and important presence for thousands of urban and especially rural women in Canada throughout the 20th century. These institutes, peppered throughout the country, were important sites not only for women to gather socially and share their knowledge and struggles with each other on a wide variety of topics, but they also became critical educational institutions that transformed the landscape of particularly rural Canada.

Ontario Veterinary College, University of Guelph, 50 Stone Road East, Guelph, Ontario N1G 2W1.
Address all correspondence to Dr. Lisa Cox; e-mail: coxl@uoguelph.ca
Use of this article is limited to a single copy for personal study. Anyone interested in obtaining reprints should contact the CVMA office (hbroughton@cvma-acmv.org) for additional copies or permission to use this material elsewhere.
The genesis of women's institutes in Canada can be closely linked with the emergence of farming organizations and periodicals. Farmers' institutes emerged in North America in the nineteenth century as venues to share knowledge, the latest and most advanced research and experimental crops, and promote agricultural education (5,6). Likewise, farming periodicals such as the Farmer's Advocate, American Agriculturist, and Hoard's Dairyman provided a venue for farmers and agricultural and livestock experts to discuss various issues and promote and debate the latest scientific approaches to agriculture. Missing from many of these organizations and periodicals, however, was substantial discussion of issues that affected women. Many farming periodicals, for example, contained sections of recipes and other household advice, but rarely did they discuss more serious matters, such as childhood mortality, food safety, or issues of sanitation (7–9). Women's institutes emerged within these changing attitudes towards agriculture and rural life.

The first Women's Institute branch began in Stoney Creek, Ontario, in 1897 under the direction of Adelaide Hoodless. Hoodless had lost a son in the 1880s to a contaminated milk-related illness and became an advocate for domestic science for women and girls (10–12). Initially it began as a gathering for women to fellowship with one another and learn homemaking skills in the hopes, as historian Linda Ambrose puts it, to improve the standard of living in rural areas and stem the decline of rural populations which had been occurring throughout the late 19th century (13). These groups would expand their functions, however. Over time, as Ambrose notes, these groups grew in popularity and expanded their role by becoming involved in a number of community causes. For example, several women's institutes became heavily involved in coordinating and overseeing voluntary efforts during the First World War. As a result of their involvement with home-front war efforts, the various women's institutes in Ontario formally came together in 1919 as the Federated Women's Institutes of Canada (14). These organizations would champion various causes such as infant, childhood, and maternal health, and a variety of public health issues (13). The OVC Student Wives' Auxiliary and other veterinary auxiliaries would follow a somewhat similar path to that of the women's institutes. The group provided a venue for fellowship and learning, but also eventually became involved in larger causes within the veterinary profession. Women's institutes across Canada, however, were not all alike. While Ontario's institutes may be viewed as more traditional in the outlook, focusing on maternal issues and social causes, other institutes encouraged their members to become involved in other pursuits. In western Canada, for example, some institutes encouraged vocational training and economic contributions women could make to their families. The OVC Student Wives' Auxiliary may be considered similar to this latter group of women's institutes, as they provided vocational training in addition to more traditional social activities (15–19).

A historical description of the lives of women married to veterinarians is limited to a minor number of works. A few women wrote their own memoirs, sharing memories and shedding light on their involvement in their husband's practices. Maria Coffey recounts her life as a veterinarian's wife in Ireland in A Lambing Season in Ireland: Tales of a Vet's Wife, and the experience of veterinary life in the United States is told by Gay Balliet in Touched by All Creatures: Doctoring Animals in the Pennsylvania Dutch Country (20,21). Additionally, some memoirs written by male veterinarians reflect on the role of their wives. Dr. Blake Graham, in his memoir, Swell Ear to Silk Purse: Anecdotes from the Life of a Veterinarian, for example, recounts his wife's role as his assistant and office manager in his home-based practice (22). To our knowledge, no published accounts on the history of student wives organizations exist.

The OVC Student Wives' Auxiliary was a unique community within the college for many years and served a number of important roles. It emerged in a time of excitement and uncertainty...
for many veterinary students and their wives. The post-World War II period saw large numbers of military veterans enrolling in universities. As a result, the student populations of many colleges and universities, including the OVC, swelled considerably in this period. For example, the Class of 1949 was so large that it was split into two parts when they began their studies in 1945 (23). These post-World War II OVC students, many of whom were married, graduated and began their own practices to care for livestock and growing numbers of companion animals. These practices required assistants and many of those roles were filled by their wives. In order for them to assist in veterinary practice and oversee or participate in the business of running a practice, the women benefited from training. The OVC Student Wives’ Auxiliary met this need by organizing lectures and demonstrations on a variety of topics relevant to the responsibilities that the women would have.

The OVC Student Wives’ Auxiliary was officially founded in 1951 as a junior chapter of the Women’s Auxiliary of the AVMA. For several years before its official beginnings, the wives of veterinary students had participated in organized meetings. Within their 25th anniversary scrapbook, for example, the Auxiliary noted that the wives of both OVC and the Ontario Agricultural College (OAC) students had formed a student wives club that met at the YMCA beginning in 1945 (1).

The OVC Student Wives’ Auxiliary was one of many vibrant auxiliaries within veterinary medicine in North America. As a junior chapter of the Women’s Auxiliary of the AVMA, the group also existed alongside the Women’s Auxiliaries of the CVMA and the OVA. Hazel MacDonald, the First Vice President of the Women’s Senior Auxiliary to the AVMA, encouraged the creation of the OVC’s auxiliary and spoke at the first meeting about the merits of a junior auxiliary to the AVMA. According to their minutes, the OVC members showed great interest in MacDonald’s advice. As a strong advocate for women’s networking within the veterinary profession, MacDonald answered many of their questions regarding fees, representation at the annual convention of the AVMA, activities for the group to pursue, and the duties of those elected to various positions such as president, secretary and treasurer (24).

From the beginning, the OVC Student Wives’ Auxiliary envisioned itself serving three roles: i) “To make available to the members an intelligible knowledge of the Veterinary Profession;” ii) “To promote a spirit of friendly relations among the wives of the students regularly enrolled in the course of Veterinary Medicine;” and iii) “To provide an additional opportunity for an understanding of common interests and problems as wives of Veterinary students” (25). In the inaugural year, the group focused on creating a constitution that worked well for the group. For example, it was decided that membership in the group would be limited to the wives and “engaged girls” of regularly enrolled OVC students, and that the group would meet twice per month on Thursdays in the OVC Student Lounge.

The working lives of OVC student wives in this period varied, with some remaining at home and others working outside the home. Doris Logan, for example, recalled that many of the women who were married to veterans of World War II stayed at home, with some having already started families (26). In fact, many OVC families were housed in a trailer park south of the OVC (23). Housing, and especially income, was tight for many families; wives often provided the sole income for the family while their husbands studied. For many years, at the farewell parties, the women were presented with a “PHT” certificate, which stood for “Putting Husband Through” (1). Helen McMorland, whose husband, Dr. Ian McMorland, was a member of the class of 1958, recalled that nearly all of the women in the Auxiliary were family breadwinners: “We were teachers, nurses, stenos, dancers — any vocation that could help finance a veterinary education for our husbands” (27).

One of the most revealing insights found in McMorland’s and other’s correspondence and conversations was an anxiety that many student wives shared, i.e., pregnancy. McMorland noted, for example: “…nearly all [wives] were the breadwinners, trying hard not to get pregnant before graduating. But — some babies did come along and they were doted on by the rest of us” (27). As another example, Peggy Willoughby, a University of Saskatchewan pharmacy graduate and married to Dr. Russ Willoughby (OVC’57), became pregnant with her first child while working at the Guelph General Hospital. Using her tall height and laboratory coat, she was able to conceal her pregnancy for most of its duration, worried that as the family breadwinner, she would be asked to resign (as many women were) if her pregnancy was discovered (28). Luckily for Willoughby, shortly after the hospital staff noticed her pregnancy and hired her replacement, she gave birth. Willoughby stayed at home with her children in the years that followed but used her pharmacy experience in her husband’s veterinary practice.

For some of the women, their husband’s graduation from OVC did not end their connection with the college. Helen Thomson, wife of Dr. Reginald Thomson (OVC’59), reflected on her continued years as the wife of a student while her husband worked through graduate school. She remarked: “…we became almost single parents as our husbands struggled long hours to achieve their goals. We had little or no money and most of us found it too difficult to try and work outside the home” (29). Eleanore Hulland, who is married to retired OVC faculty member Dr. Tom Hulland (OVC ’54), recalled the challenges of moving to Scotland shortly after getting married in the 1950s when her husband began his graduate studies at the University of Edinburgh. Despite the upheaval in their lives and raising a young child abroad, Hulland recalled the welcoming atmosphere of faculty, staff, and their families in Edinburgh and the frequent get-togethers for students and their spouses to socialize. Networking and social circles continued for OVC faculty wives as many of them served as advisors to the OVC Student Wives’ Auxiliary as well as participating in the University of Guelph College Women’s Club (30).

Given the demands placed on many OVC student wives to keep their homes running and be the principal breadwinner while their husbands studied long hours, it came as no surprise that the OVC Student Wives’ Auxiliary provided a welcomed and needed social outlet. In fact, a number of former Auxiliary members remarked on the ready-made social group that awaited them in Guelph. Helen McMorland remarked: “The club gave me a ready-made group of friends, with a common goal and no money” (27).
From the records of their meetings, it is clear that the Auxiliary created a rich experience for its members. In addition to twice-monthly meetings, the group planned and carried out a number of events. They included children’s Christmas parties, a choral singing group, clothes making (which were modelled by the women and their husbands), wedding and baby showers, a tea at the beginning of each year, and a farewell party for those members whose husbands were graduating.

Fundraising quickly became a principle activity for the OVC Student Wives’ Auxiliary. The group held various events through the year such as rummage and bake sales, selling Christmas cards, and holding concerts by the Auxiliary choral group. Funds raised from these events went to several causes including Christmas parcels for the needy, hurricane relief in 1954 for Hurricane Hazel, and donations to the OVC’s McNabb Library. A notable recipient of auxiliary fundraising throughout the 1960s was Dr. Frank Schofield (OVC ’10), a long-time OVC faculty member who was continuing his humanitarian work in Korea. Based on the correspondence he sent to the auxiliary, the funds helped support the care of orphans. In one letter from Schofield in 1963, for example, he thanked the group for their generous donation of $50, noting the funds were sorely needed that year given the low income of the orphanage (1).

One of the stated goals of the OVC Student Wives’ Auxiliary to “...make available to the members an intelligible knowledge of veterinary medicine,” has had a significant influence not only on the members of the Auxiliary, but on the Canadian veterinary profession in general. When veterinarians graduated in the post-World War II period, many began their own practices rather than going to work for an established practice. Although modern veterinary clinics have a staff typically consisting of office personnel and veterinary technicians, these personnel were less common in this period, particularly in small practices. The clerical as well as pre- and post-operative care fell to the veterinarians themselves, and more often than not, to their wives. It was critical then that wives receive some instruction in veterinary medicine as well as the business of running a practice, as many would play a key role in both. The OVC Student Wives’ Auxiliary recognized the important role its members would hold in veterinary practices and actively worked to prepare them.

The professional demonstrations and instruction that wives received during the first year of the auxiliary in 1951 set the tone for the group’s activities for years to come. A common discussion for members, particularly at the beginning of the academic year, was making sure that the group secured enough professional training activities for the year that were of sufficient variety. The kinds of instruction wives received can be roughly placed into 2 categories: veterinary medicine and the business of veterinary practice.

In 1951, the Auxiliary immediately engaged with the faculty of the college and members of the community to learn about the various aspects of veterinary medicine they might encounter in their husbands’ practices. During this first year, for example, members were given a tour of the small animal hospital at the college and observed the hysterectomy of a dog and were lectured on laboratory techniques and the duties of a veterinary wife (1). These types of activities were typical for the auxiliary in the years to come. For example, some additional lectures given by OVC faculty included syringe and anesthetic by Dr. Anthony Kingscote (OVC ’28) and professional ethics in veterinary medicine by Dr. Trevor Lloyd Jones (OVC ’34), as well as a variety of large and small animal surgical procedures (1).

Educating wives on various aspects of veterinary medicine continued for the length of the Auxiliary’s existence. Throughout the 1960s and 1970s, senior veterinary students at the college did most of the surgical and clinical demonstrations for the Auxiliary. Faculty members continued to participate in meetings and provide information on various aspects of the veterinary profession, Cesarian sections, spays and neuters, tours of OVC facilities, and techniques for restraining animals (1).

In addition to instruction in veterinary medicine, the Auxiliary organized numerous opportunities to learn about the business of running a veterinary practice. During the first year, the Auxiliary learned about bookkeeping from a chartered accountant. Lessons in bookkeeping became an almost yearly feature for the auxiliary, as would lessons on “telephone technique” from phone company representatives because many wives would serve as the primary receptionist in their husbands’ practices (1).

Not surprisingly, after graduation the wives’ roles in their husband’s practices varied considerably. As noted, for many it was a financial necessity for the wives to work in the veterinary practice because beginning a new practice left little funds to hire outside assistance. Commenting on her work in her husband’s practice, Karen Tenbergen, whose husband Dr. Dick Tenbergen was a member of the Class of 1959, noted that her free labor saved money that would otherwise have been spent on outside staff (31).

The wives of some veterinarians experienced a gradual introduction to veterinary practice. For example, when Dr. Clayton Mackay graduated from the OVC in 1970 and joined his father’s veterinary practice in Whitby, Ontario, his mother oversaw most of the day-to-day administrative operation of the clinic. Mackay’s wife, Mary Lynn, took over these duties gradually and eventually assumed them entirely as her father-in-law and mother-in-law retired (32).

The variety of activities the OVC Student Wives Auxiliary provided for these women prepared many for the various responsibilities they took on in practices across Canada and beyond. Remembering her initiation into practice, Connie Clarke, whose husband Dr. Pat Clarke was a member of the Class of 1955, remarked: “I smugly presumed that my training as a medical technologist would give me a leg up in the world of veterinary medicine. I soon learned that a talent for bookkeeping and kennel scrubbing while running a household and family on the side would have been more useful” (33).

The women often worked long hours in their husbands’ practices and were also expected to maintain their homes and families. Connie Clarke and her husband settled in the rural community of Mission, British Columbia in the mid-1950s, and she describes their day beginning at roughly 5:00 am with calls from dairy farmers worried about potential cases of milk fever in their herds. She would prepare calcium gluconate on their stove and her husband would leave for the farms, leaving her behind to take calls, arrange the day’s schedule, and prepare the clinic.
for clients. Given the few number of veterinarians in their area, a good proportion of the day saw Clarke’s husband out on farm calls. She would prepare kennels for the small animals he would see throughout the day as well as dispense various medications to people who stopped by (33). After a long day, she and her husband would tend to the various dogs and cats dropped off at their practice for treatment, often improvising and fashioning their own towels and drapes from cotton towelling (33).

Although membership in the OVC Student Wives’ Auxiliary ended when husbands graduated, auxiliaries continued to play an important role in the lives of many women and to the veterinary profession in general for many years. Many joined the auxiliaries of the OVA, OVMA, and/or AVMA, continuing their friendships and involvement in the veterinary community after graduation. Meetings of these auxiliaries allowed the women, some of whom were now living in more remote rural areas, to meet with each other and share their experiences and challenges of their lives married to practicing veterinarians.

The alumni members of the Student Wives’ Auxiliary from several classes of OVC graduates remain close and the friendships created through involvement in the auxiliary stand out as the most memorable for many. Eleanor Hulland recalled that auxiliaries provided support and an outlet during the sometimes isolating experience as the wife of a student or faculty member and stay-at-home mother. A strong legacy of the auxiliaries lies in the friendships formed during those years that lasted and continue today (30). Beyond, groups like the OVC Student Wives’ Auxiliary advocated and provided training for wives to assume important clinical and clerical roles in veterinary practice. In doing so, the OVC Student Wives’ Auxiliary was not only part of the social fabric of the OVC, but also an active participant in the teaching and delivery of veterinary medicine in Canada.

The OVC’s student body is quite different now than it was in the early 1950s. Most of the OVC students are women, and most students are not married. While perhaps now viewed as an entity of a certain time, place, and circumstances, the importance of the OVC Student Wives’ Auxiliary cannot be underestimated. The Auxiliary provided a social and supportive environment for women during this period. They participated in fundraising and provided valuable public service on behalf of the veterinary profession. Moreover, the OVC Student Wives’ Auxiliary would contribute significantly to the practice of veterinary medicine in Canada. By providing yearly information and instruction to wives on various aspects of veterinary medicine and the business of veterinary practice, the OVC Student Wives’ Auxiliary shaped and influenced what would become a profession for veterinary office managers and veterinary technicians.

References

An observational study of mortality on bison farms in Saskatchewan with special emphasis on malignant catarrhal fever

Tasha Epp, Cheryl Waldner, Murray Woodbury

Abstract — In December 2011, the Malignant Catarrhal Fever (MCF) Task Force in Saskatchewan recommended that research be conducted on the relationship between the proximity of bison and sheep under typical commercial production settings and bison deaths due to MCF. The objective of this study was to evaluate all causes of death in bison herds and compare the incidence of MCF in herds at varying distances of exposure from sheep operations. Necropsies were completed on 76 of 133 bison reported to have died during the 18-month study period. A total of 7 MCF deaths was reported from 2 large herds within 1.0 km of sheep operations. Although there was a greater risk of MCF deaths in bison herds within 1.0 km of sheep operations than in herds more than 1.0 km away, the overall incidence of MCF deaths within the study period was very low. Most deaths were attributed to non-infectious causes, including copper deficiency.

Résumé — Étude observationnelle de la mortalité dans des fermes de bison en Saskatchewan, avec une emphase particulière sur la fièvre catarrhale maligne des bovins. En décembre 2011, le groupe de travail de la Saskatchewan sur la fièvre catarrhale maligne des bovins (FCM) a recommandé la réalisation de travaux de recherche pour étudier le lien entre la proximité des bisons et des moutons dans des milieux de production commerciaux typiques et la mortalité des bisons attributable à la FCM. La recherche avait pour but d’évaluer toutes les causes de mortalité dans les troupeaux de bison, puis de comparer l’incidence de la FCM dans les troupeaux à diverses distances d’exposition des exploitations d’élevage de moutons. Des nécropsies ont été réalisées sur 76 des 133 bisons dont la mort a été signalée durant la période d’étude de 18 mois. Un total de sept morts causées par la FCM a été signalé dans deux grands troupeaux situés à une distance de moins de 1 km. Le risque de mortalité pour cause de FCM était supérieur dans les troupeaux de bisons situés à moins de 1 km des exploitations de moutons que dans les troupeaux situés à une distance de plus de 1 km. Cependant, l’incidence totale de mortalité causée par la FCM était très faible. La plupart des mortalités étaient attribuables à des causes non infectieuses, y compris une carence en cuivre.

Can Vet J 2016;57:37–45

Introduction

Malignant catarrhal fever (MCF) is caused by viruses in the herpesvirus family. In North America, MCF is most commonly the result of infection with a gammaherpesvirus known as ovine herpesvirus-2 (OVH-2) (1). The virus is carried by healthy sheep and possibly goats without clinical harm to the carrier. It can be lethal, however, when transmitted to cattle and particularly to bison (2). The first well-described outbreak of MCF in bison was reported in 3 North Dakota herds from 1973 to 1976 (3).

Over the last 20 y, several large outbreaks of MCF in farmed bison (Bison bison) have been attributed to exposure to sheep (2,4–7). In 1 study (4), mortality risks were reported relative to the distance from a large (20 000 head) sheep feedlot: 17.5% mortality at 1.6 km and 0.43% mortality at 5.1 km. Although the exact mechanism of transmission of the virus from sheep to bison is not known, direct contact with sheep is not necessary for transmission (1). Airborne transmission of aerosolized viral particles from sheep nasal secretions is the primary hypothesis, with some references to common fomites, contaminated feed and water, or birds possibly facilitating virus transmission (1,2,4–9).

The losses due to MCF associated with sheep proximity have sparked conflict between the sheep and bison industries in North America and led to calls for municipal regions to legislate minimum distances between newly establishing farms. In response to concerns from bison producers, the Government of Saskatchewan set up a task force to develop recommendations...
to effectively manage the disease within the province (10). One of the key recommendations was to study the causes of death in bison herds at varying distances from sheep flocks.

While MCF appears to be infrequently diagnosed on Saskatchewan bison farms, there has been no research on the actual incidence of MCF deaths other than isolated outbreaks associated with sheep feedlots, bison feedlots, or auction barn settings (10). While past MCF outbreaks have identified the main risk as exposure to sheep (2–7), the potential risks for bison raised near sheep under typical production conditions on the Canadian prairies have not been examined.

The main objective of this observational study was to report the relative risk of MCF deaths in commercially farmed bison across varying distances from typical commercial sheep herds. The findings will provide the industry with much needed evidence to minimize the risk of MCF transmission from sheep to bison. The second objective of the study was to estimate the relative frequency of the other common causes of mortality in commercial bison herds.

Materials and methods

Herd recruitment

Approval to collect the herd data used in this study was obtained through the University of Saskatchewan Behavioral Ethics Board (BEH 12-266). Animal ethics was not required for studies involving animals submitted for necropsy that had died from natural causes or were euthanized on-farm at the discretion of the owner.

This study was conducted from December 1, 2012 to May 31, 2014. Thirty bison herds were recruited by advertising with the Saskatchewan Bison Association and the Canadian Bison Association, as well as through local veterinarians. In an introductory letter, interested herd owners were asked to contact the study’s principal investigator for further information and to enroll. They were then asked to sign a consent form and complete a pre-study survey at time of enrollment in order to obtain an estimate of the herd size and death losses for the previous year. Any animal that was born alive and then died on-farm during the 18-month study period was eligible to be submitted for necropsy at the expense of the study. At the close of the study period, each herd owner completed a final post-study survey to confirm the herd size, the total number of deaths on-farm, and proximity to sheep during the study period. Participating bison herd owners were provided with a nominal monetary honorarium for their contribution to the study.

Diagnostic procedures

When animals were euthanized or died on-farm, the herd owner called their veterinarian to complete a necropsy. A standard protocol, necropsy kit, and submission form were provided to the veterinarians to facilitate consistent tissue collection. The recommended protocol included collection of animal identification, gender, and age; a detailed history; external examination for body condition score and gross abnormalities; and a detailed internal examination of all major organ systems. Veterinarians were instructed to collect specific samples within each of the major organ systems, which included musculoskeletal, thorax, abdomen, and urogenital tract. Additional samples listed as optional included feces, eye, spinal cord, or brain and affected joint or joint fluid. Tissues were to be fixed in formalin and/or included as fresh or frozen samples when indicated on the submission form. Any additional submitted samples (those not requested on the submission form) were based on the initial postmortem findings by the attending veterinarian. All samples were shipped to a commercial diagnostic laboratory [Prairie Diagnostic Services (PDS)], together with the history and summary of the gross postmortem findings. The laboratory did not have information on the animal’s potential for contact with sheep.

Processing of submitted samples by the diagnostic laboratory followed a standard protocol, which was to include testing for MCF, a mineral panel, and other testing suggested by specific pathology at the discretion of the pathologist to determine a cause of death, to a maximum cost of $300.00 per case. All submitted formalin-fixed tissues were examined histologically for abnormalities. Real-time polymerase chain reaction (PCR) was used to identify MCF (OVH-2) deoxyribonucleic acid (DNA) in available fresh or frozen pooled tissues (sensitivity, 97%; specificity, 100%) from each case potentially, including liver, lymph node, kidney, and spleen (11,12). If fresh liver or kidney was available, a standard mineral panel analysis was carried out, which included magnesium, manganese, iron, cobalt, copper, zinc, selenium, and molybdenum following a previously described protocol (13). If suggested from the history or examination of fixed tissues, vitamin A and E levels were also assessed (13).

Individual animal necropsy results were reported to the herd veterinarian, who then communicated the findings to the producer. Any subsequent management or treatment decisions were the responsibility of the herd owner in consultation with their veterinarian.

Statistical analysis

Descriptive analysis

Data were compiled in an Excel database; descriptive analysis included calculation of herd mortality risks (proportions) with exact 95% confidence intervals (CIs) and proportional mortality of the most frequent causes of death. The pre-study survey (2012) mortality rate was calculated as the total number of bison deaths (as reported by the owner) that occurred in 2012, divided by the total bison herd size at the start of the study period (December 2012 or January 2013). The post-study survey mortality rate (2013 to 2014) was calculated using the total number of bison deaths during the study period, divided by the total bison herd size at the start of the study period. The total number of animals that died per farm, including necropsied and non-necropsied reported deaths, was reported on the post-study survey. The proportional mortality was calculated for MCF and the other most common defined causes of death as a fraction of the total deaths submitted for necropsy. The case definition of a MCF death was any bison submitted for necropsy with a positive PCR test with or without specific clinical symptoms in the history, i.e., “found dead” could have been the only clinical sign listed, and histopathological evidence supporting a diagnosis of MCF.
The average number of bison in each herd was calculated as the average of the total number of bison in the herd from the pre- and post-study surveys. The average size of each bison herd was then categorized as small (1 to 150 animals), medium (151 to 500 animals), or large (more than 500 animals). Bison herds were classified into 2 groups based on proximity to sheep: no sheep operation boundary within 5.6 km (negligible-exposure group) and a sheep operation boundary within 5.6 km (at-risk group). Herds at risk were further classified into 2 groups: those less than 1.0 km away from a sheep operation boundary (high-exposure group) and those 1.0 to 5.6 km away from a sheep operation boundary (low-exposure group). Distance was based on the closest point of contact between bison and sheep as determined by fence line boundaries of the pastures. Age structure of the bison herd was reported as the percentage of the herd reported as calves (<1 y of age), subadults (yearlings and 2nd-year bison), and adults (≥3 y old), based on the average number of bison in the herd. Specific management factors collected on the post-survey included the use of mineral supplements, source of water, whether water was tested in the last 5 y, use of a chute to capture animals within the study time period, and whether pregnancy testing occurred in the study time period.

While the age of each bison was reported on the necropsy form, age was categorized for analysis, with adults and subadults combined into a single category for most analyses. Case submissions were reviewed to determine the number of tissues submitted (<5 or ≥5 tissues and ≥10 tissues) and the extent of autolysis in the samples (none, mild-moderate, or moderate-severe). Animals that were euthanized just before postmortem examination were identified. The number of days from the date of death to necropsy was reported if known or estimated for animals found dead.

Comparative analysis

The association between proximity of each bison herd to sheep and whether MCF was identified in the herd during the study was examined using exact logistic regression after adjusting for average bison herd size (Stata-MP 13.1; StataCorp LP, College Station, Texas, USA). A bison herd was classified as MCF-positive if at least 1 bison from the herd was reported to have died from MCF during the study period, i.e., based on a positive PCR test result. All other variables considered to be potentially important confounders were assessed to determine if adjustment for the variable resulted in a 20% change in the regression coefficient for proximity to sheep herds. No interaction terms were explored in exact regression analysis. The estimate was reported as an odds ratio (median unbiased estimate; OR-MUE), with the $P$-value calculated by the probability test. Predicted probabilities were graphed for each covariate pattern in the final model.

Additional analysis was completed to examine the association between the count of MCF-positive cases per herd and proximity to sheep operations using exact Poisson regression, with the average number of bison in each herd as the offset. Results were reported as a risk ratio (median unbiased estimate; RR-MUE), with the $P$-value calculated by the probability test.

Results

Descriptive analysis — study herds

Of the 30 herd owners who expressed interest in enrollment, 26 completed the study; 27 herds completed the enrollment process (consent form and pre-survey), but 1 herd dropped out of the study before completion due to full herd dispersal in 2013. Of the 26 herds to complete the study, 17 were enrolled in December 2012 (contributed the full 18 mo) and 9 herds were enrolled in January 2013 (contributed 17 mo). This represents approximately 14% (26/182) of the membership of the Saskatchewan Bison Association as of May 2012. There is no information, however, on the proportion of bison herds in the industry that are currently located within 5 km of sheep operations.

Of the 26 herds to complete the study, 6 were within 1.0 km of sheep operation boundaries (high-exposure group), 9 were within 1.0 to 5.6 km of sheep operation boundaries (low-exposure group), and 11 were at distances greater than 5.6 km from sheep operation boundaries (negligible-exposure group). Within the negligible-exposure group, distances ranged from 8 to 20 km away from sheep. Within the high-exposure group, 1 bison herd had been comingled with sheep in the same pasture for the past 15 y with no identified occurrence of MCF. The size of the sheep operation was recorded for 14/15 of the low- and high-exposure herds; 10 were less than 150 head, 3 were 151 to 500 head, and 1 was >500 head. All but 1 were typical commercial sheep flocks. The remaining sheep operation was classified as a small (<50 sheep) corral containing feeder lambs.

The average number of bison per herd ranged from 11 to 1300 (median: 168). Most herds were <150 bison (13 herds). Of the 4 herds with >500 bison, all were within 5.6 km of sheep operation boundaries. All herds were considered commercial bison operations where calves were produced and most were grazed or fed on pasture when available. The median age structure for all herds was 30% calves, 30% subadults, and 40% adults. While only 8 herds indicated carrying out pregnancy checks, 20 herds reported using a chute system to capture animals at least once over the study period for other reasons. Four herd owners reported treating animals that did not die during the study period. Reported reasons for treatment included copper deficiency (2 herds), blackleg (1 herd), and parasites (1 herd). Water had been tested in 7 herds within the previous 5-year period. Water sources varied within and between farms and included combinations of surface (i.e., dugout), private well, or municipal water sources.

Descriptive analysis — mortalities

In the pre-study survey, 2 herds reported the occurrence of MCF deaths during 2012; 1 of those herds also had MCF deaths during the study time period. Conditions listed by producers as the cause of death for bison in 2012 varied. Almost all calf deaths were considered pre-weaning death losses, with most citing loss of mother or handling injuries. Subadult or adult deaths were most commonly reported as injury, calving-related, or unknown. The pre-study survey (2012) mortality rate for herds with negligible exposure to sheep operations was 1.9% (Table 1).
Table 1. Mortality risks for pre-study survey (2012) and study period (2013 to 2014) (submitted for necropsy and total reported deaths on farm) by categories of exposure to sheep operation boundaries based on distance

<table>
<thead>
<tr>
<th>Herd size</th>
<th>Negligible exposure</th>
<th>Low exposure</th>
<th>High exposure</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small</td>
<td>Medium</td>
<td>Small</td>
<td>Medium</td>
</tr>
<tr>
<td>Mortality risk (2012)</td>
<td>1.0%</td>
<td>2.3%</td>
<td>3.6%</td>
<td>2.3%</td>
</tr>
<tr>
<td>Submitted for necropsy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality risk (2013 to 2014)</td>
<td>1.2%</td>
<td>0.7%</td>
<td>0.8%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Mortality risk (2013 to 2014)</td>
<td>4.1%</td>
<td>1.9%</td>
<td>2.8%</td>
<td>3.0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Categories of deaths</th>
<th>Morphological diagnoses</th>
<th>Calf &lt; 5 mo</th>
<th>Calf &gt; 5 mo</th>
<th>Total (PM)</th>
<th>Herds (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undetermined causes</td>
<td>No morphological diagnoses possible</td>
<td>2</td>
<td>1</td>
<td>3 (14.3%)</td>
<td>3</td>
</tr>
<tr>
<td>Non-infectious causes</td>
<td>Calving or trauma</td>
<td>2</td>
<td>2</td>
<td>4 (19.0%)</td>
<td>3</td>
</tr>
<tr>
<td>Infectious causes</td>
<td>MCF</td>
<td>0</td>
<td>2</td>
<td>2 (9.5%)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Septicemia</td>
<td>0</td>
<td>2</td>
<td>2 (9.5%)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Enteritis</td>
<td>1</td>
<td>0</td>
<td>1 (4.8%)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Peritonitis</td>
<td>0</td>
<td>2</td>
<td>2 (9.5%)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Hepatic lipidosis</td>
<td>0</td>
<td>1</td>
<td>1 (4.8%)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Abscesses — intestinal, hepatic</td>
<td>3</td>
<td>0</td>
<td>3 (14.3%)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Myocarditis</td>
<td>0</td>
<td>1</td>
<td>1 (4.8%)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Pulmonary edema; pneumonia</td>
<td>1</td>
<td>1</td>
<td>2 (9.5%)</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>12</td>
<td>21</td>
<td></td>
<td>8</td>
</tr>
</tbody>
</table>

PM — proportional mortality calculated as the number of deaths by specific cause divided by all deaths, expressed as a percentage.

During the study period, the mortality rate (2013 to 2014) was highest in negligible-exposure herds compared to the 2012 mortality rate in which the highest rate was for high-exposure herds (Table 1). Not all bison that died during the study were suitable for sampling; these animals included those that were found dead and some that died in known circumstances, i.e., trauma-related. Owners were asked to report any dead animals on-farm during the study period that were not necropsied and provide their assessment for the cause of death. In total, 76 bison of all ages were submitted for necropsy; 61 were found dead and 15 were euthanized. Owners reported an additional 57 deaths for which no necropsy was conducted.

The cumulative mortality rate was similar in the pre-study survey and study time periods (Table 1). The pre-study survey estimate was based on 11 to 12 mo, however, and the study period was based on 17 to 18 mo. Using a 12-month period of time, the overall mortality rate in 2013 alone (January to December) was 1.2% (23/1864) for negligible-exposure herds, 1.6% (31/1958) for low-exposure herds, and 0.7% (23/3085) for high-exposure herds. The mortality rate for all herds was 1.1% (77/6907).

For animals with samples submitted for necropsy, there were 21 deaths in calves; 9 were < 5 mo of age and 12 were > 5 mo. The major morphological diagnoses for deaths in calves are reported in Table 2; the etiologic diagnosis was undetermined for most calf losses (15/21, 71%). Of the 3 undetermined deaths for which no major morphological diagnosis was possible, 2 were possibly the result of non-infectious causes of death based on history, but this was not confirmed.

There were 55 necropsied deaths in subadults and adults. The major morphological diagnoses for subadults and adults are reported in Table 3. There was no cause of death or morphological diagnosis in 20% (11/55). Ten of the 11 necropsied animals with undetermined deaths tested negative for MCF; the single remaining dead bison without an MCF test was from a herd more than 16 km from a sheep operation. Of the 11 undetermined deaths, 2 had probable but unconfirmed causes of death based on history or veterinarian-performed postmortem examination alone, i.e., impaction and enteritis. No etiological agent was identified for 43% (10/23) of subadults or adults with an infectious diagnosis.

Both MCF deaths from calves > 5 mo of age during the study were from a single high-exposure herd. All MCF deaths from subadults or adults during the study occurred within 2 large high-risk herds; the incidence of MCF deaths was 0.2% and 0.6% for these herds. Four necropsied animals did not have an MCF test completed; 1 was a calf < 5 mo of age with pulmonary edema, 1 was a subadult with coccidia enteritis,
1 was an adult with an undetermined cause of death, and the remaining adult died of trauma.

In this study, half of the dead bison (30/61) with completed mineral panels were classified as being marginal or deficient in copper. Copper deficiency was considered the final diagnosis in only 8 animals, however, 5 of which were recorded as being thin with diarrhea before death. Only 1 of the bison herd owners did not provide a mineral supplement. Of the 25 herds that had free choice supplementation, 12 herds had deaths with marginal or deficient copper levels. Of those 12 herds, 7 changed to higher copper supplementation after receiving the postmortem results. The water sources of only 3 of these 12 herds had been tested in the past 5 y.

More deaths were submitted for necropsy during the late winter and early spring than during the summer, although there was no apparent seasonal pattern to the ability to determine etiology (Figure 1). Death from MCF occurred in January (2), June (1), September (1), and December (3). An etiology was determined for between 60% to 75% of deaths when 10 tissues per case were submitted for necropsy, but for < 50% of deaths when 10 tissues or more were provided ($P > 0.05$) (Figure 2). Autolysis (mild to severe) was reported in samples collected in all months of the year, although ‘no autolysis’ was reported only in samples collected in winter to early spring (Figure 3).

Of the dead animals that were not submitted for necropsy but were reported by owners during the study period, 67% (38/57) were attributed to non-infectious causes, such as calving, nutritional issues, and trauma. Including the information from necropsied animals, 65% (17/26) of herds had at least 1 death due to non-infectious causes. The remaining 19 reported (non-necropsied) deaths had undetermined causes; in some cases, only bones or highly predated carcasses were found. Of the non-necropsied undetermined deaths, 74% (14/19) were recorded for negligible-exposure herds and 21% (4/19) were recorded for low-exposure herds. There were no dead animals in high-exposure herds that were not necropsied and also for which there was no information on the cause of death. In 86% of animals not submitted for necropsy (49/57), only year of

**Table 3.** Major morphological diagnoses for necropsied animals within the study period for subadult and adult bison

<table>
<thead>
<tr>
<th>Categories of deaths</th>
<th>Major morphological diagnoses</th>
<th>Negligible exposure</th>
<th>Low exposure</th>
<th>High exposure</th>
<th>Grand total (PM(^b))</th>
<th>Herds (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undetermined causes</td>
<td>No morphological diagnoses possible</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>11 (20.0%)</td>
<td>7</td>
</tr>
<tr>
<td>Non-infectious causes</td>
<td>Calving, trauma, or malnutrition</td>
<td>2</td>
<td>7</td>
<td>4</td>
<td>13 (23.6%)</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Copper deficiency(^b)</td>
<td>1</td>
<td>7</td>
<td>0</td>
<td>8 (14.5%)</td>
<td>5</td>
</tr>
<tr>
<td>Infectious causes</td>
<td>MCF</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>5 (9.1%)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Degenerative myopathy</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1 (1.8%)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Bronchopneumonia; bronchitis; pneumonia; Chronic glomerulonephritis; chronic nephritis/cystitis; acute renal necrosis; Hepatitis; hepatic lipodiasis; Enteritis; parasitic abomasitis; Abscesses; granulomas</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>6 (10.9%)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3 (5.5%)</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>9</td>
<td>24</td>
<td>22</td>
<td>55</td>
<td>14</td>
</tr>
</tbody>
</table>

\(^a\) PM — proportional mortality calculated as the number of deaths by specific cause divided by all deaths, expressed as a percentage.

\(^b\) Copper deficiency was also found as a side note in bison with other conditions, but was only classed as cause of death if indicated on the post-mortem file as the key final diagnosis. In total, 30/61 bison deaths with complete mineral panels had deficient or marginal copper levels.

![Figure 1](image-url) Success in determining etiology for all deaths submitted for necropsy by month (N = 76).
Association between distance from sheep and identified cases of MCF
All MCF deaths in the study period occurred in 2 of the 6 high-exposure herds (distance of < 1.0 km from sheep). These 2 MCF-positive herds reported distances of 0.4 and 0.8 km from the nearest sheep operation boundary. As none of the low and negligible exposure herds experienced MCF deaths, they were combined into a single reference category for statistical analysis. The primary relationship between MCF herd status (dichotomous outcome; positive and negative) and distance to sheep (< 1.0 km compared to ≥ 1.0 km) produced an odds ratio, unbiased median estimate (OR-MUE) of 9.4 (P = 0.05). Average bison herd size was a perfect predictor for MCF herd status as both herds with MCF deaths were large herds (> 500 bison). As such, average herd size was condensed for analysis to large/medium herds (> 150 bison) compared to small herds (≤ 150 bison). When accounting for average herd size, the OR-MUE for MCF herd status and sheep distance dropped to 6.9 (P = 0.08).

For herds with greater proximity to sheep operations, the resulting predicted probability of a herd being MCF-positive was higher, but not significantly so (Figure 4). These predictions accounted for the slightly higher baseline risk of a MCF-positive diagnosis for large or medium bison herds than for smaller herds (Figure 4).

The association between the number of MCF deaths per herd and distance to sheep operation boundaries was assessed with Poisson regression where the average number of bison per herd was used as the offset. The resulting risk ratio median unbiased estimate (RR-MUE) suggested the risk of MCF death was 10.8 (P = 0.005) times higher in herds within 1 km of a sheep operation than in herds that were farther away. The overall incidence risk for bison in the high-exposure group was 0.002 (95% CI; 0.0005, 0.003), while the incidence risk for the low-/negligible-exposure group was 0.000 (95% CI; 0.000, 0.001).

Discussion
The primary objective of this study was to describe the risk of mortality from MCF in herds at varying distances from sheep operation boundaries. This is the first cohort study assessing risk of MCF in bison herds in proximity to commercial sheep operations. Of the 26 herds in the study, only 2 herds experienced any MCF deaths over the 18-month study time. Despite the low overall risk of MCF occurrence, bison in herds less than 1.0 km away from sheep operation boundaries were found to be at a higher risk of mortality from MCF than those at greater distances from sheep operation boundaries. When accounting for herd size, the increased risk of having at least 1 death was not statistically significant, although the lack of significant association was most likely due to limited power. When the number of deaths due to MCF was considered, the increased risk associated with proximity to sheep operations was statistically significant.

Ascribing distance to sheep operations in this study proved difficult as there was no way to ascertain the exact date of exposure for individual bison to a disease with an incubation period ranging from 1 mo to more than 200 d (5). There was also no way to assess the effects of wind speed or direction or the corresponding extent or timing of shedding of the virus in nearby
sheep. While the minimum distance between boundary fences was deemed the most reliable way to assess distance, at least 1 MCF bison death could have occurred a maximum distance of 2.5 km away from the sheep operation within the possible incubation period.

While this study suggests caution for bison farms within 1.0 km of sheep operation boundaries, there were no deaths in 4 of the 6 herds within the high-exposure group due to MCF during the 18-month study period. When the pre-study survey information was considered, 3 of these 6 herds had not identified a single case of MCF in more than 2.5 y. One of these producers had been co-habitating sheep and bison in close proximity for almost 15 y without any incidence of MCF.

At least 2 factors could influence the expression of clinical disease due to MCF in these herds: how much exposure is actually occurring in the bison on these farms and the role of stress in precipitating clinical symptoms that resulted in death in exposed bison. Exposure to MCF is often measured using serological evidence. Blood samples were not collected in the present study as study proponents did not want participants to have to physically handle their bison for this purpose. As a result, seroprevalence could not be used to estimate exposure risk.

A previous study of bison reported that the estimated seroprevalence for MCF for farmed adult bison within western Canada (cow-calf herds) was approximately 23% (19.3% to 26.3%) (14). In that study, seroprevalence varied between herds with or without evidence of MCF deaths in the previous 6 mo and differing exposures to sheep, with herd-specific estimates ranging from 20% to 31%. In northern Canada, free-ranging herds with little to no known exposure to sheep also had very low seroprevalence for exposure (< 6.5%) compared to the 1 northern commercial farmed herd with 39% seroprevalence (12). Some herds with high seroprevalence in that study did not have clinical cases and deaths due to MCF. The high seroprevalence in some herds was thought to be associated with subclinical MCF virus transmission between bison within herds (14). Transmission of MCF viruses among bison in the absence of sheep was also reported in another study, but this form of transmission was not associated with clinical disease either (6). High seroprevalence might not itself suggest increased risk of disease associated with exposure to sheep.

Differences in stressors across herds must also be considered. Clinical cases of MCF are often reported in winter or under stressful intensive management conditions or mixing of animals (1,2,4–7). All but 2 of the MCF deaths in this study occurred in the winter months. It is possible that stress plays a role in the progression of MCF clinical disease and subsequent death in bison. In the largest recorded outbreak of MCF in the province of Saskatchewan, it was highly likely that bison were exposed to OVH-2 at the sale barn and not on the originating or destination farms (5). The host mechanisms that determine why most clinical MCF bison cases occurred within 60 to 70 d of the sale, while at least 1 bison developed clinical disease over 200 d after the sale, are unresolved. Similar time delays were reported in other outbreaks (4,7). No study to date has clearly articulated the cofactors required for clinical disease expression at varied times after possible exposure. The authors of 1 study did note, however, that MCF losses coincided with handling of
bison for a variety of reasons, including vaccination or the taking of blood (6). In 2007, Traul et al (15) provided the first evidence of a genetic predisposition for MCF resistance or susceptibility based on major histocompatibility complexes.

The commonly reported distance of 5 km separation between bison and sheep operations originates from the outbreak of MCF in a bison herd that was at varying distances from a 60,000 head sheep feedlot, which was occupied by 20,000 newly introduced lambs (4). All other outbreaks reported in the literature involved 1 or more of the following: bison within a feedlot or sale barn setting, large sheep operations or feedlots, and extremely close proximity to sheep (2, 4–7). In this study, there was no occurrence of MCF in herds with sheep operations further than 1 km away, which suggests that a 5-km separation distance is not required to decrease the risk of MCF in typical commercial bison herds in close proximity to commercial sheep operations. Given that most herds in the high-exposure group, including the herd in which sheep and bison cominglyed, did not have any mortality due to MCF, this study further suggests that other, unmeasured factors could influence the development of MCF in bison and cautions against relying solely on separation distances for preventing MCF. Bison producers should work closely with the neighboring sheep operation to minimize the potential risks associated with the transmission of MCF.

This is the first cohort study reported in the literature that followed commercial bison herds for an 18-month period to assess causes of deaths. Compared to retrospective analysis of laboratory databases, this study included a consistent necropsy protocol and laboratory work-up. A similar study has been done in beef cattle (16). The mortality (2013 to 2014) was similar among herds at various distances from sheep operations, although MCF-specific deaths were only present in the high-exposure herd group. The 3 most commonly reported causes of death for both calves and adults in this study were non-infectious risks related to calving, nutrition, and trauma, followed by no diagnosis possible and copper deficiency. In comparison, a 1999 to 2000 survey of 188 adult bison submissions to selected pathology laboratories in Canada and northwestern United States reported no diagnosis possible, MCF, and pneumonia as the top 3 causes of death (17). The proportion of all deaths attributed to MCF in these 2 studies was similar; 9.2% overall in this study compared to 11.7% in the 1999 to 2000 study. The 1999 to 2000 survey also gathered information on diseases reported by producers; in this survey, only 8 of 477 (1.6%) respondents reported MCF occurrence (17).

Copper deficiency in beef cows is an important cause of economic loss and is frequently diagnosed in western Canada (18). A recent cow-calf study in Saskatchewan reported that measured...
blood copper levels varied based on location and time of year with 74% of cows being less than adequate (< 0.60 ppm) in the spring to 66% in the fall (19). Bison are susceptible to both primary and secondary copper deficiencies (20). Primary copper deficiencies have been reported to occur in varying soil types within Saskatchewan, which results in a diet low in copper (19,21). During this study period, copper deficiency was identified as a primary cause of death in bison. Even if it was not the main cause of death, however, it may have contributed to other causes of death in some cases. In addition, secondary copper deficiency can result from water high in sulfates. Only 25% of the herds with marginal or deficient levels of copper found on necropsy of animals had tested their water in the last 5 y. Information on water sulfate was not available for study herds. In this study, based on necropsy reports and not on forage testing, several producers did make changes to their individual mineral supplementation programs.

Herd owners listed causes of deaths of bison that were not submitted for necropsy as primarily non-infectious, such as calving, trauma, or nutrition. While it is possible that some of the owner-reported deaths could be due to MCF; the number of reported but non-necropsied deaths due to unexplainable causes was low. In addition, all undetermined deaths of animals that were not necropsied were in herds greater than 1.0 km from a sheep operation boundary. There were only 4 necropsied animals for which an MCF test was not completed; only 1 within the negligible exposure group had no cause of death. Since the number of undetermined deaths within high- or low-exposure herds was small, it is unlikely that misclassification bias resulted in an underestimate of the potential relationship between MCF and distance from sheep operations. This point is further emphasized by the high sensitivity and specificity reported for the real-time PCR.

Conditions from which bison died are likely to change on a year-to-year basis, particularly for environmentally related diseases. For example, if this study had been completed in 2006, anthrax would most likely have been a key disease, while copper deficiency was a concern during the present study period. With the exception of MCF, most of the diseases or causes of death identified did not cluster within herds.

In the end, the results of this study suggest that, while MCF can be a devastating disease for individual bison producers, the overall incidence within commercial settings is very low. It also supports using caution against proposing buffer zones based solely on the criteria of distance to sheep. The bison industry is already working with the sheep industry to educate both bison and sheep producers about the risks of MCF. It is hoped that the information from this study will provide perspective and be used as a starting point for further discussion and collaboration between the industries.

Acknowledgments
The authors thank Chris Wojnarowicz, pathologist at Prairie Diagnostic Services (PDS) who took over supervising the pathology protocol midway through the project. Thanks also to all the pathologists at PDS. Funding for this project was provided by the Saskatchewan Ministry of Agriculture — Agriculture Development Fund and the Canada-Saskatchewan Growing Forward bi-lateral agreement.

References
Factors associated with development of Canine Infectious Respiratory Disease Complex (CIRDC) in dogs in 5 Canadian small animal clinics

Daniel J. Joffe, Roxana Lelewski, J. Scott Weese, Jamie Mcgill-Worsley, Catharine Shankel, Sonia Mendonca, Tara Sager, Michael Smith, Zvonimir Poljak

Abstract — This study investigated the association between presence of respiratory pathogens and development of Canine Infectious Respiratory Disease Complex (CIRDC) in dogs in 5 Canadian small animal clinics. In total, 86 dogs were tested using a commercial PCR respiratory panel; 64 dogs were considered as cases and 22 were control dogs matched by veterinary clinic. No control animals (0/22) were positive for canine parainfluenza virus (CPIV), whereas 27/64 (42%) CIRDC cases were positive. Furthermore, 81% of case dogs tested positive for Mycoplasma cynos, compared with 73% of control dogs. Canine respiratory corona virus (CRCoV) was detected in no control dogs compared with 9.4% of clinical dogs. No animals were positive for any influenza virus type A present in the diagnostic panel. Presence of CPIV was associated \((P < 0.01)\) with the occurrence of CIRDC after adjustment for demographic factors and presence of CRCoV \((P = 0.09)\).

Résumé — Facteurs associés au développement de l’ensemble des maladies respiratoires infectieuses canines (MRIC) chez les chiens dans 5 cliniques pour petits animaux au Canada. Cette étude a étudié l’association entre la présence d’agents pathogènes et le développement de l’ensemble des maladies respiratoires infectieuses canines (MRIC) chez les chiens dans cinq cliniques pour petits animaux au Canada. Au total, 86 chiens ont été testés à l’aide d’un panel respiratoire commercial d’ACP; 64 chiens ont été considérés comme des cas et 22 étaient des chiens témoins jumelés par la clinique vétérinaire. Aucun animal témoins \((0/22)\) n’était positif pour le virus parainfluenza canin (VPIC), tandis que 27/64 (42 \%) des cas de MRIC étaient positifs. De plus, 81 \% des chiens des cas ont eu un résultat positif pour Mycoplasma cynos, comparativement à 73 \% des chiens témoins. Le coronavirus respiratoire canin (COVRC) n’a pas été détecté chez aucun chien, comparativement à 9,4 \% des chiens cliniques. Aucun animal n’a eu un résultat positif pour tous les types du virus de l’influenza de type A dans le groupe de diagnostic. La présence du VPIC était associée \((P < 0.01)\) à l’occurrence d’une MRIC après l’ajustement des facteurs démographiques et de la présence du COVRC \((P = 0.09)\).

Introduction

Canine infectious respiratory disease complex (CIRDC), commonly known as “kennel cough,” is an endemic respiratory syndrome that causes both sporadic disease and outbreaks (1,2). The disease is of particular concern in crowded populations and where there is extensive dog-to-dog contact, particularly in re-homing kennels (2). Sporadic and epidemic disease also occurs in dogs in the general population, and clusters of infection can occur in veterinary hospitals (3). Canine infectious respiratory disease is a complex, multifactorial disease, with similar clinical signs caused by a wide range of pathogens acting individually or as co-infections (1). Common clinical signs associated with many of these causative agents include nasal discharge, coughing, respiratory distress, and lethargy (3). Traditionally, canine parainfluenza virus (CPIV), canine adenovirus type-2 (CAV-2), and canine herpesvirus 1 (CHV-1) have been considered the main viral agents of CIRDC, with recent emergence of canine influenza...
virus (CIV) in some regions (1,2,4–6). Bordetella bronchiseptica is the most commonly identified bacterial pathogen, with Streptococcus zooepidemicus causing occasional (but often severe) disease (7). The role of Mycoplasma has been unclear, since potentially pathogenic Mycoplasma can also be found in many healthy dogs (2,8,9).

In recent years, the role of novel pathogens in the development of CIRDC has been questioned and researched (1,2). There is some debate as to whether apparently emerging pathogens such as canine respiratory coronavirus (CRCoV) (2,8,9) are truly new emerging pathogens or pre-existing pathogens that are now detectable using improved molecular diagnostic tools. Likely both situations apply, but data pertaining to CIRDC pathogens are often limited because of the failure to perform diagnostic testing in cases of sporadic disease. Hence, many questions remain about established pathogens, new pathogens, and the role of co-infection in the pathophysiology of disease. A better understanding of CIRDC is important for prevention and management of disease, including decision-making for vaccination (1–3,7,9). Thus, the objective of this study was to determine the association between CIRDC and the presence of potential pathogens in deep pharyngeal swabs in dogs.

Materials and methods
This was a case-control study with control dogs matched by the veterinary clinic for convenience. The source population consisted of dogs serviced by 5 small animal clinics from 3 Canadian provinces: Alberta (n = 1), British Columbia (n = 1), and Ontario (n = 3). One of the clinics was a full-time emergency clinic, 2 clinics were general practice and emergency clinics, and 2 clinics were general practices. For each veterinary clinic, the number of cases ranged between 3 and 20, and the number of control dogs ranged between 2 and 5. In total, 64 case dogs and 22 control dogs were included in the study. The study period was between June 2013 and February 2014.

Case definition and inclusion criteria
All canine patients of any age with an acute cough and other signs typical of CIRDC (nasal or ocular discharge, respiratory distress, or lethargy) were considered for inclusion in the study. Patients were excluded if they had a chronic cough, had been treated with antimicrobials in the last 2 mo, had co-morbidities (e.g., congestive heart failure, pneumonia) that could lead to coughing, or had received an intranasal or oral vaccine against B. bronchiseptica, CPIV, or CAV-2 in the last month. Clinical signs of CIRDC in patients were assessed by veterinarians upon presentation at each of the participating clinics. Cases were assessed based on history, physical examination, and thoracic radiographs when considered necessary according to the veterinarian’s opinion. Each client had to sign a consent form to allow their pet to be included in the study.

The following protocol was applied to case patients included in the study. Up to 3 swabs were collected from the areas of most predominant clinical signs (pharyngeal region, nasal discharge, ocular discharge), including 1 culture swab (Copan Diagnostics, Murrieta, California, USA). One to two dry sterile cotton-tipped wooden swabs were first used; swabs were broken off and submitted in a sterile “red top tube” with no medium. In addition, samples for bacteriological culture were collected with a sterile swab that was then placed into a sterile tube containing Amies transport medium (Becton Dickinson, Mississauga, Ontario). The most clinically relevant regions were cultured: nasal discharge, conjunctiva, or deep pharyngeal region. The majority of the samples were from the pharynx. Most case patients were presented in the first week of their illness. Samples were submitted to the Antech Laboratory (Antech Diagnostics Canada, Mississauga, Canada) for testing, which was conducted using CT995 — Fast Panel PCR Canine Respiratory Disease Profile. A predetermined total of 20 patients were selected from each of the 5 project sites. Each participating clinic was to enroll the first 20 eligible clinical cases over the study period. Demographic and vaccination data, where available, were then collected from the medical records for use in statistical analysis.

Control definition and inclusion criteria
To select controls, any patient which was presented at 1 of the 5 participating clinics for a regular health examination and was confirmed not to have CIRDC by regular physical examination by a veterinarian could be included in the study. For each clinic, 5 controls were to be enrolled starting September 2013. A total of 22 controls were recruited.

Diagnostic testing
Samples were submitted to the Antech Laboratory for test CT995 — Fast Panel PCR Canine Respiratory Disease Profile for the detection of B. bronchiseptica, CAV-2, canine distemper virus (CDV), CHV-1, canine influenza virus H3N8, influenza H1N1 virus, influenza H5N1 virus, CPIV, CRCoV, Mycoplasma cynos, and Streptococcus equi spp. zooepidemicus. Bacteriological swab samples were plated on Tryptic Soy agar and MacConkey agar for growth of B. bronchiseptica, and on CNA agar for growth of Streptococcus zooepidemicus.

Statistical analysis
Data for case and control dogs were described using frequencies and proportions. Simultaneous detection of multiple respiratory pathogens was tabulated using frequency tables. For the purposes of inferential statistical analysis, demographic data such as age, dog breed, and time since last vaccination were aggregated into binary variables on the basis of biologically plausible cut-off points. Exact logistic regression was used to evaluate associations between the CIRDC status and putative risk factors. This was done in 2 steps. In the first step, association between CIRDC and all diagnostic, management, and demographic variables was screened using univariable regression models. In the second step, manual forward building procedure was implemented to build the final multivariable regression model. For this purpose, only the variables that were univariably associated with CIRDC at P < 0.20 were considered in the model-building. Presence of pathogens was considered as the primary set of exposures, whereas demographic variables were considered as confounders and were a-priori determined to be forced into the model regardless of statistical significance. Management factors such as different sets of vaccination were not considered for the multivariable
model building for 3 reasons. First, vaccination status of some dogs could not be accurately assessed. Second, specific vaccinations could be applied to high-risk dogs and could give biased estimates. Third, due to small numbers of study animals and variety of vaccination practices, time since vaccination could not be defined with required accuracy and evaluated.

Two types of final multivariable models were presented. The first model contained only variables in which estimates for each covariate could be produced. The second model was adjusted for additional demographic variables that could not be used as covariates in the final model because of computational requirements. Biologically plausible interactions were evaluated for statistical significance.

### Results

Several respiratory pathogens were detected in both CIRDC case and control dogs, including *M. cynos*, CPIV, *B. bronchiseptica*, CRCoV, CHV-1, and CDV (Table 1). Complete results based on detection of individual pathogens, as well as unique combinations of pathogens further stratified by the CIRDC status are presented in Table 1. Interestingly, no study dogs tested positive for CAV-2, any influenza A virus (IAV) present in the diagnostic panel (including the CIV H3N8) or *S. zooepidemicus*.

Eighty-one percent of case dogs and 73% of control dogs tested positive for *M. cynos*. No control dogs had CPIV, while 27/64 (42%) case dogs had the virus. No control animals had CRCoV detected compared with 6/64 (9.4%) case dogs. Little difference was found between the presence of *B. bronchiseptica*, CHV-1 and CDV among healthy and clinical animals (Table 1). In dogs with CIRDC, 32/64 (50.0%) had 2 or more pathogens present, while in dogs without CIRDC, only 3/22 (13.6%) had 2 or more pathogens (Table 1).

**Table 1.** Occurrence of respiratory pathogens in CIRDC case dogs (Clinical = 1) versus control dogs (Clinical = 0) in a case-control study of 88 dogs in 5 Canadian veterinary clinics

<table>
<thead>
<tr>
<th>Status</th>
<th>Mycoplasma cynos</th>
<th>CPIV</th>
<th>Bordetella bronchiseptica</th>
<th>CRCoV</th>
<th>CHV</th>
<th>CDV</th>
<th>N pathogens</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Control</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>≥ 2</td>
<td>13</td>
</tr>
<tr>
<td>Control</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>≥ 2</td>
<td>2</td>
</tr>
<tr>
<td>Control</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>≥ 2</td>
<td>2</td>
</tr>
<tr>
<td>N + ve</td>
<td>16</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
<td>22</td>
</tr>
<tr>
<td>Mean</td>
<td>72.7%</td>
<td>0%</td>
<td>9.1%</td>
<td>0%</td>
<td>4.5%</td>
<td>0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Case</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Case</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Case</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Case</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>≥ 2</td>
<td>1</td>
</tr>
<tr>
<td>Case</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>≥ 2</td>
<td>1</td>
</tr>
<tr>
<td>Case</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>≥ 2</td>
<td>4</td>
</tr>
<tr>
<td>Case</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>≥ 2</td>
<td>20</td>
</tr>
<tr>
<td>Case</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>≥ 2</td>
<td>3</td>
</tr>
<tr>
<td>N + ve</td>
<td>52</td>
<td>27</td>
<td>7</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td></td>
<td>64</td>
</tr>
<tr>
<td>Mean</td>
<td>81.2%</td>
<td>42.2%</td>
<td>10.9%</td>
<td>9.4%</td>
<td>1.6%</td>
<td>1.6%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CPIV — Canine parainfluenza virus; CRCoV — Canine respiratory coronavirus; CHV — Canine herpes virus; CDV — Canine distemper virus.

**Table 2.** Demographics of study dogs with CIRDC from 5 Canadian veterinary clinics

<table>
<thead>
<tr>
<th></th>
<th>Case</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age of dog</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 to 6 mo</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>&gt; 6 mo to 1 year</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>&gt; 1 y to 5 y</td>
<td>39</td>
<td>14</td>
</tr>
<tr>
<td>≥ 5 y</td>
<td>27</td>
<td>77</td>
</tr>
<tr>
<td><strong>Breed (by size)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Mixed</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>Toy</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Small</td>
<td>30</td>
<td>18</td>
</tr>
<tr>
<td>Medium</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Large</td>
<td>28</td>
<td>50</td>
</tr>
<tr>
<td>Giant</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Male</td>
<td>69</td>
<td>59</td>
</tr>
<tr>
<td>Female</td>
<td>31</td>
<td>36</td>
</tr>
<tr>
<td><strong>Fertility status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Infertile</td>
<td>73</td>
<td>86</td>
</tr>
<tr>
<td>Fertile</td>
<td>27</td>
<td>9</td>
</tr>
<tr>
<td><strong>Core vaccination</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>Unknown</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>Vaccinated</td>
<td>66</td>
<td>86</td>
</tr>
<tr>
<td>Total N animals</td>
<td>64</td>
<td>22</td>
</tr>
<tr>
<td><strong>CIRDC vaccination</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>Unknown</td>
<td>19</td>
<td>5</td>
</tr>
<tr>
<td>Vaccinated</td>
<td>56</td>
<td>45</td>
</tr>
<tr>
<td>Total N animals</td>
<td>64</td>
<td>22</td>
</tr>
</tbody>
</table>

* CIRDC vaccination defined as application of any vaccine for *B. bronchiseptica* through any route, with or without CPIV and CAV-2 component.
Table 3. Univariable associations between CIRD and diagnostic and demographic variables in the case-control study conducted in 5 Canadian small animal clinics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds ratio</th>
<th>95% CI</th>
<th>P-value(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPIV (Canine parainfluenza virus)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>Baseline</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Positive</td>
<td>21.76(^b)</td>
<td>3.53</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>CRCoV (Canine respiratory corona virus)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>Baseline</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Positive</td>
<td>2.99(^b)</td>
<td>0.41</td>
<td>0.32</td>
</tr>
<tr>
<td>CDV (Canine distemper virus)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>Baseline</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Positive</td>
<td>0.34(^b)</td>
<td>&lt; 0.01</td>
<td>0.90</td>
</tr>
<tr>
<td>CHV (Canine herpes virus)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>Baseline</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Positive</td>
<td>1.23</td>
<td>0.21</td>
<td>1.00</td>
</tr>
<tr>
<td><em>M. cynos</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>Baseline</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Positive</td>
<td>1.62</td>
<td>0.43</td>
<td>0.57</td>
</tr>
<tr>
<td>Demographic variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 12 mo</td>
<td>Baseline</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>0 to 12 mo</td>
<td>5.26</td>
<td>1.08</td>
<td>0.036</td>
</tr>
<tr>
<td>Fertility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Baseline</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Fertile</td>
<td>3.57</td>
<td>0.73</td>
<td>0.15</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Baseline</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Female</td>
<td>0.80</td>
<td>0.26</td>
<td>0.85</td>
</tr>
</tbody>
</table>

\(^a\) P-values estimated using exact logistic regression.
\(^b\) Estimates represent “median unbiased regression estimates”.
95% CI — 95% confidence interval.

Table 2 contains basic demographic information on case and control dogs. Descriptively, a higher proportion of control dogs were large breed dogs, and > 5 y of age (Table 2). A lower proportion of control dogs were fertile (Table 2).

Table 3 contains variables that were univariably associated with the CIRD status of dogs. All exposure variables (i.e., pathogens) regardless of statistical significance and demographic and management variables associated at the P < 0.20 level are shown. Vaccination status was not reported here.

Results of the final multivariable regression models are reported in Table 4. Once adjusted for the effect of age and other demographic factors, dogs with CIRD had higher odds of infection with CPIV (Table 4; OR = 20.07, 95% CI: 3.17, ∞, P < 0.001). Once adjusted for the effect of age, fertility status, and breed category, dogs with CIRD had higher odds of infection with CRCoV (Table 4; OR = 6.11), although this association was not statistically significant at P < 0.05 level (Table 4, P = 0.087, 95% CI: 0.79, ∞). This association was based on a small number of dogs (Table 1) and requires care in interpretation. The variable representing age of dogs was forced into the model. In the model that was not adjusted for the effect of fertility and the breed category, the age of < 12 mo was a risk factor for development of CIRD (OR = 4.54, P = 0.092, 95% CI: 0.83, 50). Once further adjusted for the fertility status and the breed category, the age of > 12 mo was not statistically significant (Table 4), but it was forced in the model as an important confounder. Spearman correlation coefficient indicated negative correlation between presence of CPIV and CRCoV when considering all data, but this was not statistically significant (r = −0.18, P = 0.088). When considering cases alone, the Spearman correlation coefficient indicated a negative correlation between the presence of CPIV and CRCoV at a level that was significant (r = −0.27, P = 0.028). No CIRD-case dog had simultaneous detection of CPIV and CRCoV (Table 1).

**Discussion**

The results of this study suggest that CPIV was associated with presence of CIRD in this population of dogs, after adjustment for the effect of age, fertility, and dog size. Canine parainfluenza virus is a well-known canine respiratory pathogen that belongs to the *Paramyxoviridae* family of RNA viruses (3). The incubation period varies between 2 to 9 d (10,11) and clinical signs are typically present for 3 to 5 d (11). Usually, the animal is infectious between 2 and 10 d post infection (11) and viral shedding often precedes clinical signs (3). Clinical signs include a dry hacking cough, along with nasal discharge, pharyngitis, and tonsillitis. This virus is spread mainly through direct contact and infectious aerosols, and transmissibility and attack rates within susceptible populations are high. Our data, along with a recent outbreak case report (3), suggest that CPIV is an important contributor to CIRD in the general dog population.
Data regarding the influence of CRCoV on CIRDC are less conclusive. The pathogen was first isolated from dogs with CIRDC in 2003 (2,12) and characterized as having importance in the development of CIRDC, especially in dogs entering kennels (1). CRCoV belongs to the Betacoronavirus genus of the Coronaviridae family and is distinct from the enteric canine coronavirus (CCoV), both genetically and serologically (2). It is not clear whether CRCoV alone can lead to clinical signs of CIRDC, or whether it plays a secondary role in disease and predisposes animals to become susceptible to infection by other respiratory pathogens (13). It has been shown recently that CRCoV likely plays a role in the early stages of CIRDC and, in combination with other pathogens, can lead to clinical signs like dry cough and nasal discharge (2). In the current study, infection with CRCoV approached significance in terms of association with the presence of CIRDC. As a pathogen that was only recently identified and for which testing is often limited, the role of CRCoV in CIRDC deserves further study (1,9).

The role of Mycoplasma in CIRDC has been difficult to discern, and data from this study provide no clarity. Mycoplasma cynos was found in 81% of affected dogs, but was also found in 73% of controls. There was no association between its presence and CIRDC, although previous work suggested that M. cynos could play a role in the development of the CIRDC (14–16). It is possible that diagnostic results based on pharyngeal swabs were not suitable for evaluating the role of M. cynos in CIRDC.

In fact, Chalker et al (17) reported that M. cynos was the only canine Mycoplasma that showed significantly higher presence in CIRDC cases than controls, but only for samples taken from the lower respiratory tract by tracheal and bronchial lavage (BAL). Tracheal swabs and BAL were attempted for M. cynos detection in another study (14), but such sampling was beyond the scope of the current study.

The detection rate of B. bronchiseptica in this study was similar in CIRDC positive and negative dogs, despite a well-established role that this pathogen plays in the development of CIRDC (13). This finding is not surprising because B. bronchiseptica can be present in healthy dogs and in dogs affected by CIRDC, because of its ability to self-regulate its virulence (13). Overall, with the exception of B. bronchiseptica, the results of this study are in agreement with a study recently conducted in Germany (18).

The CIV was not detected in case or control animals, which is consistent with one Ontario surveillance study (19) and clinical observation that CIV is very rare to non-existent in the Canadian dog population. This contrasts with reports from parts of the US (20); however, it appears that CIV has a rather patchy distribution and is uncommonly implicated in endemic disease.

Co-infections in this study were common, largely because of the high prevalence of Mycoplasma. We did not identify statistically significant interactions among pathogens in this study. Overall, the role of co-infections in CIRDC is poorly understood (1,3,15) and is another area worth investigating.

Demographic variables were considered primarily as confounders. Nonetheless, when considered in isolation, an age of > 12 mo was protective and reproductive status was a risk factor. The protective effect of older age is likely a result of immunity against one or more pathogens through previous exposure or vaccination, and potentially a lower incidence of exposure to high risk situations (e.g., puppy classes).

This study has several limitations. Most importantly, selection of controls was based on convenience sampling and could lead to selection bias. Ideally, the control group should represent the source population from which the cases were recruited. Several dogs owned by veterinary staff at the clinics were sampled as a part of this group. If bias occurred because of that, we would argue that it could lead to an overestimate of associations due to viral pathogens, and underestimate of associations with bacterial pathogens. In future studies of this nature, more strict definition of the source population would help study validity. Recording of the response rate and comparison of demographics with the source population would also be of benefit. Misclassification bias could have occurred due to the nature of some measurements, including pharyngeal swabs. It is possible that with such measurement the true role of pathogens such as B. bronchiseptica and M. cynos could not be fully evaluated since both pathogens could be present in healthy animals (13,17). We were also not aware of diagnostic sensitivity and specificity of assays for pathogens used in the panel. Use of cotton-tipped wooden swabs could also affect diagnostic sensitivity of assays used in the study. The sample size calculation was not done before the study commenced and it is likely that the number of animals used in the study was sufficient to detect only strong
associations. Vaccination against various respiratory pathogens could have affected the presence of pathogens. Vaccine type and vaccination protocols, time since their application, rationales for applying them, and a considerable amount of missing data made this task difficult. For future studies, we recommend that the effect of specific vaccines be investigated as the primary research question and that possible case control study be designed and conducted around this primary question.

In conclusion, we demonstrated that CPIV plays an important role in the development of CIRDC in dogs admitted to veterinary clinics, and under conditions of this study. The CRCoV was detected in cases only, but difference in the presence of this pathogen between cases and controls was not significant at $P < 0.05$. The frequency of M. cynos was similar in affected and control patients, so the significance of finding this organism in a pharyngeal swab is questionable. Sampling from the lower respiratory tract is likely necessary to confirm that M. cynos is associated with clinical respiratory disease. Practitioners should consider such possibility when interpreting diagnostic results obtained from predominantly pharyngeal swabs. No dogs with influenza virus were detected, which adds further support that influenza A virus has not been circulating in the Canadian dog population.

Acknowledgments
The authors thank the clinicians and staff at Blue Cross Animal Hospital in Sarnia, Calgary North Veterinary Hospital, Ottawa Veterinary Hospital, Vancouver Animal Emergency Clinic, and Westside Animal Hospital in Toronto, for their help with this study. Laboratory testing was funded by Merck Animal Health.

References
Dr. Ed Pajor named as the 2015 Metacam® 20® Bovine Welfare Award

“It is our distinct pleasure to announce Dr. Ed Pajor as the recipient of the 2015 Metacam® 20 Bovine Welfare Award”, says Dr. John Campbell, Secretary-Treasurer of the Canadian Association of Bovine Veterinarians (CABV)/Association Canadienne des Vétérinaires Bovins (ACVB).

Dr. Pajor is the Anderson Chisholm Chair in Animal Care and Welfare, and Professor of Animal Welfare at the University of Calgary, Faculty of Veterinary Medicine, Department of Production Animal Health. He is recognized internationally for his research in the areas of bovine and swine behaviour and welfare as well as his expertise in animal welfare standards and legislation.

“I am truly honoured and humbled to receive this prestigious award,” said Dr. Pajor. “The opportunity to work with different industries to improve animal welfare is very rewarding in itself, and to be recognized in this manner is more than I could have imagined. I want to sincerely thank the CABV and Boehringer Ingelheim for this individual award but more importantly for their recognition of efforts in animal welfare science.”

Dr. Pajor was presented with the 2015 Metacam® 20 Bovine Welfare Award at the 48th Annual Conference of the American Association of Bovine Practitioners on September 17, 2015 in New Orleans, Louisiana. The Metacam® 20 Bovine Welfare Award is given annually to a DVM or animal scientist working in Canada, a faculty member or a graduate student of a Canadian university to recognize his/her achievements in advancing the welfare of animals via leadership, public service, education, research/product development, and/or advocacy.

“We are very pleased to be able to continue helping recognize those who have made outstanding contributions to a better understanding of livestock behaviour, animal welfare and animal well-being,” said Dr. Rob Tremblay, Bovine/Equine Specialist with Boehringer Ingelheim (Canada) Ltd. “Dr. Pajor’s enthusiasm for the well-being of all cattle, and in particular beef cattle, is an inspiration for the veterinary profession and beef industry.”

Contact: CABV/ACVB, 2nd Floor–226E Wheeler Street, Saskatoon, Saskatchewan S7P 0A9; phone: (306) 956-3543; e-mail: c...
Characterizing 1341 cases of veterinary toxicoses confirmed in western Canada: A 16-year retrospective study

Vanessa Cowan, Barry Blakley

Abstract — Veterinary toxicoses are frequently observed in western Canada. This study reports the frequency and characteristics of intoxications in animals reported between January 1, 1998 and December 31, 2013. Information was obtained from toxicological case records from the Prairie Diagnostic Services, Saskatoon, Saskatchewan. There were 1341 animal poisonings with 19 compounds over the investigational period. Lead poisoning was the most common toxicity (43.7%). Poisoning with acetylcholinesterase inhibitors and strychnine were also common events. Poisonings were most common in 2001, 2009, and 2012. Intoxications occurred most frequently during the months of May through July. Cattle were the most commonly poisoned species (n = 696), followed by dogs and eagles.


Can Vet J 2016;57:53–58

Introduction

Domestic and wildlife animal poisonings are common in western Canada (1). The vast array and availability of compounds used in industry and agriculture, feed nutrition and ration formulation, and environmental contamination all contribute to annual poisonings. In conjunction with veterinary medical intervention in the diagnosis of animal poisonings, diagnostic laboratories are often employed to perform analytical testing to determine a cause of sickness or death. The diagnostic case records from such laboratories have informed the medical community of the epidemiology of these poisonings.

Causative agents, annual frequency, temporal frequency, and species affected can all be determined using toxicological case record data. This information can be used to infer the use of a toxic agent (e.g., spraying of agricultural pesticides or use of essential mineral nutrients in feed), the misuse of a toxic agent (e.g., strychnine baiting for off-label use), and the presence of contamination in the immediate or greater environment of the animals (e.g., lead batteries on pasture grazed by cattle). Epidemiologic information acquired from these records may inform veterinarians, livestock producers, and farmers in animal management and husbandry, and government agencies involved in surveillance and regulation. The purpose of this study was to report the frequency and characteristics of veterinary intoxications in western Canada diagnosed by the Prairie Diagnostic Services diagnostic toxicological laboratory between January 1, 1998 and December 31, 2013.

Materials and methods

Poisoning events from case records received by Prairie Diagnostic Services (Western College of Veterinary Medicine, Saskatoon, Saskatchewan) between January 1, 1998 and December 31, 2013 were identified and compiled. Toxic agent, animal species affected, month of poisoning, and year of poisoning were
Table 1. Classes of compounds in veterinary toxicoses confirmed by Prairie Diagnostic Services in western Canada from 1998 to 2013

<table>
<thead>
<tr>
<th>Class of compound</th>
<th>Number of cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toxic metals</td>
<td>592</td>
<td>44.1</td>
</tr>
<tr>
<td>Pesticides</td>
<td>421</td>
<td>31.4</td>
</tr>
<tr>
<td>Essential metals</td>
<td>295</td>
<td>22.0</td>
</tr>
<tr>
<td>Hemoglobin oxidizing agents</td>
<td>14</td>
<td>1.0</td>
</tr>
<tr>
<td>Toxic plants</td>
<td>10</td>
<td>0.7</td>
</tr>
<tr>
<td>Vitamins (A, E)</td>
<td>9</td>
<td>0.7</td>
</tr>
<tr>
<td>Total</td>
<td>1341</td>
<td>100.0</td>
</tr>
</tbody>
</table>

a Pb, Cd, Hg, As.

b Insecticides (acetylcholinesterase inhibitor); rodenticides (strychnine); molluscicides (metaldehyde).

c Cu, Se, Fe, Mo, Mn, Mg, Zn, and Na.

d Sweet clover (dicoumarol) and plants containing cyanogenic glycosides.

Results

Toxicological case records identified 1341 poisoning events from 1998 to 2013. Nineteen agents in 6 major classifications of compounds were associated with the observed toxicoses (Table 1). Lead poisoning was the most common toxicity and comprised 43.6% of the total cases (Table 2). Acetylcholinesterase inhibitor pesticide and strychnine rodenticide cases were also common (20.8% and 10.5% of reported cases, respectively). Other toxic agents identified in the poisoning events were listed in Table 2 and categorized in Table 1. Toxic metal poisoning (Pb, Cd, Hg, As) accounted for most of the observed toxicities (44.1%) (Table 1). Pesticide poisonings (including insecticides, rodenticides, and molluscicides) were 31.4% of the total cases. Toxicity from trace minerals/essential metals (Cu, Se, Fe, Mo, Mn, Mg, Zn, and Na) occurred in 22% of the cases.

Poisoning events occurred annually (Table 3). The mean case frequency on an annual basis was 83. Frequency of poisonings was highest in the years 2009 (n = 143), 2001 (n = 126), and 2012 (n = 114). The Chi-square probability of no annual difference of poisoning with all agents was P < 0.0001. Incidence of lead poisoning was highest in 2009 (n = 84). Incidence of strychnine poisoning was highest in 2001 (n = 22). Incidence of poisoning with acetylcholinesterase inhibitors was highest in 2006 (n = 31). The individual Chi-square probabilities of no annual difference for lead, acetylcholinesterase inhibitors, and strychnine were all P < 0.0001.

Case submissions were most common in the months of May (n = 198), July (n = 196), and June (n = 175) (Table 4). The mean monthly poisoning occurrence was 111. The Chi-square probability of no month effect of poisoning with all agents was P < 0.0001. Lead poisoning occurred most frequently in July.
Eagles were the most commonly poisoned wildlife species (Table 8). The 117 poisonings occurred in the bald eagle (*Haliaeetus leucocephalus*) and the golden eagle (*Aquila chrysaetos*). Poisoning with acetylcholinesterase inhibitors was the most common toxicity in eagles (55.6% cases). Lead (42 cases), strychnine (9 cases), and mercury (1 case) were other causes of intoxication.

**Discussion**

Lead poisoning was the most common heavy metal toxicity and the most common toxicosis in cattle over the investigational period. These observations are widely accepted and are comparable to other Canadian retrospective studies (1,9). A 5-year retrospective study in Ontario, Canada, reported that approximately 45% of positive diagnoses of metal toxicities were associated with lead and cattle constituted 72.9% of animals poisoned with lead (9). These values are similar to those found in the present study. Lead poisoning in cattle appears to be more common in western Canada, likely due to the prevalence of livestock-based agriculture in western Canada. In the Ontario study, the authors reported that cattle were also found to be poisoned with copper, zinc, and iron (9). In the present study, selenium, copper, and molybdenum intoxications were also observed in cattle.

### Table 3. Annual occurrence of animal poisonings in western Canada confirmed by Prairie Diagnostic Services from 1998 through 2013*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead*</td>
<td>39</td>
<td>33</td>
<td>29</td>
<td>66</td>
<td>27</td>
<td>35</td>
<td>19</td>
<td>20</td>
<td>54</td>
<td>31</td>
<td>24</td>
<td>84</td>
<td>41</td>
<td>27</td>
<td>31</td>
<td>25</td>
</tr>
<tr>
<td>Acetylcholinesterase inhibitors*</td>
<td>9</td>
<td>14</td>
<td>26</td>
<td>25</td>
<td>23</td>
<td>16</td>
<td>24</td>
<td>18</td>
<td>31</td>
<td>26</td>
<td>1</td>
<td>11</td>
<td>11</td>
<td>18</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td>Strychnine*</td>
<td>10</td>
<td>7</td>
<td>17</td>
<td>22</td>
<td>9</td>
<td>5</td>
<td>12</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>7</td>
<td>15</td>
<td>8</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>Copper</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>7</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>15</td>
<td>9</td>
<td>11</td>
<td>31</td>
<td>16</td>
</tr>
<tr>
<td>Selenium</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>15</td>
<td>10</td>
<td>5</td>
<td>18</td>
<td>5</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>17</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Iron</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sodium</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Other*</td>
<td>6</td>
<td>6</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>62</td>
<td>83</td>
<td>126</td>
<td>91</td>
<td>68</td>
<td>65</td>
<td>58</td>
<td>99</td>
<td>71</td>
<td>46</td>
<td>143</td>
<td>91</td>
<td>77</td>
<td>114</td>
<td>77</td>
</tr>
</tbody>
</table>

*The probability of no month effect for all toxic agents was P < 0.0001.

### Table 4. Monthly occurrence of animal poisonings confirmed by Prairie Diagnostic Services from 1998 through 2013*

<table>
<thead>
<tr>
<th>Toxic agent</th>
<th>Jan</th>
<th>Feb</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead*</td>
<td>43</td>
<td>9</td>
<td>25</td>
<td>42</td>
<td>94</td>
<td>115</td>
<td>132</td>
<td>23</td>
<td>14</td>
<td>19</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>Acetylcholinesterase inhibitors*</td>
<td>19</td>
<td>12</td>
<td>19</td>
<td>38</td>
<td>57</td>
<td>24</td>
<td>27</td>
<td>12</td>
<td>11</td>
<td>15</td>
<td>19</td>
<td>26</td>
</tr>
<tr>
<td>Strychnine*</td>
<td>2</td>
<td>6</td>
<td>22</td>
<td>14</td>
<td>15</td>
<td>5</td>
<td>13</td>
<td>7</td>
<td>20</td>
<td>18</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Copper</td>
<td>16</td>
<td>5</td>
<td>12</td>
<td>16</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>15</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Selenium</td>
<td>2</td>
<td>4</td>
<td>19</td>
<td>23</td>
<td>13</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>6</td>
<td>5</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>16</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Iron</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sodium</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Other*</td>
<td>7</td>
<td>4</td>
<td>8</td>
<td>10</td>
<td>7</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>92</td>
<td>41</td>
<td>106</td>
<td>149</td>
<td>198</td>
<td>175</td>
<td>196</td>
<td>64</td>
<td>64</td>
<td>101</td>
<td>91</td>
<td>64</td>
</tr>
</tbody>
</table>

*The probability of no month effect for all toxic agents was P < 0.0001.

### Table 5. Poisoning in animals according to sex and age

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age</th>
<th>Poisoning</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>12</td>
<td>25</td>
<td>107</td>
</tr>
<tr>
<td>Female</td>
<td>23</td>
<td>12</td>
<td>35</td>
</tr>
</tbody>
</table>

(n = 132), June (n = 115), and May (n = 94). Strychnine poisoning occurred most frequently in March (n = 22), September (n = 20), and October (n = 10). Acetylcholinesterase inhibitor poisoning occurred most frequently in May (n = 57), April (n = 38), and July (n = 27). The individual Chi-square probabilities of no monthly difference for lead, acetylcholinesterase inhibitors, and strychnine were all P < 0.0001.

Cattle were the most commonly poisoned animal species (n = 696) (Table 5). Poisonings in cattle were attributed to lead (525 cases), selenium (58 cases), copper (30 cases), and molybdenum (19 cases). Lead poisoning comprised 75.4% of the total cattle poisonings. Other poisoning events in cattle included nitrite toxicity (13 cases), salt poisoning (12 cases), and sweet clover/dicoumarol poisoning (7 cases).

Copper was the primary source of toxicity for the combined ovine and caprine species (n = 62) (Table 6). Sheep and goats, collectively, were the second most frequently poisoned livestock species.

The number of dog poisonings over the investigational period was 139. Dogs represented the second most commonly poisoned animal species during the investigational period (Table 7). Strychnine (93 cases), acetylcholinesterase inhibitors (19 cases), and copper (16 cases) comprised the majority of the agents in canine toxicities.
Despite homeostatic mechanisms that regulate trace mineral concentrations, cattle may become poisoned with these elements through dietary sources. Selenium poisoning in cattle can originate from grazing of highly seleniferous plants and soils. Point sources of selenium in agriculture include bactericides, fungicides, and herbicides (10,11). Selenium injectables for veterinary use also represent an important point source. Organic selenium, the form used in agricultural pesticide formulations, appears to be more toxic to cattle and ruminants in general compared to inorganic selenium (11). Incomplete or absent case histories prevented identification of the source of selenium toxicity in the present study. Trace mineral interactions likely played a role in the observed toxicities. An example of this is molybdenum toxicity as the cause of conditioned copper deficiency (12). Molybdenum toxicity was responsible for a number of cattle toxicities in the present study. Cattle are the least tolerant livestock species to high dietary molybdenum (12), which appears to be reflected in the data in the current study. It is unclear whether or not the animals poisoned with molybdenum were experiencing hypocuprosis; however, it should be considered in ruminant management practices.

In a study of diagnostic case records from the province of Saskatchewan from 1968 to 1982, lead toxicosis was a predominant animal intoxication (1). In agreement with the current study and that of Hoff et al (9), cattle were the species most commonly affected with lead poisoning (86.5% of recorded lead poisoning cases) (1). The results from 1968 through 1982, along with those of the current study suggest that lead poisoning in cattle has been the most common veterinary toxicosis in western Canada (Alberta, Saskatchewan, and Manitoba) for the past 4 decades. Blakley (1) also reported that cattle often became poisoned with dicoumarol (36 cases) and nitrite (8 cases). Cattle poisonings with these compounds were observed over the 16-year period of the present study, but occurred at a relatively low frequency. Changing pasture management and the reduced production of crops containing dicoumarol or nitrite contaminants may have contributed to the decline in toxicoses.

Dogs were the second most frequently poisoned animal species. This is consistent with the findings of Blakley (1). In that study (1), dogs accounted for almost 92% of all strychnine poisonings from 1968 through 1982. In the present study, the percentage of dogs poisoned with strychnine appeared to have decreased. Almost 3 times as many dogs (n = 261) were poisoned with strychnine in the previous Blakley study (1) compared to the present study. This decline is likely due to the more stringent regulations on the access to strychnine and the compliance with the use of strychnine (13). The labelled-use for strychnine in Canada is for control of pocket gophers and Richardson’s ground squirrels (13–15). The recommended time of year to place strychnine-laced baits is the early spring (14). This is consistent with the high incidence of poisoning with strychnine in March. The incidence of strychnine poisoning reported in the prior Blakley study was highest in February, March, and April for all species (1). The high frequency of cases in September and October suggests off-label or malicious use.

A 10-year study of sudden death in dogs from 1989 to 1999 in Saskatchewan described toxicity as the second leading cause of death, following heart disease (16). Considering the 25 cases of toxicity-related sudden deaths reported, strychnine poisoning accounted for 24 (or 96%) of these cases. Strychnine poisoning, although declining, remains a concern for dog owners and veterinarians.

In contrast to the findings for strychnine, an epidemiologic study using information gathered by the American National Poison Data System from 2000 to 2010 described long-acting anticoagulant rodenticides as the major cause of death in dogs (17). This was followed by “unknown” rodenticides and carbonates. Prairie Diagnostic Services does not conduct tests for long-acting anticoagulant rodenticides, such as brodifacoum and diphacinone. The addition of these compounds to the diagnostic testing repertoire may be reasonable considering the information described in the study by Buttke et al (17). It should be noted that local or regional restrictions or use patterns throughout North America may also contribute to the discrepancies among these studies.

The Ontario study (9) did not document toxicities in addition to metals and thus did not describe the incidence of strychnine poisoning (9). However, dogs which accounted for 133 of the 887 cases of metal toxicosis were found to be poisoned with...
copper, lead, and zinc (9). In contrast to these results, lead poisoning was uncommon for dogs in the present study. This may reflect differences in industrial or domestic (paint, plumbing) sources of lead between the 2 regions and local (water) contamination issues. However, many copper and zinc poisoning cases were observed. Copper poisoning in dogs appears to be related to a genetic predisposition to hepatitis in many instances (9). For example, terrier species may have impaired copper excretion relating to an inherited metabolic dysfunction (18). Other species may be subject to copper accumulation due to chronic cholestasis from primary inflammatory hepatic disease (18). Zinc poisoning in dogs is often the result of ingestion of zinc-containing metallic objects, e.g., coins, or consumer products with high zinc content, e.g., zinc diaper ointment (19,20).

Copper toxicity was responsible for most of the poisonings observed in sheep and goats. These animals were considered as a group due to a similar phylogeny. However, sheep appear to be more sensitive to dietary copper exposure than goats (21). One study investigating copper toxicity in lambs and goats indicated that liver copper storage was 6 to 9 times greater in lambs than in goats (21). Sheep are unable to enhance copper excretion in response to increasing copper body burdens (22).

The bald eagle (Haliaeetus leucocephalus) and the golden eagle (Aquila chrysaetos), were the most frequently poisoned wildlife species. The predilection of eagles, especially the bald eagle, for scavenging of carcasses may explain this result (23). Poisonings with acetylcholinesterase inhibitor insecticides and lead were prevalent. Poisoning of raptor species with organophosphate and carbamate insecticides has been reported previously in Canada (24,25). Eagles may become exposed to this class of pesticides through multiple routes, including relay toxicity, in which the eagle is poisoned through ingestion of a poisoned animal or toxic carrion (24,25). Secondary toxicity also appears to be a major mechanism of exposure of eagles to lead. Lead poisoning in eagles has been shown to originate from consumption of contaminated game animals killed by lead shot. Carcasses and entrails left on-site by hunters may be scavenged by eagles (26). Richardson’s ground squirrels killed by hunters’ lead shots have been demonstrated to be a source of lead for scavenging hawks (27) and may also be of risk to eagles. Strychnine, licensed for Richardson’s ground squirrel control, was responsible for a small portion of poisoning events in eagles. This may suggest that eagles scavenge on rodents killed as part of pest-control efforts. Non-target poisoning of eagles with pesticides and lead appears to be related to scavenging of toxic carcasses and carrion. This remains a substantial wildlife conservation concern.

Poisoning with acetylcholinesterase inhibitor compounds (i.e., organophosphate and carbamate insecticides) was commonly observed during the period of this study. This is contrary to the results of Blakley (1), in which acetylcholinesterase inhibitor pesticide poisonings accounted for only 24 of the total cases (1). This difference may be related to increased wildlife carcass submission, increased public interest, greater regulatory presence, increased use of these agents, or a greater availability of diagnostic testing services. The exposure data in the case records in the present study did not allow us to determine whether poisoning was accidental or malicious. However, the high temporal incidence of the cases generally coincides with intense agricultural activities. This may be indicative of poisoning due to spray drift or ingestion of contaminated feed and water. Regardless, non-target toxicity occurred in greater numbers in wildlife, livestock, and companion animals.

As indicated in the Blakley study (1), chlorinated compounds were implicated in 58 of the 990 cases reported from 1968 to 1982. This reflects a historical contamination issue; organochlorine pesticides were in use during the late 1960s and early 1970s but have since been banned in Canada. Acetylcholinesterase inhibitor pesticides entered the North American market following the ban to meet the demands of agricultural development. The increase in poisoning with acetylcholinesterase inhibitor agents is likely a reflection of the replacement of the chlorinated pesticides with these agents.

There were no reported cases of warfarin or trichothecene mycotoxin poisonings (1). Limited crop contamination with mycotoxins accounted for the latter observation. Mercury and metaldehyde poisoning were more prevalent from 1968 and 1982 and have declined to a minimal occurrence from 1998 to 2013. The use of mercury as a seed treatment in agriculture has been banned. The dry field conditions during most of the study period likely limited the use of metaldehyde.

Over an extended period of time, it is evident that patterns associated with animal poisonings are influenced by changing environmental conditions, government regulations, testing capabilities, chemical availability, and husbandry practices. (cv)

References


The participation of advertisers in the CVJ is an indication of their commitment to the advancement of veterinary medicine in Canada. We encourage our readers to give their products and services appropriate consideration. — Ed.

Le support des annonceurs démontre leur engagement pour l’avancement de la médecine vétérinaire au Canada. Nous vous encourageons à prendre connaissance de leurs services et produits. — NDLR

Benjamin W. Brunson, J. Brad Case, Gary W. Ellison, W. Alexander Fox-Alvarez, Stanley E. Kim, Matthew Winter, Fernando L. Garcia-Pereira, Lisa L. Farina

Abstract — This study evaluated the safety of preoperative computed tomography angiography (CTA) and its effect on surgical time and clinical outcomes in dogs that underwent surgical correction of a single congenital extrahepatic portosystemic shunt (CEPSS). Patient data were retrospectively collected from medical records and owner communications for 124 dogs with single CEPSS, undergoing preoperative CTA (n = 43) or not (n = 81) which were surgically treated from 2005 to 2014. The frequency of major postoperative complications was 4.7% and 9.9% for the CTA and no CTA groups, respectively (P = 0.49). Mean ± standard deviation (SD) surgical time for the preoperative CTA group was 84 ± 40 min and 81 ± 31 min for the no CTA group (P = 0.28). We conclude that anesthetized preoperative CTA appears to be a safe method for diagnosis and surgical planning in dogs with single CEPSS, and does not appear to affect surgical procedure time, complication rate, or clinical outcome.

Résumé — Évaluation des résultats chirurgicaux, des complications et de la mortalité chez les chiens subissant une angiographie par tomodensitométrie préopératoire pour le diagnostic d’un shunt portosystémique extrahépatique : 124 cas (2005–2014). Cette étude a évalué l’innocuité d’une angiographie par tomodensitométrie préopératoire (AT) pour le diagnostic et la planification chirurgicale des chiens ayant un shunt portosystémique congénital simple (SPSEHC). Les données des patients ont été recueillies pour 124 chiens subissant une AT préopératoire (n = 43) ou non (n = 81), et qui avaient été traités par chirurgie entre 2005 et 2014. La fréquence des complications postopératoires majeures était de 4.7 % et de 9.9 % pour les groupes AT et sans AT, respectivement (P = 0.49). La durée moyenne ± SD de la chirurgie pour le groupe AT préopératoire était de 84 ± 40 minutes et de 81 ± 31 minutes pour le groupe sans AT (P = 0.28). Nous avons conclu que l’AT préopératoire semble être une méthode sûre pour le diagnostic et la planification chirurgicale des chiens ayant un SPSEHC simple et qu’elle ne semble pas affecter la durée de l’intervention, le taux de complication ou les résultats cliniques.

Can Vet J 2016;57:59–64

Introduction

Preoperative computed tomography angiography (CTA) is the preferred diagnostic modality for evaluation of the portal vasculature in human medicine and has recently been reported to have superior accuracy compared with abdominal ultrasound (AUS) in dogs with congenital extrahepatic portosyste-
Computed tomography angiography is the image modality of choice for planning many hepatic vascular procedures in human medicine such as liver lobe transplantation, liver lobectomy, and transjugular intrahepatic portosystemic shunts (TIPS) (5–9). However, preoperative CTA requires heavy sedation or general anesthesia, which may increase the number of anesthetic events compared to AUS. Both humans and animals with hepatic dysfunction are considered to be high risk anesthetic candidates (10,11). Computed tomography angiography has also been associated with deleterious hemodynamic changes after administration of intravenous contrast agents (12,13).

Consequently, it is feasible that additional anesthesia and administration of IV contrast may affect the frequency of perioperative and postoperative complications in dogs with CEPSS. However, the improved preoperative localization and planning afforded by CTA may decrease surgical time (2,4).

To the authors' knowledge, there are no studies evaluating the frequency of complications and clinical outcomes in dogs with CEPSS undergoing preoperative CTA. The goal of this study was to evaluate whether dogs that underwent preoperative CTA had a significant difference in frequency of major complications, surgery time, and short-term survival compared with dogs that did not undergo preoperative CTA. We also aimed to evaluate the necropsy findings to determine possible cause of death in dogs that died in the postoperative period.

Our hypotheses were that preoperative CTA in anesthetized dogs would have an effect on surgery time but not the frequency of major complications or short-term survival.

Materials and methods

Selection of cases

Medical records of all dogs presented for evaluation and surgical treatment of a single CEPSS from 2005 to 2014 were evaluated for inclusion in this study. Dogs were enrolled in the study if medical records were available and included preoperative examination findings, medication history, blood work (e.g., complete blood cell count, serum chemistry, and bile acids), diagnostic imaging (e.g., AUS and/or CTA), anesthesia and surgical reports, documentation of postoperative complications, and short-term follow-up information. Dogs were excluded from the study if the medical record was missing or if it was determined that they did not have a CEPSS.

Medical records review

Patient data were retrospectively collected from the medical records and by communication with referring veterinarians and clients. Information collected included breed, gender, body weight, age, history of neurologic signs, history of preoperative administration of anti-seizure prophylaxis, date of surgery, preoperative clinical signs, pre- and post-operative serum chemistry results, imaging modality and anatomic diagnosis, anesthetic and surgical procedures, surgical anatomic diagnosis, surgical time, postoperative complications, and follow-up information. Major complications recorded included severe intraoperative hypotension (systolic pressure < 65 mmHg), postoperative neurological dysfunction (focal or generalized seizures), cardiorespiratory arrest, and sudden death. For patients that were deceased, information regarding cause of death (related or unrelated to CEPSS based on medical records, referring veterinarian records, and clinical signs at the time of death), date of death and necropsy results (if performed), was recorded.

Abdominal ultrasound (AUS) and computed tomography angiography (CTA)

All AUS and CTA studies were evaluated by a board-certified radiologist when initially performed and the radiology report was used for data collection. All CTAs were performed with patients under general anesthesia and placed in dorsal recumbency. An 8-slice helical CT scanner (Toshiba Aquilion 8 CT Scanner; Toshiba Medical Systems, Tustin, California, USA) was used for all CTAs. Approximately 20 s of manual hyperventilation, followed by manual breath-hold or an intravenous bolus of a short acting opioid was used to accomplish transient apnea. A 640 mgI/kg body weight (BW) dose of iodinated contrast medium (Omnipaque 350; GE Healthcare, Milwaukee, Wisconsin, USA) was administered into the left or right cephalic vein in a single bolus at a rate of 3 mL/s using a power injector. Computed tomography angiography studies consisted of a precontrast enhanced volume of the caudal thorax and abdomen, followed by 3 post-contrast volume acquisitions highlighting the arterial, venous, and delayed phases. A proprietary bolus tracking software (SureStart; Toshiba Medical Systems) was used to evaluate peak contrast enhancements in areas of interest. 2D multiplanar reformation images and 3D reconstruction of the portal system from the portal phase scan were generated using a DICOM workstation (Kodak DirectView web software; Eastman Kodak Company, Rochester, New York, USA). Portal vasculature was assessed in dorsal (coronal), transverse (axial), and sagittal planes.

For all AUS, dogs were imaged in dorsal recumbency with or without sedation using the same ultrasound equipment (Philips iU22; microconvex C8–5, convex C9–4, and micro-linear L15–7i transducers; Philips Healthcare, Andover, Massachusetts, USA). A diagnosis of CEPSS was made via AUS upon visualization of the origin or insertion of an anomalous vessel and/or when the radiologist concluded that enough additional criteria (turbulent blood flow within the caudal vena cava, decreased hepatic portal vein markings, nephrolithiasis, cystolithiasis, PV:Ao diameter ratio < 0.7, alterations in PV blood flow velocity, subjective microhepatica) were present to indicate the presence of a CEPSS without direct visualization of an aberrant vessel. A negative diagnosis was determined to be any evaluation that did not meet the above criteria. Groups were defined as either undergoing preoperative CTA or not.

Statistical analysis

Continuous data of normal distribution are presented as mean ± SD values. The Shapiro-Wilk Goodness-of-fit test was used to screen the distribution of all continuous data sets. Nonparametric data are presented as median and range values. For comparison of surgery time between groups, a Student’s t-test was used. A Fisher’s exact test was used to compare the frequency of preoperative administration of levetiracetam and major complications between groups as well as to examine the relationship
between severe hypotension, frequency of postoperative seizures, and death. The relative risk of survival in dogs with and without preoperative seizures was determined. Survival was evaluated using Kaplan-Meier actuarial curves and the log rank test. *P*-values < 0.05 were considered statistically significant. Data were analyzed using marketed statistical software (JMP version 10.0; SAS Institute, Cary, North Carolina, USA).

**Results**

Between January 1, 2005 and July 1st, 2014, 163 dogs underwent imaging and surgery for CEPSS at a referral small animal hospital, with 124 meeting the inclusion criteria. Of these CTA was performed in 43 dogs and AUS without CTA in 81 dogs. Mean body weight was 4.50 ± 3.91 kg. Mean age at surgery was 2.35 ± 2.04 y. There were 32 castrated males, 22 intact males, 41 spayed females, and 29 intact females. Breeds in the study included: Yorkshire terrier (n = 43), mixed breed (n = 15), miniature schnauzer (n = 13), Maltese (n = 8), bichon frise (n = 8), shih tzu (n = 5), Chihuahua (n = 5), teacup Yorkshire terrier (n = 4), pug (n = 3), 2 each of the following: miniature dachshund, golden retriever, standard schnauzer, and 1 each of the following: longhaired miniature dachshund, Clumber spaniel, Pembroke Welsh corgi, German shorthaired pointer, Havenese, Jack Russell terrier, Lhasa apso, papillon, Pekingese, miniature pinscher, pomeranian, toy poodle, beagle, and west Highland white terrier.

Preoperative neurologic signs including mental dullness, ataxia, tremors, seizures, and visual deficits were reported in 63 (51.0%) dogs in this study. A history of preoperative seizure activity was present in 2 (4.8%) dogs and 13 (16.1%) dogs in the CTA and no CTA groups, respectively (P = 0.08). Medical management of hepatic encephalopathy typically included lactulose, neomycin, and a low-protein diet and was based on the referring or attending veterinarian’s preference. Anti-seizure prophylaxes including phenobarbital, potassium bromide, and/or levetiracetam were administered according to referring veterinarian or surgeon’s preference. Levetiracetam was prescribed preoperatively by the operating surgeon in 6 (7.4%) of no CTA and 23 (53.5%) of CTA dogs (P < 0.0001).

All diagnostic imaging was performed by faculty radiologists and reviewed by both radiologists and surgeons involved with the case. The anatomic location of the CEPSS based on CTA was consistent with intraoperative findings in all 43 dogs. In the CTA group, 33 were portocaval, 7 were portoazygous, and 3 were gastrohepatic. The presence of a CEPSS based on AUS was consistent with intraoperative findings in 50/81 (62%) dogs with CEPSS not undergoing CTA. However, AUS was incorrect or not definitive in the anatomic location of the shunt in 31/81 (38%) cases where an aberrant vessel was identified in surgery.

Surgery was performed by faculty surgeons or by surgery residents with direct faculty assistance. Anesthetic protocols varied by anesthesiologist preference but in general included: premedication with hydromorphone (Hypromorph; Hospira, Lake Forest, Illinois, USA) [0.05 mg/kg body weight (BW) to 0.2 mg/kg BW, IV or IM] or methadone (Methadone; Hospira), 0.3 mg/kg to 0.5 mg/kg BW, IV, sometimes combined with midazolam (Midazolam; Hospira), 0.2 to 0.3 mg/kg, IV or IM.

**Table 1.** Comparison of individual variables and the potential association with post-operative seizures

<table>
<thead>
<tr>
<th></th>
<th>No post-operative seizures</th>
<th>Post-operative seizures</th>
<th><em>P</em>-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTA</td>
<td>41</td>
<td>2</td>
<td>0.49</td>
</tr>
<tr>
<td>No CTA</td>
<td>73</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Intraoperative hypotension</td>
<td>87</td>
<td>8</td>
<td>0.87</td>
</tr>
<tr>
<td>No intraoperative hypotension</td>
<td>25</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Preoperative levetiracetam</td>
<td>26</td>
<td>3</td>
<td>0.70</td>
</tr>
<tr>
<td>No preoperative levetiracetam</td>
<td>88</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

CTA — computed tomography angiography.

General anesthesia was induced using Propofol (Propofol28TM, Abbott Laboratories, Abbott Park, Illinois, USA), 2 to 8 mg/kg BW, IV, and after endotracheal intubation anesthesia was maintained by Isoflurane (Isoflurane; Piramal Healthcare, Bethlehem, Pennsylvania, USA) in 100% oxygen. All patients received crystalloid fluids during anesthesia (5 to 20 mL/kg BW per hour, IV). If hypoglycemia was present just prior to induction of anesthesia, 2.5% dextrose solution was added to the crystalloid. Fentanyl (Fentanyl; Hospira) CRI, 2 to 5 µg/kg BW per hour, IV, was often used intraoperatively. Hypotension was treated with hetastarch (Hospira), 5 mL/kg BW, IV, and/or dopamine (Hospira) CRI, 3 to 15 µg/kg BW per min, IV during hypotensive episodes refractory to conventional treatment (crystalloid bolus, decrease in inhalant concentration and/or anticholinergic as needed). Vital signs that were monitored included pulse oximetry, arterial blood pressure (invasive or non-invasive), electrocardiography and capnometry. Post-operative analgesia was maintained with fentanyl (Fentanyl; Hospira) CRI, 2 to 5 µg/kg BW per hour, IV, or fentanyl transdermal patch (Fentanyl Patch; Actavis, Parsippany, New Jersey, USA), 25 to 100 µg/h. Dogs were surgically treated with an ameroid ring (n = 99) or cellophane band (n = 25) depending on surgeon preference. Sixty-four percent (n = 16) of dogs treated with a cellophane band underwent preoperative CTA while 27.3% (n = 27) of dogs treated with an ameroid constrictor had a CTA performed (P = 0.0008).

**Surgery and complications**

Surgery time was not different between dogs undergoing CTA (84.05 ± 39.58 min) compared to dogs that did not undergo CTA (80.67 ± 30.66 min) (P = 0.28). Severe intraoperative hypotension was seen in 30 (73.2%) and 65 (80.2%) dogs undergoing preoperative CTA or no CTA, respectively (P = 0.49). Severe hypotension was not associated with development of postoperative seizures (P = 0.87) (Table 1) or with death (P = 0.73).

Ten dogs in this study developed postoperative seizures that were not associated with hypoglycemia [n = 2, 4.7% (CTA); n = 8, 9.9% (no CTA)] (P = 0.49). Among these dogs, 2 in the CTA and 4 in the no CTA group died or were euthanized after surgery as a consequence of refractory seizure activity. None of the dogs euthanized because of refractory seizure activity had a history of preoperative seizure activity. Of the 15 dogs with reported preoperative seizure activity, 5 (33%) developed...
Short-term survival

Eight dogs died prior to discharge from the hospital, 6 in the no CTA group, and 2 in the CTA group. Of the 6 dogs that died in the no CTA group, 4 were euthanized due to refractory seizure activity and 2 died of sudden cardiac arrest in the immediate post-operative period. Both of the dogs in the CTA group were euthanized due to refractory seizure activity. Of the 41 surviving dogs undergoing preoperative CTA, 1 patient died of CEPSS-related causes between discharge and the time of this study and another dog died of unrelated causes. Four of the 75 surviving dogs in the no CTA group died of CEPSS-related causes, and 3 dogs died of unrelated causes between the time of discharge and the time of this study. One and 2-year survival rates were 88.6% and 87.8% for the no CTA group and 93.1% and 91.0% for the CTA group dogs (Figure 1).

Necropsies with examination of the brain were performed on 3 dogs (2 in the no CTA, and 1 in the CTA group). In 1 dog, euthanized approximately 42 h post-surgery, there was mild laminar cortical necrosis, as well as neuronal necrosis in the thalamus and hippocampus. A second dog, euthanized 9 days after surgery, also had laminar cerebral cortical necrosis, along with neuronal necrosis in the thalamus. The third dog, which died spontaneously 3 days after surgery, also had laminar cortical necrosis.

Discussion

Computed tomography angiography in the anesthetized dog appears to be a safe diagnostic test in the evaluation and surgical planning of dogs suspected of CEPSS. Preoperative CTA did not reduce surgery time but the additional anesthesia and administration of IV contrast did not affect complication rate or clinical outcome. While significant complications including cardiac arrest and post-ligation seizures were observed, they were infrequent, did not differ between groups, and occurred with similar frequency to what has been previously described (14–17). The finding of a greater probability for survival after post-ligation seizure activity in dogs with a history of preoperative seizures may reflect the occurrence of 2 distinct neurologic syndromes in dogs with CEPSS.

Dogs included in this study were of typical signalment and body weight as previously reported for CEPSS (14,16,18–20). Further, clinical signs and preoperative medical management strategies were also similar to previous studies (14,18–20), aimed at controlling or preventing signs of hepatic encephalopathy in addition to perioperative seizure prophylaxis.

Aside from anesthesia-related risks, another potential concern with CTA in dogs with hepatic dysfunction is the use of IV contrast material, which has been associated with significant bradycardia, tachycardia, hypotension, hypertension, allergic-type reactions in dogs and humans (12,13,21), as well as nephrotoxicity, and neurotoxicity (22,23). In our study, there was no significant difference between dogs that received IV contrast (CTA group) and those that did not with regard to intraoperative hypotension and post-operative neurologic abnormalities. Although postoperative surveillance for renal tubular injury would have been ideal, no clinical signs of renal injury or azotemia were reported. The use of IV contrast with preoperative CTA appears to be safe and can be recommended for use in dogs with CEPSS.

Both humans and animals with hepatic dysfunction are considered to be high risk anesthetic candidates (10,11). As such, the choice of anesthetic agents for patients with CEPSS is of particular concern. Our anesthetic procedures included: propofol, isoflurane inhalant, and an opioid (hydromorphone, methadone, or fentanyl) which have been used safely in dogs with CEPSS in prior studies (16,24). Benzodiazepines (midazolam or diazepam) were also occasionally administered in our

<table>
<thead>
<tr>
<th></th>
<th>No postoperative seizures</th>
<th>Postoperative seizures</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical time (min)</td>
<td>81.7 ± 34.2</td>
<td>83.0 ± 31.0</td>
<td>P = 0.90</td>
</tr>
<tr>
<td>Anesthesia time (min)</td>
<td>134.6 ± 37.9</td>
<td>128.8 ± 37.7</td>
<td>P = 0.65</td>
</tr>
</tbody>
</table>

Table 2. Surgery and anesthesia times of patients that developed post-operative seizures and those that did not.

Figure 1. Survival curves for dogs undergoing preoperative CTA (solid black line) and dogs not undergoing preoperative CTA (dashed black line).
study; however, it has been suggested that these agents should be used with caution in dogs with CEPSS (11).

Although both groups of dogs (CTA or no CTA) were similar, there was a tendency for more CTA dogs to be treated with cellophane. The most likely explanation for this is the fact that CTA has recently become recognized as the diagnostic method of choice for dogs with CEPSS and the surgeon who prefers cellophane was more recently employed by the institution. We do not feel that this difference affected outcome between groups in our study, as ameroid constrictors and cellophane have yielded similar clinical outcomes (16,18), despite having slightly different rates of occlusion (25).

While preoperative CTA did not affect surgical time, complications, or short-term outcome compared with the no CTA group, the authors believe it provided valuable information regarding the nature and location of the shunt, which facilitated the surgical approach to the vessel. Additionally, CTA is more likely to prevent unnecessary laparotomy in cases that have portal vein hypoplasia with or without acquired shunts by detecting these vessels with greater sensitivity (2).

Systemic mean arterial pressure <65 mmHg is known to result in loss of perfusion auto regulation and subsequent myocardial, renal and cerebral ischemia (26,27). Severe intraoperative hypotension (systolic pressure <65 mmHg) was documented in 78% of our dogs using indirect measurements via Doppler ultrasonography, and the incidence was not different between groups nor was it associated with increased frequency of post-operative complications or death. The most likely explanation for the high incidence of severe hypotension in our dogs is the combination of anesthetic agents and hypoproteinemia, which is common in CEPSS dogs. Doppler blood pressure monitoring has been found to be accurate in the face of hypotension, with 1 study finding readings to be within 10 mmHg of direct blood pressure measurements 95% of the time (28). It has also been demonstrated that Doppler measurements tend to overestimate systolic values in hypotensive patients (29). However, most of these studies were performed in medium-sized dogs and it is possible that Doppler readings of systolic pressure were underestimated within the population of this study (mean body weight 4.50 ± 3.91 kg). While there are no studies specifically looking at the accuracy of Doppler in small dogs, it is plausible that smaller dogs give Doppler readings similar to cats, which more accurately predict the mean arterial pressure, rather than systolic (30).

Post-ligation or post-surgery seizures along with varying degrees of neurological dysfunction can occur after anesthesia and surgery and can result in postoperative death of the CEPSS patient (31). Many causes have been proposed; however, none alone have been definitively shown to cause seizure activity exclusively (15,16,32–34). While no statistically significant explanations were identified in our study, it is plausible that severe systemic hypotension may also play a role. Severe hypotension has the potential to cause cerebral ischemia which in turn could lead to seizure activity or death (35–38). The 3 dogs which had necropsies with examination of the brain in this series all had laminar cortical necrosis, and 1 had some neuronal necrosis in the thalamus and hippocampus as well. Classically, hypoxia and ischemia most affect the cerebral cortex, hippocampus, cerebellar Purkinje cells, basal ganglia, and thalamus (39). The neuronal necrosis in these cases was considered most likely to have resulted from poor perfusion of the brain secondary to hypotension.

Fifty percent of the dogs in our study exhibited pre-operative neurological signs consistent with hepatic encephalopathy prior to surgical correction of their CEPSS. Preoperative treatment with a seizure prophylaxis, such as levetiracetam or phenobarbital, has been proposed as a possible intervention to decrease the occurrence of postoperative seizures (32,39). One study found that of 42 dogs pre-treated with Levetiracetam none developed postoperative seizures while 5% in the control group that did not receive Levetiracetam exhibited post-operative seizure activity (39). Pharmacokinetic data show that levetiracetam is excreted via the kidneys with little hepatic metabolism as opposed to barbiturates which rely on hepatic microsomal metabolism (39,40). Preoperative levetiracetam administration did not appear to provide a protective effect against post-operative seizure activity in our study population (P = 0.70).

Short-term survival was compared between the CTA and no CTA dogs in this study as an indirect method of screening for potential latent differences between groups. The 1- and 2-year mortality rates of approximately 10% were similar between groups and are comparable to previous reports (14–16,18,19). Given the similarities in complications and outcome in our study, preoperative CTA in dogs suspected of CEPSS appears to be a safe diagnostic imaging modality.

Further limitations of this study include variability in surgeon experience and method of gradual occlusion as well as lack of a homogenous patient population.

In summary, CTA in anesthetized dogs appears to be a safe diagnostic modality in the evaluation and surgical planning of dogs suspected of CEPSS. Although preoperative CTA did not reduce surgery time, the associated additional anesthesia and administration of IV contrast did not adversely affect complication rate or clinical outcome. Post-surgical seizures and sudden cardiac arrest were infrequent and did not differ between groups. The finding of a protective effect for survival after post-ligation seizure activity in dogs with a history of preoperative seizures may reflect 2 distinct neurologic syndromes, but this requires further investigation.

Acknowledgments
The authors thank Shelby Listokin for technical assistance and the Merial Summer Veterinary Scholars Research Grant for providing funding.

References


Erratum
CVJ 2015;56:1181
Canine nail bed keratoacanthoma diagnosed by immunohistochemical analysis
Chang-Bum Yoo, Dae-Hyun Kim, A-Jin Lee, Hyun-Jung Suh, Saejung Yoo, Jung-Hyang Sur, Ki Dong Eom
Dr. Hwi-Yool Kim, Department of Veterinary Surgery, College of Veterinary Medicine, Konkuk University, Seoul, Republic of Korea.

This author was omitted from the original submitted article.
Antimicrobial susceptibility of *Staphylococcus pseudintermedius* colonizing healthy dogs in Saskatoon, Canada

Roshan Priyantha, Mathew C. Gaunt, Joseph E. Rubin

**Abstract** – This study reports antimicrobial susceptibility of *Staphylococcus pseudintermedius* carried by healthy dogs in Saskatoon, and describes changes in antimicrobial resistance since a 2008 study. One hundred healthy dogs presenting to the wellness service at the Western College of Veterinary Medicine were screened for *S. pseudintermedius* by culturing rectal and pharyngeal swabs. *Staphylococcus pseudintermedius* was identified biochemically and antimicrobial minimum inhibitory concentrations were determined by broth micro-dilution. Methicillin resistance was confirmed by polymerase chain reaction (PCR) and sequencing of the mecA gene. Of 221 *S. pseudintermedius* isolates from 78 dogs, 7 were methicillin resistant. No resistance to the fluoroquinolones, nitrofurantoin, tigecycline, vancomycin, quinupristin-dalfopristin, linezolid, or daptomycin was identified. Of the 78 positive dogs, isolates resistant to penicillin were found in 78%, to ampicillin in 61% and to tetracycline in 26%; resistance to oxacillin, erythromycin, clindamycin, trimethoprim + sulfamethoxazole, chloramphenicol, and gentamicin was found in < 10% of dogs. Compared to the 2008 study, the frequency of resistance to all drugs increased, and the frequency of colonization with pan-susceptible isolates decreased from 46% to 30%.

**Introduction**

*Staphylococcus pseudintermedius* (recognized as distinct from *S. intermedius* in 2005) colonizes the skin and mucosal surfaces of up to 90% of healthy dogs (1–3). Clinically, *S. pseudintermedius* is the most common cause of pyoderma and otitis externa, the second most common cause of urinary tract infections, and is frequently implicated in nosocomial infections in dogs (4,5). The ubiquity of canine *S. pseudintermedius* infections in the community and the frequency of empiric treatment by veterinarians highlight the importance of antimicrobial resistance surveillance to inform evidence-based empiric therapeutic selection.
The emergence of antimicrobial resistance is a great challenge to antimicrobial therapy for animals and humans. The propensity of staphylococci to adapt to the selection pressure of antimicrobial use has been recognized since the first description of penicillin resistant *S. aureus* in the 1940s (6). Resistance to penicillin among staphylococci, including companion animal *S. pseudintermedius* isolates, is most commonly due to the production of staphylococcal beta-lactamase, conferred by the *bla*Z gene (7,8). *Staphylococcus pseudintermedius* has historically remained remarkably susceptible to antimicrobials, but since 2006 there has been a dramatic worldwide increase in the frequency of methicillin resistance (4,9). Methicillin resistance, which is rapidly emerging among *S. pseudintermedius* in dogs and common among *S. aureus* in humans is a serious threat to the efficacy of the most frequently used antibiotics, the beta-lactams (10–12). Methicillin resistance conferred by the mecA and mecC genes results in the production of altered cell wall proteins with a low affinity for beta-lactam drugs; leading to resistance to all beta-lactam antimicrobials currently licensed for use in veterinary medicine including the penicillins, cephalosporins, and carbapenems (13). Because methicillin resistance is not the product of beta-lactamase production, addition of beta-lactamase inhibitors such as clavulanic acid does not restore susceptibility. Furthermore, methicillin resistance in *S. pseudintermedius* is often associated with multidrug resistance, further limiting the treatment options available to veterinarians (4,9).

In the late 2000’s there was an explosive increase in the incidence of MRSP associated with 2 lineages of *S. pseudintermedius*, sequence type (ST) 71 in Europe and ST68 in North America (11,14). Among healthy dogs in North America and Europe 0 to 4.5% have been found to carry MRSP, while up to 66% (11,14). Among healthy dogs in North America and Europe 0 to 4.5% have been found to carry MRSP, while up to 66% of clinical *S. pseudintermedius* isolates have been reported to be methicillin resistant (4,15–19). In Saskatoon, *S. pseudintermedius* carried by healthy dogs and those causing infections have historically been remarkably susceptible; a 2008 study failed to identify any animals carrying MRSP (2,5). Since 2009, reports of canine infections with MRSP in Saskatoon including urinary tract infections and necrotizing fasciitis suggest the emergence of MRSP associated with 2 lineages of *S. pseudintermedius* in dogs and common among *S. aureus* in humans is a serious threat to the efficacy of the most frequently used antibiotics, the beta-lactams (10–12). Methicillin resistance conferred by the mecA and mecC genes results in the production of altered cell wall proteins with a low affinity for beta-lactam drugs; leading to resistance to all beta-lactam antimicrobials currently licensed for use in veterinary medicine including the penicillins, cephalosporins, and carbapenems (13). Because methicillin resistance is not the product of beta-lactamase production, addition of beta-lactamase inhibitors such as clavulanic acid does not restore susceptibility. Furthermore, methicillin resistance in *S. pseudintermedius* is often associated with multidrug resistance, further limiting the treatment options available to veterinarians (4,9).

In the late 2000’s there was an explosive increase in the incidence of MRSP associated with 2 lineages of *S. pseudintermedius*, sequence type (ST) 71 in Europe and ST68 in North America (11,14). Among healthy dogs in North America and Europe 0 to 4.5% have been found to carry MRSP, while up to 66% of clinical *S. pseudintermedius* isolates have been reported to be methicillin resistant (4,15–19). In Saskatoon, *S. pseudintermedius* carried by healthy dogs and those causing infections have historically been remarkably susceptible; a 2008 study failed to identify any animals carrying MRSP (2,5). Since 2009, reports of canine infections with MRSP in Saskatoon including urinary tract infections and necrotizing fasciitis suggest the emergence of resistance in this region (20,21). The objective of this study was to determine the antimicrobial susceptibility profiles of *S. pseudintermedius* colonizing healthy dogs in Saskatoon, and identify changes in the frequency of resistance since the 2008 investigation.

**Materials and methods**

**Sample collection**

Between June and September 2014, 100 clinically healthy dogs presenting to the wellness service of the Veterinary Medical Centre at the Western College of Veterinary Medicine were investigated (Table 1). Pharyngeal and rectal samples were collected using sterile swabs with Stuart transport media (Becton Dickinson, Sparks, Maryland, USA) as previously described (2). Pharyngeal samples were collected by gently rolling a sterile swab across the pharynx for 1 to 3 s, and rectal swabs were collected by gently inserting a second swab 3 cm into the dog’s rectum and rotating for 1 to 3 s. All samples were processed within 4 h of collection. This study was approved by the University of Saskatchewan animal research ethics board (protocol #20130135).

**Table 1. Characteristics of sampled dogs (n = 100)**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td>18</td>
<td>91</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intact male</td>
<td>18</td>
<td>33</td>
</tr>
<tr>
<td>Neutered male</td>
<td>33</td>
<td>32</td>
</tr>
<tr>
<td>Intact female</td>
<td>14</td>
<td>91</td>
</tr>
<tr>
<td>Neutered female</td>
<td>32</td>
<td>91</td>
</tr>
<tr>
<td>History of antimicrobial use, past 6 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>No</td>
<td>91</td>
<td>91</td>
</tr>
</tbody>
</table>

* Information on gender was not recorded for 1 dog.

**Culture and susceptibility testing**

All swabs were plated on CHROMagar Staph aureus (CHROMagar, Paris, France), and Mueller-Hinton agar + 4 μg/mL oxacillin. Plates were then incubated overnight at 35°C and up to 5 *S. pseudintermedius*-like colonies (mauve color) were sub-cultured to Columbia agar with 5% sheep blood (Becton, Dickinson). Isolates were identified based on colony morphology (small, creamy grey to white, round colonies with a smooth margin and double zone of hemolysis on blood agar) and biochemically using the catalase test, and tube coagulase test with rabbit plasma, the production of acetoin and hyaluronidase, and the fermentation of mannitol, maltose, and trehalose (2,22). Since the carriage of genetically diverse *S. pseudintermedius* strains by individual dogs has been recognized, 3 isolates per animal were saved for future testing to increase the likelihood of detecting resistant organisms (23). Bacteria were stored at −80°C in trypticase soy broth + 15% glycerol. For dogs carrying *S. pseudintermedius* at both sites, 2 pharyngeal and 1 rectal isolate were saved.

Antimicrobial minimum inhibitory concentrations were determined by broth microdilution using the GAPLL1F Sensititre panel (Thermo Fisher Scientific, Oakwood Village, Ohio, USA). Tests were conducted according to the Clinical and Laboratory Standards Institute (CLSI) and manufacturer’s guidelines (24). A panel of drugs including: penicillin (PEN), ampicillin (AMP), oxacillin (OXA) with 2% NaCl, erythromycin (ERY), clindamycin (CLI), tetracycline (TET), tigecycline (TGC), trimethoprim + sulfamethoxazole (SXT), ciprofloxacin (CIP), levofloxacin (LEV), moxifloxacin (MOX), gentamicin (GEN), chloramphenicol (CHL), rifampin (RIF), nitrofurantoin (NIT), vancomycin (VAN), linezolid (LZD), daptomycin (DAP) and quinupristin + dalfopristin (QDA) was used. For quality control *S. aureus* ACTCC 29213 and *Enterococcus faecalis* ACTCC 29212 were used (25). Antimicrobial MICS were used to categorized isolates as susceptible or resistant using CLSI breakpoints for all drugs except tigecycline and daptomycin for which the EUCAST interpretive criteria were used (25–27). Isolates were considered to be MRSP when resistant to oxacillin (MIC ≥ 0.5 μg/mL); genotypic resistance was confirmed by PCR and sequencing of the mecA and mecC genes using previously described primers (28). Isolates resistant...
to erythromycin and susceptible to clindamycin were tested for inducible clindamycin resistance using the D-test as described by the CLSI (26).

**Results**

Of the 100 dogs tested, *S. pseudintermedius* was isolated from 78. A total of 221 isolates were collected, including single isolates from 5 dogs, 2 isolates from 3 dogs, and 3 isolates from 70 dogs. For dogs in which < 3 isolates were initially identified, all isolates were saved. No *S. pseudintermedius* was isolated from Müller-Hinton agar with 4 μg/mL oxacillin; all isolates were recovered from CHROMagar *Staph aureus*. Antimicrobial susceptibility testing revealed phenotypic diversity among multiple isolates from individual dogs. Of the 78 positive animals, isolates with varying susceptibility profiles were grown from 30, while phenotypically homogeneous isolates were grown from 48. Consequently, the frequency of resistance among the overall isolate collection was lower than the percentage of animals carrying isolates expressing any particular resistance phenotype; for example, if 1 of 3 isolates carried by a dog was resistant to tetracycline, that dog was considered to carry tetracycline-resistant isolates (Table 2). No resistance to ciprofloxacin, levofloxacin, moxifloxacin, nitrofurantoin, rifampin, tigecycline, vancomycin, quinupristin + dalfopristin, linezolid or daptomycin was identified. The most common resistance profile was penicillin + ampicillin resistance (*n* = 70; 31.7%) followed by pan-susceptibility (*n* = 67; 30.3%) (Table 3). Methicillin resistant isolates (*n* = 8) were identified in 7 dogs carrying *S. pseudintermedius*. Resistance to trimethoprim + sulfamethoxazole, chloramphenicol, and gentamicin was less common (Table 3). All oxacillin resistant isolates possessed the mecA gene, while mecC was not identified. None of the 5 erythromycin resistant, clindamycin susceptible isolates were inducibly clindamycin resistant.

Fifteen multidrug resistant isolates (MDR; resistance to 3 or more drugs classes) were identified, all were methicillin susceptible *S. pseudintermedius* (MSSP) (Table 3). Notably, 1 isolate was resistant to PEN, AMP, TET, ERY, CLI, CHL and GEN.

**Discussion**

Compared to the previous resistance surveillance study targeting *S. pseudintermedius* from healthy dogs presenting to the wellness service at our institution in Saskatoon in 2008, a higher frequency of resistance to specific antimicrobials, and resistance to more drugs including methicillin was identified. Furthermore, only 30% of the dogs carried pan-susceptible isolates compared to 46% in 2008 (2). Differences in sample collection between the present investigation and that done in 2008 (the inclusion
of a single isolate per dog in 2008 versus 3 presently, and the inclusion of nasal swabs in the 2008 investigation preclude statistical comparisons between studies. However, the higher frequency of resistance including MRSP in 2014 is consistent with local clinical observations suggesting the emergence of resistance and with global MRSP trends. The frequency of carriage of healthy dogs with MRSP (7%) was higher than previously described elsewhere in North America or Europe (≈ 4.5%) perhaps reflecting the continued emergence of MRSP following previous studies (4,18). This frequency was lower than that reported in Asia, where up to 45% colonization has been reported in Thailand, Japan and Hong Kong (29–31). The inclusion of Müeller-Hinton agar with 4% NaCl, erythromycin (ERY), clindamycin (CLI), tetracycline (TET), trimethoprim + sulfamethoxazole (SXT), gentamicin (GEN), chloramphenicol (CHL),

<table>
<thead>
<tr>
<th>Resistance profile</th>
<th>Number of isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pan-susceptible</td>
<td>67</td>
</tr>
<tr>
<td>PEN + AMP</td>
<td>70</td>
</tr>
<tr>
<td>PEN</td>
<td>27</td>
</tr>
<tr>
<td>TET</td>
<td>13</td>
</tr>
<tr>
<td>PEN + AMP + TET</td>
<td>13</td>
</tr>
<tr>
<td>PEN + AMP + OXA</td>
<td>6</td>
</tr>
<tr>
<td>PEN + AMP + SXT + TET</td>
<td>6</td>
</tr>
<tr>
<td>PEN + TET</td>
<td>4</td>
</tr>
<tr>
<td>PEN + AMP + TET + ERY + CLI</td>
<td>4</td>
</tr>
<tr>
<td>PEN + AMP + TET + ERY</td>
<td>3</td>
</tr>
<tr>
<td>PEN + AMP + SXT + TET</td>
<td>2</td>
</tr>
<tr>
<td>PEN + AMP + OXA + TET</td>
<td>1</td>
</tr>
<tr>
<td>PEN + AMP + OXA + ERY</td>
<td>1</td>
</tr>
<tr>
<td>TET + ERY</td>
<td>1</td>
</tr>
<tr>
<td>PEN + ERY + CLI</td>
<td>1</td>
</tr>
<tr>
<td>PEN + AMP + TET + CHL</td>
<td>1</td>
</tr>
<tr>
<td>PEN + AMP + ERY + CLI + CHL + GEN</td>
<td>1</td>
</tr>
</tbody>
</table>

Resistance profiles of *S. pseudintermedius* isolates (left column), and number of isolates with each profile (right column). Penicillin (PEN), ampicillin (AMP), oxacillin (OXA) with 2% NaCl, erythromycin (ERY), clindamycin (CLI), tetracycline (TET), trimethoprim + sulfamethoxazole (SXT), gentamicin (GEN), chloramphenicol (CHL).

Antimicrobial resistance appears to be emerging among *S. pseudintermedius* colonizing healthy dogs in Saskatoon. Although we presume that infections with MRSP are encountered with increasing frequency in our region, these data are not available. Culture and susceptibility testing should be encouraged to aid in the identification of MRSP in veterinary patients and to guide antimicrobial therapy. Methicillin resistance should be suspected when empiric beta-lactam therapy fails to cure *S. pseudintermedius* infections or for isolates demonstrated to be resistant to potentiated penicillins such as amoxicillin + clavulanic acid. Further studies to describe the susceptibility of clinical isolates in this region would be complementary to this investigation.

Acknowledgments

The authors acknowledge Dr. Jordan Woodsworth for sample collection and Champika Fernando for technical support. We also thank the Companion Animal Health Fund for funding this project and providing a fellowship to Roshan Priyantha.

References

in the dog: 
Staphylococcus pseudintermedius

13. 
14. 
16. 
17. 
18. 
22. 
7
6
3 .

Staphylococcus aureus: 
The adaptive resistance of a plastic genome. Cell
MB
B
of Veterinary Medicine Veterinary Teaching Hospital, 2002–2007. Can

van Duijkeren E, Catry B, Greko C, et al. Review on methicillin-
CLSI. VET01-S2 Performance standards for antimicrobial disk and dilution susceptibility tests for bacteria isolated from animals; 2nd informational supplement. Wayne, Pennsylvania: Clinical and Laboratory Standards Institute, 2013.
CLSI. M100-S24 Performance standards for antimicrobial susceptibility testing; 24th informational supplement: Clinical and Laboratory Standards Institute, 2014.
EUCAST. European Committee on Antimicrobial Susceptibility Testing breakpoint tables for interpretation of MICs and zone diameters, 2014.
Case Report Rapport de cas

The use of dexmedetomidine continuous rate infusion for horses undergoing transvenous electrical cardioversion — A case series

Charlotte Marly-Voquer, Colin C. Schwarzwald, Regula Bettschart-Wolfensberger

Abstract — Five horses were presented for treatment of atrial fibrillation by transvenous electrical cardioversion (TVEC). A dexmedetomidine infusion was administered for sedation during positioning of the cardioversion catheters, and continued during general anesthesia. Shocks were applied until return to sinus rhythm. Dexmedetomidine infusion provided excellent conditions for TVEC catheter placement and procedure.

Résumé — Utilisation d’une perfusion continue de dexmedetomidine lors de cardioversion électrique transveineuse chez le cheval: une série de cas. Cinq chevaux présentant une fibrillation atriale ont été traités par cardioversion électrique transveineuse (TVEC). Pour le positionnement des cathéters de cardioversion, les chevaux ont reçu une perfusion de dexaméthomidine, poursuivie pendant l’anesthésie générale. Les chocs électriques sont répétés jusqu’au retour en rythme sinusal. La perfusion de dexaméthomidine a fourni d’excellentes conditions pour le positionnement des cathéters et la procédure de TVEC.

(A traduit par les auteurs)

Atrial fibrillation is one of the most common pathologic cardiac arrhythmias diagnosed in horses and significantly impairs performance capacity. Medical treatment with quinidine can be attempted in these cases, but transvenous electrical cardioversion (TVEC) is becoming more popular as an alternative treatment, considering the frequent adverse effects of quinidine and the high success rate of TVEC (1). Despite becoming a more frequent procedure, there are only a few reports of the anesthetic management of these cases (2–4).

Dexmedetomidine is an α2-adrenoreceptor agonist that is gaining interest as part of a balanced anesthetic protocol in equine anesthesia (5–7) as it provides reliable sedation, has a minimum alveolar concentration (MAC) sparing effect, and potentially results in better quality of recovery compared to other balanced protocols used in horses (8,9). Its potential cardioprotective (10,11) and anti-arrhythmic properties (12,13) make it a potentially suitable drug to use as a part of the anesthetic protocol in horses presented for TVEC.

This case series describes the use of a dexmedetomidine constant rate infusion for sedation during instrumentation and as part of a balanced anesthetic protocol for horses undergoing a TVEC procedure for treatment of atrial fibrillation.

Case descriptions

Atrial fibrillation was diagnosed in 3 Warmblood, 1 Shire, and 1 Trakehner horses (Table 1) referred to the Equine Department of the Vetsuisse Faculty, University of Zurich for exploration of poor performance or arrhythmia. The horses were used for pleasure riding, breeding, dressage, or jumping. The exact duration of atrial fibrillation was not known but was estimated to be of at least 1 mo (horse 3) or 4 mo (remaining horses) based upon the medical history. None of the horses had been treated for atrial fibrillation. After a full physical examination, complete blood cell count, serum biochemistry profile including cardiac tropin I concentration (cTnl), and a complete cardiac examination including electrocardiography and echocardiography, the horses underwent a TVEC procedure for treatment of atrial fibrillation.

The signalment and echocardiographic findings for the horses at admission are summarized in Table 1. The horses were fasted for 12 h before the procedure, but water was provided free choice all the time. In the morning of the procedure, all horses received flunixin (Flunixin ad us. vet; Biokema SA, Crissier, Switzerland), 1 mg/kg body weight (BW), IV; sodium penicillin (Penicilline Natrium Streuli; G. Streuli & Co AG, Uznach, Switzerland), 30 000 IU/kg BW, IV; and gentamicin (Genta; CP-Pharma GMBH, Burgdorf, Germany), 9 mg/kg BW, IV, through a previously placed left jugular vein catheter.
bolus dose of dexmedetomidine (Dexdomitor; Janssen Animal Health, Germany), 3.5 μg/kg BW, was prepared in 20 mL of NaCl (NaCl; Fresenius Kabi AG, Switzerland). A dose of 1.75 μg/kg BW, was administered together with butorphanol (Alvegesic 1% forte ad us. vet.; Virbac AG, Glattbrugg, Switzerland), 30 μg/kg BW, slowly intravenously in the box, and then the horses were walked to the procedure room where the remaining dexmedetomidine, 1.75 μg/kg BW, was administered. When the sedation was considered insufficient, additional boluses of 0.5 to 2 μg/kg BW dexmedetomidine were administered to effect (horses 1, 2, 4).

The TVEC procedure was performed in a manner similar to a previously described method (13). However, in contrast to that method, percutaneous catheter introducers (8.5 French; Argon Medical Devices, Athens, Texas, USA) were used for placement of the cardioversion catheters. Catheters were placed with horses standing free in the room, restrained by an experienced handler. To provide a constant level of sedation during the placement of the cardioversion catheters, a continuous rate infusion (CRI) of dexmedetomidine was started at a dose of 1.75 μg/kg BW per hour administered with an infusion pump (Phoenix D; Schoch Electronics AG, Möriken, Switzerland), when an adequate initial sedation was reached in the procedure room. The quality of sedation was assessed by the same experienced anesthetist (RB) in all horses. The criteria that were assessed were head and ear position, head and ear movement in response to external stimuli, and catheter placement, and movement. Sedation was considered adequate when the horse was standing still, had a low head position with drooping ears and lip, and did not react to external stimulation. When required, additional sedation was provided by administering dexmedetomidine boluses, with a dose ranging from 0.5 to 2 μg/kg BW and the rate of the CRI adapted subsequently. Details of the anesthetic drugs and doses used are presented in Table 2. The total dose rates for dexmedetomidine during sedation were calculated by determining the total amount of dexmedetomidine administered as CRI and additional boluses, and dividing it by the total duration of the sedation phase. Placement of the cardioversion catheter was pressure-guided and correct positioning of the catheters in the right atrium and in the left branch of the pulmonary artery was confirmed by echocardiography and thoracic radiography. In contrast to the original description of the procedure (13), thoracic radiographs were obtained before inducing anesthesia.

The catheters were then secured in place, and anesthesia was induced in the same room with ketamine (Narketan; Chassot AG, Basel, Switzerland), 2.2 mg/kg BW, and diazepam (Valium; Roche Pharma, Basel, Switzerland), 0.02 mg/kg BW, IV. After orotracheal intubation with a cuffed endotracheal tube (internal diameter 26 or 30 mm), the horses were positioned on an air mattress in left lateral recumbency and a urinary catheter was inserted. The endotracheal tube was connected to a large animal rebreathing unit (LAVC-2000; JD Medical distributing, Phoenix, Arizona, USA) with an out-of-circuit isoflurane vaporizer. Anesthesia was maintained with isoflurane (Isoflo ad us. vet.; Dr. Graeub AG, Bern, Switzerland) in oxygen and air (FiO2: 0.5). Isoflurane was given to effect in order to maintain a sluggish palpebral reflex. Lactated Ringer’s solution (Ringer-Lactat-Lösung; Fresenius Kabi AG) was delivered at a rate of 5 mL/kg BW per hour. The dexmedetomidine CRI was maintained, and the rate was chosen based on individual rate necessary to maintain an adequate sedation for cardioversion catheter placement (1.75 to 5.3 μg/kg BW per hour; Table 2). Controlled mechanical ventilation was started for each horse with a tidal volume ranging from 6 to 10 mL/kg BW and the respiratory rate was adapted in order to maintain PEEP between 4.5 and 5.8 kPa (35 to 45 mmHg). Monitoring consisted of electrocardiogram, pulse oximetry, capnography, measurement of inhaled and exhaled gas composition, and invasive blood pressure monitoring (Cardiocap 55; Datex Anandic Medical, Schaffhausen, Switzerland). For invasive blood pressure monitoring, a 22-gauge catheter was placed in the right transverse facial artery and connected to a pressure transducer placed at the level of the manubrium, and zeroed at atmospheric pressure. One arterial blood gas was analyzed (iStat; AxonLab AG, Baden, Switzerland) at least 5 min before the first shock was applied. Dobutamine (Dobutrex; Eli Lilly S.A., Switzerland) was started at a rate of 0.5 μg/kg BW per minute and the rate was adapted until the horse had a stable mean arterial blood pressure > 65 mmHg. The Dobutamine CRI was stopped at least 5 min before the first shock was applied. The vital parameters, arterial blood gas results and total dobutamine doses are presented in Table 3.

The TVEC protocol started with a first shock of 100 J and increased in increments of 25 J. The horses required between 6 and 8 shocks to convert to normal sinus rhythm. Mean arterial blood pressures were maintained, except in 2 horses.
where pressures dropped by 15 mmHg during and after application of the shocks. Anesthesia was maintained for another 20 min during which ECG was observed for immediate recurrence of atrial fibrillation, and morphine, 0.1 mg/kg BW, IM was administered. The TVEC catheters and the catheter introducers were removed and the horses were hoisted into a padded recovery stall, adjoining the procedure room. Post-anesthetic sedation consisted of intravenous dexmedetomidine, 1 µg/kg BW for all horses except horse 1, which had exhibited a difficult behavior prior to anesthesia and received a dose of 3 µg/kg BW. The trachea was extubated after 20 min or when a swallowing reflex was observed. Recoveries were uneventful in all horses and the horses were standing between 32 and 47 min after being placed in the recovery box; horses had a recovery score of 1 to 2 of 5. Cardiac troponin I concentrations were measured 6 and 24 h after cardioversion (Table 2; normal < 0.06 ng/mL; 14). Echocardiography and 24-hour Holter ECG monitoring were conducted 1 day and 3 days after successful cardioversion, followed by re-evaluation or telephonic follow-up at regular intervals.

In horse 5, progressive left atrial and left ventricular dilation, occurrence of supraventricular premature beats (13 over 24 h) and large numbers of ventricular premature beats (173 single and 5 couplets over 24 h) over the first day of follow-up after TVEC prompted for treatment with Sotalol (Sotalex 80 mg; Bristol-Myers Squibb, Steinhausen, Switzerland), 1 mg/kg BW, PO, q12h, and Quinapril (Accupro 20 mg; Pfizer, Zürich, Switzerland), 0.25 mg/kg BW, PO, q24h. On day 2 after the TVEC procedure, the horse developed progressive ventricular arrhythmias and clinical signs of dyspnea, pulmonary edema, and restlessness. Intravenous treatment with furosemide, lidocaine, and magnesium sulfate was unsuccessful and the horse died from progressive multiform ventricular arrhythmias. Postmortem examination revealed moderate mitral valve endocardiosis, multifocal endocardial and myocardial fibrosis in the left atrium, multiple endocardial tears in the left atrium and ventricle, and moderate to severe subacute diffuse pulmonary congestion. The cardiac arrhythmias and death may have been the result of the underlying structural cardiac disease; however, an influence of the TVEC procedure cannot be ruled out. Of the remaining horses, 3 were still in normal sinus rhythm 2 y after the procedure and 1 horse was sold and lost to follow-up.

**Discussion**

Although atrial fibrillation is one of the most frequent pathologic cardiac arrhythmias in the horse and its treatment with TVEC is becoming more and more popular, there are only few reports in the literature on the anesthetic management for this procedure. The present case series reports a new safe standing sedation protocol and anesthetic maintenance including dexmedetomidine CRI and inhalational anesthesia with isoflurane, resulting in stable cardiopulmonary function and good quality recovery.

In the normal horse, ventricular filling is dependent on the duration of diastole to maintain cardiac output, as it largely depends on passive blood flow from the venous circulation...
during rapid, early-diastolic ventricular filling. Late-diastolic atrial contraction further contributes to ventricular filling and accounts for 15% to 25% of cardiac output at rest (16). During atrial fibrillation, the uncoordinated depolarization of the atrial myocardial cells results in the absence of an atrial contraction. This can be detrimental to cardiac output, particularly during exercise when heart rates are high, diastole is short and atrial contribution to ventricular filling is crucial to maintain an adequate ventricular preload. High heart rates should generally be avoided in these patients (17).

Transvenous electrical cardioversion consists of the administration of an electrical shock across the atria in order to terminate disorganized electrical activity and restore normal sinus rhythm. There is evidence that this procedure produces cardiomyocyte damage, as can be detected by increased plasma concentrations of cardiac troponins (18).

Dexmedetomidine has a myocardial energy sparing effect at low doses, and at increasing doses, maintains the balance between myocardial oxygen demand and delivery due to its effects on the cardiac α2-receptors (10). In patients with heart disease and possible myocardial injury, these effects may be beneficial. By producing α2-mediated coronary vasoconstriction, dexmedetomidine helps to favor redistribution of blood flow into ischemic regions of the myocardium (19,20). The effect of TVEC on equine myocardium is not described, but previously demonstrated after TVEC in horses leading to sedation and MAC reduction approximate for prolonged sedation in horses, but published dose rates in 24% of the dose rates of medetomidine (6), which consists.

Table 3. Mean and ranges of monitored variables for 5 horses treated for atrial fibrillation, during general anesthesia for transvenous electrical cardioversion. The dobutamine dose is calculated by dividing the total amount of dobutamine received over the entire anesthesia time.

<table>
<thead>
<tr>
<th>Horse</th>
<th>Heart rate (bpm)</th>
<th>Respiratory rate (breaths/min)</th>
<th>ETISO (%)</th>
<th>Mean arterial pressure (mmHg)</th>
<th>pH</th>
<th>pCO2 (mmHg)</th>
<th>pO2 (mmHg)</th>
<th>BE (mEq/L)</th>
<th>Dobutamine (µg/kg per minute)</th>
<th>Duration of anesthesia (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>33 (31 to 36)</td>
<td>6.5 (6 to 7)</td>
<td>1.1 (1.0 to 1.2)</td>
<td>87.1 (81 to 91)</td>
<td>7.4</td>
<td>48</td>
<td>129</td>
<td>7</td>
<td>0.12</td>
<td>55</td>
</tr>
<tr>
<td>2</td>
<td>38 (31 to 49)</td>
<td>5.9 (5 to 6)</td>
<td>1.1 (1.1 to 1.3)</td>
<td>87 (73 to 99)</td>
<td>7.47</td>
<td>38.7</td>
<td>83</td>
<td>1</td>
<td>0.05</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>35 (28 to 41)</td>
<td>6.1 (6 to 7)</td>
<td>0.9 (0.7 to 1.3)</td>
<td>102 (94 to 118)</td>
<td>7.41</td>
<td>38.4</td>
<td>124</td>
<td>0</td>
<td>0.03</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>28 (24 to 36)</td>
<td>6 (4 to 7)</td>
<td>1.2 (1.1 to 1.3)</td>
<td>66 (60 to 76)</td>
<td>7.40</td>
<td>42.5</td>
<td>138</td>
<td>2</td>
<td>0.12</td>
<td>45</td>
</tr>
<tr>
<td>5</td>
<td>39 (31 to 49)</td>
<td>5.7 (3 to 9)</td>
<td>1.0 (0.7 to 1.2)</td>
<td>86.7 (74 to 99)</td>
<td>7.37</td>
<td>46.8</td>
<td>181</td>
<td>2</td>
<td>0</td>
<td>45</td>
</tr>
</tbody>
</table>

bpm — beats per minute; ETISO — end-tidal isoflurane; pCO2 — partial pressure of CO2 in arterial blood; pO2 — partial pressure of oxygen in arterial blood; BE — base excess.
of 50% dexmedetomidine and 50% levomedetomidine, an enantiomer without significant action (27). Therefore it was expected that dexmedetomidine could be dosed following previously described medetomidine protocols (26), using half of the dose of medetomidine. However, the depth of sedation was adjusted to the patients’ needs, judged by an experienced anesthetist, and additional boluses were administered or infusion rates were adjusted as necessary to produce adequate sedation. This resulted in a large variability of loading doses and infusion rates, probably because of the variable temperaments of the horses. Due to the very short-lived effect of the dexmedetomidine, maintenance of adequate depth of sedation seemed more difficult in fractious horses than with other longer acting α-2 adrenoreceptors.

Transvenous electrical cardioversion of atrial fibrillation can profoundly affect cardiovascular function during general anesthesia. During TVEC, when electrical shocks are applied, cardiac output and blood pressure are unstable (3). Nonetheless, during anesthesia, oxygen delivery to the muscles should be maintained to ensure a safe recovery of anesthetized horses. Pretreatment with dexmedetomidine decreases the oxygen demand of the peripheral tissues and increases the tolerance of tissues to ischemic injuries despite a decrease in cardiac output (28). This can be an additional benefit of the use of dexmedetomidine during TVEC in horses.

In the horses presented here, dobutamine was used at very small doses to maintain a stable mean arterial blood pressure above 65 mmHg prior to application of the first electrical shock. It was stopped 5 min before the first shock to avoid potential proarrhythmic effects during the TVEC procedure. As the elimination half-life of dobutamine is about 2 min (29), its influence on cardioversion and subsequent blood pressures was expected to be minimal. Nonetheless, mean arterial blood pressures as well as heart rates stayed within an acceptable range throughout anesthesia. This was likely made possible by being able to decrease the isoflurane to levels below the reported MAC for horses, as a result of the addition of dexmedetomidine.

Dexmedetomidine in the present report proved to be useful, although individual necessary dose ranges were wide. Resulting sedation was good, analgesia appeared adequate, cardiopulmonary function during anesthesia was stable, and the quality of recovery was good. The influence of dexmedetomidine on the outcome of the TVEC has not been determined, but its cardio-protective and energy sparing effects on the myocardium and the peripheral tissues make it an interesting option as a part of the anesthetic protocol.

References


Book Review
Compte rendu de livre

Seizures in Dogs and Cats


This book is a delight to read, and a genuine treasure to add to one’s veterinary textbook collection.

This book was written by a veterinary neurologist who happens to be a former journalist, thus rendering his work one of the most readable veterinary texts ever written. The author states that the book was designed to be read by both veterinarians and interested owners, a truly great idea. This book is accessible to most readers, with or without a veterinary background. Remarkably, there is even an almost raucous sense of humour sweetly inserted into the text — almost unheard of in this genre.

The book is divided into sensible chapters, including: the history of seizures (far more interesting than you might expect), the biology of seizures (thoroughly answering the age-old question of what exactly causes a seizure), the pharmacology of seizure control (including both older and newer medications for seizure treatment), communicating with the client (arguably the most important chapter of all), emergency treatment of status epilepticus (including a handy chart), alternative/holistic treatment of seizures (tempting to skip this one but don’t — the topic is of undue significance to many ill-informed owners), and rounding off with a speculative chapter on the future of seizure control and treatment.

The accompanying website contains a mesmerizing array of videos with concise explanations of specific diagnoses, although it would be helpful to have the list of videos with an identifier (they are listed numerically, with no hint of specific content until one opens the video). Perhaps the next edition (I am certain there will be a next) will include a case study of each video for the more curious among us. The website also contains a glossary and seizure log.

The charts contained in the text are nicely simplified — no busy, unintelligible diagrams to be found here; however, a few of them are clearly not designed to be shown in the black and white format that this book was printed in. Additionally, the copy editor might have cleaned up a few grammar errors sprinkled throughout the book — but these are minor complaints! Overall, the book was truly a pleasure to read from beginning to end.

The author stresses the point that this is the first edition of the first book dedicated solely to seizures, and that a society with distinct seizure protocols and definitions needs to be established by the veterinary community. An excellent suggestion and one that should be acted upon forthwith.

Reviewed by Lisa Watt, DVM, Dewdney Animal Hospital, Maple Ridge, British Columbia.
Aberrant heartworm migration to the abdominal aorta and systemic arteriolitis in a dog presenting with vomiting and hemorrhagic diarrhea

Janet A. Grimes, Katherine D. Scott, John F. Edwards

Abstract — A 2-year-old Dachshund was presented for vomiting and diarrhea. Abdominal ultrasound revealed *Dirofilaria immitis* in the abdominal aorta and an avascular segment of small intestine. The dog was euthanized. Necropsy revealed *D. immitis* in the abdominal aorta and widespread necrotizing arteriolitis. This is a unique presentation of aberrant migration of *D. immitis*.

In dogs, infection with *Dirofilaria immitis* is common, particularly in the southeastern United States (1). The prevalence of *D. immitis* infection in dogs in the United States is 1.4%, with 5.5% prevalence within the state of Texas (1). The prevalence of *D. immitis* infection in Canada has been reported to be 0.16% to 0.18%, with the highest occurrences in southern Ontario and Manitoba (2,3). Common presenting complaints of dogs infected with *D. immitis* include cough, dyspnea, ascites, and exercise intolerance. These signs occur as a result of local damage to the pulmonary arteries and lungs caused by migration and presence of the heartworms, thrombosis, and ensuing inflammation. When this inflammation is chronic or severe, infection may eventually lead to clinical signs of right heart failure (4). Diagnosis of heartworm infection is typically achieved by antigen testing with or without typical radiographic changes, visualization of worms on echocardiography, or visualization of microfilariae in blood. The pathogenesis and clinical impact of heartworm disease has previously been reviewed (4,5).

Aberrant migration of *D. immitis* has been previously reported (6,7). The most common intraocular parasite of the dog is *D. immitis*, and these cases present with anterior uveitis. Aberrant migration to the central nervous system has been documented (8). Few cases of aberrant migration to the left side of the circulatory system have been reported (7,9,10). The purpose of this report is to describe a case of aberrant heartworm migration to the abdominal aorta resulting in systemic arteriolitis and hemorrhagic diarrhea.

Case description

A 5.0 kg, 2-year-old, castrated male Dachshund was referred to the Texas A&M University Veterinary Medical Teaching Hospital for a 6-day history of vomiting and a 3-day history of hematochezia. The dog had been treated by the referring veterinarian with famotidine, maropitant citrate, penicillin, and metronidazole without clinical improvement. The patient had been previously diagnosed as heartworm positive when it was adopted 2 mo prior to presentation, and had received 2 once-monthly doses of ivermectin heartworm preventative. On physical examination, the patient was depressed and icteric. A grade II/VI, left apical systolic heart murmur was ausculted. The remainder of the physical examination was within normal limits.

A complete blood (cell) count (CBC) revealed a normocytic, normochromic, non-regenerative anemia with a red blood cell count of 3.48 × 10¹²/L [reference interval (RI); 5.5 to 8.5 × 10¹²/L], leukocytosis (23.6 × 10⁹/L; RI: 6.0 to 17.0 × 10⁹/L), neutrophilia (16.76 × 10⁹/L; RI: 3.0 to 11.5 × 10⁹/L) with a left shift (1.65 × 10⁹/L bands; RI: 0 to 0.3 × 10⁹/L), monocytosis (1.65 × 10⁹/L; RI: 0.15 to 1.25 × 10⁹/L), and severe thrombocytopenia (7 × 10⁹/L; RI: 200 to 500 × 10⁹/L). A chemistry profile revealed total hypocalcemia (1.93 mmol/L;
RI: 2.33 to 2.95 mmol/L), hypoproteinemia (44 g/L; RI: 57 to 78 g/L), hypoalbuminemia (17 g/L; RI: 24 to 36 g/L), hyperbilirubinemia (150.5 μmol/L; RI: 0 to 13.7 μmol/L), hyponatremia (136 mmol/L; RI: 139 to 147 mmol/L), hypokalemia (2.9 mmol/L; RI: 3.3 to 4.6 mmol/L), and hypochloremia (105 mmol/L; RI: 107 to 116 mmol/L). A coagulation profile revealed an increased partial thromboplastin time (16.4 s; RI: 7.1 to 10.0 s), and low antithrombin (91.7 μg/L; RI: > 114% NHP). D-dimers could not be measured due to icterus.

Thoracic radiographs revealed dilation and blunting of the caudal and right middle pulmonary arteries. The pulmonary parenchyma appeared normal. Mild enlargement of the right heart and main pulmonary artery was noted. Radiographic findings were consistent with pulmonary hypertension and right-sided cardiomegaly caused by heartworm disease. An echocardiogram was performed to rule out caval syndrome. No heartworms were observed.

Abdominal ultrasound revealed heartworms within the abdominal aorta from the level of the diaphragm to both femoral arteries (Figure 1). A segment of small intestine was thickened, hypoechoic, and displayed loss of layering (Figure 2). No blood flow could be demonstrated in this segment with Doppler ultrasound, and it was considered to be avascular. This segment of small intestine, along with the stomach, was fluid-filled and hypomotile, consistent with functional ileus. Infarcts were visualized in the spleen and left kidney.

The dog was euthanized and submitted for necropsy. At necropsy, four 8- to 16-cm long heartworms were present in the abdominal aorta from just cranial to the right renal artery to the iliac bifurcation (Figure 3). These were unassociated with thrombi or intimal fibroelastosis. Three similar filariae were present in the right ventricle and pulmonary artery, also unassociated with thrombi and with minimal intimal fibroelastosis. Ischemic necrosis was noted in the myocardium of the left ventricle. Multiple splenic and left renal infarcts were noted, and the pancreas was hemorrhagic. The mucosa of the urinary bladder had multifocal hemorrhages, and the urine was red. The lungs were rubbery and clear fluid oozed from cut sections, indicating pulmonary edema. Small thrombi were macroscopically visualized in several branches of the pulmonary arteries and this was confirmed histologically. The gastric and intestinal mucosa and serosa were petechiated. Necrohemorrhagic colitis was noted in 2 discrete sections of colon, with a necrohemorrhagic typhlitis. Histologically, mural necrosis of small arterioles was seen with hemorrhagic infarcts in the liver, lung, kidney, pancreas, lung, and heart. This arteriolitis was especially severe in the submucosa and muscularis of the entire gastrointestinal (GI) tract. The arterioles affected were 1 to 3 leiomyocytes thick and the outside diameter of the arterioles never exceeded 120 μm in early stages. Arteriolitis began with fibrinoid necrosis of the media that was later infiltrated by leukocytes (Figures 4 and 5), but minimal inflammation, beyond edema, was seen. Most unusual, was that the lumina of necrotic arterioles did not contain thrombi and remained lined by swollen and hypertrophied endothelium. No macroscopic obstruction was noted, except by the small thrombi.
in the lungs. Few microfilariae were seen histologically. The renal infarcts were acute on histologic evaluation. Glomeruli and tubules were unremarkable with no protein or cellular casts. The brain had small thrombi in capillaries, but no arteriolitis was seen.

Discussion

Aberrant migration of *D. immitis* has previously been reported to involve the eye, brain, and systemic circulation. With typical heartworm infection in the dog, a mosquito bite allows entry of L3 larvae which travel within the subcutaneous tissues and molt into the L4, and then L5 stages. After approximately 100 d, the L5 larvae enter the vascular system and migrate to the pulmonary arteries, where they cause inflammation that leads to endothelial damage and changes within the vascular walls. These changes are characterized by villous myointimal proliferation which leads to narrowing of the vessel. Endothelial damage leads to thrombosis (5). The proposed theory behind the aberrant ocular migration is via direct penetration into the globe by 4th stage larvae (6). Aberrant migration to the central nervous system can present with a multitude of neurologic signs depending on the vessel obstructed by the filaria. One dog with a 3-month history of neurologic signs (seizures, blindness, ataxia, and circling) following administration of arsenamide sodium and diathiazine iodide for heartworm infection was found to have a *D. immitis* worm in the right posterior communicating artery on necropsy; however, no theories were given for the aberrant migration in this case (8). There have been few reports of aberrant migration to the left side of the circulatory system (7,9–11). Most reports on *D. immitis* in the femoral arteries of dogs describe lameness of 1 or both hind limbs (9–11). The largest case series evaluated 5 dogs infected with *D. immitis* in the abdominal aorta and/or femoral arteries (9). All dogs in the study presented with lameness, paresthesia, and/or self-mutilation of the pelvic limbs. A right to left shunt was diagnosed in 2 of these dogs with aberrant migration, and the shunt was thought to be the cause of the systemic involvement. The shunt was diagnosed more specifically as a patent foramen ovale in 1 dog and an aorticopulmonary window in the other (9). Our case is unique in that *D. immitis* worms were in the abdominal aorta and femoral arteries without clinical pelvic limb signs, and the primary clinical signs were GI in origin and associated with widespread arteriolitis.

Necrotizing vasculitis has been reported in a case of aberrant migration of *D. immitis* to the left side of the circulatory system, but was limited to areas where the worms were located (7). In our case, vessel inflammation was limited to arterioles and was widespread. The connection between arteriolitis and the heartworm infection is unclear. In human medicine, a link has been found between various infectious agents and the presence of vasculitis (12–14). Mechanisms postulated for the development of vasculitis from an infectious agent include direct invasion of endothelial cells, immune complex deposition leading to vessel wall damage, and stimulation of autoreactive lymphocytes (12–14). The presence of *D. immitis* in human lungs has been shown to cause pulmonary vasculitis, but this is usually localized (15). In dogs, antigen-antibody complexes formed during heartworm infection can cause glomerulonephritis, leading to proteinuria (16). Presumably, in our case, arteriolitis caused the severe thrombocytopenia, with vessel leakage causing hypoalbuminemia and loss of clotting factors, and may have resulted in the development of the widespread thrombosis and hemorrhagic infarcts in the GI tract that ultimately led to the dog’s clinical signs. Also, it was suspected that the heartworms in the aorta of the dog herein also contributed to thrombosis or obstruction of vasculature to portions of the GI tract and viscera, as typically occurs in the pulmonary arteries with heartworm infection (5).

Directly linking the unique vessel lesion to *D. immitis* is difficult because most cases of vessel inflammation in human and veterinary literature are referred to as vasculitis, and the anatomic site and nature of the vasculitis in reported cases is usually not described adequately. The term vasculitis may refer...
to large or small venous or arterial vessels or both in many published reports. Because arteriolitis is uncommonly described, it is difficult to link it to pathogenesis or agents. Many would assume that any *D. immitis*-associated vessel lesions would be linked to pulmonary hypertension arteriopathy (PHA) described in pulmonary arteries of humans and dogs, and caused by a variety of processes leading to pulmonary hypertension (17). Also, PHA also can cause some arteritis (18). However, the lesion of PHA is different from that of our case, and our subject had multi-organ arteriolitis. The possibility of a second, circulating, infectious agent causing the acute-onset lesion of our dog was considered. Leishmaniasis is associated with widespread “systemic vasculitis” that is seen as necrosis of arterioles in dogs; however, no *Leishmania* organisms were seen, and the lesions in leishmaniasis are associated with pleocellular cuffing not seen in our dog (19). Novel agents such as canine circovirus and canine bocavirus are described to cause vasculitis of small vessels and hemorrhagic enteritis, but again, their lesion is limited to the bowel (20,21). Interestingly, the vessel lesion of canine circovirus is similar to that of our case. Classic, type III immune reactions have been described in dogs exposed to repeated doses of human serum albumin (22,23). This results in lesions similar to the arteriolitis we saw. The lesions seen in our case could have resulted from episodic release of fibrilar antigens. It is possible that release of fibrilae on the systemic side permitted delivery in a more noxious manner. Experiments with soluble dirofilarial antigens may show this to occur, but have not been performed to our knowledge. Finally, fibrilar antigen release may have led to an autoimmune condition like that of Henoch-Schönlein purpura (HSP), a transient, though severe, and treatable disease of children that is characterized by widespread arteriolitis similar to our case (24). Again, being aware that a treatable HSP-like disease syndrome could result from *D. immitis* may provide a more favorable outcome for prepared practitioners. These theories linking *D. immitis* with arteriolitis are as yet unproven and would require further research to substantiate.

How the heartworms crossed to the left side of the circulatory system in this case is unclear. Previous reports have documented probable migration through a cardiovascular shunt (9,10,25) although other reports of aberrant heartworms have not demonstrated evidence of a cardiovascular shunt (8–10,25–27). In the dog in this report, heartworms were in the heart and lungs at necropsy, demonstrating the dog had a right-sided heartworm infection, but no cardiovascular shunts were identified. Therefore, presumably aberrant worm migration resulted in the presence of heartworms in the aorta. Arteriolitis may have played a role in aberrant migration, or may have been the result of aberrant migration.

To our knowledge, this is the first case of aberrant migration of *D. immitis* with systemic arteriolitis and presenting primarily with GI signs. The primarily GI presentation of the dog in this report was atypical for the clinical signs commonly seen with heartworm infection. Aberrant worm migration may have caused thromboembolism that resulted in ischemia and hemorrhage in the GI tract. Thus, it should be known that migration of heartworms in the aorta may cause thrombus formation and may present with primary clinical signs of hemorrhagic diarrhea, as in this case. This dog also had systemic arteriolitis diagnosed on necropsy that further contributed to the coagulation changes and thrombosis. Therefore, heartworm disease with aberrant migration should be considered in dogs with possible heartworm disease that demonstrate signs of hemorrhagic gastroenteritis.

References

Poorly differentiated cutaneous carcinoma of non-sebaceous origin in a 3-year-old Mongolian gerbil (*Meriones unguiculatus*)

Heather Fenton, Maria J. Forzán, Marion Desmarchelier, Meghan Woodland, Soraya Sayi, Cornelia V. Gilroy

**Abstract** — A 3-year-old female gerbil developed a non-healing skin wound due to a malignant neoplasm. Histology, immunohistochemistry (cytokeratin 19 positive; vimentin, estrogen, and progesterone receptor negative), and electron microscopy (no desmosomes or melanosomes) revealed an undifferentiated carcinoma with pulmonary metastasis. Unlike in previous reports, it did not arise from the abdominal pad's sebaceous gland.

**Case description**

A 64-g, 3-year-old, female gerbil (*Meriones unguiculatus*) was presented with a 0.5-cm diameter and 0.2-cm deep draining wound in the left axilla and alopecia on the left front limb (Figure 1A). The lesion had first been noticed by the owners approximately 3 wk earlier. The wound was flushed with sterile saline and cleaned with 4% chlorhexidine gluconate solution (Germi-Stat 4%; Germiphere Corporation, Brantford, Ontario). Radiographs of the left forelimb revealed a soft tissue swelling around the humerus and elbow, as well as a radiolucent region within the proximal radius and ulna (Figure 1B). Based on differential diagnoses of severe ulcerative dermatitis, traumatic dermatitis, or underlying neoplasia, prescribed therapy consisted of meloxicam (Metacam; Boehringer Ingelheim, Burlington, Ontario), 0.5 mg/kg body weight (BW) PO, q12h for 10 d, oral suspension of enrofloxacin (Baytril; Bayer, Toronto, Ontario), 10 mg/kg BW, PO, q12h for 10 d, and silver sulfadiazine cream 1% (Flamazine; Smith and Nephew, St. Laurent, Quebec) topically twice daily for 10 d.

There was poor response to therapy and the lesion worsened into ventral swelling and bruising of the left forelimb, alopecia, and deep ulceration with serous discharge leaking from the caudoventral surface of the wound. The gerbil was unable to bear weight on the front left limb and was bradypneic. A 3 × 1-cm mass was noted on radiographs; it extended from the left submandibular region along the left side of the neck to the left axilla and was multilobulated with many firm regions. Cytological examination of a fine-needle aspirate of the mass revealed primarily clusters of neoplastic cells and fewer inflammatory cells, such as neutrophils and macrophages (Figure 1C). The neoplastic cells were polygonal with little-to-moderate blue mottled cytoplasm occasionally containing small (0.5 to 1 μm in diameter) clear round vacuoles; nuclei were ovoid, with coarse chromatin and distinct, often very large, nucleoli. Anisocytosis and anisokaryosis were moderate to marked, with occasional nuclear molding and bi- or multi-nucleation. Due to poor prognosis, euthanasia by intracardiac injection of pentobarbital sodium (Euthansol; Shering-Plough, Pointe-Claire, Quebec) was carried out under general anesthesia with isoflurane (Isoflurane; Pharmaceutical Partners of Canada, Richmond Hill, Ontario).

On macroscopic postmortem examination, the gerbil was in good body condition with adequate subcutaneous and visceral fat stores and had a 1 × 0.5-cm area of alopecia on the left front limb above the radius/ulna. Beneath the left mandible at the caudoventral thorax and attached to the underlying muscle tissue was a well-circumscribed, firm, tan, multilobulated L-shaped subcutaneous neoplasm. The short portion of the mass (1 × 1.5 cm) was present in the neck, while its long...
portion (3 × 1 cm) extended ventrally and caudally along the external surface of the rib cage; the mass did not reach the umbilical region and was not associated with the abdominal pad. Additionally, the right ovary was grossly enlarged by a pale tan mass 1.5 × 2 cm, or approximately 10 times the diameter of the left ovary (unidentified ovarian tumor). Tissue samples were fixed in 10% neutral buffered formalin (NBF) and processed for histologic examination and electron microscopy (Figure 1D).

Histologically, the neoplastic mass had invaded the dermis and subcutis, was unencapsulated, multilobular, and expansile, and was composed of nests, cords, and trabeculae of polygonal to oval cells with marked anisocytosis and anisokaryosis (Figure 2A). Neoplastic cells had scant, pale, faintly granular eosinophilic cytoplasm and large nuclei often with a single, prominent nucleolus. Tumoral nests and cords were separated by a thick collagenous stroma, as well as multiple small foci of central necrosis infiltrated in some areas by small numbers of lymphocytes, plasma cells, and macrophages. The mitotic rate was 3 per high power (40 ×) field. There was no evidence of myoepithelial differentiation. In the lungs, intravascular metastatic emboli with similar appearance to the subcutaneous mass occasionally spilled into alveolar spaces (Figure 2B). As no histopathological examination of the regional bones was done, it is uncertain whether the radiolucency observed in the proximal radius and ulna was due to neoplastic metastasis.

When immunohistochemical stains were applied to sections of skin infiltrated with tumoral nests (Figure 2C), approximately 90% of neoplastic cells had intracytoplasmic immunopositivity for Cytokeratin 19 (CK19). The healthy overlying epidermis served as a positive internal control and follicular epithelium, sebaceous glands, and surrounding dermal fibrous connective tissue served as negative internal controls (Figure 2D). Neoplastic cells were diffusely negative for melanin pigment (Fontana Masson stain) and for Vimentin C (Figure 2E). The regional dermis was diffusely positive for Vimentin, serving as the internal positive control and the overlying epidermis was diffusely negative, serving as an internal negative control. Neoplastic cells were also diffusely negative for estrogen and progesterone receptors.
(immunohistochemical staining conducted at the Michigan State Diagnostic Laboratory). Electron microscopy (EM) revealed the occasional presence of multiple small nucleoli and several variably sized mitochondria, free and bound ribosomes, and occasional membrane-bound clear vacuoles of varying sizes in the cytoplasm (Figure 1D). Unfortunately, fixation for EM was poor so that intact intercellular junctions were rare and no distinct desmosomes were noted. Based on cytologic, histologic, immunohistochemical, and electron microscopic characteristics, the mass was diagnosed as a poorly differentiated subcutaneous carcinoma of non-sebaceous origin.

The origin of the ovarian tumor was not determined. This tumor was composed of sheets of tightly packed round-to-polygonal cells with scant, slightly pale, granular eosinophilic cytoplasm, and prominent nuclei with 1 to 2 nucleoli. Ovarian tumors, particularly granulosa cell tumors, are not uncommon in female gerbils (1). Differentiation between granulosa cell tumors and luteomas in gerbils is complicated by the common luteinization of granulosa tumor cells and the inconsistent presence of Call-Exner bodies, which are characteristic of human granulosa cell tumors (2). Ovarian tumors in gerbils rarely metastasize and, when they do, metastases seem limited to invasion of adjacent peritoneal viscera (2). Because the histologic morphology of the neoplasm in the ovary was distinct from that of the tumors found in the skin and metastatic foci in the lung, and considering the low probability of an ovarian neoplasm metastasizing to both skin and thoracic viscera, the ovarian tumor in this gerbil was considered distinct from the other tumors and an incidental finding with little to no clinical significance.

The finding of neoplasia in a gerbil is common, as approximately 25% to 40% of gerbils over 2 y of age will develop a tumor (3). Cutaneous tumors, among the most common in gerbils, are reported to arise almost exclusively from the sebaceous...
glands of the abdominal pad (4–6). Tumors of the abdominal pad are more frequently found in males and may have a predominantly sebaceous or squamous cell differentiation. The function of the abdominal pad is mostly related to marking of territory and, in males, it involves after castration (5). Little is known of the behavior of the tumors. The few cases for which such information exists suggest that metastasis does not occur (4,5) and that resection, particularly with concurrent castration, may be curative (5).

The carcinoma found in the skin of this female gerbil was highly pleomorphic, but morphologically and immunohistochemically consistent with an epithelial tumor. Unlike the most common cutaneous tumors described in previous reports, the tumor did not arise from the abdominal pad and had no evidence of sebaceous or squamous differentiation, but appeared instead to be of basal cell origin. Immunohistochemical staining of the tumor and adjacent skin with CK19 resulted in positive staining of the neoplastic cells and adjacent epidermis, but negative staining of the follicular epithelium and sebaceous glands, further supporting the non-sebaceous origin of the neoplasm. The lack of positive staining in the healthy sebaceous glands in this case matches what little is known about cutaneous immunohistochemical characteristics in gerbils. Although sebaceous glands in humans tend to stain positively with CK19, gerbil sebaceous glands seem to be negative to pan-cytokeratin staining, which includes CK19 (6).

Alternative origins for the cutaneous neoplasm, given its location and histologic morphology, include a carcinoma of the apocrine, salivary, or mammary glands. Mammary gland tumors of gerbils are rarely reported in the literature, despite the common occurrence in other small rodent species. Salivary tumors have been reported in mice, sometimes in association with polyoma-virus infection (7,8), but have not been reported in gerbils. The mammary markers used in this case (estrogen and progesterone receptors) were negative, but this does not completely rule out the possibility of a mammary origin for the subcutaneous mass as it is unknown whether healthy mammary gland tissue in gerbils is immunopositive for these markers. Unfortunately, staining for prolactin, to which mammary tumors in other rodents are bilis is immunopositive for these markers. Unfortunately, staining of the follicular epithelium and sebaceous glands, staining of the neoplastic cells and adjacent epidermis, but negative of the tumor and adjacent skin with CK19 resulted in positive evidence of sebaceous or squamous differentiation, but appeared instead to be of basal cell origin. Immunohistochemical staining of the tumor and adjacent skin with CK19 resulted in positive staining of the neoplastic cells and adjacent epidermis, but negative staining of the follicular epithelium and sebaceous glands, further supporting the non-sebaceous origin of the neoplasm. The lack of positive staining in the healthy sebaceous glands in this case matches what little is known about cutaneous immunohistochemical characteristics in gerbils. Although sebaceous glands in humans tend to stain positively with CK19, gerbil sebaceous glands seem to be negative to pan-cytokeratin staining, which includes CK19 (6).

Less likely possibilities include a poorly differentiated squamous cell carcinoma and an amelanotic melanoma. Squamous cell carcinomas tend to include keratinous differentiation and desmosomes formation, neither of which was detected on histopathology or EM (9). Melanoma in gerbils tends to arise in the ear, foot, or base of the tail, and often contains melanin granules visible by Fontanna Masson staining and melanosomes visible on EM (7,9); neither feature was present in this case. A trichoblastic carcinoma was considered, but it is not supported by the immunohistochemical staining: the normal hair follicular epithelium was negative for CK19 staining, whereas the tumor cells were strongly positive.

Another possibility is an oncocytoma, a tumor that characteristically has cytoplasmic eosinophilic granules corresponding to numerous mitochondria. Such a tumor of the parotid gland is rare, but has been previously reported in humans and cats (10,11). Oncocytomas have also been reported in the pinnæ of rats, as well as in many locations in humans, often associated with glands (thyroid, parathyroid, salivary, and lacrimal glands) (10,12). The exact cellular origin of oncocytotes is not understood, although it is thought to be epithelial. The tumors tends to be benign in humans, although rare malignancies have been reported (10). The final consideration of cellular origin, albeit unlikely given the lack of specific evidence, was a salivary gland tumor, which has not to our knowledge, been previously reported in a pet gerbil. Salivary gland tumors are rare in veterinary species, with an overall incidence of 0.17% in dogs and cats (13). Although salivary-specific markers are available for human tumors, none has been validated for use in veterinary species (14).

This report describes an undifferentiated carcinoma in a female gerbil that did not arise from the sebaceous glands of the abdominal pad, as is common in the species, and illustrates the value of using immunohistochemical staining as part of the diagnostic protocols for non-domestic species.

Acknowledgments
The authors extend special thanks to the diagnosticians, veterinary students, and intern who helped us with this case, including Dr. Matti Kiupel, Aimee Elson, Dr. Letitia Chow, and Sarah Mouri, and to Kathy Jones who conducted some of the immunohistochemical staining. The authors also thank the anonymous reviewer whose comments helped to improve this manuscript.

References
Outbreak investigation of porcine epidemic diarrhea in swine in Ontario

Tim Pasma, Mary Catherine Furness, David Alves, Pascale Aubry

Abstract — Porcine epidemic diarrhea virus was first diagnosed in Ontario in January of 2014. An outbreak investigation was conducted and it was hypothesized that feed containing spray-dried porcine plasma contaminated with the virus was a risk factor in the introduction and spread of the disease in Ontario.


In January of 2014, porcine epidemic diarrhea virus (PEDV) was diagnosed in a swine herd in southwestern Ontario (1,2). Porcine epidemic diarrhea had not been previously diagnosed in Canada but was reported in the United States in May of 2013. Following the initial discovery, another 62 cases of PEDV were diagnosed between January 22, 2014 and July 21, 2014.

An outbreak investigation was conducted by veterinarians at the Ontario Ministry of Agriculture, Food and Rural Affairs to describe the outbreak of PEDV in Ontario and to generate hypotheses regarding the origin and spread of the outbreak. The investigation was conducted between January 23 and July 21, 2014, and consisted of 3 components: an outbreak investigation survey of cases with an in-depth investigation into the first 6 cases; environmental surveillance from transport trailers, processing plants, and an assembly yard; and feed testing based on results of the survey of the initial cases.

Outbreak investigation survey

The outbreak investigation survey (available upon request) was designed based on a similar survey conducted in the United States (3). The survey collected information pertaining to the premises, characteristics of the facility and the herd, feed sources, and clinical presentation of the disease. Records of movements were compiled for animals, humans, feed, equipment, and other potential fomites moving on and off the farm during the 2-week period prior to the onset of clinical signs of disease or a positive PEDV RT-PCR test. Veterinarians, either government, private or both, interviewed producers using the survey.

Information was compiled on 25 of the first 28 cases that occurred from January 22 to February 28, 2014 (Table 1). In 3 of the 28 cases there was no response to requests for an interview. Due to limited human resources, information collected on the 3 non-respondents and the next 35 cases was limited to date of diagnosis, county, and production type. The next 35 cases occurred from March 4 to July 21, 2014. A summary of the 63 cases by production type is presented in Table 2.

Spatiotemporal characteristics

The investigation revealed that the outbreak affected farms across a widespread area and within many counties in Ontario (Figure 1). The largest number of cases was reported in Bruce, Huron, Middlesex, Oxford, and Perth counties.

Cases were significantly clustered in relation to controls to the 1st and 4th nearest neighbor. Case and control data were loaded into cluster detection and analysis software (ClusterSeer 2.5.1; Biomedware, Ann Arbor, Michigan, USA). A Cuzick and Edwards’ statistic (4) was calculated and the Statistical Distance Test was significant as well as the test for the 1st and 4th nearest neighbor (Table 3), indicating that cases were more likely to neighbor cases than controls. This clustering could reflect spread between neighboring farms (1st nearest neighbor) and spread within a production system as pigs move from farrowing.
Table 1. Proportion of case farms with and without exposure to the factor, PEDV in Ontario, January 22 to February 28, 2014

<table>
<thead>
<tr>
<th>Factor</th>
<th>First 28 cases</th>
<th>Last 35 cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sows and gilts (n = 18)</td>
<td>70 (0.38)</td>
<td>25 (0.15)</td>
</tr>
<tr>
<td>Pigs 21 to 65 days old (n = 18)</td>
<td>117 (0.65)</td>
<td>46 (0.28)</td>
</tr>
<tr>
<td>Pigs 65 to 120 days old (n = 12)</td>
<td>172 (0.81)</td>
<td>66 (0.39)</td>
</tr>
<tr>
<td>Average percent of pigs sick</td>
<td>38 (range 0–100)</td>
<td>15 (range 0–100)</td>
</tr>
<tr>
<td>Average percent of pigs dead</td>
<td>5 (range 0–100)</td>
<td>2 (range 0–100)</td>
</tr>
</tbody>
</table>

Table 2. Production type of case farms, PEDV in Ontario, January 22 to July 21, 2014

<table>
<thead>
<tr>
<th>Production type</th>
<th>First 28 cases</th>
<th>Last 35 cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farrow-to-finish</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>Farrow-to-feeder</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Nursery</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Wean-to-finish</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Finisher</td>
<td>0</td>
<td>21</td>
</tr>
</tbody>
</table>

Clinical presentation

Sows and piglets in the farrowing rooms were most severely affected by the disease, although clinical signs were variable across farms. Average morbidity and mortality rates were calculated based on data reported by producers who were interviewed (Table 1). Sows presented with clinical signs of anorexia, diarrhea, occasional vomiting and negligible mortality, while nursing piglets had clinical signs of diarrhea, vomiting, and an average mortality of 53%. Older animals, including starters, growers, and finishers, had mild clinical signs of disease including anorexia and diarrhea with an average morbidity of 29% to 40% and average mortality of 1% to 2%. Onset of the disease was variable; most farms reported a sudden onset of clinical signs although a few reported gradual onset. On 1 finisher farm, animals co-infected with other diseases experienced an increased mortality of 5%.

On average, herds recovered from the illness approximately 3 wk after onset and took longer to recover when ground intestinal material was used as a method of feedback to help develop herd immunity. A follow-up survey was conducted approximately 1 mo after the onset of clinical signs to determine the clinical progression of and recovery from disease (available upon request). Fifteen producers were questioned regarding clinical signs in their affected herd and the date on which they thought their herd had recovered from the disease. The average duration of illness was 19 d, although 3 producers reported ongoing effects from the outbreak (Table 4). Producers were also questioned on whether they used fecal material or ground intestine as a method of feedback. Herds that used ground intestinal material took almost twice as long to recover from the illness (19.6 d) compared with herds that used fecal material only (10.6 d). This difference was almost statistically significant (P = 0.054), although the sample size was small (n = 10).
As the outbreak progressed, more finisher than farrowing farms became affected. Most of the first 28 cases were farrow-to-finish farms, while the last 35 cases were predominantly finisher farms (Table 2). This could be attributed to a different type of exposure, previously infected animals moving through the production system, breaches in on-farm biosecurity, or vehicles contaminated with PEDV entering premises.

Field investigation
An extensive field investigation of the initial 6 cases did not find any common risk factors associated with farm biosecurity, feed transporters, service providers, a rendering company, or livestock haulers. The private veterinarians involved with these 6 cases reported that the farms had excellent biosecurity. Fifteen feed delivery trucks from 3 feed companies were swabbed in 5 places, including the cab step, steering wheel and cab interior, floor mats and pedals, wheel wells, and blower pipe. All of these samples tested negative for PEDV. Two service providers were on the index farm approximately 7 d prior to the initial diagnosis of PEDV. The equipment taken onto the premises was swabbed and tested negative for PEDV. No service providers were reported to have entered the premises of the other 5 cases in the 2 wk prior to the onset of disease. A vehicle belonging to a rendering company was in contact with 10 farms following contact with the index case; this vehicle was swabbed and all samples were negative on testing for PEDV. All farms in contact with this vehicle were notified and asked to monitor for signs of PEDV; no clinical signs consistent with PEDV developed in these herds. Livestock trailers in contact with the first 4 cases were sampled and were negative on tests for PEDV.

Environmental surveillance
Surveillance testing of hog transport and processing networks demonstrated that the virus was not highly prevalent across Ontario. To determine the extent and spread of the virus throughout Ontario, environmental samples were taken between January 24 and March 17, 2014 from transport trailers and hog processing plants handling approximately 85% of the hogs marketed in the province. Trailers were sampled using a protocol modified from one validated for detection of porcine reproductive and respiratory virus (8). After the hogs were

Table 3. Summary of spatial and temporal analyses, PEDV in Ontario, January 22 to July 21, 2014

<table>
<thead>
<tr>
<th>Test</th>
<th>Statistic</th>
<th>P-value</th>
<th>Clustering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cuzick and Edwards’ Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st nearest neighbor</td>
<td>2.932</td>
<td>0.030</td>
<td>S</td>
</tr>
<tr>
<td>2nd nearest neighbor</td>
<td>2.911</td>
<td>0.201</td>
<td>NS</td>
</tr>
<tr>
<td>3rd nearest neighbor</td>
<td>3.055</td>
<td>0.204</td>
<td>NS</td>
</tr>
<tr>
<td>4th nearest neighbor</td>
<td>4.034</td>
<td>0.031</td>
<td>S</td>
</tr>
<tr>
<td>5th nearest neighbor</td>
<td>4.137</td>
<td>0.237</td>
<td>NS</td>
</tr>
<tr>
<td>Statistical Distance Test</td>
<td>5.704</td>
<td>0.009</td>
<td>S</td>
</tr>
<tr>
<td>Modified Cusum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014-02-15</td>
<td>1.456</td>
<td>0.459</td>
<td>NS</td>
</tr>
<tr>
<td>2014-02-07</td>
<td>0.450</td>
<td>0.995</td>
<td>NS</td>
</tr>
<tr>
<td>2014-02-04</td>
<td>0.447</td>
<td>0.998</td>
<td>NS</td>
</tr>
</tbody>
</table>

S — Significant; NS — Not significant.
Treating otitis externa just got easier.

Breakthrough product, innovative dosing

- Two easy doses, one week apart
- Smart gel formulation stays in the ear
- Same dose for any dog, regardless of its size and weight
- Single-dose tube with soft, flexible tip is gentle on a dog’s ears
- Easy application leads to better compliance

Ask your Elanco sales representative about Osurnia™ today.
unloaded, trailers were swabbed using a cloth (Swiffer Sweeper Dry Unscented Sweeping Cloth, Procter and Gamble Company, Toronto, Ontario) soaked in a 90% saline/10% propylene glycol solution. The solution was extracted from the cloth and tested for PEDV using the RT-PCR test. Only 7.5% of 1555 trailers tested had samples positive for PEDV. Producers who shipped hogs on contaminated trailers were contacted and on follow-up testing 3 farms were diagnosed with PEDV.

Environmental sampling, as described previously, was conducted on January 24, 2014 at an assembly yard that had contact with 8 out of 25 cases within 2 wk prior to the outbreak and PEDV was detected in all 10 samples collected. It is not possible to determine the contribution of this contact, if any, to the initial infection with PEDV. This is attributed to the structure of the transport industry in which animals are often congregated at a site prior to movement to a larger yard. This structure provides ample opportunity for mixing of animals from various sources and transmission of pathogens. Further tracing activities were not performed at the assembly yard. In the United States, it was suggested that the transport process (including collection points and vehicles) can be a source of transmission of PEDV if adequate hygiene measures are not implemented (9).

**Feed investigation**

It was hypothesized that spray-dried porcine plasma (SDPP) contaminated with PEDV was a risk factor for the introduction and spread of PEDV in Ontario. The investigation found that 21 out of the 25 cases investigated were associated with shipments of creep or nursery feeds from a single feed company. Samples from these feeds and a batch of imported SDPP used to manufacture the feed were positive for PEDV on RT-PCR testing. The feed also tested positive on RT-PCR testing for transmissible gastroenteritis virus, porcine respiratory coronavirus and the North American strain of porcine reproductive and respiratory virus. The Canadian Food Inspection Agency (CFIA) was notified and subsequently sampled the SDPP and feed, which were sent to the National Centre for Foreign Animal Disease in Winnipeg for testing. Both the SDPP and the feed contained PEDV genetic material, as determined by RT-PCR (10). The CFIA also conducted swine bioassays and found that the SDPP blood plasma contaminated

---

**Table 4. Results of follow-up survey, PEDV in Ontario, January 22 to February 28, 2014**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Response (proportion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Date that the clinical signs appeared in pigs on this farm (n = 15)</td>
<td>January 21 to March 13, 2014</td>
</tr>
<tr>
<td>3.2 Initial clinical signs (n = 15)</td>
<td>diarrhea 15 (1.0) vomiting 4 (0.27) mortality 3 (0.2) anorexia 1 (0.07)</td>
</tr>
<tr>
<td>3.3 Have all the pigs remaining on the site recovered (n = 15)</td>
<td>Yes 12 (0.8) No 3 (0.2)</td>
</tr>
<tr>
<td>3.4 If yes, what was the date the PED illness stopped in this herd (n = 11)</td>
<td>January 30 to April 3, 2014</td>
</tr>
<tr>
<td>Average length of illness (n = 11)</td>
<td>19.1 days</td>
</tr>
<tr>
<td>4.1 What was the date that you began feedback (n = 14)</td>
<td>January 25 to February 21, 2014</td>
</tr>
<tr>
<td>4.2 How did you conduct the feedback program (n = 14)</td>
<td>feces 7 (0.5) intestine 7 (0.5)</td>
</tr>
<tr>
<td>4.3 Did you use a PED vaccine (n = 13)</td>
<td>Yes 0 (0.0) No 13 (1.0)</td>
</tr>
<tr>
<td>Average length of illness by feedback method (n = 10)</td>
<td>Feces 10.6 days (n = 5) Intestine 19.6 days (n = 5)</td>
</tr>
</tbody>
</table>

---

**Figure 2.** Epidemic curve by epidemiological week, PEDV in Ontario, January 22 to July 21, 2014.
with PEDV was capable of infecting inoculated piglets; however, they could not infect piglets with PEDV using the complete feed containing the PEDV-contaminated SDPP (10). Nevertheless, the CFIA's epidemiological assessment provided support for a link between pelleted swine feed containing a contaminated lot of imported SDPP, and the outbreak of PEDV that started in Ontario in January 2014 (Pascale Aubry, manuscript in preparation). However, the role, if any, of spray-dried porcine plasma or pelleted swine feed in general in the epidemiology of PEDV requires further investigation. A recent study demonstrated that complete feed contaminated with PEDV was infective to naïve pigs using natural feeding behavior; however, this feed did not contain any animal by-products and may represent post-processing contamination (11). The feed containing the contaminated SDPP was voluntarily withdrawn from the Canadian market on February 9th, 2014, represented by the dashed line on the epidemic curve (Figure 2). The epidemic curve could suggest an initial peak of cases in non-finisher farms exposed to the contaminated SDPP followed by secondary transmission related to spread between farms. This could also explain the observed shift in the type of hog production system affected (Table 2).

In conclusion, PEDV affected many farms over a widespread area in Ontario without any significant temporal clustering. The disease caused high morbidity and mortality in nursing piglets and had less impact on older animals, although clinical signs were variable across farms. Extensive surveillance of hog transportation and processing networks showed that the virus was not highly prevalent across Ontario at the time of the investigation. An in-depth outbreak investigation of the cases suggested that feed containing PEDV-contaminated spray-dried porcine plasma could be a source of the virus, although a swine bioassay was unable to confirm this link in complete feed.

**Acknowledgments**

The authors thank Dr. Sue Burlatschenko of Goshen Ridge Veterinary Services for assisting the outbreak investigation. The authors acknowledge numerous other individuals involved in this investigation, including staff of the Ontario Ministry of Agriculture, Food and Rural Affairs; and the Animal Health Laboratory, University of Guelph. The authors also thank the many producers and industry partners who participated in and provided information for the investigation.

**References**

No fleas. No ticks. No mess.

Monthly, soft beef-flavoured NexGard for dogs is easy for owners to give and provides strong and consistent efficacy against both fleas and ticks all month long.2

Safe and efficacious for puppies eight weeks of age or older.3

2 NexGard Canadian product label.
3 NexGard is a trademark of Merial. ©2016 Merial Canada Inc. All rights reserved.

Rated #1 in efficacy in a survey by Canadian veterinarians.1
Minimizing the cost of your veterinary education: Saving through expedited student debt repayment

Minimiser le coût des études vétérinaires : économiser en accélérant le remboursement de la dette étudiante

Chris Doherty

In recent months, the issue of student debt has been at the forefront of many discussions within the veterinary community. Economists with the American Veterinary Medical Association (AVMA) have gone so far as to question the return on investment on a veterinary education, given that the average debt load that American veterinary students graduate with has reached $135 000 (1).

In Canada, we are fortunate to typically have substantially lower tuition fees compared to our colleagues south of the border. That being said, many students in this country still graduate with significant debt.

During the fall season of 2015, the Canadian Veterinary Medical Association’s Business Management Program partnered with the respective provincial veterinary medical associations to commission a Survey of Compensation and Benefits for Associate Veterinarians within each province. While the primary purpose of this survey was to gather information on compensation, hours worked, and benefits for associate veterinarians, a number of questions relating to student debt were also asked. In order to standardize the population examined, only data from those respondents who attended a Canadian veterinary college, and paid domestic student tuition, were included in this analysis.

According to the 2015 provincial associate surveys, 75% of Canadian veterinary college graduates between 2013 and 2015 graduated with student debt. Of those with debt, the median owed ranged from $40 000 to $65 000. The median debt of all graduates from 2013 to 2015 was $51 500 (Table 1).
The median annual compensation of all graduates from 2013 to 2015, employed as associate veterinarians, was $71 000. The Canada Revenue Agency (CRA) Payroll Deduction Calculator allows us to accurately estimate a monthly net income (after taxes and deductions) from this median figure for annual compensation (2). Using an annual compensation of $71 000, monthly net income ranges from $4022 to $4368, depending on the province of employment.

Assuming a repayment of $600 (14% to 15% of median net income) and an interest rate of 3.7% [as is currently being advertised by Canadian financial intuitions for veterinary student lines of credit (3)], a recent veterinary graduate paying down their debt of $51 500 can expect to have it paid off after 8.3 years. Holding debt for this amount of time will cost these graduates almost $8500 in interest (Table 2).

By increasing monthly student loan payments by 50%, recent veterinary graduates can save meaningfully on the interest they pay over the course of holding their debt. Paying $900 (21% to 22% of median net income) a month would reduce the time required to pay off a $51 500 student loan to just over 5 years, with approximately $5200 paid in interest. This results in saving more than $3100.

By being even more aggressive and increasing monthly repayment to 100% above the original figure of $600, recent veterinary graduates can earn themselves greater savings. Committing $1200 (27% to 29% of median net income) each month towards paying down a $51 500 student loan, the debt can be erased in less than 4 years, and cost under $4000 in interest; a savings of over $4500.

Dedicating $1200 towards paying down student debt can be a manageable target to strive for, especially with a median monthly net income of over $4000. It will necessitate frugality in other areas, but the payoff in saved interest makes it a worthwhile goal. The added bonus is the mental satisfaction that many people realize from being debt-free.

For many of Canada’s veterinary students, student debt is necessary in achieving their educational goals. By taking an aggressive approach to paying down this debt after graduation, it is possible to save over $4500 in interest payments. Better to keep this $4500 for oneself, rather than handing it over to financial institutions, simply for the privilege of staying indebted for longer.

Table 1/Tableau 1. Median student debt of domestic students at graduation from Canadian veterinary colleges, stratified by year of graduation/Dette moyenne des étudiants canadiens au moment de l’obtention du diplôme dans les écoles de médecine vétérinaire canadiennes, stratifiée selon l’année d’obtention du diplôme

<table>
<thead>
<tr>
<th>Year of graduation/ Promotion</th>
<th>Median student debt at graduation/ Dette étudiante moyenne à l’obtention du diplôme</th>
<th>Number of observations</th>
<th>Number d’observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>$41 500</td>
<td>37</td>
<td>37</td>
</tr>
<tr>
<td>2014</td>
<td>$40 000</td>
<td>51</td>
<td>51</td>
</tr>
<tr>
<td>2015</td>
<td>$65 000</td>
<td>73</td>
<td>73</td>
</tr>
<tr>
<td>Total</td>
<td>$51 500</td>
<td>161</td>
<td>161</td>
</tr>
</tbody>
</table>

Table 2/Tableau 2. Time required and interest paid on $51 500 stratified by monthly repayment amount/Durée du remboursement et intérêts versés sur une dette de 51 500 $ stratifiés selon le montant du remboursement

<table>
<thead>
<tr>
<th>Amount paid per month/ Montant payé par mois</th>
<th>Time required to pay off $51 500 (years)/ Durée du remboursement à 51 500 $ (années)</th>
<th>Total interest paid on $51 500/ Total des intérêts versés sur 51 500 $</th>
<th>Savings realized/ Économies</th>
</tr>
</thead>
<tbody>
<tr>
<td>$600</td>
<td>8.3</td>
<td>$8413</td>
<td>$0</td>
</tr>
<tr>
<td>$900</td>
<td>5.3</td>
<td>$5247</td>
<td>$3166</td>
</tr>
<tr>
<td>$1200</td>
<td>3.9</td>
<td>$3826</td>
<td>$4587</td>
</tr>
</tbody>
</table>

La rémunération moyenne annuelle de tous les diplômés ayant terminé leur cours entre 2013 et 2015 et qui travaillaient en tant que vétérinaires salariés était de 71 000 $. Le calculateur de retenues à la source de l’Agence de revenu du Canada (ARC) nous permet d’estimer avec exactitude un revenu mensuel net (après impôt et déductions) à partir de ce chiffre moyen de la rémunération annuelle (2). En se basant sur une rémunération annuelle de 71 000 $, le revenu mensuel net moyen varie entre 4022 $ et 4368 $, selon la province.

En supposant un remboursement de 600 $ (14 % ou 15 % du revenu net moyen) et un taux d’intérêt de 3,7 % [soit celui offert par les institutions financières canadiennes pour les marges de crédit des étudiants en médecine vétérinaire (3)], un diplômé en médecine vétérinaire récent qui a une dette de 51 500 $ peut s’attendre à rembourser la dette dans un délai de 8,3 ans. Le financement de cette dette pendant une telle durée coûtera à ces diplômé(e)s près de 8500 $ en intérêts (tableau 2).

En augmentant les paiements mensuels de la dette étudiante de 50 %, les diplômé(e)s récents en médecine vétérinaire peuvent réaliser des économies importantes sur l’intérêt versé pendant le financement de la dette. Un paiement de 900 $ (21 % ou 22 % du revenu net moyen) par mois réduira la durée du remboursement d’un prêt étudiant de 51 500 $ à seulement 5 ans et un montant d’environ 5200 $ sera versé en intérêts, pour une économie de plus de 3100 $.

Or, en augmentant les paiements mensuels de 100 % au-dessus du montant original de 600 $, les diplômé(e)s récents en médecine vétérinaire peuvent réaliser des économies encore plus importantes. En s’engageant à verser 1200 $ (27 % à 29 % du revenu net moyen) chaque mois pour rembourser un prêt étudiant de 51 500 $, on pourra payer la dette en moins de 4 ans, avec des intérêts de moins de 4000 $, et ainsi réaliser des économies de plus de 4500 $.

L’affectation de 1200 $ au remboursement de la dette étudiante peut être une cible facile à atteindre, particulièrement si le revenu mensuel net moyen se chiffre à plus de 4000 $. Cela exigera de la frugalité dans d’autres domaines, mais les
économies réalisées sur le paiement des intérêts en valent la peine. De plus, le remboursement de la dette procurera un certain soulagement psychologique.

Pour beaucoup d’étudiants en médecine vétérinaire canadiens, la dette étudiante est nécessaire afin d’atteindre leur objectif au niveau des études. En adoptant une approche accélérée face au remboursement de la dette après l’obtention du diplôme, il est possible d’économiser plus de 4500 $ sur les intérêts. Par ailleurs, il est préférable de garder ce montant de 4500 $ pour soi-même plutôt que de le remettre à des institutions financières simplement pour se prévaloir du privilège d’être endetté plus longtemps.

**References**


**Renvois**


**New Products**

New products

**Nouveaux produits**

Modern Veterinary Therapeutics announces two new products in Canada

Modern Veterinary Therapeutics, LLC announces that the Veterinary Drugs Directorate (VDD) has approved Ketoprofen VTM (ketoprofen injection — 100 mg/mL) and Nerfasin 20TM (xylazine injection — 20 mg/mL) in Canada. Ketoprofen VTM, presented in 100 mL and 250 mL vials, is a nonsteroidal anti-inflammatory agent possessing anti-inflammatory, analgesic, and antipyretic properties. Ketoprofen VTM is approved for use in horses, swine, and cattle. Ketoprofen is the only NSAID approved in Canada with NO milk withdrawal period.

Nerfasin 20TM, presented in a 25 mL vial, is indicated for use in dogs, cats, and cattle when it is desirable to produce a state of sedation accompanied by a shorter period of analgesia.

“Modern Veterinary Therapeutics, LLC is pleased to announce these new approvals in Canada which further expands our line of products for the production animal industry, as well as expanding our veterinary line of sedative and analgesic products.” said Dr. Cuong Tu Ba, President of Modern Veterinary Therapeutics, LLC.

Contact: Modern Veterinary Therapeutics, 18001 Old Cutler Road, Suite 633, Miami, Florida 33157 USA; phone: (407) 852-8039; website: www.modernveterinarytherapeutics.com
1. **B)** Aortic regurgitation from aortic valvular endocarditis and a vegetative lesion is the source of the bounding femoral pulses, which are caused by a large difference between systolic and diastolic blood pressure.

**B)** La régurgitation aortique provenant d'une endocardite valvulaire aortique et une lésion végétative sont la source des pouls féromaux bondissants qui sont causés par une grande différence entre les pressions sanguines systolique et diastolique.

2. **D)** The correct answer is skin biopsy to diagnose zinc deficiency, well-known in the Nordic breeds. The other choices are tests for parasitic and infectious causes, not a nutritional skin disease.

**D)** La bonne réponse est une biopsie cutanée pour diagnostiquer une carence en zinc, bien connue chez les races de chien nordiques. Les autres choix sont des tests pour des causes parasitaires et infectieuses et non pour une maladie cutanée d'origine nutritionnelle.

3. **E)** A majority of feline mammary masses are malignancies; therefore, a “wait and see” attitude would clearly not be appropriate. With feline mammary masses it is typically recommended to remove the entire mammary chain, and with this cat having bilateral involvement, this procedure would be the best choice. Lumpectomy and mammectomy are procedures to be used on occasion in canine patients, but not typically in cats. The response of mammary tumors to chemotherapeutic agents has been frustratingly poor, and cisplatin administration is contraindicated in felines as it can cause fatal pulmonary edema.

**E)** La majorité des masses mammaires chez le chat sont malignes; ainsi, une attitude «d'attendre pour voir» n'est clairement pas appropriée. Avec la présence de masses mammaires chez le chat, il est recommandé de façon caractéristique d'enlever toute la chaîne de glandes mammaires. Chez ce chat qui a une atteinte bilatérale, cette façon de faire est le meilleur choix. La lumpectomie et la mammectomie sont des procédures à utiliser à l'occasion chez le chien, mais non chez le chat. La réponse des tumeurs mammaires aux agents chimiothérapeutiques a malheureusement été très frustrante, et l'administration de cisplatine est contre-indiquée chez le chat puisqu'elle peut causer de l'œdème pulmonaire fatal.

4. **C)** In foals, it is usually associated with gastroduodenal ulceration, while in adults, it is usually associated with pain.

**C)** Chez le poulain, le bruxisme est habituellement associé aux ulcères gastroduodénaux, alors que chez l'adulte, il est habituellement associé à la douleur.

5. **B)** Etiology of umbilical hernias is usually multifactorial and difficult to establish. Risk factors include omphalitis and familial incidence. Genetic predisposition does not always preclude repair. Although sonography is useful, it is not necessary; careful examination can determine most complications and the therapeutic plan. Conservative methods, such as abdominal bandaging, are very successful in repair of smaller, uncomplicated hernias. Complications include dehiscence; this occurs less frequently prior to rumen maturation. The prevalence of umbilical hernias is dwarfed by that of enteritis and pneumonia in calves, and umbilical hernias typically have a better prognosis than either.

**B)** L'étiologie des hernies ombilicales est habituellement multifactorielle et difficile à établir. Les facteurs de risques incluent l'omphalite et l'incidence familiale. Les prédispositions génétiques ne préviennent pas toujours une correction. Même si l'échographie peut être utile, elle n'est pas nécessaire; un examen minutieux peut déterminer la plupart des complications et le plan thérapeutique. Les méthodes conservatrices, tel un bandage abdominal, sont très utiles pour corriger de petites hernies non compliquées. Les complications comprennent la déhiscence, qui se produit moins fréquemment avant le développement du rumen. La prévalence des hernies ombilicales est éclipsée par celles de l'entérite et de la pneumonie chez le veau et les hernies ombilicales ont de façon caractéristique un meilleur pronostic que les deux autres.
Diagnostic Ophthalmology
Ophtalmologie diagnostique

Lynne S. Sandmeyer, Bianca S. Bauer, Bruce H. Grahn

History and clinical signs

A 2-year-old spayed female Cavalier King Charles spaniel was examined at the ophthalmology service at the Western College of Veterinary Medicine for evaluation of a brown mass in the cornea of the left eye. The dog was presented to her referring veterinarian the previous day with acute onset of a red eye and blepharospasm. Topical ofloxacin 0.3% antibiotic solution (PMS-Ofloxacin; Pharmascience, Montreal, Quebec), q6h, and diclofenac sodium 0.1% (Voltaren ophtha; Novartis, Mississauga, Ontario), q8h had been initiated as topical therapy on the left eye prior to presentation. The menace responses, and palpebral, occulocephalic, direct and consensual pupillary light reflexes were present bilaterally. Schirmer tear test (Schirmer Tear Test Strips; Alcon Canada, Mississauga, Ontario) values were 12 and 22 mm/min in the right and left eyes, respectively. The intraocular pressures were estimated with a rebound tonometer (Tonvet; Tiolat, Helsinki, Finland) and were 19 and 14 mmHg in the right and left eyes, respectively. Fluorescein staining (Fluorets; Bausch & Lomb Canada, Markham, Ontario) was positive surrounding the brown structure in the left cornea. On direct examination there was mild conjunctival hyperemia and serous ocular discharge in the left eye. A slightly raised, $2 \times 4$ mm, roughly oval, brown mass was present in the medial cornea approximately 5 mm from the limbus. Mild corneal edema was noted in the cornea between the mass and the limbus. Both corneas contained axially located, round to oval, faint crystalline opacities. Biomicroscopic examination (Osmare 64222; Carl Zeiss Canada, Don Mills, Ontario) revealed the brown mass was superficially located in the corneal stroma. The bilateral axial opacities were consistent with subepithelial lipid deposition. Following application of 0.5% tropicamide (Mydriacyl; Alcon Canada, Mississauga, Ontario) indirect ophthalmoscopic (Heine Omega 200; Heine Instruments Canada, Kitchener, Ontario) examination was completed and did not reveal abnormalities in either eye. A photograph of the left eye at presentation is provided for your assessment (Figure 1).

What are your clinical diagnosis, differential diagnoses, therapeutic plan, and prognosis?

Discussion

The clinical diagnoses were a superficial corneal foreign body of the left eye and associated ulcerative keratitis, as well as mild bilateral corneal dystrophy. Corneal stromal dystrophy is believed to be inherited in the Cavalier King Charles breed (1). The opacities are due to depositions of cholesterol, lipid, and fatty acids within the stroma. In general, corneal stromal dystrophies do not require or respond to medical therapy. Corneal foreign bodies usually present with acute onset of unilateral blepharospasm and tearing. Conjunctival hyperemia and mild surrounding corneal edema are also common. The eye may appear comfortable if the epithelium has healed over the foreign body. The clinical appearance of the foreign material itself is variable; however, plant material is often tan to brown in color.

The differential diagnoses for a brown discoloration of the cornea include: corneal pigmentation, corneal sequestrum, dematiaceous fungal keratitis, melanocytic neoplasia, corneal dermoid, uveal prolapse, and corneal foreign body. Pigmentation of the corneal surface is usually a result of chronic irritation or inflammation such as in chronic ulcerative keratitis, chronic superficial keratitis (i.e., pannus), pigmented keratitis, and...
Corneal sequestrum is most commonly diagnosed in cats; however, there are case reports of this condition in other species including the dog (3,4). The cause of corneal sequestrum is not defined but may involve multiple contributing factors such as chronic irritation related to exposure, desiccation, ulceration, or trauma (3–5). Dematiaceous fungal keratitis of the cornea is rare but can cause a black lesion resembling a corneal sequestrum (6). The most common form of melanocytic neoplasia involving the cornea is limbal melanocytoma which are smooth, pigmented masses that usually have a raised component in the sclera and extend in a shelf-like manner from the limbus into the adjacent cornea (7). Dermoids of the cornea are most commonly located at the limbus, although large dermoids covering most of the cornea have been described. They often contain hairs and other non-corneal tissue, and are present from birth (8). Uveal prolapse occurs with penetrating corneal lesions and is associated with marked uveitis and dyscoria. In this case the clinical appearance and acute onset of clinical signs were most consistent with a corneal foreign body.

There are two basic categories of corneal foreign body: superficial and penetrating. Penetrating foreign bodies may enter the anterior chamber and traumatize intraocular structures, including the lens. Penetrating corneal foreign bodies are best treated by microsurgical techniques which may involve primary corneal repair following removal, in addition to phacoemulsification in cases in which lens capsule disruption has resulted in the potential for development of phacoclastic uveitis. Superficial and penetrating corneal foreign bodies may be removed using various techniques, including dislodging with cotton-tipped applicators, needles, and hydropulsion or extraction using metal forceps (9–11). Removal can often be completed using manual restraint and topical anesthetic eye drops. In some cases sedation or short general anesthesia may be required to provide adequate restraint. Ideally, removal should be completed in an atraumatic fashion as possible to avoid damage to the surrounding and underlying cornea. A cotton-tipped applicator is atraumatic but often not sufficient to dislodge firmly adherent foreign material. Hydropulsion is also very atraumatic and has a high success rate. Use of a needle to remove the foreign body carries a small risk of inadvertent corneal laceration or rupture. Using metal forceps for extraction carries a risk of pushing the foreign body deeper into the cornea making removal more difficult and necessitating microsurgery (10).

Manual restraint was sufficient in this dog due to its quiet temperament. Following application of topical anesthetic (0.5% proparacaine hydrochloride; Alcaine, Alcon Canada, Mississauga, Ontario), a Barraquer eyelid speculum was placed to maintain the eyelids in an open state. Unsuccessful attempts were made to remove the foreign material by brushing it with a cotton-tipped applicator followed by hydropulsion using a 6 cc syringe filled with eyewash solution attached to a 25-gauge needle with the shaft removed. Finally, a 25-gauge needle tip was used to dislodge the foreign body by applying it at an angle roughly parallel to the base of the foreign body and gently lifting it away from the corneal surface. Head loupes were worn to increase magnification by 2× and improve visualization during the procedure. The superficial corneal ulcer that remained after removal of the foreign material was rinsed with eyewash solution. Topical antimicrobial and non-steroidal anti-inflammatory eye drops were continued until the cornea was confirmed to be fluorescein negative at a recheck examination approximately 1 wk later.

Prognosis for superficial corneal foreign bodies is generally excellent. These can usually be removed without need for microsurgery. However, care and attention to provide adequate restraint and apply removal techniques with the minimal amount of corneal trauma are important.

**References**

ERIC HOFFMANN
T 514 695 4114  F 514 695 4926  C 514 889 1580
E eric@uxr.ca  W www.uxr.ca
227G Brunswick Blvd., Pointe-Claire, QC H9R 4X5

Classifieds  Petites annonces

Business Directory

Horsetack Expeditions
Into British Columbia’s Northern Working Wilderness
Now Booking, Expeditions & Base Camps
(June–September)
Veterinary recommended by jleonn@hotmail.com
(519) 326-3171
Experience with horses is useful, but not necessary; Fitness however is mandatory....
www.go2mk.ca…wstawchuk@pris.ca
(http://vimeo.com/user17242253/muskwa-kechika)

Animal Health Laboratory
Full service veterinary diagnostics. State of the art testing and in-house veterinary specialists to provide optimal services to you.

“Working for animal health”
Guelph (519) 824-4120 ext. 54530
Kemptville (913) 258-8520
Email ahlinfo@uoquelph.ca
Website www.ah.uoquelph.ca

DOUGLAS C. JACK – Counsel
• Practice Management Agreements
• Incorporations
• Employment Matters
• Discipline Proceedings and Malpractice Defence
• Buying and Selling a Practice

P 416.367.6389  |  TF 800.563.2595
416.361.2448  |  dcjack@blg.com

Chiron Compounding Pharmacy Inc.
100% Canadian Owned and Operated

F 416.367.6389  |  TF 800.563.2595
416.361.2448  |  dcjack@blg.com
Scots Plaza, 40 King St W
Toronto, ON, Canada M5H 3Y4

Vetlaw

FMS Medical Systems Ltd.
1075 Marine Drive, Suite 104
North Vancouver, BC V7P 1S6
Phone (604) 446-9999
www.fmsmeds.com
Email info@fmsmeds.com

X-Ray: Digital & Analog Ultrasound
ElectroSurgery & Laser Autoclave, Centrifuge & Microscope
Procedure & Surgery Light
Vital Sign Monitor
IV Pump & Warmer
Anesthesia & Surgery Accessories
Stainless Steel & Veterinary Table
Dental Unit & Dental X-Ray

Gallant Custom Laboratories Inc.
Your Canadian Leader for Autogenous Biologics

1425 Bishop St. N. Units 10-13
Cambridge, ON N1R 6J9
Phone: (519) 620-2488
Fax: (519) 620-2489
Toll Free: 1-866-638-5233
E-mail: jackson@gallantcustomlaboratories.com
www.gallantcustomlaboratories.com
**PractiCe One Consulting**

Practice Valuations • Practice Purchase
Practice Sale • Practice Management

Dr. Frank Richardson, DVM, MBA
Veterinary Management Consultant

P.O. Box 176
Western Shore, Nova Scotia
B0J 3M0

Phone: (902) 531-2617
E-mail: frank.richardsondvm@gmail.com
Fax: (902) 531-2618

---

**Introducing a New CVME Conference for Veterinary Healthcare Professionals**

**VETERINARY EDUCATION TODAY**

CONFERENCE & MEDICAL EXPOSITION

**SEPT 29 - OCT 01 | 2016**

**THE INTERNATIONAL CENTRE**

TORONTO

**MARK YOUR CALENDAR TODAY!**

Developed and planned by

**UNIVERSITY OF SASKATCHEWAN**

Western College of Veterinary Medicine

**Featuring:**
- 12 hours of CVME credit
- 3 Keynotes
- 27 Sessions
- Pre-Conference Workshops
- Industry Symposia
- Interactive Exhibit Hall

**REGISTRATION FEES — 2 days**

(opens April 1, 2016)

<table>
<thead>
<tr>
<th>Category</th>
<th>Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veterinarians</td>
<td>$145</td>
</tr>
<tr>
<td>Vet Technicians</td>
<td>$95</td>
</tr>
<tr>
<td>Students</td>
<td>$45</td>
</tr>
</tbody>
</table>

Exhibitor inquiries please contact:
Dan Joyce Tel: 289-789-2229
Email: djoyce@divcomevents.com

www.VeterinaryEducationToday.ca

---

**Reaching Canada’s Veterinarians**

Get your message into

The Canadian Veterinary Journal
For more information contact:
Laima Laffitte
Advertising Manager
Tel.: (613) 673-2659
Fax: (613) 673-2462
e-mail: llaffitte@cvma-acmv.org
MINIMALISM CAN BE MAGNIFICENT.

The ULTRA™ line of 0.5 mL vaccines* offers pet owners exactly what they want for their pet – safe, effective protection with minimal injection volume.

A more comfortable vaccine experience...
now that’s a beautiful thing.

Contact your Boehringer Ingelheim (Canada) Ltd. sales representative to learn more about ULTRA™ Duramune® and ULTRA™ Fel-O-Vax®.

*The ULTRA vaccine line includes ULTRA DURAMUNE and ULTRA FEL-O-VAX.

ULTRA DURAMUNE and ULTRA FEL-O-VAX are registered trademarks of Boehringer Ingelheim Vetmedica, Inc. © 2015 Boehringer Ingelheim (Canada) Ltd.
For over 45 years we’ve partnered with veterinarians who share our passion for bringing out the best in cats and dogs. We know that 1 in every 3 pets suffers from multiple health conditions. That’s why, through nutritional innovation, we are proud to introduce a line of precise solutions you can trust to effectively manage complex cases, without compromise.

Find out more at vet.royalcanin.ca