A rare case of malignant vagus nerve sheath tumor presenting with multiple cranial nerve dysfunction in a dog

Investigation of clinical outbreaks of American foulbrood in honey-bee operations in Saskatchewan

Primary hyperlipidemia with associated ischemic strokes in a West Highland white terrier dog

Factors associated with the adoption of technologies by the Canadian dairy industry

Outcome following surgical stabilization of distal diaphyseal and supracondylar femoral fractures in dogs

Effect of intravenous fluid warming on core body temperature during elective orthopedic procedures

Incidence of incisional complications after exploratory celiotomy in equids affected with enterolithiasis

Teleconsulting in the time of a global pandemic: Application to anesthesia and technological considerations

Influence of abdominal elevation on radiographic measurements of the thoracolumbar interspinous spaces in asymptomatic horses

Ixodes scapularis ticks and Borrelia burgdorferi on Prince Edward Island: Passive tick surveillance and canine seroprevalence

Left-sided dacryostenosis in a dog
Let’s start the conversation today.
sellmypractice@vetstrategy.com • vetstrategy.com
Join now and receive preferred member pricing on Commercial Insurance and Employee Benefits!

Available exclusively to members of the Canadian Veterinary Medical Association. The CVMA Insurance Program offers the most comprehensive and cost-effective insurance protection for you, your employees and your practice.
Neo® Software is brilliantly simple and completely ready to go

Get up and running quickly. Cloud-based and affordable, Neo® Software is built to make switching easy.

Designed for everyone to use with ease. One-click functionality helps staff complete tasks quickly. Integrates with IDEXX diagnostics, top apps, and services, including the SmartFlow Workflow Optimization System.

All the benefits of the cloud. Access your practice information on any internet-connected device, anywhere. Neo Software offers automatic updates and helps reduce IT costs and server needs.

It’s really neat that IDEXX listens to what the users ask for and constantly updates Neo. Support is phenomenal, always very quick. And the built-in training saves me time and ensures that everyone on my team feels confident and comfortable using Neo.

Candice Barber, office manager
Acadian Animal Hospital

Watch the webinar to learn more about Neo Software today  idexx.ca/neo
A rare case of malignant vagus nerve sheath tumor presenting with multiple cranial nerve dysfunction in a dog
Lucile Giraud, Stéphane Lezmi, Eymeric Gomes, Laurent Cauzinille

Investigation of clinical outbreaks of American foulbrood in honey-bee operations in Saskatchewan
Michael W. Zabrodski, Geoff Wilson, Igor Moshynsky, Alexandra Wentzell, Sarah C. Wood, Colby D. Klein, Ivanna V. Koziy, Igor Medici de Mattos, Tasha Epp, Elemir Simko

Primary hyperlipidemia with associated ischemic strokes in a West Highland white terrier dog
Stephen Everest, Gibrann Castillo, Luis Gaitero

Factors associated with the adoption of technologies by the Canadian dairy industry
Murray D. Jelinski, David F. Kelton, Chris Luby, Cheryl Waldner

Outcome following surgical stabilization of distal diaphyseal and supracondylar femoral fractures in dogs

Effect of intravenous fluid warming on core body temperature during elective orthopedic procedures
Robert B.E. Brady, William T. Poppell

Incidence of incisional complications after exploratory celiotomy in equids affected with enterolithiasis
Albert Torrent Crosa, Scott A. Katzman, Maureen E. Kelleher, Jorge E. Nieto, Isabelle Kilcoyne, Julie E. Dechant

Influence of abdominal elevation on radiographic measurements of the thoracolumbar interspinous spaces in asymptomatic horses
Charlène Pigé, Isabelle Masseau, Alvaro G. Bonilla

Ixodes scapularis ticks and Borrelia burgdorferi on Prince Edward Island: Passive tick surveillance and canine seroprevalence
Alexandra H. Foley-Eby, Christine Savidge, Vett K. Lloyd

Left-sided dacryostenosis in a dog
Jamey Erjavec

Effect of intravenous fluid warming on core body temperature during elective orthopedic procedures
Robert B.E. Brady, William T. Poppell

Incidence of incisional complications after exploratory celiotomy in equids affected with enterolithiasis
Albert Torrent Crosa, Scott A. Katzman, Maureen E. Kelleher, Jorge E. Nieto, Isabelle Kilcoyne, Julie E. Dechant

Influence of abdominal elevation on radiographic measurements of the thoracolumbar interspinous spaces in asymptomatic horses
Charlène Pigé, Isabelle Masseau, Alvaro G. Bonilla

Ixodes scapularis ticks and Borrelia burgdorferi on Prince Edward Island: Passive tick surveillance and canine seroprevalence
Alexandra H. Foley-Eby, Christine Savidge, Vett K. Lloyd

Left-sided dacryostenosis in a dog
Jamey Erjavec
Welcoming new hospitals run by veterinarians like you

Join our community of hospitals 24+ years strong

NVA is more than a business partner. We’re your connection to an entire community of DVMs and resources ready to expand the practice you’ve built with a proven strategic plan for keeping your business growing and thriving for many years to come.

We’re equipped to take on your recruitment needs, and we have a 90% DVM retention rate. Our marketing programs are designed so your hospital gets maximum visibility across 70+ digital services and search engines.

We look forward to hearing more about the vision for your practice and welcoming you to our community.

NVA has more than 900 partnerships across the U.S., Canada, Australia, New Zealand and Singapore. Our veterinarians provide a full range of medical and surgical services, while our passionate pet resort leaders embody NVA’s entrepreneurial spirit in assisting pet parents with ongoing care. Our mission is to improve the comfort and well-being of animals everywhere by providing progressive and compassionate care, unifying our community by the love of animals and the people who love them.

Connect with us at 888.767.7755 and info@nva.com or visit us at www.nva.com.
Contents Table des matières

FEATURES RUBRIQUES

EDITORIAL ÉDITORIAL
1033 We are family/Nous sommes une famille
Carlton Gyles

1035 VETERINARY MEDICAL ETHICS DÉONTOLOGIE VÉTÉRINAIRE

THE ART OF PRIVATE VETERINARY PRACTICE L’ART DE LA PRATIQUE VÉTÉRINAIRE PRIVÉE
1115 Fixed and flexible practice communication
Myrna Milani

BOOK REVIEW COMPTE RENDU DE LIVRE
1064 The Story of Lexi, and a Dream that Follows Her
Michael Zigler

NOTICES ANNONCES
1072 New Products
Nouveaux produits

1091 Index of Advertisers
Index des annonceurs

1117 Classifieds
Petites annonces

NEWS NOUVELLES
1039 NEWS NOUVELLES
Heather Broughton, Sophie Perreault

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-acvm.org
Website/Site Web: www.canadianveterinarians.net
www.veterinairesaucanada.net

© Canadian Veterinary Medical Association 2020
L’Association canadienne des médecins vétérinaires 2020

The Canadian Veterinary Journal is indexed or abstracted in:
- AGRICOLA, Biological Abstracts, Capsule Report, Current Contents — Agriculture,
- Derwent Veterinary Drug File, EMBASE/Excerpta Medica,
- Index Veterinarius, Index Medicus, Quarterly Index, Science Citation Index, Small

Photo by/Photo de : Jim McLane, Battleford, Saskatchewan

Typesetting/Typographie
AN Design Communications

Printed by/Imprimé par
Dolcol Print Solutions Group
Ottawa, Ontario

ISSN 0008-5286

Report undeliverable Canadian addresses to:
e-mail: hbroughton@cvma-acvm.org

Subscriptions (2020): Annual, Canada $220 + applicable GST or HST; foreign $235 US; institutional $290. Express subscriptions available. Single issue/back issue: $25 each, institutional single issue = $50.00 + GST or HST, if applicable. (All prices
subject to change.) Missing issues will be replaced if the Subscriptions Office is
notified within 6 months (for requests within Canada) and 1 year (for requests from
abroad) of the issue date. The publisher expects to supply missing issues only when
losses have been sustained in transit and when the reserve stock will permit. Telephone
(613-236-1162) or (1-800-567-2862) and fax (613-236-9681) orders accepted with
a valid Visa or MasterCard number. Please advise the publisher of address changes
promptly.

Abonnements (2020): Annuel, Canada 220 $ + TPS ou TVH en vigueur; pays
étranger 235 $ É-U; prix d’une institution 290 $. Abonnement express disponible.
Anciens numéros (chacun) : 25 $, ancien numéro d’institution 50 $ + TPS ou TVH
en vigueur. Les prix sont sujets à changement sans préavis. Les numéros qui ne sont pas
reçus seront remplacés si l’éditeur en est informé dans les 6 mois (pour les demandes
venant du Canada) et 1 an (pour les demandes venant de l’étranger) suivant la date
de parution. L’éditeur s’engage à remplacer les numéros manquants seulement lorsque
les pertes ont été subies en transit et lorsque ses réserves le permettent. On peut payer
son abonnement par téléphone (613-236-1162) ou (1-800-567-2862), par télécopieur
(613-236-9681) ou par carte de crédit (Visa ou MasterCard). Veuillez aviser le bureau
de l’éditeur de tout changement d’adresse.

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.

The Canadian Veterinary Medical Association holds complete copyright of all articles
within this issue.

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.

L’Association canadienne des médecins vétérinaires détient le droit d’auteur complet
sur tous les articles contenus dans le présent numéro.

Editor-in-Chief/Rédacteur en chef
Dr. Carlton Gyles, Guelph, Ontario

Associate Editors/Rédacteurs associés
Dr. Bruce Grahn, Saskatoon, Saskatchewan
Dr. Wayne McDonell, Guelph, Ontario
Dr. Murray Jelinski, Saskatoon, Saskatchewan

Feature Editors/Rédacteurs des chroniques
Dr. Jangi Bajwa, Burnaby, British Columbia
Dr. Bruce Grahn, Saskatoon, Saskatchewan
Dr. Myrna Milani, Charlottetown, New Hampshire
Dr. Debbie Stoeven, Ayr, Ontario
Dr. Tim Blackwell, Fergus, Ontario

Assistant Editors/Rédacteurs adjoints
Dr. Aylin Attilla, Calgary, Alberta
Dr. Marcio Costa, Saint-Hyacinthe, Quebec
Dr. Robert Friendship, Guelph, Ontario
Dr. Luis Gaitero, Guelph, Ontario
Dr. Emily John, Charlottetown, Prince Edward Island
Dr. Ron Johnson, Guelph, Ontario
Dr. Shawn McKenna, Charlottetown, Prince Edward Island
Dr. Shannon Morrison, Charlottetown, Prince Edward Island
Dr. Javier Sanchez, Charlottetown, Prince Edward Island

Managing Editor/Directrice de la rédaction
Heather Broughton, Ottawa, Ontario

Assistant Managing Editor/Directrice adjointe de la rédaction
Stella Wheatley, Ottawa, Ontario

Editorial Coordinator/Coordonnatrice de la rédaction
Kelly Gray-Sabourin, Ottawa, Ontario

Advertising and Sponsorship Consultant/Consultante, publicité et commandites
Laïma Laffitte, Wendover, Ontario

Published monthly by/
Publication mensuelle de
Canadian Veterinary Medical Association

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

Scotiabank.
Banque Scotia.
Whatever and wherever you practice, the CVMA is with you every step of your way.

We speak for you on veterinary issues of national importance and protect the integrity of our profession.

As a CVMA member, you benefit from...
- Engagement with Government and stakeholders to influence policy decisions
- International relations to provide the Canadian veterinary perspective
- Media/public relations to provide trustworthy information and promote veterinary professionals
- Position statements addressing animal welfare and national veterinary issues
- Member consultations on key veterinary issues
- Leadership initiatives on antimicrobial stewardship and surveillance, cannabinoids, telemedicine
- Administration of national veterinary exams to ensure uniform certification of professional credentials
- Accreditation of veterinary colleges and veterinary technician programs

We provide resources to help you achieve a meaningful career and personal wellness.

As a CVMA member, you benefit from...
- The Canadian Veterinary Journal
- The Canadian Journal of Veterinary Research
- Member e-newsletter ‘Online from 339’
- CVMA national convention and CE
- CVMA National Issues Forum
- CVMA Summit
- CVMA Emerging Leaders Program
- CVMA Canadian Veterinary Reserve
- LifeLearn products (preferred pricing)
- MyVetStore.ca™ CVMA web store solution for clinics
- Practice owner’s economic survey
- Individual practice diagnostic and valuation report
- Provincial suggested fee guide
- Associate compensation and benefits report
- Compensation report for non-DVM staff
- Compensation report for DVMs outside private practice
- Practice management articles and career/business resources
- CVMA specialized group insurance program
- CVMA mentoring program
- VetLaw Online™ legal advice column
- CVMA Green Veterinary Practice and self-audit tool
- Veterinarian health and wellness resources
- Early career DVM resource hub
- Guidelines for the successful employment of new graduates
- Guidelines for the legitimate use of compounded drugs
- CVMA Guidelines for Veterinary Antimicrobial Use (online database)
- Therapeutic decision cascade poster
- Animal abuse resources for practitioners
- Preventive healthcare, nutritional assessment and client education tools and resources
- Animal Health Week, National Tick Awareness Month and Mental Health in Vet Med Awareness Week campaigns

We put money in your pocket to increase your profitability.

As a CVMA member, you benefit from...
- GoodLife Fitness (discount)
- CVMA Petcard™ Program – financing options for your clients
- Moneris™ payment processing services (preferred pricing)
- HRdownloads™ (discount)
- Mont Tremblant SkiMax/GolfMax (discount)
- Hotels worldwide discount program
- The Personal Insurance for home/auto/travel (preferred pricing)
- National and Enterprise car rental (discount)
- Scotiabank® business banking and lending solutions
- Classified ads in The CVJ (discount)
- Clinician’s Brief™ (free global digital edition)
- Plumb’s Veterinary Drugs™ (subscription discount)
- Staples Advantage™ business products
- Adtell® telephone hold service and digital signage (preferred pricing)
- Petro-Canada SuperPass™ fuel/diesel discount
- CVMA Annual Convention (registration discount)
- WSAVA World Congress and WVA Congress (registration discount)

Visit our website or contact us to learn how to get more value from your membership.
Nobivac EDGE™ Lepto4 is the FIRST 0.5 ml leptospirosis vaccine to help prevent mortality and urinary shedding* for dogs of all sizes.

LEPTOSPIROSIS IS A SMALL SIP AWAY

Get full-size protection in a half-size vaccine.

Nobivac EDG™ Lepto4 is the FIRST 0.5 ml leptospirosis vaccine to help prevent mortality and urinary shedding* for dogs of all sizes.

*Shown to be effective against disease, mortality and shedding caused by Leptospira canicola, L. icterohaemorrhagiae, L. pomona and L. grippotyphosa.

© 2019 Intervet Canada Corp. All rights reserved.
Merck® is a registered trademark of Merck Canada Inc.
My ideas about family were formed in my childhood days in Jamaica. I grew up in a small village, one of 7 children to a mom who was an elementary school teacher and a dad who was a foreman with the Public Works Department. My mom became qualified as a teacher by studying at home then taking the required examinations. Her mother lived with us and was a major caregiver. My father supplemented his income by mixed farming — we had a variety of animals (chickens, goats, cows, pigs, horses) in small numbers and we had various crops (bananas, pineapple, potatoes) — all on 10 acres of land. The children all helped on the farm and in the home. There was a lot of love in the family and as children we always knew that we could express and debate our views even when those views were not acceptable to our parents.

Later there would be important family ties that were not based on blood relations. There was no high school in my village and I went to high school 100 km away, where I boarded at an amazing Victorian British high school, which had been founded by the Congregational Church in 1942. I remained at this school for 7 years and bonded with numerous schoolmates — bonds which are still strong today. The school had a unique emphasis on agriculture and all male students had to take agricultural science as a subject. The belief was that it was vital to enrich agriculture with science and make it respectable in a country in which it was important but not popular. Past students get together frequently to reminisce about the good old days and to support one another. There remains an amazing amount of love in the group and we debate fiercely but lovingly.

In 1959 I was fortunate to be accepted into the Ontario Veterinary College (OVC). This marked my entry into another family. Schoolmates (classmates in particular) and faculty were members of this new profession to which I aspired. There was enormous pride in being a member of the OVC. Following graduation, I pursued graduate work at OVC then postdoctoral work in England and Denmark before joining the faculty at Ontario Veterinary College (OVC). This marked my entry into another family. Schoolmates (classmates in particular) and faculty were members of this new profession to which I aspired. There was enormous pride in being a member of the OVC. Following graduation, I pursued graduate work at OVC then postdoctoral work in England and Denmark before joining the faculty at

We are family
Nous sommes une famille

A conception de la famille s’est formée durant mon enfance en Jamaïque. J’ai grandi dans un petit village, et j’étais l’un des sept enfants d’une mère enseignante à l’école primaire et d’un père contremaître au département des travaux publics. Ma mère est devenue enseignante en étudiant à la maison puis en passant les examens requis. Sa mère vivait avec nous et prenait soin de nous. Mon père supplémentait son revenu par la polyculture — nous avions plusieurs espèces d’animaux (poulets, chèvres, vaches, porcs, chevaux) en petits nombres et divers types de cultures (bananes, ananas, pommes de terre), le tout sur 10 acres de terre. Les enfants devaient tous aider à la ferme et à la maison. Il y avait beaucoup d’amour dans la famille et, en tant qu’enfants, nous savions que nous pouvions toujours exprimer et justifier nos points de vue même lorsque ces derniers n’étaient pas acceptables pour nos parents.

Plus tard, j’ai tissé avec d’autres personnes des liens très forts qui ne reposent pas sur la parenté de sang. Comme il n’y avait pas d’école secondaire dans mon village, j’ai dû partir étudier à 100 km de la maison — j’ai donc été pensionnaire dans une formidable institution britannique victorienne fondée par l’Église congrégationaliste en 1942. J’y suis resté pendant 7 ans, et j’ai établi des relations avec de nombreux camarades de classe qui sont encore solides aujourd’hui. À cette école on mettait un accent particulier sur l’agriculture, et tous les étudiants de sexe masculin devaient suivre des cours de sciences agricoles. L’idée était de enrichir l’agriculture avec la science et de rendre le travail agricole respectable dans un pays où elle était importante mais pas si populaire. Les anciens élèves se réunissent encore souvent pour se remémorer le bon vieux temps et pour se soutenir les uns les autres. Il y a beaucoup d’amour dans le groupe, ce qui ne nous empêche pas de débattre de façon vigoureuse, mais toujours amicale.

En 1959, j’ai eu la chance d’être admis à l’Ontario Veterinary College (OVC). C’était le début d’une nouvelle famille. Les étudiants de l’école vétérinaire (en particulier ceux de ma cohorte) et les professeurs faisaient partie de cette
OVC in 1969. I loved teaching and supervising students and conducting research into animal diseases and public health, before retiring in 2005. I have been a part of OVC, and OVC has been a part of me for some 60 years; it is still family to me.

There is much for which I am thankful. I started life with loving, caring parents and a family that was all anyone could hope for. Growing up in rural Jamaica I observed that there were so many people who had very little but lived full and happy lives. My high school years were marked by camaraderie, and learning, not only academic skills, but also social and life skills. Several teachers were dedicated to helping us grow. As a student at OVC I was blessed with classmates who were thoughtful and caring, teachers who were generous and dedicated, leaders who were outstanding role models. Later, I was blessed with faculty colleagues who were kind and caring.

I took on the responsibility of Editor-in-Chief of The Canadian Veterinary Journal (The CVJ) in 2008. In my work with The CVJ I became part of a small family consisting of the journal staff, the editors, and members of the editorial committee — coworkers who are not only highly competent but also caring and supportive.

I am proud to be part of a profession whose characteristics include not only high technical competence but also compassion and caring for animals and people. During my travels, and at various meetings, I had the privilege of meeting veterinarians from all over the world. I always felt a close kinship with them as members of my veterinarian family. Family involves a genuine concern about the welfare of each other, being able to talk with each other about difficult subjects, to disagree without being hostile, and most of all being loving towards each other. Love, compassion, trust and support are key elements of the family relationship and I am grateful to my profession and the numerous individuals who have been kind, generous and supportive through good times and bad. If we think of each other as family this will only strengthen our profession. It is important to remember this, not only during the COVID-19 pandemic, but at all times.

Carlton Gyles

(Opinions expressed in this column are those of the Editor.)
An ethicist's commentary on the role of zoos

The simple but ambivalent answer to this query is “both.” I had a student who got a summer job at the National Zoo in Washington, D.C. His primary task was to shadow visitors and determine how they spent their time. Much to his surprise, most visitors spent more time in the souvenir shop than reading the information signs, by a major order of magnitude, even though the signage had recently been updated! This experience is replicated in the experience of many others. On the other hand, there are some zoologists who were first inspired to their careers by zoo visits.

As a young and ignorant man, I visited many zoos and was struck by the extent to which the animals were listless and depressed — simply lying around in their cages. I was drawn to visit zoos when I was myself depressed. Years later, I realized that my attraction to zoos came from seeing creatures worse off than I was. At one zoo I visited, the giraffes were housed in cages too low for them to stand up.

Such deplorable situations have happily been rectified in the course of society developing greater concern for animal welfare. Outrageous roadside zoos have shrunk in number as visitors grow increasingly disgusted by the animals’ living situations. Zoological societies now accredit and rate zoos, even as televised nature programs provide viewers with a glimpse of the animals’ natural lives.

I know this from personal experience. A few years ago, I began to serve on the American Humane Association’s newly formed committee for carefully accrediting zoos. There is no question that the bad publicity generated by negative reports have affected both zoo managers and the general public.

To return to our original question, it appears that the general public will not tolerate small, cramped quarters for animals that do nothing to respect their needs and natures. It is for this reason that many zoos have updated their animal facilities. For members of the general public who increasingly care about animals, learning about animals is an important component of visiting zoos. On the other hand, there is still a large contingent of “yahoos” who tease, bait, and make fun of the animals. One can fervently hope that as animal welfare occupies a greater component of public consciousness, the educational component of zoos will assume greater prominence as people realize that learning about the animals is as important as watching them. This, in turn, can provide a major boost to concern about threatened species, and lead to greater welfare and conservation thinking in the minds of subsequent generations.

Bernard E. Rollin, PhD

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 — October 2020

Male chicks are a by-product of the modern egg industry. Unable to lay eggs and unsuitable for the broiler industry, male layer chicks are incubated and hatched out, only to be culled as day-olds. In Canada and the United States, maceration is the most common method of euthanasia, providing instantaneous death. While this may provide a humane death, the practice is cited as a welfare concern among animal activists, consumers, and industry. Significant efforts have been made in Canada and the United States to develop commercial egg sexing technologies that would allow for the elimination of this practice, but none have proven economically feasible. Is it ethical to hatch out chicks with the intention of euthanizing half of them? If dual-purpose breeds are less efficient as both layers and broilers, is it ethical to raise these despite the associated additional inputs/costs?

Submitted by Megan Allore, Montreal, Quebec

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.

Question de déontologie du mois — Octobre 2020

Les poussins mâles sont un sous-produit de l’industrie moderne des œufs. Incapables de pondre et ne convenant pas à l’industrie des poulets de chair, les poussins mâles sont abattus à l’âge d’un jour. Au Canada et aux États-Unis, la macération est la méthode d’euthanasie la plus courante. Bien que cette méthode entraîne une mort instantanée jugée sans cruauté, elle soulève des préoccupations en matière de bien-être animal chez les défenseurs des droits des animaux, parmi les consommateurs et au sein de l’industrie. Des efforts importants ont été faits au Canada et aux États-Unis pour développer des technologies commerciales de sexage des œufs qui permettraient d’éliminer cette pratique, mais aucune ne s’est avérée économiquement réalisable. Est-il éthique de faire éclorer des poussins avec l’intention d’en euthanasier la moitié? Si les races à double usage sont moins efficaces pour la production d’œufs et de viande, est-il éthique de les élever malgré les intrants et les coûts supplémentaires que cela implique?

Question soumise par Megan Allore, Montréal, Québec

Critical Care Animal Testing Made Simple

Introducing a new generation veterinary critical care analyser that combines the revolutionary micro-electronics of the consumer world with Nova Biomedical’s innovative MicroSensor Card™ for a simple, small, fast and less expensive analyser.

22 Test Stat Menu
- pH, PCO₂, PO₂, Na, K, CI (Ca, Mg, TCO₂), Glu, Lac, Urea
- Creat, Hct, Hb, SO₂%, O₂Hb, COHb, MetHb, HHb, HbF, tBil

- New tests added for urea, creatinine, ionized magnesium

- New disposable, maintenance-free co-oximeter technology

- Maintenance-free measurement sensors

- Automated liquid quality control

- Bidirectional connectivity with remote review and remote control

- Comprehensive cybersecurity protection

Compact Size

Height: 18.2 in (45.7 cm)

Width: 14.2 in (35.6 cm)

Depth: 15.5 in (39.1 cm)

For more information contact

NOVA BIOMEDICAL CANADA, LTD
17 - 2900 Argentia Road, Mississauga, Ontario L5N 7X9 Canada

TEL: (905) 567-7700 (800) 263-5999 Fax: (905) 567-5496
e-mail: info@novabio.ca

FOR PERSONAL USE ONLY
1. An 8-month-old intact female German shepherd, recently in estrus, presents with acute weight-bearing lameness. Pain is elicited on palpation of the femur, and radiographs show areas of increased density and an accentuated trabecular pattern within the medullary cavity. Which of the following is the most likely diagnosis for this patient?
   A. Elbow dysplasia
   B. Panosteitis
   C. Hypertrophic ostearthropathy
   D. Hypertrophic osteopathy

2. A 2-week-old puppy has acquired the L1 stage of heartworm from which of the following sources?
   A. It is not possible for a 2-week-old puppy to acquire this stage of heartworm.
   B. Milk transmission
   C. Infective mosquito
   D. Flea or lice transmission
   E. Placental transmission

3. A healthy, 1-year-old intact male dog is examined, and the incidental finding is made of a soft swelling in the scrotum. The most likely diagnosis is which of the following?
   A. Orchitis
   B. Testicular torsion
   C. Contact dermatitis
   D. Scrotal hernia

4. A 15-year-old mare has intermittent fevers, severe weight loss, ventral edema, and regional lymphadenopathy. This leads to a high suspicion of which of the following diagnoses?
   A. Multicentric lymphosarcoma
   B. Gastric ulceration
   C. Abdominal abscess
   D. Cecal dysfunction

1. Une chienne berger allemand âgée de 8 mois, non stérilisée, récemment en œstrus, présente une boiterie aiguë à l’appui. La palpation du fémur provoque la douleur et les radiographies révèlent des régions d’augmentation de la densité osseuse et une accentuation des travées osseuses dans la cavité médullaire. Lequel des diagnostics suivants est le plus probable?
   A. Dysplasie du coude
   B. Panostéite
   C. Ostéodystrophie hypertrophique
   D. Ostéopathie hypertrophique

2. Comment un chiot âgé de 2 semaines pourrait-il avoir des larves L1 du ver du cœur?
   A. Il n’est pas possible pour un chiot âgé de 2 semaines d’avoir des larves L1 du ver du cœur.
   B. Transmission par le lait
   C. Transmission par un moustique
   D. Transmission par les puces ou les poux
   E. Transmission par le placenta

3. Durant l’examen d’un chien mâle entier âgé de 1 an en bonne santé, on fait la découverte imprévue d’une enflure molle dans le scrotum. Lequel des diagnostics suivants est le plus probable?
   A. Orchite
   B. Torsion testiculaire
   C. Dermatite de contact
   D. Hernie scrotale

4. Une jument âgée de 15 ans présente de la fièvre intermittente, une perte de poids importante, de l’œdème ventral et une lymphadénopathie régionale. Ces signes conduisent à une forte suspicion de laquelle des affections suivantes?
   A. Lymphosarcome multicentrique
   B. Ulcération gastrique
   C. Abcès abdominal
   D. Dysfonction cœcale

Quiz Corner
Test éclair

Quiz Corner is generously sponsored by Dechra
Le Test Eclair est généreusement commandité par Dechra

Dermcare Malaseb®
Medicated Shampoo for Dogs and Cats
2% Chlorhexidine Gluconate / 2% Miconazole Nitrate

Now Available in Canada!
5. Which of the following does NOT explain why Johne’s disease is difficult to eradicate?
A. Insensitivity of commercially available tests
B. Long incubation time
C. Fecal shedding in clinically normal cattle
D. Environmental tolerance
E. Nonspecific clinical signs

(See p. 1105 for answers./Voir les réponses à la page 1105.)

Tips to Help your Clients Manage Cat Allergens at Home

As millions of Canadians continue to spend record amounts of time at home, it also means spending unprecedented amounts of time with their pets. For cat owners who have sensitivities to cat allergens, this can create unforeseen challenges.

Dr. Ebenezer Satyaraj, immunologist for Nestlé Purina Research and lead investigator on the research that led to the development of Pro Plan LiveClear, caught up with us to provide vets and clinic staff with some tips for clients who are looking to manage their cat allergens at home.

Dr. Satyaraj had four tips to share with our readers who are looking to help their clients manage cat allergens at home.

1. Vacuum and dust regularly
It’s best to vacuum carpet at least twice a week and make sure to focus on spaces where cats play and lay frequently, including below furniture and the furniture itself. This ensures even those cozy corners get clean and don’t become a hot spot for allergens.

2. Change your cat’s diet
When cats groom themselves, the major cat allergen called Fel d 1 is transferred to the hair and skin through saliva. The allergen eventuallylands in the environment as the cat’s hair and dander shed naturally.

Available in Canada as of October, vets can suggest their clients try Purina Pro Plan LiveClear, the first and only cat food that reduces the allergens in cat hair and dander. Instead of trying to manage the allergen once it’s already in the environment, the allergen is neutralized at its source in the cat’s mouth. When cats eat the food, the key ingredient — a specific protein sourced from eggs — binds to Fel d 1 and safely neutralizes it. In a published study, the food was shown to reduce the allergens in cat hair and dander by an average of 47%, starting in the third week of daily feeding.

3. Groom and brush your cat
Regularly groom or brush your cat, particularly if they are prone to matted hair. The act of grooming reduces loose hair and thereby reduces the overall allergen load.

4. Wash household items
Consider making a habit of washing bedding and blankets weekly to remove allergens from your home. Be sure to wash all sheets, blankets and pillowcases in hot water! By combining these allergen management strategies, cat owners can better handle their current situations and be closer together with the cats they love.
Annual General Meeting (AGM) & Council Update

The year of the COVID-19 Pandemic: Unfortunately, the Canadian Veterinary Medical Association (CVMA), like many other organizations, had to cancel its 2020 Convention planned for Quebec City. However, in 2021, veterinarians from across Canada will be gathering from July 22–25 at the CVMA Convention in Calgary, in 2022 in Halifax, and in 2023 in Quebec City.

This year all meetings were held remotely, including the CVMA AGM, Council and Executive meetings, meetings with the deans, Registered Veterinary Technologists and Technicians of Canada (RVTTC), Students of the CVMA, and the National Examining Board (NEB). Some 139 members participated virtually in the CVMA’s 72nd AGM. The president, Dr. Melanie Hicks, provided an update on the CVMA’s broad number of initiatives serving the profession. The complete 2019 Annual Report can be found in the July edition of The CVJ, which can be found on the CVMA website. Thank you and congratulations to Dr. Hicks, Council members, all volunteers, and staff for a successful year including the adaptations needed to serve our members during the novel coronavirus outbreak.

The CVMA’s new president, since July 13, 2020, is Dr. Enid Stiles, a small animal practitioner from Montreal, Quebec. Joining Dr. Stiles on Executive are Dr. Louis Kwantes, president-elect; Dr. Chris Bell, vice-president; the new executive member, Dr. Trevor Lawson, and Dr. Melanie Hicks, immediate past-president. A special thank you to Dr. Terri Chotowetz, the former immediate past-president, for her many years on Executive and Council, her dedication to the CVMA, and to the profession in general.

Given the COVID-19 restrictions, the CVMA Award winners were honored in a different way, by video posted through CVMA social media and other platforms. The 2020 CVMA Awards recipients are:

- Small Animal Practitioner Award: Dr. Suann Hosie
- Merck Veterinary Award: Dr. Egan Brockhoff
- Humane Award: Dr. Bettina Bobsien
- Practice of the Year Award: Delaney Veterinary Services Ltd.
- Industry Award: Dr. Daniel Venne
- Life Membership: Dr. Eugene David Janzen
- RVL Walker Award: Ms. Audrey Roy
- President’s Award: Dr. Jack Wilson

Assemblée générale annuelle (AGA) et mise à jour du Conseil


Cette année, toutes les réunions ont eu lieu à distance, y compris l’AGA et les réunions du Conseil et du Comité exécutif, ainsi que les réunions avec les doyens, l’association des Technologues et techniciens vétérinaires agréés du Canada (TTVAC), le Comité des étudiants de l’ACMV et le Bureau national des examinateurs (BNE). Au total, 139 membres ont participé virtuellement à la 72e AGA de l’ACMV. La présidente, Dʳ Melanie Hicks, a fait le point sur le grand nombre d’initiatives de l’ACMV au service de la profession. Le rapport annuel complet pour 2019 peut être consulté dans le numéro de juillet de La RVC, accessible sur le site Web de l’ACMV. Nous tenons à remercier et à féliciter la Dʳ Hicks, les membres du Conseil, le personnel de l’ACMV et tous les bénévoles pour cette année fructueuse malgré les adaptations nécessaires pour servir nos membres pendant la pandémie.

Depuis le 13 juillet 2020, la nouvelle présidente de l’ACMV est la Dʳ Enid Stiles, médecin vétérinaire en pratique des animaux de compagnie à Montréal, au Québec. Se joignent à la Dʳ Stiles au sein du Comité exécutif le Dʳ Louis Kwantes, président désigné, le D’Chris Bell, vice-président, le D’ Trevor Lawson, nouveau membre exécutif, et la D”Melanie Hicks, présidente sortante. Nous souhaitons également remercier la D” Terri Chotowetz, ancienne présidente sortante, pour les nombreuses années au sein du Comité exécutif et du Conseil ainsi que pour son dévouement à l’ACMV et à la profession en général.

Compte tenu des restrictions relatives à la COVID-19, les lauréats des prix de l’ACMV ont été honorés différemment cette année, c’est-à-dire par une vidéo publiée sur les médias sociaux de l’ACMV et d’autres plateformes. Voici les récipiendaires des prix de l’ACMV de 2020 :

- Prix du praticien des petits animaux : D” Suann Hosie
- Prix vétérinaire Merck : D” Egan Brockhoff
- Prix humanitaire : D” Bettina Bobsien
- Prix de la pratique de l’année : Delaney Veterinary Services Ltd.
- Prix de l’industrie : D’ Daniel Venne
- Membre à vie : D’ Eugene David Janzen
- Prix R.VL. Walker : M” Audrey Roy
- Prix de la présidente de l’ACMV : D’ Jack Wilson
Council meeting

The following are a few excerpts from the wealth of information shared with Council and the discussions held:

National Issues

- **COVID-19 response**: From the outset, the CVMA focused on providing the profession across the country with pertinent, timely and credible information, particularly in the areas of finance, legal, veterinary wellness and COVID, and animal issues. On the latter, the CVMA has been part of the Public Health Agency of Canada (PHAC) led COVID Working Group, including federal and provincial government experts, that provided one reliable voice on COVID and animal-related questions. The CVMA offered weekly interactive Townhall Sessions on evolving issues. All the recorded webinars and information can be found on the COVID-19 section of the CVMA’s website. Upon request of the Canadian Food Inspection Agency (CFIA), the CVMA called up the Canadian Veterinary Reserve (CVR) to assist CFIA with inspection duties in slaughterhouses across Canada.

- **National Veterinary Oversight of Antimicrobials (NVOS)**: NVOS has finished its first year of a 4-year Agriculture and Agri-Food Canada (AAFC)-funded project. The objectives of this project include developing and testing a prototype of electronic collection and analyzing Antimicrobial Use (AMU) prescription data from the major food animal veterinary practices; collecting and documenting alternatives to AMU; expanding the CVMA Prudent Use Guidelines (PUGs) with the addition of equine and aquaculture species; and increasing awareness of AMU stewardship. The current focus of work is on establishing PUGs for the 2 additional species, ameliorating access to the PUGS, and establishing data-warehouseing and collection requirements and options. This project is being developed with the involvement of a broad group of veterinary practitioners and government and private stakeholders.

- **African Swine Fever (ASF)**: Industry groups, veterinarians and governments remain concerned about the significant threat of African Swine Fever. In early 2019 and again in February 2020, during an in-person meeting with CFIA officials that included the Chief Veterinary Officer (CVO), the CVMA offered the assistance of the CVR should the need arise.

  The CVMA is also involved in the CFIA-led ASF Communications Working Group and a Federal-Provincial-Territorial Working Group, which considers depopulation-related issues. In addition, the CFIA worked with the CVMA on the delivery of 2 one-hour webinars offered in September, and to stage a national disease outbreak exercise with a broader stakeholder group. The CVMA has also worked with Animal Health Emergency Management (AHEM) on the promotion of the Foreign Animal Disease (FAD)/foot-and-mouth disease (FMD) recognition and response training that took place from May 4, 2020 to June 1, 2020.

- **Importation of animals**: A project entitled “Identification of Data Sources to Support Risk Assessment of Public Health Implications of Importation of Dogs into Canada” is under

Réunion du Conseil

Voici quelques éléments de toute l’information communiquée au Conseil et des discussions qui ont eu lieu.

Enjeux nationaux


- **Peste porcine africaine (PPA)** : Les groupes de l’industrie, les médecins vétérinaires et les gouvernements restent préoccupés par la menace importante que représente la peste porcine africaine. Au début de 2019 et de nouveau en février 2020, lors d’une réunion en personne avec des représentants de l’ACIA dont le vétérinaire en chef du Canada, l’ACMV a offert l’aide de la RVC si le besoin s’en faisait sentir.

  L’ACMV participe aussi à un groupe de travail sur les communications concernant la PPA dirigé par l’ACIA et à un groupe de travail formé de représentants du gouvernement fédéral et des gouvernements des provinces et des territoires qui évoquent les questions liées à la dépopulation. De plus, l’ACIA et l’ACMV ont collaboré pour offrir deux webinaires d’une heure en septembre et pour organiser un exercice national d’éclosion.
way. This is a CVMA-managed and government-funded initiative, carried out by a university. The project report was targeted to be ready in September and will form the foundation for some further work. In the meantime, the CVMA, PHAC and the CFIA are jointly looking into regulatory means and advocacy/public education regarding the importation of dogs. This issue was recently brought to the attention of the public following an importation of puppies from the Ukraine that resulted in a large number of deaths.

• Lyme disease: The CVMA continues to participate in the Lyme Disease Roundtable led by PHAC. This has led to a proposed collaboration between PHAC and CVMA on raising awareness of tick-borne zoonotic diseases, in addition to activities during the CVMA’s Annual Tick Awareness Month.

• New position statement under development: Service animals.

• Position statements under review: Veterinary telemedicine; surgical procedures performed on animals; aquatic animal veterinary medicine; extra-label drug use; antimicrobial use in animals (being revised and reintroduced); legislation concerning dangerous dogs; microchip animal identification.

Animal Welfare

• New initiatives: Pain Management Initiative; Extreme Breeding Awareness.

• New position statements under development: Surplus neonatal dairy calf management.

• Animal Welfare Issues at Auction Markets: Council approved that the Animal Welfare Committee (AWC) develop a position statement on Animal Welfare issues at Auction Markets with the proviso that relevant species groups (production animals) members be consulted.

• Position statements under review: Pain management in animals; euthanasia of animals; humane mass depopulation of animals; humane slaughter of farm animals; tail docking of sheep; use of animals in science; seal hunt in Atlantic Canada; humane training methods for dogs; use of lead fishing sinkers and lead shot in Canada; and pest control.

• Revisions beginning now: Induced moulting of poultry; disbudding and dehorning of ruminants; and tail docking of dairy cattle.

• Codes of Practice: Cattery code under review; new small mammal code under development.

Other

CVMA Workforce Study 2020: This study provides an outlook for the current supply and demand of veterinary services in Canada. The research was conducted pre-COVID by a consultant and economists and includes post-COVID forecasts. The primary mandate for this research was to examine the equilibrium between supply capacity and demand for veterinary services across the Canadian companion animal, food animal, and equine sectors now and into the future.

A webinar moderated by Dr. Hicks and led by the consultant, Colin Siren, was offered to all CVMA members on June 18. The recorded version can be found on the CVMA website. An Executive Summary was published in the August issue of de maladie avec un groupe d'intervenants plus large. L'ACMV a également travaillé avec la Coalition canadienne pour la santé des animaux dans le cadre du Projet de gestion des urgences sanitaires animales pour la promotion d'une formation sur la détection et l'intervention en cas de maladie animale exotique ou de fièvre aphteuse offerte du 4 mai au 1er juin 2020.

• Importation d'animaux : Un projet visant à identifier des sources de données pour appuyer l'évaluation des risques liés aux répercussions sur la santé publique de l'importation de chiens au Canada est en cours. Il s'agit d'une initiative financée par le gouvernement, gérée par l'ACMV et menée par une université. Le rapport de projet dû en septembre constituera la base de certains travaux ultérieurs. L'ACMV, l'ASPC et l'ACIA étudient conjointement la réglementation et les moyens de sensibiliser et d'éduquer le public concernant l'importation de chiens. Cette question a été récemment portée à l'attention du public à la suite d'une importation de chiots d'Ukraine durant laquelle plusieurs animaux sont morts.

• Maladie de Lyme : L’ACMV continue de participer à la table ronde sur la maladie de Lyme dirigée par l’Agence de la santé publique du Canada (ASPC). Cette participation a mené à une proposition de collaboration entre l’ASPC et l’ACMV pour accroître la sensibilisation aux maladies zoonotiques transmises par les tiques, en plus des activités organisées par l’ACMV pendant le Mois annuel de sensibilisation aux tiques.

• Nouvel énoncé de position en cours d’élaboration : Un nouvel énoncé de position sur les animaux d’assistance est en cours d’élaboration.

• Énoncés de position en cours de révision : Les énoncés de positions sur la télémédecine vétérinaire, les interventions chirurgicales effectuées sur des animaux, la médecine vétérinaire des animaux aquatiques, l’utilisation des médicaments en dérogation des directives de l’étiquette, l’utilisation d’antimicrobiens chez les animaux, les lois concernant les chiens dangereux et l’identification des animaux à l’aide d’une micropuce sont en cours de révision.

Bien-être des animaux

• Nouvelles initiatives : Initiative de prise en charge de la douleur, sensibilisation à la reproduction excessive.

• Nouveaux énoncés de position en cours d’élaboration : Un nouvel énoncé de position sur la régie des veaux laitiers nouveau-nés excédentaires est en cours d’élaboration.

• Questions relatives au bien-être animal dans les encans : Le Conseil a approuvé l’élaboration par le Comité sur le bien-être animal d’un énoncé de position sur les questions relatives au bien-être animal dans les encans, à la condition que les membres des groupes d’espèces concernés (animaux de production) soient consultés.

• Énoncés de position en cours de révision : Les énoncés de position sur la gestion de la douleur chez les animaux, l’euthanasie des animaux, la dépopulation de masse d’animaux de manière non cruelle, l’abattage sans cruauté des animaux de ferme, l’amputation de la queue des moutons, l’utilisation des animaux à des fins scientifiques, la chasse au phoque dans la région atlantique du Canada, les méthodes de dressage sans violence pour les chiens, l’utilisation des plombs pour la chasse...
The CVJ and the full report is accessible to all CVMA members via the website.

NEB: By mid-2020, the National Examining Board received 317 new applications (compared to 406 in all of 2019). COVID-19 largely interrupted the exam process but since mid-June, the North American Veterinary Licensing Examination (NAVLE) and the Basic and Clinical Sciences Examination (BCSE) exams had resumed and by late summer, the 2 clinical exams, the Preliminary Surgical Assessment (PSA) and Clinical Proficiency Examination (CPE), were expected to resume as well. In 2019, about 44% or 277 of the 632 Certificates of Qualifications issued by the NEB were issued to internation-

Ally trained veterinarians, about half of them to graduates from accredited veterinary colleges.

Animal Health Week (AHW): The 2020 AHW will take place from October 4 to 10 with the theme “Understanding Zoonotic Diseases: Community Health — Animals and You.” This campaign will showcase how Canada’s veterinary professionals occupy unique positions within the national One Health community to support the fight against these diseases and how the protection of animal health protects everyone’s health. This campaign will empower the national veterinary community through awareness, recognition, and knowledge of threats, thereby improving public health and animal welfare.

Mental Health: The CVMA’s 2020 campaign, supported by Merck Animal Health, ran from September 6 to 12 and featured another one-hour webinar held on World Suicide Prevention Day, Thursday, September 10. This webinar will help foster better understanding of risk factors for suicide in veterinary medicine and increase awareness about training opportunities for suicide prevention. The CVMA mental health webinars are held quarterly.

Tick Awareness: During March 2020, the CVMA, with support of Merck Animal Health, hosted the 5th Annual National Tick Awareness Month. As in previous years, the CVMA produced communications material and support tools to help veterinary teams communicate with clients. This year’s resources highlighted the unique seasonality of ticks, provided pet parents with updates regarding the expansion of ticks across Canada, and increased awareness of the One Health approach to tick control and Lyme disease prevention.

Business Management Program: The CVMA continues its economic Benchmarking Program that includes valuable practice management tools and resources such as provincial suggested fee guides, compensation and benefits reports for associate veterinarians, non-DVM wage reports, provincial economic reports, and individual practice reports. These reports are based on CVMA’s annual economic surveys. This program is financially supported by IDEXX Laboratories, Merck Animal Health, Petsecure, Scotiabank, and the CVMA.

Diversity and Inclusion: “The Canadian Veterinary Medical Association (CVMA) commits to diversity and inclusion and rejects discrimination or harassment based on grounds such as race, color, ancestry, ethnic origin, place of origin, age, creed, religion, sex, gender identity, family status, marital status, or disability. We affirm that each human being is valuable and deserves to be treated with dignity and respect.
Sensibilisation aux tiques : En mars 2020, l’ACMV, avec le soutien de Merck Santé animale, a organisé la 5e édition du Mois national de sensibilisation aux tiques. Comme les années précédentes, l’ACMV a produit du matériel et des outils pour aider les équipes vétérinaires à communiquer avec leurs clients. Les ressources de cette année ont mis en évidence la saisonnalité unique des tiques, fourni aux propriétaires d’animaux de compagnie des mises à jour concernant l’expansion de la présence des tiques au Canada et accru la sensibilisation à l’approche « Une santé » pour la lutte contre les tiques et la prévention de la maladie de Lyme.

Programme de gestion commerciale : L’ACMV poursuit son programme d’analyse économique comparative qui comprend des outils et des ressources de gestion de la pratique utiles tels que des guides provinciaux des tarifs suggérés, des rapports sur la rémunération et les avantages sociaux des vétérinaires salariés et des employés non vétérinaires, des rapports économiques provinciaux et des rapports sur les pratiques individuelles. Ces rapports sont fondés sur les sondages économiques annuels de l’ACMV. Ce programme est soutenu financièrement par IDEXX Laboratories, Merck Santé animale, Petsecure, la Banque Scotia et l’ACMV.

Diversité et inclusion : L’ACMV appuie la diversité et l’inclusion et rejette la discrimination et le harcèlement fondés sur des motifs tels que la race, la couleur de la peau, l’ascendance, l’origine ethnique, le lieu d’origine, l’âge, la croyance, la religion, le sexe, l’identité de genre, la situation familiale, l’état matrimonial ou un handicap. Nous affirmons que chaque être humain a de la valeur et mérite d’être traité avec dignité et respect.

Le bien-être de notre société et de notre profession est vital. L’ACMV s’engage à continuer à développer ses services et à les rendre accessibles sans parti pris, et à promouvoir la diversité et l’inclusion.

L’ACMV soutient également les programmes existants des écoles de médecine vétérinaire qui encouragent l’inclusivité et la diversité et permettent une sélection équitable des étudiants. Nous appuyons les mesures prises par les associations canadiennes, le gouvernement et les établissements d’enseignement pour rendre la formation vétérinaire plus accessible aux groupes sous-représentés et minoritaires.

Nous soutenons le dialogue ouvert de nos membres sur ces questions et restons unis avec les médecins vétérinaires, les étudiants en médecine vétérinaire et les membres associés des équipes vétérinaires qui font face à la discrimination.


(by Jost am Rhyn, CEO, CVMA)
Happy Animal Health Week!
Veterinary Teams Across Canada Unite to Highlight Zoonotic Diseases!

Bonne Semaine de la vie animale!
Des équipes vétérinaires de partout au Canada s’unissent pour parler des zoonoses!

This month, we celebrate Animal Health Week from October 4 to 10, 2020. The Canadian Veterinary Medical Association (CVMA) is highlighting the importance of understanding zoonotic diseases through the campaign slogan, “Understanding Zoonotic Diseases: Community Health — Animals and You.”

During this Animal Health Week, we are emphasizing that:
• Regular veterinary wellness checks can help protect you, your family, and your pet from zoonotic diseases.
• Zoonotic diseases may be transmitted from animals to people, but they can be easily prevented.
• Always wash your hands after being around animals, even if you did not touch them.
• Talk to your veterinary team for information on zoonotic diseases.

Social media
The CVMA has promoted Animal Health Week for 35 years. We invite you to share your celebrations on Facebook (facebook.com/CanadianVeterinaryMedicalAssociation), Twitter (in English @CanVetMedAssoc and in French @Assoccanmedvet), and Instagram (@cvma.acmv) using the hashtag #AnimalHealthWeek. Please also tag us in your social media posts to be featured in our social media promotions.

The CVMA would not be able to carry out the important educational campaign that Animal Health Week is without the generous support of our sponsors and the dedication of veterinary teams throughout the country. Thank you.

Sponsors
Generous support of the 2020 Animal Health Week campaign is provided by Program Plus Sponsors, IDEXX and Merck Animal Health, and Program Sponsors, iFinance Canada (Petcard), Petsecure, and Virbac.

This month we highlight one of our Program Sponsors, Petsecure Pet Health Insurance:

Petsecure pet health insurance celebrates veterinary care teams as community health champions across Canada during October 4 to 10, 2020.

Médias sociaux
L’ACMV fait la promotion de la Semaine de la vie animale depuis 35 ans. Nous vous invitons à partager vos célébrations sur Facebook (facebook.com/CanadianVeterinaryMedicalAssociation), Twitter (@CanVetMedAssoc en anglais et @Assoccanmedvet en français), et Instagram (@cvma.acmv) à l’aide des mots-clics #AnimalHealthWeek et #SemaineDeLaVieAnimale. Veuillez également nous identifier dans vos publications sur les médias sociaux pour figurer dans nos promotions sur les médias sociaux.

L’ACMV ne serait pas en mesure de mener l’importante campagne de sensibilisation que constitue la Semaine de la vie animale sans le soutien de ses commanditaires et le dévouement des équipes vétérinaires du pays. Merci!

Commanditaires
La campagne de la Semaine de la vie animale 2020 est génèreusement appuyée par les commanditaires principaux IDEXX et Merck Animal Health, et les commanditaires iFinance Canada (Petcard), Petsecure et Virbac.

Ce mois-ci, nous saluons l’un de nos commanditaires de programme, Petsecure assurance maladie pour animaux.

Petsecure assurance maladie pour animaux souligne l’importance des équipes de soins vétérinaires pour la santé des communautés partout au Canada pendant la Semaine de la vie animale. Les médecins vétérinaires ont une perspective intéressante en tant que leaders du savoir dans la lutte contre les zoonoses. Ensemble, l’expertise médicale et la compréhension de la relation entre les humains et les animaux permettent des stratégies d’action intégrées, que les zoonoses soient présentes dans la chaîne d’approvisionnement de la ferme à la table ou à la maison avec les animaux de compagnie.

Les chats et les chiens sont de plus en plus perçus comme des membres de la famille à part entière, et cette réalité crée...
Animal Health Week. Veterinarians have valuable perspectives as knowledge leaders in the fight against zoonotic diseases. Medical expertise combined with understanding the human-animal relationship allows for integrated action strategies whether zoonoses are found in the chain from farm to table or in the home with companion animals.

Cats and dogs are increasingly identified as close family members, and this reality creates the potential for illness transmission between people and their pets. Petsecure is committed to supporting veterinary staff and their canine and feline patients. Doctors and their care teams are in the perfect position to build awareness about both the real and unlikely zoonotic potential of different diseases in their communities. Petsecure products allow veterinarians to examine, diagnose, and treat pets according to individual needs with the peace of mind that financial protection brings to clients. Unlike some pet insurance companies, Petsecure covers examination fees and taxes. Petsecure also provides coverage for zoonotic diseases a dog or cat may develop while the animal is insured under a Petsecure policy*.

“The role of the veterinary team is critical to the One Health concept of community wellness,” says Dr. Colleen Fisher, Petsecure’s Veterinary Medical director. “The successful approach to any particular zoonotic disease must incorporate both the health of animals and the health of people. To highlight that commitment, Petsecure plans include $1000 per policy year for boarding fees where clients are hospitalized and unable to care for their pets*.”

Petsecure makes insurance better with comprehensive accident and illness coverage, including dental and behavior benefits on all plans. Petsecure’s in-clinic voucher program is a 6-week trial policy offering new pet owners financial protection in the event of unexpected veterinary expenses. Find out more about Petsecure’s wellness plans that include coverage for routine vaccines, parasite control, and routine health testing.

Vets are the experts when it comes to identifying and treating zoonotic disease in patients. Set up your clients for a lifetime of great pet healthcare by offering Petsecure Pet Health Insurance. Local territory managers are available across Canada to support care teams in clinic with educational seminars and information materials. CVMA members may contact their local territory manager or reach out to Petsecure’s Vetline at 1-877-202-5813 for information about their products.

(*Underwriting and designated waiting periods may apply. See policy wordings for full details.)

un potentiel de transmission de maladies entre les humains et leurs animaux de compagnie. Petsecure s’engage à soutenir le personnel vétérinaire et les patients canins et félinis. Les médecins vétérinaires et les membres de leur équipe de soins sont les mieux placés pour sensibiliser le public au potentiel zoonotique, qu’il soit réel ou peu probable, des différentes maladies dans leurs communautés. Les produits Petsecure permettent aux médecins vétérinaires d’examiner les animaux, d’établir un diagnostic et de traiter leurs patients en fonction de leurs besoins individuels, avec la tranquillité d’esprit que la protection financière apporte aux clients. Contrairement à certaines compagnies d’assurance pour animaux de compagnie, Petsecure couvre les frais d’examen et les taxes. Petsecure offre également une couverture pour les maladies zoonotiques qu’un chien ou un chat peut développer pendant qu’il est assuré en vertu d’une police Petsecure*.

* Le rôle de l’équipe vétérinaire est essentiel dans le concept Une santé du bien-être collectif *, déclare la Dr Colleen Fisher, directrice médicale vétérinaire de Petsecure. « La prise en charge réussie de toute maladie zoonotique doit intégrer à la fois la santé des animaux et la santé des humains. Pour souligner cet engagement, les régimes Petsecure incluent 1000 $ par année d’assurance pour les frais de pension lorsque les propriétaires sont hospitalisés et ne peuvent pas prendre soin de leurs animaux de compagnie*.”

Petsecure améliore l’assurance en offrant une couverture complète contre les accidents et les maladies, y compris les problèmes dentaires et les troubles du comportement, dans tous ses régimes. Le programme de bons en clinique de Petsecure est une politique d’essai de 6 semaines offrant aux nouveaux propriétaires d’animaux une protection financière en cas de dépenses vétérinaires imprévues. Renseignez-vous sur les régimes de Petsecure qui incluent une couverture pour les soins préventifs tels que les vaccinations, la maîtrise des parasites et les tests de santé de routine.

Les médecins vétérinaires sont les experts en matière de diagnostic et de traitement des maladies zoonotiques chez les animaux. Donnez à vos patients la possibilité de recevoir des soins de santé optimaux durant toute leur vie en offrant à vos clients une assurance maladie pour animaux de compagnie Petsecure. Les représentants de Petsecure sont disponibles partout au Canada pour soutenir les équipes de soins en clinique avec des séminaires éducatifs et du matériel d’information. Les membres de l’ACMV peuvent communiquer avec leur représentant ou le personnel du service vétérinaire de Petsecure au 1-877-202-5813 pour obtenir de plus amples renseignements sur leurs produits.

(* La souscription et des périodes d’attente peuvent s’appliquer. Voir le libellé des polices pour plus de détails.)
October Celebrates RVTs with New RVT Month App!

The Registered Veterinary Technologists and Technicians of Canada (RVTTC) and the provincial RVT associations across Canada (BCVTA, ABVTA, SAVT, MVTa, OAVT, EVTA) celebrate and recognize Registered Veterinary Technologists/Technologists (RVTs) every October. This year there is even more reason to recognize and celebrate RVTs.

RVTs were identified as essential along with their veterinary team members during the COVID-19 pandemic. Veterinary medicine came together to hold strong for all Canadian pets and pet owners as an essential service.

Now in its 4th consecutive year, RVT Month celebrates approximately 10 000 RVTs across Canada throughout October. This year, the theme is celebrating the Heart of the RVT. Veterinary health care teams continued to work as the country closed down to stop the spread of COVID-19; RVTs continued to care and advocate for animals across Canada. Whether RVTs work in an animal hospital, livestock health facility, animal shelter, research facility, educational institution, government, animal health care industry sales or in zoo animal and wildlife care, they all have one thing in common: the animals. Caring for animals is at the heart of being an RVT.

This year RVT Month is going DIGITAL! The RVTTC will be providing all the same materials previously included in the RVT Month Kits on a uniquely designed app just for RVT Month. The app will have a special “Thank an RVT” message.
Cette année, le Mois des RVT/TSAc passe à l’ère NUMÉRIQUE! L’association TTVAC fournira les mêmes outils qui étaient inclus dans les trousse de Mois des RVT/TSAc sur une application conçue expressément pour l’événement. L’application aura un babillard spécial sur lequel les propriétaires d’animaux et les collègues pourront remercier un technicien et exprimer leur appréciation.

Dans le cadre d’un effort conjoint des associations de techniciens du Canada, ce guichet unique pour le Mois des RVT/TSAc a été créé et permettra aux techniciens, aux employeurs et aux gens du public de participer au Mois des RVT/TSAc… avec tout le nécessaire à portée de main!

L’application donnera aux utilisateurs :
• un accès à du matériel pédagogique et promotionnel sur la profession de technicien vétérinaire;
• des liens vers la marchandise offerte, les concours des commanditaires, les événements du mois des RVT/TSAc;
• un babillard où afficher des messages pour remercier les techniciens pour le travail qu’ils accomplissent;
• la possibilité de partager des affiches et des vidéos à partir de l’application directement sur leurs pages de réseaux sociaux.

L’application est disponible pour téléchargement direct (rvtmonth.ca). Les cliniques, les organisations et les entreprises sont invitée à partager le lien de l’application avec leurs clients et leurs collègues afin d’atteindre un public aussi large que possible.

La boutique en ligne du Mois des RVT/TSAc propose divers vêtements et accessoires arborant la mention « Proudly RVT » (https://urstore.ca/rvt-month); visitez-la pour découvrir les différents produits offerts.

Each provincial association, as well as the RVTTC, will have different things planned throughout the month of October. Check with the specific association for more information on RVT Month in your province.

Contacts
British Columbia Veterinary Technologists Association (BCVTA): (bcvtaboard@gmail.com)
Alberta Veterinary Technologist Association (ABVTA): (info@abvta.com)
Saskatchewan Association of Veterinary Technologists (SAVT): (savt@savt.ca)
Manitoba Veterinary Technologists Association (MVTA): (info@mymvta.ca)
Ontario Association of Veterinary Technicians (OAVT): (oavt@oavt.org)
Eastern Veterinary Technicians Association (EVTA): (bev@evta.ca)
Registered Veterinary Technologists and Technicians of Canada (RVTTC): (info@rvttcanada.ca)

Coordinées
British Columbia Veterinary Technologists Association (BCVTA) : bcvtaboard@gmail.com
Alberta Veterinary Technologist Association (ABVTA) : info@abvta.com
Saskatchewan Association of Veterinary Technologists (SAVT) : savt@savt.ca
Manitoba Veterinary Technologists Association (MVTA) : info@mymvta.ca
Ontario Association of Veterinary Technicians (OAVT) : oavt@oavt.org
Eastern Veterinary Technicians Association (EVTA) : bev@evta.ca

Technologues et techniciens vétérinaires agréés du Canada (TTVAC) : info@rvttcanada.ca
Communication Is Key: Having Difficult Conversations in the Workplace

HRdownloads, one of the CVMA’s valued partners, provides advice on how to have difficult conversations in the workplace.

Having difficult, and sometimes awkward, conversations with employees is part of a manager’s role. Often these conversations are about sensitive matters and are uncomfortable for both parties. Good leaders address sensitive issues rather than avoiding them. But how you communicate an issue to an employee greatly affects the outcome of the situation.

Part of the challenge when having these conversations is getting over the fear or discomfort of having to do it. Some of the hardest conversations can be those regarding personal hygiene, performance issues, or very specific situations relating to a person’s habits. While these conversations can be difficult, they have to happen for the issue to be corrected.

Once a concern is brought to your attention, you must decide whether a conversation needs to take place. A single incident usually doesn’t warrant action unless it’s a serious matter. For example, if an employee arrives at work late once in 3 years, tardiness probably isn’t a concern. However, if this is the 3rd time they’ve been late this week, you’ll need to talk.

After you’ve established that an issue exists and a conversation is needed, it’s important to schedule a meeting with the employee. Every situation is unique and will have its own considerations, but it’s essential that managers communicate the issue with care and take a constructive approach.

Do you think you might need to have a difficult conversation with an employee but are still feeling uneasy? HRdownloads has a number of resources for challenging HR and workplace situations just like this. With Canada’s leading library of HR documents, templates, and articles available in the scalable and newly re-designed HRIS platform, they are sure to have what you need.

Want to talk it out? Live HR Advice service gives you unlimited access to a team of HR experts available for extra support. The tools will help you feel confident and get the job done so you can get back to doing what you love.

Find out more on the HRdownloads website (https://www.hrdownloads.com) and get the free downloadable guide on their blog (https://www.hrdownloads.com/blog/article/communication-is-key-four-difficult-hr-conversations-2018).

La communication est la clé : Avoir des conversations difficiles en milieu de travail

HRdownloads, l’un des précieux partenaires de l’ACMV, offre des conseils sur la façon d’aborder les conversations difficiles en milieu de travail.

Avoir des conversations difficiles, et parfois gênantes, avec les employés fait partie du travail d’un gestionnaire. Souvent, ces conversations portent sur des sujets délicats et sont inconfortables pour les deux parties. Cela dit, les bons leaders abordent les questions sensibles plutôt que de les éviter. Mais la façon dont vous communiquez un problème à un employé peut avoir un impact important sur l’issue de la situation.

Une partie du défi lié à ces conversations difficiles est de surmonter la peur ou la gêne qu’elles génèrent. Certains des sujets les plus délicats à aborder sont entre autres ceux qui concernent l’hygiène personnelle, le rendement ou des situations très spécifiques en lien avec les habitudes d’une personne. Bien que ces conversations puissent être pénibles, elles doivent avoir lieu pour que le problème soit corrigé.

Lorsqu’une préoccupation est portée à votre attention, vous devez décider si une conversation doit avoir lieu. Un incident isolé ne justifie généralement pas une intervention, sauf s’il s’agit d’une faute grave. Par exemple, si un employé arrive en retard au travail une fois tous les trois ans, la ponctualité n’est probablement pas un problème. Cependant, si c’est le troisième retard de la semaine, vous devrez y voir.

Une fois que vous avez établi qu’un problème existe et qu’une conversation est nécessaire, il est important de planifier une réunion avec l’employé. Chaque situation est unique et aura ses particularités, mais il est essentiel que les gestionnaires communiquent le problème avec tact et adoptent une approche constructive.

Si une conversation difficile s’impose avec un employé et que vous ne savez pas trop comment vous y prendre, HRdownloads offre des ressources pour vous aider lors de situations difficiles en matière de travail et de ressources humaines de ce genre.

Comme HRdownloads a la plus imposante collection au Canada de documents, de modèles et d’articles sur les ressources humaines disponibles dans la plateforme évolutive et récemment reconfigurée SIRH, vous y trouverez assurément tout ce dont vous avez besoin en matière de gestion des ressources humaines. Vous voulez en parler? Le service Live HR Advice vous donne un accès illimité à une équipe d’experts en ressources humaines disponibles pour vous offrir un soutien supplémentaire. Les outils vous aideront à vous sentir en confiance et à mener à bien vos tâches de gestionnaire afin que vous puissiez à nouveau vous consacrer à ce que vous aimez faire.

Pour en savoir plus, consultez le site de HRdownloads (https://www.hrdownloads.com) et obtenez le guide téléchargeable gratuitement sur le blogue du site (https://www.hrdownloads.com/blog/article/communication-is-key-four-difficult-hr-conversations-2018).
A rare case of malignant vagus nerve sheath tumor presenting with multiple cranial nerve dysfunction in a dog

Lucile Giraud, Stéphane Lezmi, Eymeric Gomes, Laurent Cauzinille

Abstract — A 5-year-old intact male Gascon Saintongeois dog was presented with a 6-month history of coughing, laryngeal paralysis, a deglutition disorder of gradual onset, and left-sided Horner’s syndrome. The dog was admitted as an emergency for acute central vestibular signs. Magnetic resonance images identified a left extra-axial brainstem lesion extending caudally from the medulla to the vagosympathetic trunk. Histological and immunohistological examination revealed a high grade epithelioid malignant peripheral nerve sheath tumor (MPNST). This case report is the first description of a MPNST of the vagus nerve compressing the brainstem and causing multiple cranial nerve dysfunction in a dog.

Key clinical message: Nerve sheath tumors have been reported in many locations arising from spinal nerve roots and cranial nerves. Although the trigeminal nerve is the most commonly affected nerve, other cranial nerves such as the vagus can be affected.

Résumé — Un cas rare de tumeur maligne de la gaine du nerf vague à l’origine d’une dysfonction de plusieurs nerfs crâniens chez un chien. Un chien mâle entier de cinq ans de race Gascon Saintongeois a été présenté avec un historique de 6 mois de toux, paralysie laryngée, trouble de la déglutition d’évolution progressive et un syndrome de Claude Bernard Horner à gauche. Le chien a été admis en urgence pour des signes vestibulaires centraux. Une imagerie par résonnance magnétique a mis en évidence une lésion extra-axiale gauche localisée au niveau du tronc cérébral s’étendant caudalement de la medulla vers le tronc vagosympathique. Les examens histologique et immunohistologique ont révélé une tumeur épithéliale maligne des gaines nerveuses de haut grade (TMGN). Ce rapport de cas est la première description de TMGN du nerf vague comprimant le tronc cérébral et à l’origine d’une dysfonction de plusieurs nerfs crâniens chez un chien.

Message clinique clé : Les tumeurs des gaines des nerfs ont été rapportées de plusieurs localisations prenant leur origine des racines des nerfs spinaux et des nerfs crâniens. Bien que le nerf trijumeau soit le nerf le plus fréquemment affecté, d’autres nerfs crâniens, tel que le vague, peuvent être affectés.

Published in Can Vet J 2020;61:1049-1054

Peripheral nerve sheath tumors (PNSTs) arise within the nerve sheaths from 1 or more populations of endogenous cells, including Schwann cells, perineurial cells, or fibroblasts. Based on their morphologic and biologic behavior, PNSTs are divided into benign (Schwannoma, neurofibroma, perineurioma) and malignant forms (MPNSTs) (1). These tumors commonly arise from spinal nerve roots (e.g., brachial plexus, lumbosacral plexus) and cranial nerves but have also been reported in the liver, spleen, adrenal gland, skin, lungs, eyes, and other locations (2–6). The brachial plexus is the most commonly affected site in dogs (7), while trigeminal PNST is the most frequently encountered neoplasm of the cranial nerves (8,9). Reported cases of PNSTs of the vagus are rare in both human and veterinary medicine. A literature search identified only 3 reported canine cases (10–12). One dog with a malignant PNST of the right proximal cervical vagosympathetic trunk was euthanized without treatment following confirmation of cervical neoplasia (10). A second dog with a malignant vagus PNST located between the carotid artery and esophagus in the mid-cervical region had an 18-cm section of thickened vagus nerve excised during exploratory surgery. This dog was alive 19 mo after surgery at the time of the report (11). The last dog...
was diagnosed with an intrathoracic malignant PNST of the right vagus nerve at the level of the bronchus. A vagotomy was performed to excise a lesion measuring 2 cm in diameter and 5 cm in length, which was connected to the right vagus nerve cranially. The dog was alive 710 d after surgery at the time of the report (12). Both dogs had no signs of local recurrence or metastasis. A PNST primarily involving the hypoglossal nerve (CN XII) with secondary invasion of the vagus and accessory nerves (CN X and XI) has also been documented (13).

Peripheral nerve sheath tumors are most common in middle-aged to older dogs (8,14,15). Clinical signs depend on location of the lesion. Intracranial extension is rare but compression of the adjacent brainstem is described with trigeminal neoplasia resulting in ipsilateral proprioceptive deficits, obtundation, and/or vestibular signs (16,17). Additionally, ipsilateral clinical signs such as reduced facial and corneal sensation and face rubbing have been reported (8).

Definitive diagnosis requires histopathology, but a presumptive diagnosis can be made based on imaging findings. Magnetic resonance imaging (MRI) is the imaging modality of choice due to its superior soft tissue contrast resolution (18). Peripheral nerve sheath tumors are frequently iso- to hyper-intense on T2-weighted images, isointense on pre-contrast T1-weighted images, and display moderate to marked contrast enhancement (19).

This is the first report of a malignant vagal PNST infiltrating several other cranial nerves and causing brainstem compression. Clinical signs as well as MRI and histopathological characteristics are discussed.

Case description

A 5-year-old intact male Gascon Saintongeois dog weighing 25.1 kg was presented to the emergency department because of an acute deterioration of his neurological status, including head tilt and an inability to stand. This active hunting dog had a 6-month history of coughing. A canine infectious tracheobronchitis was first suspected by his referring veterinarian. None of the dogs of the pack had any respiratory signs. The dog was initially responsive to an oral doxycycline and prednisolone treatment lasting 2 wk, but the cough relapsed a few days after discontinuation. He was then treated with oral amoxicillin-clavulanic acid and meloxicam lasting 4 wk with partial improvement. Owing to the worsening of cough and sputum, the dog was then treated with oral prednisolone treatment lasting 2 wk, but the coughing frequency increased; in addition, ptyalism, gagging, and dysphagia developed. Prior to admission to emergency, the owner had noticed a 1-month history of left Horner’s syndrome (miotic pupil, prominent third eyelid, and droopy upper eyelid) and an abnormal gait characterized by unsteadiness for a few days.

On physical examination, the dog was dull and unresponsive, tachycardic (190 beats/min), and tachypneic (60 breaths/min). The rectal temperature was 41.8°C. The dog had semi-dry mucous membranes and a minimal loss of skin turgor. A left-sided purulent nasal discharge and left conjunctival hyperemia were also observed. On neurological examination, the dog was non-ambulatory with left-sided postural deficits along with a left-sided head tilt. There was a horizontal to rotatory nystagmus with a fast phase towards the right, an incomplete left palpebral closure, left Horner’s syndrome, and mild unilateral left temporal muscle atrophy. Atrophy of the lingual muscles on the left side with deviation of the rostral third was also noticed. Based on the abnormal neurological findings, a neuropathy involving cranial nerves V, VII, VIII, IX, X, and XII was presumed with brainstem involvement.

Routine hematology revealed mild neutrophilic leukocytosis (14 800 cells/μL; reference range 6000 to 13 000 cells/μL) as the sole abnormal finding; serum biochemistry was unremarkable. Magnetic resonance imaging of the brain and the neck was performed with a 0.25 T scanner (Vet-MR Grande; Esaote, Genoa, Italy). Acquisition included transverse T1- and T2-weighted, dorsal FLAIR, 3D SST1, and 3D SST2 sequences. Images revealed a large, rounded, extra-axial mass with sharp margins on the ventro-lateral aspect of the brainstem at the left cerebellopontine angle, extending as a tubular lesion through the left jugular foramen and the left tympano-occipital fissure (Figure 1). The lesion appeared mildly heterogeneous on T1- and T2-weighted images with T1 hypo- and iso-intense areas and a T2 hyperintense peripheral rim with a hyper- and iso-intense center. The lesion was homogenously hyperintense on T2 FLAIR and showed mildly heterogeneous and strong contrast enhancement. The mass exited the cranial vault and extended along the parapharyngeal region and formed a mass at the level of the carotid bifurcation in the area of the cranial cervical ganglion. This massive round mass (22 × 25 × 33 mm) was well-margined, with a hypointense non-enhancing center and thick peripherally enhancing rim. Mild atrophy of the left temporal muscles was also noted. Due to the highly invasive nature of the lesion and the poor prognosis, the owner elected to have the dog euthanized and consented to a necropsy.

Gross examination at postmortem confirmed a left extra-axial brainstem mass arising from the dorsal aspect of the medulla oblongata. The elongated mass exited through the tympano-occipital fissure and emerged just caudal to the left glossopharyngeal and vagus nerves (Figure 2). The mass further...
encompassed the vagus and the accessory nerve and continued caudally towards the vagosympathetic trunk through the cranial cervical ganglion. The mass appeared pinkish-white, well-circumscribed, and encapsulated and did not seem to infiltrate the neighboring tissue on gross examination. Samples of normal brain tissue and of the neoplasm were fixed in 10% formalin and routinely processed for histopathological analyses.

Transverse cross sections of the lesion were stained using hematoxylin and eosin (H&E). Histologically, the mass was densely cellular with large areas of necrosis and hemorrhage (Figure 3). In some areas, neoplastic cells formed large and poorly defined sheets. These cells were round, fusiform, or stellate in shape with an abundant pale eosinophilic cytoplasm (epithelioid-like) producing a variably abundant mucinous-like matrix (Figure 4). Neoplastic cells had a large oval vesicular nucleus and a prominent nucleolus. The mitotic index was up to 4 per high power field (×400). Neoplastic cells invaded the proximal part of nerves but were not observed in the brainstem itself. Some nerve sections minimally infiltrated by neoplastic cells showed a severe loss of axons (Figure 5). This was confirmed using BIII tubulin (Promega G7121, Madison Wisconsin, USA) immunohistochemistry (IHC), a marker of neuronal cells and axons (Figure 6). In the tumor, cells were strongly positive for S100 (Abcam ab11428, Cambridge, UK), but GFAP (Dako Z0334, Santa Clara, California, USA) and BIII tubulin negative. Immunohistochemical staining was performed using standard avidin-biotin-peroxidase complex (ABC) method. Based on the macroscopic, microscopic, and IHC

![Figure 1. T1-weighted transverse (a–d), dorsal (e), and parasagittal (f) magnetic resonance images obtained after IV administration of gadolinium. Transverse images (a–d) from the caudal aspect of the brainstem to C1. Note the extensive mass from the ventrolateral left side of the brainstem and along the medial aspect of the tympanic bulla. The mass is exiting at the level of the jugular foramen and tympano-occipital fissure and heterogeneously contrast enhanced, with relatively defined margins.](image-url)
evaluations, the morphological diagnosis of a high grade, poorly differentiated, epithelioid, malignant vagus peripheral nerve sheath tumor was reached. Two lymph node segments obtained proximal to the tumor did not show any evidence of metastasis.

**Discussion**

Clinical and pathological examinations in this case revealed a tumor derived from the left vagosympathetic trunk. This case is unique because of the unusual presentation of clinical signs, the highly expansive nature of the tumor, and the resulting compression causing multiple cranial nerve dysfunction.

The vagus nerve provides both sensory and motor innervation to the palate, pharynx, larynx, trachea, and esophagus, as well as to thoracic and abdominal organs (20). The efferent axons in the vagus arise from 2 nuclei located in the medulla oblongata. The somatic efferent fibers have their cell bodies in the nucleus ambiguus from which the glossopharyngeal nerve (IX) arises rostrally and the cranial root of the accessory nerve (XI) arises caudally. These nerves emerge very close to each other, lateral to the myelencephalon, exit the jugular foramen and tympano-occipital fissure, and course down to supply the musculature of the pharynx, larynx, and esophagus. These nerves cannot be differentiated from each other on MRI (21).

The dog was initially presented for coughing, inspiratory dyspnea, and exercise intolerance. A chronic bronchitis was diagnosed associated with a unilateral left laryngeal hemiplegia. The cause of the chronic bronchitis was unclear but thought likely to reflect a swallowing disorder and laryngeal tracheal mucosal irritation. All laryngeal muscles, except for the cricothyroid, are innervated by the recurrent laryngeal nerve, which branches from the vagus nerve at the level of the heart base (on the left) or rostral to the heart base (on the right) (20). Therefore, a lesion in the cervical vagosympathetic trunk can be expected to induce ipsilateral laryngeal hemiplegia, which could predispose the affected patient to aspiration. Radiographic evidence of aspiration pneumonia was not apparent initially, although recheck radiographs were not performed.

Laryngeal paralysis is usually diagnosed by examination of the movement of arytenoid cartilages and vocal cords, either via direct visualization when the patient is conscious or using ultrasonography or computed tomography (CT) (22). In equivocal cases, electromyography is helpful. Polyneuropathy complex and idiopathic laryngeal paralysis are the most frequent causes of laryngeal paralysis, but other diseases must be considered, such as accidental or iatrogenic trauma to the recurrent laryngeal nerve, toxicity (lead or organophosphates), primary neoplasia, or secondary to processes such as thyroid masses or brainstem inflammatory or neoplastic diseases (22).

Over time, dysphagia became obvious in this patient. Swallowing disorders can occur with mechanical (anatomical), functional (neurological), or pain-related disorders. Functional dysphagia can occur with lesions in the nucleus ambiguus of the medulla, the glossopharyngeal (IX) and vagus (X) nerves, or the
pharyngeal or esophageal muscles. In this case, the dysphagia was secondary to a primary dysfunction of cranial nerves IX and X. Furthermore, the characteristic combination of a miotic pupil, prolapsed third eyelid, and upper eyelid ptosis indicating Horner’s syndrome was observed by the owner. Symptoms related to Horner’s syndrome result from dysfunction of the sympathetic supply along its 3-neuron pathway. For this dog, a second neuron lesion in the cranial cervical vagosympathetic trunk most likely resulted in Horner’s syndrome due to disruption of the sympathetic supply to the ipsilateral eye.

Considering the evolution of the clinical signs and the results of the initial diagnostic tests, a neoplastic disorder was the main hypothesis. In light of MRI sequences, anatomopathological, and histological findings, a tumor originating from the left vagosympathetic trunk was presumed. Over the course of a couple months, the tumor likely gradually infiltrated other cranial nerves such as glossopharyngeal and accessory nerves, and compressed the brainstem causing the more recently central nervous signs observed (central vestibular syndrome, proprioceptive deficits, and obtundation). A mild left temporal muscle atrophy observed on MRI was presumed to be secondary to involvement of the mandibular branch of the trigeminal nerve.

 Intracranial PNSTs are relatively uncommon tumors in dogs. The most common cranial nerve involved is the trigeminal nerve (8,14,19). Case reports describing other cranial nerve sheath tumors are rare (10,11,13). Various diagnostic imaging modalities have been reported in the diagnosis of PNSTs (8). Computed tomography and MRI are both appropriate options for identifying affected nerves, nerve root involvement, and potential vertebral canal or intracranial extension. In this case, MRI was chosen as it provides excellent soft-tissue resolution and has the ability to distinguish nerve bundles from vessels (8,18,19).

Histopathology findings confirmed the diagnosis of a high-grade epithelioid malignant PNST in this dog. Malignant PNSTs are derived from Schwann cells or pluripotent cells of the neural crest and can be graded according to the WHO classification. Several distinct subtypes have been recognized including “Schwannoma,” “Neurofibrosarcoma,” or “Neurosarcoma.” A malignant poorly differentiated PNST is usually defined as a tumor with nerve sheath differentiation and neoplastic cell invasion beyond the confines of the epineurium. Grossly, these tumors lack an epineural tumor capsule and may aggressively invade the surrounding structures. At microscopic examination, PNSTs are generally characterized by spindle-shaped cells arranged in palisades or spiral shapes (Antoni A & B patterns or Verocay bodies) (23). In our case, these specific patterns, more frequently observed in low-grade tumors, were not observed. The epithelioid nature of this malignant PNST was based on the presence of neoplastic cells with an abundant eosinophilic cytoplasm and the presence of a myxoid matrix frequently described in tumors of this type in literature on humans cases (WHO classification) (24). Malignant PNSTs are frequently S100 positive and variably positive for GFAP (1). BIII tubulin is a neuronal marker which allowed us to visualize the marked loss of axons in several nerve sections present on tissue sections. This observation was consistent with the multiple cranial nerve dysfunctions observed in this case.

Treatment of malignant PNSTs involves the removal of the tumor when surgically accessible, radiation therapy, or both (14,25,26). Without treatment, survival times for dogs with trigeminal PNST range from 5 to 21 mo and affected dogs typically die as a result of tumor invasion of the adjacent brainstem structures (8). The prognosis for PNSTs is variable and mainly dependent on the treatment. Local recurrence is common, with a guarded to poor long-term prognosis.

Tumor removal was not considered in this case due to the highly expansive nature of the tumor and the intracranial involvement. Indeed, intracranial nerve surgeries are rarely performed due to the combination of a challenging approach and a high postoperative morbidity rate (8). If the lesion had...
been confined to the cervical region, a surgical excision might have been proposed. Two case reports described successful vagotomies with tumors located in the mid-cervical region and intrathoracic location allowing resolution of the clinical signs induced by vagal dysfunction (11,12).

Radiation therapy is currently the preferred treatment modality for most patients with trigeminal PNSTs. One retrospective analysis demonstrated that stereotactic radiotherapy (SRT) is a beneficial and well-tolerated treatment option (25). In this study, 8 dogs treated by stereotactic radiotherapy [3 doses of 8 Gray (Gy)] had a mean disease-specific survival time of 745 d (range: 99 to 1375 d). In another study (14) including 15 dogs treated by SRT with 3 fractions of 8 to 10 Gy megavoltage radiation, the median survival time was 441 d. Curative intent high dose hypofractionated frameless volumetric modulated arc radiotherapy for treatment of trigeminal PNST has also been evaluated (27). Overall, median survival was 952 d with a 95% confidence interval of 543 to 1361 d. When considering spinal PNSTs, it has been described that dogs treated with SRT as a second-line treatment after tumor recurrence, following surgery alone or having already solely received SRT as their initial treatment, may gain an additional 125 to 346 d survival time (26).

Chemotherapy is not commonly used alone or in conjunction with surgery or radiation for peripheral nerve sheath tumors. Palliative care includes corticosteroids to reduce cerebral edema if present. This case report describes an uncommon presentation of a malignant PNST in a dog. Clinical signs progressed over 6 mo, presenting initially as coughing with a suspicion of unspecified bronchitis and laryngeal hemiplegia progressing with dysphagia and Horner’s syndrome eventually resulting in a multifocal brainstem dysfunction. We strongly recommend functional laryngeal assessment for cases with no apparent radiographic brainstem dysfunction. We strongly recommend functional laryngeal assessment for cases with no apparent radiographic brainstem dysfunction. We strongly recommend functional laryngeal assessment for cases with no apparent radiographic brainstem dysfunction. We strongly recommend functional laryngeal assessment for cases with no apparent radiographic brainstem dysfunction. We strongly recommend functional laryngeal assessment for cases with no apparent radiographic brainstem dysfunction.

References

Case Report  Rapport de cas

Investigation of clinical outbreaks of American foulbrood in honey-bee operations in Saskatchewan

Michael W. Zabrodski, Geoff Wilson, Igor Moshynskyy, Alexandra Wentzell, Sarah C. Wood, Colby D. Klein, Ivanna V. Kozii, Igor Medici de Mattos, Tasha Epp, Elemir Simko

Abstract — Four outbreaks of American foulbrood were investigated in honey-bee operations in Saskatchewan during the summer of 2019. Clinical signs were confirmed by the Saskatchewan Provincial Specialist in Apiculture and the causative agent was cultured and identified through matrix-assisted laser desorption/ionization-time of flight mass spectrometry (MALDI-TOF MS). Evaluation of management practices revealed off-label metaphylactic use of oxytetracycline in 3 of 4 operations and a discontinuation of antibiotic use in the fourth. Recent regulatory changes regarding access to medically important antimicrobials has provided an opportunity for veterinarians to promote evidence-based use of antimicrobials in apiculture while safe-guarding the health of commercial honey-bee populations and the economic viability of their producers.


(Traduit par Dr Serge Messier)


American foulbrood (AFB), caused by Paenibacillus larvae, is a highly infectious, destructive bacterial disease that affects the young brood of honey-bee colonies (1,2). Newly hatched larvae are inadvertently fed bacterial spores, which germinate and replicate in the midgut causing an overwhelming septicemia and producing over 1 billion new spores per infected larva (2,3). As deceased larvae are cleaned from their cells by worker caste bees, spores are picked up and disseminated throughout the hive products including honey and wax, as well as hive equipment including frames and boxes (4–7). Spores are resilient to environmental conditions and chemical treatments and have been reported to maintain infectivity for decades (8). This resiliency poses significant challenges regarding the management and control of disease. If clinical signs consistent with AFB infection are observed, burning the bees and equipment of affected colonies or, if available, subjecting equipment to gamma irradiation or high velocity electron-beam irradiation are the only practical solutions to eliminate spores (9–12).

In Canada, prevention of clinical disease relies heavily on the use of biannual, metaphylactic, antibiotic treatments with oxytetracycline in the spring and fall. Treatments are administered as either a dusting of antibiotic mixed with powdered sugar, or as...
Four suspected outbreaks of AFB were identified in commercial honey-bee operations across central and southeastern Saskatchewan in June, 2019. In this manuscript, outbreaks are defined as an incidence of clinical disease in hives in excess of what is expected. All 4 operations — identified here as Operations A, B, C, and D — varied in their management practices for control of AFB, which are summarized in Table 1. All 4 operations are large honey-producing operations with 2100 to 4000 honey-producing colonies. Given the use of metaphylactic antibiotics in 3 operations and the long duration of freedom from observable disease in the 4th, antibiotic-free operation, the expected incidence of clinical disease in each operation is zero.

**Operation A**

Operation A had ceased using metaphylactic antibiotics and had last treated its colonies with oxytetracycline in the fall of 2016. On June 10th, 2019, staff identified a single colony in 1 yard with a scattered, “shotgun” brood pattern, abnormal cell cappings, larval scale, and larval ropiness. The colony was treated with a single application of oxytetracycline administered over the frames in icing sugar, and the Provincial Specialist in Apiculture was contacted to inspect the affected hive. A clinical diagnosis of AFB was confirmed based on the described clinical signs, and the entire hive was destroyed through burning; the remainder of the yard was treated with oxytetracycline as per label directions. Several affected frames were submitted to the laboratory for bacteriological culture.

**Operation B**

Operation B treats its colonies twice annually with oxytetracycline mixed with powdered sugar in the spring and fall, but only performs a single application of antibiotics per feed treatment instead of the on-label instructions requiring 3 applications given 4 to 5 days apart. Brood frames are inspected frequently throughout the season and, on June 14th, 2019, a single colony within a large yard of nucleus colonies (n = 195) was marked with clinical signs similar to those described in Operation A. Frames and bees from the colony were destroyed by burning, and the remaining colony materials (i.e., super boxes, lids, and bottom) had their surfaces scorched with a torch before being re-used in circulation. The last suspected case of AFB in this operation was identified 3 y ago, and a clinical diagnosis was made by the Provincial Specialist in Apiculture at that time.
Table 1. Summary of management variables from 4 commercial honey-bee operations in Saskatchewan diagnosed with a clinical outbreak of American foulbrood during the summer of 2019.

<table>
<thead>
<tr>
<th>Management variable</th>
<th>Operation ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of honey-producing colonies</td>
<td>A 4000</td>
</tr>
<tr>
<td></td>
<td>B 2700</td>
</tr>
<tr>
<td></td>
<td>C 2800</td>
</tr>
<tr>
<td></td>
<td>D 2100</td>
</tr>
<tr>
<td>Total number of bee yards</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Number of affected yards</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>Total number of colonies in affected yard</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>195</td>
</tr>
<tr>
<td></td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>Number of affected colonies in affected yard</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Affected colony status</td>
<td>Alive</td>
</tr>
<tr>
<td></td>
<td>Alive</td>
</tr>
<tr>
<td></td>
<td>Dead</td>
</tr>
<tr>
<td></td>
<td>Dead</td>
</tr>
<tr>
<td>Metaphylactic antibiotic use</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Antibiotic used</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Oxytetracycline</td>
</tr>
<tr>
<td></td>
<td>Oxytetracycline</td>
</tr>
<tr>
<td></td>
<td>Oxytetracycline</td>
</tr>
<tr>
<td>On-label antibiotic use?</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Frequency of brood inspection</td>
<td>Spring and</td>
</tr>
<tr>
<td></td>
<td>whenever weak</td>
</tr>
<tr>
<td>Who performs brood inspection</td>
<td>Owner and staff</td>
</tr>
<tr>
<td></td>
<td>Owner and staff</td>
</tr>
<tr>
<td></td>
<td>Owner and staff</td>
</tr>
<tr>
<td></td>
<td>Owner</td>
</tr>
<tr>
<td>Proportion of brood frames inspected</td>
<td>Few</td>
</tr>
<tr>
<td></td>
<td>Few</td>
</tr>
<tr>
<td></td>
<td>Few</td>
</tr>
<tr>
<td></td>
<td>All</td>
</tr>
<tr>
<td>Percentage of brood frames renewed annually</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Over 50% (^a)</td>
</tr>
<tr>
<td></td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Less than 5%</td>
</tr>
<tr>
<td>Last suspected case of American foulbrood</td>
<td>25 years ago</td>
</tr>
<tr>
<td></td>
<td>3 years ago</td>
</tr>
<tr>
<td></td>
<td>3 years ago</td>
</tr>
<tr>
<td></td>
<td>1 year ago</td>
</tr>
</tbody>
</table>

\(^a\) Estimated frame replacement proportion for new nucleus hives, from which the affected colony originated.

\(^b\) All colonies were overwintered together indoors and individual yard assignments were not tracked for nucleus colonies.

\(^c\) Fall treatment of oxytetracycline in 2018 was given as 2 applications, not 3.

\(^d\) N/A — Not applicable.

**Operation C**

Unlike operations A and B, which had identified clinical signs in living colonies, Operation C identified a suspect colony during its annual inspection of dead colonies that failed to survive overwintering. Frames contained scattered, abnormal cappings and adhered scale along the ventral aspect of numerous cells. The Provincial Specialist in Apiculture was alerted, and the entire hive was burned. Similar to Operation B, this commercial outfit reported a 3-year gap between this case of AFB and its last suspected case. The previous case was identified by clinical signs observed by the operation owner alone without visual confirmation by the Provincial Specialist. The owner of this operation also noted that a nearby hobbyist had lost their colonies to AFB in 2013 but had left the hives out instead of having them destroyed. There was a high likelihood of these contaminated colonies being robbed out by bees belonging to Operation C, a behavior whereby foraging bees from strong hives will collect (steal) unprotected honey within weak and dead hives and bring it back into their hives. Operation C had therefore been using metaphylactic oxytetracycline, but only once annually in the spring since 2010 instead of the label-prescribed twice annual treatments.

**Operation D**

Operation D identified a total of 7 deceased nucleus colonies suspected to have succumbed to AFB during examination of its overwinter mortalities. This operation overwinters all of its colonies together indoors and performs rigorous inspection of all brood frames 2 to 3 times each spring. Suspect colonies were initially identified due to a noticeable malodor, and subsequent inspection of frames revealed capping abnormalities and the presence of scale. All identified colonies and frames were destroyed by burning. The operation reported administering oxytetracycline twice annually and adhering to label instructions but noted that the fall treatment in 2018 was only given as 2 applications instead of the label-prescribed 3.

From all operations, only those frames with either visible larval scale or cells identified as positive for ropiness were collected for bacterial culture. Scales were collected from affected frames, vortexed in sterile water, and subjected to heat treatment to eliminate other microbial contaminants. Samples were plated on both Columbia sheep blood agar (CSA) (BD Biosciences, San Jose, California, USA) and MYPGP [prepared according to published protocols (6,7)] and incubated at 37°C with 5% CO\(_2\) for 48 h. Plates were confirmed for lawns of colony growth consistent with the high concentration of spores expected from contaminated larval scale and with colony morphology consistent with *P. larvae* (7). Two serial sub-cultures were performed from these lawns to generate a pure culture. Colony growth from the second sub-culture was submitted to Prairie Diagnostic Services, Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, Saskatchewan, and tested using matrix-assisted laser desorption/ionization-time of flight mass spectrometry (MALDI-TOF MS) with a pre-existing library for *Paenibacillus larvae*. Bacterial isolates from all operations were positively identified as *Paenibacillus larvae*. An isolate...
from Operation A was confirmed as *Paenibacillus larvae* using both MALDI-TOF MS and PCR with primers designed by Dobbelare et al (22). Independent samples collected by the Provincial Specialist in Apiculture were submitted to the Animal Health Laboratory, (University of Guelph, Guelph, Ontario) for antimicrobial susceptibility testing by Kirby Bauer disk diffusion following Canadian Laboratory Standards Institute (CLSI) VET06 guidelines. Isolates from all operations were confirmed to be susceptible to oxytetracycline.

Follow-up with all 4 operations was performed following routine fall inspections. All operations confirmed that they had detected no additional clinical evidence of AFB. Operation A returned to metaphylactic, on-label use of oxytetracycline and the 3 other operations had adjusted their metaphylactic antibiotic protocols to follow label instructions.

**Discussion**

The current landscape of AFB in Saskatchewan remains largely unknown due to the long-term masking of disease through antibiotic metaphylaxis; outbreaks are difficult to predict. Suppression of clinical disease can lead to a high build-up of infectious spores within contaminated colonies, unknown to both hobbyists and commercial beekeepers applying treatment (17,23,24). In Saskatchewan, cases of AFB are identified through a combination of random inspections and self-reporting by beekeepers. Four outbreaks of AFB were reported in 2018, primarily among small-scale beekeepers and hobbyists. In 2019 the number of cases increased to 8, but were mostly seen in commercial operations, 4 of which were investigated here. Many factors associated with the pathogen, host, and environment are thought to play a role in determining the development of clinical disease, including strain virulence, the hygienic behavior of worker bees within a colony (social immunity), and basic management practices, respectively (7,25–27). How these factors interplay in the presence of chronically treated colonies remains unknown. Investigations of potential risk factors for disease have helped to shed light on management practices critical to American foulbrood management and control in countries such as New Zealand and Belgium, but because antibiotic use in these regions is prohibited, the applicability of the results of these investigations to Saskatchewan and Canadian beekeeping is uncertain (10,27).

With the recent regulatory changes on December 1, 2018, requiring all medically important antimicrobials for veterinary use to be sold by prescription only, the current use of antibiotics in the honey-bee industry must be re-evaluated, and Canadian veterinarians have an opportunity to establish themselves as leaders in the judicious use of antimicrobials in this industry (28). Common to all operations investigated here was the variability of approaches taken with regard to antibiotic use. Operation A had discontinued antibiotic metaphylaxis in their management program, and although operations B, C, and D were using regular antibiotic metaphylaxis, all were doing so with different, off-label protocols. It is possible that the cessation of antibiotics in operation A, or under-dosing of antibiotic in the other operations, may have contributed to the clinical appearance of AFB. Until there is a better understanding of the risk factors associated with clinical outbreaks of AFB in antibiotic-managed systems, Canadian veterinarians are uniquely poised to build effective, working veterinary-client-patient relationships with hobbyist and commercial beekeepers around communicating the importance of on-label use of antibiotic therapy to minimize the likelihood of clinical disease and slow the development of antimicrobial resistance within the apiculture industry.

Conversely, if beekeepers wish to cease the use of antibiotics for metaphylactic control of AFB, veterinarians can be relied upon to consider this decision in an evidence-based manner through risk assessment, the testing of hive products, and the implementation of frequent brood frame examination to minimize the likelihood of occurrence of clinical disease. Here, Operation A had discontinued the use of oxytetracycline due to concern about the development of antimicrobial resistance and saw an emergence of clinical disease less than 3 y after cessation of treatment in an operation that had had no clinical disease for the previous 25 y. It is suspected that the long-term viability of bacterial spores, combined with a silent accumulation of spores through clinical masking with chronic antimicrobial use, can create a false sense of contamination-free colony status (24). Removing the suppressive effects of antimicrobials in these hives without an understanding of underlying contamination of *P. larvae* spores and relevant risk factors could potentially be disastrous. If antibiotic use is discontinued, then a rigorous health management plan must be in place that emphasizes frequent and thorough examination of brood frames to improve the early detection of disease and prompt destruction of affected colonies to reduce the spread of AFB. This approach for control of AFB has been implemented in New Zealand and many European countries and it is being adopted successfully by a few commercial beekeepers in Saskatchewan and Alberta (10,23). Veterinarians again have an opportunity to educate and aid in the implementation of such plans, and can advocate the testing of hive products such as honey and bees to detect the presence of spores of *P. larvae* and the presence of antimicrobial resistance that may influence the decision to use antibiotic metaphylaxis or not (23,29).

Practitioners are advised to follow the procedures listed in suspected AFB cases:

i) Contact the Provincial Specialist in Apiculture to establish a working relationship with their team. Provincial apiculture teams are a valuable resource in both knowledge and skills concerning beekeeping practices and the detection/diagnosis and management of honey-bee diseases. Strong collaboration is necessary for efficient prevention, early detection, and optimal management of AFB. Provincial apiculturists also perform a regulatory role to implement and enact provincial acts related to beekeeping.

ii) Inspect the colony frames for presence of pathognomonic signs: ropiness and/or scales.

iii) Submit suspect frame(s) to an appropriate microbiology laboratory to confirm the presence of *P. larvae*.

iv) If a diagnosis of AFB is confirmed and is a notifiable disease within your province, report to the Chief Veterinary Officer within 24 h of laboratory diagnosis.

v) Burn affected colonies and equipment or irradiate exposed equipment if this service is available. Treat the remaining
colonies with antibiotics or implement frequent and rigorous inspections to identify and destroy bacteria in new cases at early stages to prevent spread of the disease.

Acknowledgments

The authors thank Sarah Barnsley, Jocelyne Chalifour, Marina Carla Bezerra de Silva, and Juliana Sartori Lunardi for their assistance with collection and processing of samples. Additional thanks to Patricia Wolf Veiga (National Bee Diagnostic Centre), Dr. Durda Slavic (Animal Health Laboratory, University of Guelph), Dr. Musungu Ngeleka and Lilian Fernandez (Prairie Diagnostic Services) for their assistance with the development of culture protocols and MALDI-TOF MS identification. Finally, thank you to beekeepers who allowed us to use their data in this manuscript, but who shall remain anonymous to preserve confidentiality.

This research was supported by the Saskatchewan Development Agriculture Fund (20180249), Mitacs, the Saskatchewan Beekeepers Development Commission, and the Development Agriculture Fund (20180249), Mitacs, the Saskatchewan Beekeepers Development Commission, and the Development Agriculture Fund (20180249)

References


Case Report  Rapport de cas

Primary hyperlipidemia with associated ischemic strokes in a West Highland white terrier dog

Stephen Everest, Gibrann Castillo, Luis Gaitero

Abstract — A 3-year-old spayed female, West Highland white terrier dog was evaluated because of a 4-month history of recurrent brain clinical signs. Magnetic resonance imaging (MRI) revealed multifocal brain lesions consistent with ischemic injuries. Blood analysis was unremarkable aside from severe hypertriglyceridemia and hypercholesterolemia with no underlying cause, suggesting primary hyperlipidemia. The patient was treated for hyperlipidemia and started on a low-fat diet and omega-3 supplementation. Clinical signs resolved over the following 12 months along with improvement in lipidemia. This represents the first reported case of MRI findings suggestive of multiple cerebrovascular injuries associated with primary hyperlipidemia in a dog, and the first primary hyperlipidemia reported in a West Highland white terrier dog.

Résumé — Hyperlipidémie primaire associée à des accidents vasculaires cérébraux ischémiques chez un chien terrier West Highland white. Une femelle stérilisée West Highland white âgée de 3 ans fut évaluée à cause d’une histoire de signes cliniques cérébraux récurrents d’une durée de 4 mois. Une imagerie par résonnance magnétique (RMI) révéla des lésions cérébrales multifocales compatibles avec des blessures ischémiques. Une analyse sanguine s’avéra peu concluante sauf pour une hypertriglycéridémie et une hypercholestérolémie sévère sans cause sous-jacente, suggérant une hyperlipidémie primaire. Le patient fut traité pour l’hyperlipidémie et débuta une diète faible en gras et une supplémentation en oméga-3. Les signes cliniques se sont résolus dans les 12 mois suivants avec une amélioration de la lipidémie. Ceci représente le premier cas rapporté de trouvailles par MRI suggestives de lésions cérébro-vasculaires multiples associées avec une hyperlipidémie primaire chez un chien, et le premier cas d’hyperlipidémie primaire rapporté chez un terrier West Highland white.

Case description

A 3-year-old spayed female, West Highland white terrier dog, which had been in her owner’s possession since she was a puppy, was presented for evaluation because of a 4-month history of right-sided head tilt and circling to the left. Previous medical history included 1 episode of walking diagonally in an unusual manner. The dog was also noted to have been particularly clumsy from a young age, but had otherwise been healthy. These clinical signs mostly resolved over the following few days; however, she had a milder, persistent head tilt. A repeat episode occurred 1 mo later, with the same clinical signs: right-sided head tilt, spontaneous nystagmus, and circling to the left. These signs again improved without intervention. A subsequent, more severe episode occurred 1 wk before presentation, which prompted the owners to investigate further. On presentation, the dog showed similar clinical signs to those mentioned before; however, these were noted to be more severe by the owners. The owners also observed that the dog had developed ptyalism, which was a novel clinical sign at this point.

A physical examination revealed a body condition score of 7 out of 9, but was otherwise unremarkable, and no hypertension was noted. On neurological examination the dog was quiet, but responded appropriately to stimuli. No obvious ataxia or paresis was present, but there was a right-sided head tilt and left pleurothotonous. The dog would also stop intermittently when walking and turn to the left in a tight circle. There were no cranial nerve deficits other than absent menace response on the right side. Postural reactions were mildly delayed in both right limbs, but normal in both left limbs. Spinal reflexes and nociception were normal, and there was no pain response elicited on spinal palpation or cervical manipulation. Based on the neurological examination, it was determined that there were lesions localized to the left forebrain and the cerebellovestibular system,

Canada
Figure 1. A—T1W transverse MRI showing a mildly T1 hyperintense lesion at the level of the caudate nucleus and a mildly hypointense lesion at the level of the left piriform lobe (indicated by arrows). B—T2W transverse MRI showing T2 hyperintense, heterogeneous lesions at the level of the left piriform lobe and a slightly T2 hyperintense lesion surrounded by a strongly T2 hyperintense rim at the level of the caudate nucleus. C—DWI MRI showing a hyperintense lesion surrounded by a less hyperintense rim at the level of the caudate nucleus. D—ADC MRI showing a hypointense lesion surrounded by a hyperintense rim at the level of the caudate nucleus. E—T2W FLAIR MRI showing a heterogeneous, wedge shaped, T2 hyperintense lesion at the dorsolateral aspect of the left parietal lobe. F—T1W MRI showing a mildly T1 hyperintense lesion at the dorsolateral aspect of the left parietal lobe.

with differential diagnoses including cerebrovascular accidents, meningitis of unknown etiology (MUE) or, less likely, neoplasia.

A complete blood (cell) count (CBC) and serum biochemistry were performed. The CBC revealed markedly elevated total solids (TS)/protein of 102 g/L [reference range (RR): 55 to 75 g/L] but no other abnormalities. Biochemistry revealed a marked hypercholesterolemia of 49.95 mmol/L (RR: 3.60 to 10.20 mmol/L). The rest of the biochemistry profile was unremarkable. A thyroid panel, fasting cholesterol/triglyceride panel and an adrenocorticotropic hormone (ACTH) stimulation test were performed to determine whether the hypercholesterolemia was primary, or secondary to an underlying cause. Fasting cholesterol/triglyceride panel confirmed hypercholesterolemia (41.07 mmol/L) and also revealed hypertriglyceridemia (3.4 mmol/L, RR: 0.2 to 1.3 mmol/L) indicating a general hyperlipidemia. An ACTH stimulation test and thyroid panel were both normal, ruling out hypothyroidism and hyperadrenocorticism. Based on this information, primary hyperlipidemia was suspected. Abdominal ultrasound was considered, but ultimately not performed due to lack of indication based on blood analysis and physical examination.

The dog underwent general anesthesia and a magnetic resonance imaging (MRI) study of the brain revealed multifocal intra-axial lesions (Figure 1). One of these was a well-circumscribed oval lesion at the level of the left caudate nucleus, which was 0.65 cm × 0.7 cm, mildly T2 hyperintense, with a prominent T2 hyperintense rim. There was a slightly T1 hyperintense lesion adjacent to this, extending caudally into the thalamus. The left piriform lobe showed moderate T2 hyperintense and T1 hypointense heterogenicity, with a poorly defined, slightly hypointense, wedge-shaped lesion. The last lesion was a wedge-shaped T2 hyperintense, and mildly T1 hyperintense, heterogeneous lesion affecting the dorsolateral parietal cerebral cortex (Figures 1E, F). This lesion was much more prominent on the T2W sequence and could be visualized running medially from the dorsolateral border of the parietal cerebral cortex. Only the most medial aspect of this lesion could be clearly visualized on the T1W sequence. All lesions were mildly contrast enhancing. It was also noted that the lesion at the level of the caudate nucleus showed restricted diffusion (bright or hyperintense signal) on diffusion weighted imaging (DWI) and was hypointense on apparent diffusion coefficient (ADC) map MRI sequences, suggestive of ischemic stroke (Figures 1C, D). The appearance of the lesions suggested that they could have been the result of multiple ischemic accidents, which could be associated with metabolic causes (e.g., hypothyroidism, hypoadrenocorticism, hypercoagulable state, or protein-losing nephropathy), infectious/inflammatory causes (e.g., vasculitis or septic thromboembolism), parasitic emboli, migrating parasites or neoplastic conditions (e.g., intravascular lymphoma or metastatic thromboembolism). Given the T1 hyperintensity and known hyperlipidemia, it was thought lipid deposition within the infarcts could also be a possibility. Cerebrospinal fluid (CSF) was collected and analysis revealed a mononuclear pleocytosis with a cell count of 0.006 × 10^6/L [reference range (RR): < 0.005 × 10^6/L] and a borderline elevated CSF protein level of 0.31 g/L (RR: < 0.3 g/L). Thromboelastography was also performed and revealed the patient to be mildly hypercoagulable, with a coagulation index of 3.2 (RR: 3 to 3).

The dog was discharged on a low-fat diet to attempt to reduce her hyperlipidemia. At recheck 2 wk after initial presentation, the dog’s owners reported that her neurological clinical signs were much improved. Blood analysis was repeated at that time and revealed that the patient was still markedly hyperlipidemic, with a blood cholesterol of 42.09 mmol/L (RR: 3.60 to 10.20 mmol/L) and triglycerides of 4.3 mmol/L (RR: 0.2 to 1.3 mmol/L). The dog was continued on the low-fat diet. Since it was noted that transitioning to this diet had not had a significant impact on the dog’s hyperlipidemia, the dog was started on omega-3 fatty acids supplementation.

By her following recheck, 8 mo after initial presentation, the dog’s clinical signs had almost completely resolved, with only
a mild head tilt noted on occasion. Omega-3 fatty acids supplementation was continued.

Cholesterol and triglyceride levels were rechecked approximately 1 year after initial development of clinical signs. Both were still elevated; however, there had been a marked decrease in the dog’s hypercholesterolemia, with a blood cholesterol of 18.34 mmol/L (RR: 3.60 to 10.20 mmol/L). Triglycerides, however, had increased, with a reading of 5.5 mmol/L (RR: 0.2 to 1.3 mmol/L). The dog was to be continued on her low-fat diet and was prescribed bezafibrate [50 mg; approximately 6 mg/kg body weight (BW) q24h] to help control her hyperlipidemia. She was discharged, with regular monitoring of her cholesterol and triglyceride concentrations to continue at the hospital. Neurological examination at time of discharge confirmed that her clinical signs had completely resolved.

**Discussion**

The case of a dog which developed recurrent neurological signs with concurrent severe hypercholesterolemia and hypertriglyceridemia is described in this report. However, no underlying cause for this hyperlipidemia could be identified. The thyroid panel ruled out hypothyroidism and an ACTH stimulation test ruled out hypoadrenocorticism. Serum biochemistry did not reveal any evidence of hepatic damage, insufficiency, or cholestasis and there was no evidence of pancreatitis or other pancreatic issues. Abdominal ultrasound was not performed as there was no indication for further diagnostics at the time. Retrospectively, this may have been valuable to confirm the absence of gross changes to the patient’s liver and pancreas. There was also no history of urinary abnormalities and no evidence of renal disease on blood analysis. The dog was not on any medications at the time of presentation. Diabetes mellitus and recent ingestion of a high-fat meal were considered as other potential causes of hyperlipidemia. Diabetes mellitus was ruled out because the dog never showed any evidence of hyperglycemia or other clinical signs suggestive of this. Additionally, the patient was fasted for at least 12 hours before blood sampling on each occasion, ruling out recent ingestion of a high-fat meal. On this basis, all known causes of secondary hyperlipidemia were ruled out, suggesting a primary hyperlipidemia as the underlying etiology for the patient’s clinical signs.

The dog in this case had neurological signs and MRI findings consistent with multiple ischemic strokes and blood analysis revealing a severe hypercholesterolemia, with levels 4 to 5 times the upper end of the reference range. This correlates with the literature in human medicine, in which it has long been demonstrated that there is a strong positive correlation between stroke incidence and hypercholesterolemia. In particular, it has been shown that a reduction in low-density lipoprotein (LDL) cholesterol of 1 mmol/L can reduce the incidence of major coronary events, coronary revascularization, and stroke by approximately 20% over a 5-year period [1]. An association has also been noted between total cholesterol (TC)/high-density lipoprotein (HDL-C) ratio and recurrence of embolic stroke [2-4].

The patient in this case was presented with severe hyperlipidemia, with no underlying cause found on diagnostic tests, suggesting primary hyperlipidemia. In humans, familial hypercholesterolemia is attributed to approximately 2% of cases of hypercholesterolemia in the population, with 15% being attributed to primary hypercholesterolemia in general [5]. Three main mechanisms are suspected to be responsible for the remaining cases: hepatic overproduction of lipoproteins, reduced affinity of LDL for their receptors, and reduced LDL receptor activity [5,6].

Although primary hyperlipidemia is relatively common in humans, it is very rare in dogs. There is a familial component, with miniature schnauzers first being implicated as a predisposed breed by Rogers et al [7] who noted hypertriglyceridemia in 6 dogs, 5 of which were miniature schnauzers. Since then, numerous studies have found hypertriglyceridemia with or without concurrent hypercholesterolemia to be overrepresented in this breed [8-10]. Although there have been associations noted with other breeds (beagles, Labradors, Shetland sheepdogs, Briards, rough collies, and poodles) [11-13], a familial predisposition in West Highland white terriers has not been noted in the literature.

As in humans, there appears to be an increased incidence of cerebrovascular events in dogs with hyperlipidemia; however, in previous case reports and studies this has either been secondary, or due to familial hyperlipidemia. Patterson et al [14] reported on a 6-year-old, obese, spayed doberman pinscher which was presented because of a 1-day history of seizures. The dog also had a long history of intermittent bouts of ataxia, circling, and head tilt. This dog had multifocal lesion localization, and died 2 days after presentation despite adequate control of seizures using phenobarbital. On necropsy, generalized atherosclerosis was noted, along with cortical laminar necrosis, acute vasculitis within the cerebrum, and congestive heart failure. This was consistent with severe hypoxic, ischemic injuries to the cerebrum (strokes), most likely secondary to vascular occlusion as a result of cerebrovascular atherosclerosis. Severe follicular atrophy of the thyroid gland supported hypothyroidism as the primary disease process. This case had many similarities to one reported by Blois et al [15], who described an obese, 2-year-old male, castrated Australian shepherd dog which was presented with multifocal neurological deficits. Blood analysis revealed a marked hypercholesterolemia of 25.38 mmol/L (RR: 3.6 to 10.2 mmol/L), as well as a mild non-regenerative anemia. The dog was ultimately euthanized due to multiple neurological deficits, with necropsy revealing marked atrophy of both lobes of the thyroid gland and generalized atherosclerosis of vasculature supplying the cerebrum, brainstem, and cervical spinal cord.

Vitale and Olby [16] also noted neurological signs secondary to severe hyperlipidemia associated with primary hyperlipidemia. Vitale and Olby [16] studied the medical records of 4 dogs, 3 of which were Labrador retrievers, and another a Labrador cross. Each had severe hypertriglyceridemia with concurrent severe hypercholesterolemia and neurological signs. Two of these dogs exhibited chronic neurological signs, whereas the other 2 had more acute onset signs, which resolved. Each showed different clinical signs and lesion localizations, with the 1 common clinical sign being lethargy. Interestingly, in these 4 cases, hypercholesterolemia was more severe than in previous studies,
with mean serum cholesterol concentration of 1568 mg/dL (40.55 mmol/L) (14) compared to 417 mg/dL (10.78 mmol/L) (17), and 11.4 mmol/L (18) in other studies. Chikamune et al (17) and Dixon et al (18) studied the association between obesity and hyperlipidemia in dogs, and hypothyroidism and hyperlipidemia in dogs, respectively. Both studies compared serum triglyceride concentrations and clinical signs among populations. Neurological signs were not noted in either of these studies; however, the mean serum cholesterol levels in reports were much lower than in the study performed by Vitale and Olby (16). Interestingly, the dog herein had a serum cholesterol concentration of 41.07 mmol/L, which was similar in severity to the cases in Vitale and Olby's study (16). This suggests that, as in humans, the severity of hyperlipidemia positively correlates with incidence of vascular injury as these neurological signs only appear to be described in dogs with severe hyperlipidemia, but not in milder cases.

Finally, a study carried out by Liu et al (19) looked at necropsies of 21 dogs from 1970 to 1983, all of which had atherosclerosis, and most of which had had hypercholesterolemia, hypertriglyceridemia, and hypothyroidism noted on ante-mortem blood analysis. Among the most common clinical signs seen across these dogs was collapse, due to neurological or cardiopulmonary pathology. On necropsy, atherosclerosis was seen to have affected arteries in multiple locations, including cerebral arteries. This study also suggests that neurological signs, or at least neurological pathology, are associated with hyperlipidemia and atherosclerosis. Although atherosclerosis could not be confirmed in the patient in this report, MRI images revealed multifocal lesions consistent with ischemic stroke within the telencephalon and diencephalon. This was associated with marked hypercholesterolemia and hypertriglyceridemia confirmed on blood analysis, similar to the dogs mentioned in the study by Liu et al (19).

The neurological examination localized multifocal intra-axial forebrain lesions, which were confirmed on MRI. It was noted that there were no brain stem or cerebellar lesions, which could have accounted for the head tilt and nystagmus that were noted. Vestibulocerebellar signs such as these, however, have been previously reported in association with thalamic or midbrain lesions such as those described in this case (20). It has been inferred by Wijesinghe et al (21) that the thalamus plays a key role in processing of vestibular information, and integration of other sensory inputs. A study performed by Kirsch et al (22) describing multiple projections, which course from the vestibular nuclei to the thalamus, support this theory. Given the close association between the thalamus and vestibulocerebellar system, it makes sense that thalamic lesions could present with vestibulocerebellar signs, as has previously been described in human patients. Saiki et al (23) described 2 patients, both of whom presented with loss of balance and astasia, amongst other neurological signs. Magnetic resonance imaging in these cases revealed lesions in the ventrolateral thalamus, which had terminated fibers from the vestibulocerebellum. Despite these being human cases, it could be inferred that a similar mechanism was responsible for the clinical signs shown by the dog reported in this case.

The appearance of these lesions on MRI was suggestive of ischemic vascular injuries (i.e., stroke). This dog was presented with recurrent neurological signs localizing to multifocal regions in the brain, similar to the dogs mentioned in case reports by Patterson et al (14), Vitale and Olby (16), and Blois et al (15) as well as the study conducted by Liu et al (19). Unlike the dogs in these previous studies, the patient discussed in this study had no known breed predisposition to hypothyroidism. The MRI and clinical signs were in accordance with ischemic vascular injury to the brain and clinical signs reported in case reports and studies of neurological issues in dogs with secondary hyperlipidemia.

In conclusion, this appears to be the first reported case of MRI findings suggestive of multiple cerebrovascular injuries associated with primary hyperlipidemia in a dog and the first primary hyperlipidemia reported in a West Highland white terrier dog. Cholesterol and triglyceride blood levels should be evaluated in cases of suspected cerebrovascular ischemic injury since, despite being much less common, primary hyperlipidemia can be associated with cerebrovascular incidents in dogs as well as humans.

References
The Story of Lexi, and a Dream that Follows Her


The Story of Lexi, and a Dream that Follows Her, is a book for children dealing with the mutual love between people and their pets and the sense of loss when one of them dies.

We are first introduced to Lexi, a miniature schnauzer, with her photograph on the cover of the book where she sits quietly in a field of white and pink clover. There are a few other photos of Lexi in the book but most of the time she is represented by adorable illustrations drawn by Paul Grignon. This animation technique allows Lexi to “come alive” on the page.

We are also introduced to Lexi’s human companions Trish and her son Rico, who adopted Lexi as a puppy, and Maureen (the author) who is called “Aunty-Mom” who adopts Lexi when sadly, Trish dies.

When Lexi is 7 years old Trish discovers that Lexi has dental disease and needs 20 extractions. Trish notes that dogs have 42 teeth and following the extractions Lexi still has 22 teeth… lucky for her!! We also discover that Lexi has a loud heart murmur, and that she may need heart medicine in the future.

Following Trish’s passing, and without overdoing the anthropomorphism we learn that Lexi is saddened by the loss of her “mom,” and she has difficulty dealing with the move from the northern prairie to the northwest rainforest with her new family. Soon enough Lexi becomes well integrated into her new community of family, friends, and other pets.

When Lexi is 10 years of age, she begins to cough and wheeze and become lethargic. She rallies for a few days, but then the symptoms return, and soon after Lexi and Aunty-Mom arrive at the animal hospital Lexi dies.

Around the time that Trish dies and again the morning that Lexi dies, Rico has dreams in which he sees his mom as a formless deity surrounded by fog. Although he can’t see clearly, he knows that he is seeing Trish and Lexi reunited, and he is comforted by this. The book is dedicated to Lexi and Trish, and to all those beloved ones we have lost — 2 legged and 4 legged — as they disappeared into the “Greater Mystery.”

This is a lovely and comforting book that can be appreciated by children and adults. My only hesitation about recommending this book as supportive material in your veterinary clinic is the apparent lack of veterinary follow-up after Lexi was diagnosed with a significant heart murmur at 7 years of age to what presented as an acute cardiovascular collapse and sudden death at 10 years of age.

Factors associated with the adoption of technologies by the Canadian
dairy industry

Murray D. Jelinski, David F. Kelton, Chris Luby, Cheryl Waldner

Abstract — Data generated from Statistics Canada's 2016 Census of Agriculture and Census of Population were used to describe the adoption of 8 technologies by the Canadian dairy industry: computer/laptop, smartphone/tablet, auto-steering, auto-feeding, auto-environment, robotic milking, global positioning systems (GPS), and geographical information systems (GIS). Logistic regression was used to analyze the adoption of each technology by geographical region, operators’ gender, operators’ age, herd size, and number of operators per farm. Gender and age were marginally related to the level of adoption of each technology, whereas the number of operators per dairy farm and farm size were associated with increased adoption of most technologies. Quebec had the smallest average farm size, but the highest levels of adoption for 5 of 8 technologies.

Résumé — Facteurs associés avec l’adoption des technologies par l’industrie laitière canadienne. Les données générées par le Recensement de la population et le Recensement de l’agriculture de 2016 de Statistiques Canada furent utilisées pour décrire l’adoption de huit technologies par l’industrie laitière canadienne : ordinateur/portable, téléphone intelligent/tablette, assistant à la navigation, alimentation automatique, environnement automatisé, traite robotisée, système de positionnement global (GPS), et système d’information géographique (GIS). Une régression logistique fut utilisée pour analyser l’adoption de chaque technologie par région géographique, sexe de l’opérateur, l’âge de l’opérateur, taille du troupeau, et nombre d’opérateurs par ferme. Le sexe et l’âge étaient reliés de manière marginale au degré d’adoption de chaque technologie, alors que le nombre d’opérateurs par ferme et la taille de la ferme étaient associés avec une augmentation de l’adoption de la plupart des technologies. Le Québec avait la taille moyenne des fermes la plus petite, mais le niveau d’adoption le plus élevé pour cinq des huit technologies.


Introduction

The dairy industry has a long history of supporting research dedicated to nutrition, management practices, and technologies. Exemplars are the Journal of Dairy Science, a journal that has been in existence for more than 100 years (1), and the Society of Dairy Technology, which has been publishing on advances in dairy technologies since 1943 (2). Furthermore, agricultural conferences on precision livestock farming frequently have sessions dedicated to new and innovative dairy technologies. On this point, several terms such as precision agriculture, precision farming, and smart farming have entered the agricultural lexicon to describe the use of technologies. One proposed definition of precision dairy farming is “the use of information and communication technologies for improved control of fine-scale animal and physical resource variability to optimise economic, social and environmental dairy farm performance” (3). Regardless of the definitions or the terminology used, precision or smart agricultural technologies are comprised of both information and communication technology (ICT) and decision support systems (DSSs). The ICT component includes data acquisition (sensors), recording, and the communication of information, while the DSSs are software systems that interface with operators to inform management’s decision-making process (3,4). While precision dairy farming is frequently categorized as the utilization of “Big Data,” these terms are not synonymous because precision dairy farming lacks some of the central components for fulfilling the definition of Big Data, namely the volume, variety, and velocity of the data (5). Currently, much of the data are generated from individual animals; however, to fulfill the volume and variety criteria more data must be generated and integrated across a broad population of animals, farms, as well as milk processors, retailers, and consumers. This will be
challenging since it requires the integration and sharing of data across different acquisition and processing systems, which are frequently provided by different manufacturers and suppliers. The other component that is missing is velocity, which refers to how frequently the data are generated with the ultimate goal being for the decision-making processes to be made in real time.

Like other facets of agriculture, Canada’s dairy industry has been consolidating, resulting in fewer but larger operations (6), which is also a global phenomenon (7,8). A main driver of consolidation has been the ability for larger operations to capture economies of scale. For instance, a US study found that costs per hundredweight of milk sold were twice as high for the smaller (< 50 head) versus larger dairies (≥ 500 head), with per unit costs continuing to decline as herd size increased (9). Consolidation in American dairies is also being driven by improvements in individual animal milk production: from 1991 to 2010 individual animal production increased by 42%, while the number of dairy farms decreased by 66% (10). A similar trend has occurred in Canada with individual animal production increasing by 9.7% between 2011 and 2016 (11).

A number of demographic factors are associated with the adoption of technologies and increased milk production. A US study found that increasing farm size as well as dairy operators having a college education were 2 factors associated with the adoption of productivity-influencing technologies, management practices, and production systems (TMPPS) (10). This is supported by an Australian study reporting that larger operations (> 500 head) were 2 to 5 times more likely to adopt precision dairy farming technologies than smaller dairies (12). And a review article on precision agricultural (PA) practices reported that increasing farm size, producers’ level of education, familiarity with computers, and the perception that the adoption of PA will lead to improved competitiveness and greater profitability were all associated with adopting PA practices (13).

In North America, the relationship between herd size and adoption of technologies appears to be confounded by other factors. Barkema et al (8) reported that the adoption of automated milking systems (AMSs) was higher in Canada than in the United States, even though US dairies tend to be larger than Canadian dairies. These authors surmised that lower US milk prices and lower labor costs deterred the adoption of AMSs by US producers. Other researchers have posited that the slower uptake of the use of AMSs by US dairies may be related to the lack of service providers and that the initial AMSs were better suited for smaller dairies (14). However, several factors may accelerate the adoption of AMSs in the US. First, the introduction of AMS parlors has led to an increase in the adoption of these units by larger dairies. Secondly, changing immigration policies are projected to exacerbate labor shortages in agricultural sectors that are intensive users of labor (15), which will have ramifications for the US dairy industry since immigrant labor accounts for more than half of the labor force (16). In general, labor shortages in both Canada and the US will undoubtedly lead to increased adoption of AMSs in North America.

Both the Census of Agriculture and Census of Population are administered concurrently every 5 y, providing data that describe the socioeconomic traits of Canada’s agricultural operators. Historically, the Census of Agriculture’s technology

### Table 1. Proportion and 95% confidence interval (95% CI) of producers who were using computers and/or laptops, stratified by region, number of operators/herd, gender, age, and herd size (breeding heifers and cows) and absolute differences in proportions among groups.

<table>
<thead>
<tr>
<th>Region</th>
<th>95% CI Mean</th>
<th>Lower</th>
<th>Upper</th>
<th>Difference from reference group</th>
<th>95% CI Lower</th>
<th>Upper</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic</td>
<td>0.69</td>
<td>0.66</td>
<td>0.73</td>
<td>–0.04</td>
<td>–0.04</td>
<td>–0.03</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Ontario</td>
<td>0.68</td>
<td>0.63</td>
<td>0.73</td>
<td>–0.05</td>
<td>–0.07</td>
<td>–0.03</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Quebec</td>
<td>0.74</td>
<td>0.69</td>
<td>0.79</td>
<td>0.01</td>
<td>0.00</td>
<td>0.03</td>
<td>0.121</td>
</tr>
<tr>
<td>Western Canada</td>
<td>0.73</td>
<td>0.69</td>
<td>0.77</td>
<td>Reference</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operators</th>
<th>95% CI Mean</th>
<th>Lower</th>
<th>Upper</th>
<th>Difference from reference group</th>
<th>95% CI Lower</th>
<th>Upper</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Operator</td>
<td>0.64</td>
<td>0.58</td>
<td>0.71</td>
<td>–0.13</td>
<td>–0.17</td>
<td>–0.09</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>≥ 2 Operators</td>
<td>0.77</td>
<td>0.74</td>
<td>0.80</td>
<td>Reference</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>95% CI Mean</th>
<th>Lower</th>
<th>Upper</th>
<th>Difference from reference group</th>
<th>95% CI Lower</th>
<th>Upper</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>0.70</td>
<td>0.65</td>
<td>0.75</td>
<td>–0.02</td>
<td>–0.05</td>
<td>0.00</td>
<td>0.080</td>
</tr>
<tr>
<td>Male</td>
<td>0.72</td>
<td>0.68</td>
<td>0.76</td>
<td>Reference</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operator age (years)</th>
<th>95% CI Mean</th>
<th>Lower</th>
<th>Upper</th>
<th>Difference from reference group</th>
<th>95% CI Lower</th>
<th>Upper</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 30</td>
<td>0.69</td>
<td>0.63</td>
<td>0.75</td>
<td>0.05</td>
<td>–0.06</td>
<td>0.15</td>
<td>0.397</td>
</tr>
<tr>
<td>31 to 40</td>
<td>0.75</td>
<td>0.73</td>
<td>0.77</td>
<td>0.11</td>
<td>0.04</td>
<td>0.17</td>
<td>0.002</td>
</tr>
<tr>
<td>41 to 50</td>
<td>0.73</td>
<td>0.70</td>
<td>0.77</td>
<td>0.09</td>
<td>0.04</td>
<td>0.14</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>51 to 60</td>
<td>0.73</td>
<td>0.64</td>
<td>0.81</td>
<td>0.08</td>
<td>0.07</td>
<td>0.09</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>≥ 61</td>
<td>0.65</td>
<td>0.56</td>
<td>0.72</td>
<td>Reference</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Herd size</th>
<th>95% CI Mean</th>
<th>Lower</th>
<th>Upper</th>
<th>Difference from reference group</th>
<th>95% CI Lower</th>
<th>Upper</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 50</td>
<td>0.50</td>
<td>0.46</td>
<td>0.54</td>
<td>–0.19</td>
<td>–0.30</td>
<td>–0.08</td>
<td>0.001</td>
</tr>
<tr>
<td>51 to 100</td>
<td>0.72</td>
<td>0.68</td>
<td>0.75</td>
<td>0.03</td>
<td>–0.08</td>
<td>0.13</td>
<td>0.617</td>
</tr>
<tr>
<td>101 to 200</td>
<td>0.83</td>
<td>0.79</td>
<td>0.86</td>
<td>0.14</td>
<td>0.07</td>
<td>0.21</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>201 to 300</td>
<td>0.79</td>
<td>0.75</td>
<td>0.83</td>
<td>0.10</td>
<td>0.04</td>
<td>0.16</td>
<td>0.001</td>
</tr>
<tr>
<td>301 to 500</td>
<td>0.70</td>
<td>0.50</td>
<td>0.84</td>
<td>0.01</td>
<td>–0.12</td>
<td>0.13</td>
<td>0.932</td>
</tr>
<tr>
<td>≥ 501</td>
<td>0.69</td>
<td>0.60</td>
<td>0.77</td>
<td>Reference</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
section was restricted to a few questions relating to computer usage (17). The 2016 Census, however, was the first to inquire about the adoption of technologies by all the commodity groups (18). The timing of this change is somewhat fortuitous since it provides a baseline for the adoption of dairy technologies before the implementation of both the Canada-European Union Comprehensive Economic and Trade Agreement (CETA) and the Canada-United States-Mexico Agreement (CUSMA). These agreements will increase foreign access to Canada’s domestic market, thereby encouraging Canadian dairy producers to adopt more technology in order to become more competitive.

The objective of this study was to examine the relationship between operator/farm characteristics and the adoption of 8 technologies.

**Materials and methods**

Data were generated from Statistic’s Canada (StatsCan) 2016 Census of Agriculture (18), with a customized data extraction of the answers to the following question: “"In 2015, which of the following TECHNOLOGIES were used on this operation? Computers/laptops for farm management, Smartphones/tablets for farm management, automated steering (auto-steer), GPS technology, GIS mapping (e.g., soil mapping), greenhouse automation, robotic milking, automated environmental controls for animal housing, automated animal feeding, Other technologies (specify), and None of the above."” Greenhouse automation and “other technologies” were excluded because of very low adoption, 0.8% and 0.6%, respectively (19). The following 8 technologies were analyzed: computer/laptop, smartphone/tablet, auto-steering, auto-feeding, auto-environment, GPS, and GIS. Robotic milking is used synonymously with automated milking systems (AMSs).

Statistics Canada defined a farm operator as any person who, as of May 10, 2016, was responsible for the management decisions in controlling the function of an agricultural operation, including owners, tenants, or hired managers (20). While dairy operators were defined as producers who reported having dairy cows and dairy replacement heifers. Statistics Canada’s customized data extraction resulted in a cross-tabulation of the adoption of the 8 technologies by 5 operator/farm characteristics: operators’ gender (female and male); number of dairy operators per farm (1 and ≥ 2); operator age (< 26 y, 26 to 30 y, 31 to 35 y, 36 to 40 y, 41 to 45 y, 46 to 50 y, 51 to 55 y, 56 to 60 y, and > 60 y); herd size (≤ 50, 51 to 100, 101 to 200, 201 to 300, 301 to 500, and ≥ 501); and geographical region (Canada, Atlantic provinces, Quebec, Ontario, and western Canada).

The extracted data were provided in a commercial spreadsheet (Microsoft Excel v. 12; Microsoft Corporation, Redmond, Washington, USA) and then imported into a statistical program for analyses (IBM SPSS Statistics Ver 25; IBM Corporation, Armonk, New York, USA). Descriptive statistics were used to assess the adoption of each technology by each of the 5 operator/farm characteristics. The mean adoption of each technology was calculated by dividing the total number of operators using each technology (numerator) by the total number of operators reporting to the census in each category (denominator). The operators’ ages were reduced from 9 to 5 age groups: (< 31, 31 to 40, 41 to 50, 51 to 60, ≥ 61 y). Univariate analyses were

---

Table 2. Proportion and 95% confidence interval (95% CI) of producers who were using smartphones and/or tablets, stratified by region, number of operators/herd, gender, and herd size (breeding heifers and cows) and absolute differences in proportions among groups.

<table>
<thead>
<tr>
<th>Region</th>
<th>95% CI</th>
<th>Difference from reference group</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>Atlantic</td>
<td>0.54</td>
<td>0.51</td>
<td>0.57</td>
</tr>
<tr>
<td>Ontario</td>
<td>0.56</td>
<td>0.53</td>
<td>0.60</td>
</tr>
<tr>
<td>Quebec</td>
<td>0.62</td>
<td>0.59</td>
<td>0.66</td>
</tr>
<tr>
<td>Western Canada</td>
<td>0.62</td>
<td>0.60</td>
<td>0.65</td>
</tr>
<tr>
<td>Operators</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Operator</td>
<td>0.55</td>
<td>0.52</td>
<td>0.58</td>
</tr>
<tr>
<td>≥ 2 Operators</td>
<td>0.62</td>
<td>0.59</td>
<td>0.66</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.59</td>
<td>0.55</td>
<td>0.61</td>
</tr>
<tr>
<td>Male</td>
<td>0.59</td>
<td>0.56</td>
<td>0.63</td>
</tr>
<tr>
<td>Operator age (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 30</td>
<td>0.66</td>
<td>0.60</td>
<td>0.71</td>
</tr>
<tr>
<td>31 to 40</td>
<td>0.65</td>
<td>0.62</td>
<td>0.68</td>
</tr>
<tr>
<td>41 to 50</td>
<td>0.60</td>
<td>0.57</td>
<td>0.63</td>
</tr>
<tr>
<td>51 to 60</td>
<td>0.53</td>
<td>0.49</td>
<td>0.57</td>
</tr>
<tr>
<td>≥ 61</td>
<td>0.49</td>
<td>0.45</td>
<td>0.54</td>
</tr>
<tr>
<td>Herd size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 50</td>
<td>0.33</td>
<td>0.30</td>
<td>0.37</td>
</tr>
<tr>
<td>51 to 100</td>
<td>0.50</td>
<td>0.47</td>
<td>0.53</td>
</tr>
<tr>
<td>101 to 200</td>
<td>0.65</td>
<td>0.58</td>
<td>0.68</td>
</tr>
<tr>
<td>201 to 300</td>
<td>0.67</td>
<td>0.61</td>
<td>0.73</td>
</tr>
<tr>
<td>301 to 500</td>
<td>0.68</td>
<td>0.59</td>
<td>0.76</td>
</tr>
<tr>
<td>≥ 501</td>
<td>0.69</td>
<td>0.53</td>
<td>0.81</td>
</tr>
</tbody>
</table>
performed for each technology by operator/farm characteristic. A generalized estimating equation (GEE) with a logit link function and binomial distribution was used to examine factors associated with the adoption of each of the 8 technologies, correcting for clustering associated with herds within a geographical region (Atlantic provinces, Ontario, Quebec, western provinces). All 5 operator/farm characteristics were included in all 8 multivariable models. Data were excluded when the denominator was 0 or was rounded off as 0 by Statistics Canada, or in a few instances in which the rounding procedure resulted in a numerator greater than the denominator. The number of valid combinations of data for each analysis are reported.

The GEE analyses provided statistically significant differences among groups with common operator/farm characteristics as well as the measure of effect (difference between estimates of the mean). Complete census data were available for the analysis; therefore, the GEE model was used to generate predicted probabilities of adopting the management tool for each category with 95% confidence interval (CI). The absolute differences in the probabilities of those adopting and those not adopting each management tool were determined for each factor with 95% CI. Residuals were examined for outliers. No interactions were evaluated for any model. Level of significance was $P < 0.05$ (2-tailed).

### Results

Statistics Canada reported 26,935 dairy operators on 12,895 dairies in 2016 with most ($n = 20,180$; 75%) co-managing with another operator. Only 505 (7%) of the single dairy operators were female; therefore, most (93%; $n = 6,650$) were co-managing with $\geq 1$ male operator(s). The greatest number of operators ($n = 5,500$; 20%) were in the oldest age cohort ($\geq 61$ y), 26% ($n = 1415$) of which were single operators. Conversely, the youngest cohort, $\leq 30$ y of age, represented only 9% ($n = 2,315$) of all operators, 19% ($n = 450$) of which were single operators.

While a GEE was generated for each of the 8 technologies, only the results from 5 technologies are provided in Tables 1 to 5. The 3 technologies not shown (auto-environment, auto-steer, and GIS) either had low adoption and/or there was minimal variation by geographical region, gender, age of operator, number of operators/farm, or herd size.

There were several trends across the 8 technologies. Quebec dairy operators had the highest adoption for 5 of the 8 technologies. Quebec operators were the least likely to be using GPS technology, while western Canadian and Ontario producers were the highest adopters of this technology. Increasing farm size was generally associated with increasing adoption and farms with $\geq 2$ operators were consistently more likely to be adopters of all technologies compared to single operator farms. There was little to no association between gender and the adoption of most technologies. While there were significant differences in adoption by operator age, the measure of effect was often small.

More specifically, the adoption of AMS (robotic milking) was consistently low (6% to 11%) by region, herd size, number of operators/farm, and operator age (Table 5). The highest estimated mean adoption rate was in western Canada (11%), which was greater than both Ontario (8%) and Atlantic Canada (8%) ($P = 0.001$), but not different from Quebec (10%) ($P = 0.302$). Although there were significant differences in adoption by region, the measures of effect were very small. Unlike most

<table>
<thead>
<tr>
<th>Table 3. Proportion and 95% confidence interval (95% CI) of producers who were using global positioning systems (GPS), stratified by region, number of operators/herd, gender, age, and herd size (breeding heifers and cows) and absolute differences in proportions among groups.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region</td>
</tr>
<tr>
<td>Atlantic</td>
</tr>
<tr>
<td>Ontario</td>
</tr>
<tr>
<td>Quebec</td>
</tr>
<tr>
<td>Western Canada</td>
</tr>
<tr>
<td>Operators</td>
</tr>
<tr>
<td>1 Operator</td>
</tr>
<tr>
<td>$\geq 2$ Operators</td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Operator age (years)</td>
</tr>
<tr>
<td>$\leq 30$</td>
</tr>
<tr>
<td>31 to 40</td>
</tr>
<tr>
<td>41 to 50</td>
</tr>
<tr>
<td>51 to 60</td>
</tr>
<tr>
<td>$\geq 61$</td>
</tr>
<tr>
<td>Herd size</td>
</tr>
<tr>
<td>$\leq 50$</td>
</tr>
<tr>
<td>51 to 100</td>
</tr>
<tr>
<td>101 to 200</td>
</tr>
<tr>
<td>201 to 300</td>
</tr>
<tr>
<td>301 to 500</td>
</tr>
<tr>
<td>$\geq 501$</td>
</tr>
</tbody>
</table>
other technologies, the adoption of AMS was not related to the number of operators per operation (\(P = 0.147\)), nor to gender (\(P = 0.070\)). The adoption of AMS by age was steady at 9%, except for the 31 to 40 y cohort, which had higher adoption at 11% (\(P < 0.013\)). Herd size had an effect on the adoption of AMS (\(P < 0.001\), with the smallest herds (\(\leq 50\) head) having the lowest adoption at 1%, while 21% of herds with 201 to 300 head had adopted this technology.

For the 3 technologies not shown, 20% to 30% of operators used auto-environment technology. Adoption was lowest in western Canada and highest in Quebec (\(P < 0.001\)). The oldest operators (> 60 y) were less likely to use environmental technology compared to all other age cohorts (\(P < 0.001\)). Generally, adoption of auto-environment increased with increasing herd size. Auto-steer was more commonly used in western Canada and increased with increasing herd size. Although the list of technologies provided by the Census of Agriculture was short and non-specific to the dairy industry, the 8 technologies serve as a proxy for the adoption of technology by Canadian dairy operators.

In describing the factors influencing the adoption of precision agriculture for dry-land farming, Pierce et al (21) coined the phrase “do the right thing, in the right place, at the right time, and in the right way.” However, there are a number of steps needed before arriving at the point of adoption. The first step is rooted in the diffusion theory, which explains how innovative technologies are first communicated amongst operators before being adopted (22). This well-recognized theory is supported by a European study that found that access to information from extension services, service providers, and those selling the technology (vendors) was a determinant for the adoption of precision agricultural (PA) technologies (13). Thus, there is a need for intermediaries or “translators” such as nutritionists, veterinarians, technicians, and vendors to participate in the diffusion of information. Although awareness of the technology is important, other factors such as return on investment, total cost of the investment, and ease of use must also be factored into the decision (23). The last point is salient because the installation of precision dairy farming technologies often results in a steep learning curve (3).

As previously discussed, there is a strong correlation between increasing farm size and the adoption of PA technologies. Therefore, it is paradoxical that Quebec producers, whose average herd size is the smallest in Canada (24), led the nation in adoption of computers/laptops, smartphones/tablets, auto-feeding, auto-environment, and auto-milking technologies.

Table 4. Proportion and 95% confidence interval (95% CI) of producers who were using auto-feeding technology, stratified by region, number of operators/ herd, gender, age, and herd size (breeding heifers and cows) and absolute differences in proportions among groups.

<table>
<thead>
<tr>
<th>Region</th>
<th>Mean Lower 95% CI</th>
<th>Difference from reference group</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic</td>
<td>0.20 0.25 0.30</td>
<td>0.02</td>
<td>0.00 0.04</td>
</tr>
<tr>
<td>Ontario</td>
<td>0.20 0.17 0.22</td>
<td>-0.06</td>
<td>-0.07 -0.04</td>
</tr>
<tr>
<td>Quebec</td>
<td>0.47 0.43 0.52</td>
<td>0.22</td>
<td>0.18 0.25</td>
</tr>
<tr>
<td>Western Canada</td>
<td>0.26 0.24 0.27</td>
<td>Reference</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operators</th>
<th>Mean Lower 95% CI</th>
<th>Difference from reference group</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Operator</td>
<td>0.27 0.25 0.30</td>
<td>-0.03</td>
<td>-0.06 -0.01</td>
</tr>
<tr>
<td>≥ 2 Operators</td>
<td>0.31 0.27 0.34</td>
<td>Reference</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>Mean Lower 95% CI</th>
<th>Difference from reference group</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>0.29 0.26 0.32</td>
<td>-0.01</td>
<td>-0.03 0.01</td>
</tr>
<tr>
<td>Male</td>
<td>0.30 0.27 0.32</td>
<td>Reference</td>
<td>0.27 0.32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operator age (years)</th>
<th>Mean Lower 95% CI</th>
<th>Difference from reference group</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 30</td>
<td>0.30 0.26 0.35</td>
<td>0.03</td>
<td>0.03 0.10</td>
</tr>
<tr>
<td>31 to 40</td>
<td>0.28 0.24 0.32</td>
<td>0.01</td>
<td>-0.04 0.06</td>
</tr>
<tr>
<td>41 to 50</td>
<td>0.32 0.29 0.35</td>
<td>0.05</td>
<td>0.00 0.10</td>
</tr>
<tr>
<td>51 to 60</td>
<td>0.28 0.26 0.31</td>
<td>0.01</td>
<td>-0.01 0.04</td>
</tr>
<tr>
<td>≥ 61</td>
<td>0.27 0.23 0.31</td>
<td>Reference</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Herd size</th>
<th>Mean Lower 95% CI</th>
<th>Difference from reference group</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 50</td>
<td>0.10 0.07 0.12</td>
<td>-0.30</td>
<td>-0.38 -0.23</td>
</tr>
<tr>
<td>51 to 100</td>
<td>0.29 0.24 0.33</td>
<td>-0.11</td>
<td>-0.23 0.01</td>
</tr>
<tr>
<td>101 to 200</td>
<td>0.40 0.37 0.43</td>
<td>0.00</td>
<td>-0.11 0.11</td>
</tr>
<tr>
<td>201 to 300</td>
<td>0.38 0.36 0.40</td>
<td>-0.02</td>
<td>-0.11 0.08</td>
</tr>
<tr>
<td>301 to 500</td>
<td>0.29 0.20 0.40</td>
<td>-0.10</td>
<td>-0.16 -0.05</td>
</tr>
<tr>
<td>≥ 501</td>
<td>0.40 0.31 0.49</td>
<td>Reference</td>
<td></td>
</tr>
</tbody>
</table>

Discussion
The 2016 Census was the first time Statistics Canada included a section dedicated to technologies. This section, however, was designed to capture data on all commodities, not just dairy. Thus, some technologies such as auto-steer, GIS, and GPS were not particularly relevant, while reproductive technologies such as estrus detection and sexed semen were not included.
This may be explained by the diffusion of information within the Quebec dairy industry. Consider that ~10 700 dairies in Canada ship milk, 48% of which are in Quebec (25). This concentration of dairies presumably results in more interactions between dairy producers as well as more vendors and technicians servicing the industry. Furthermore, the province subsidizes both veterinary and dairy extension services, resulting in a relatively high number of dairy veterinarians and consultants. And while many provinces have moved away from providing extension services, Quebec has created a knowledge translation service within their milk recording program (Valacta). With the 2019 launch of Lactanet (a partnership between Valacta, Canwest DHI, and the Canadian Dairy Network), some of these services may be offered nationally in the future, although when and how this will happen has yet to be determined. The density of dairy farms coupled with the number of translators has created an ideal environment for the diffusion of technology.

Of the 8 technologies analyzed, the 3 most closely aligned with the dairy industry were auto-feeding, auto-environmental control, and automated milking systems (AMSs). However, auto-feeding was not defined by Statistics Canada, hence it could have been interpreted as feed mixing, feed delivery, or pushing up the feed to the cattle. Similarly, auto-environment did not specify whether it applied to cow housing or calf housing. Furthermore, the census asked about the use of robotic milking, whereas AMS is perhaps a more encompassing term. That said, dairy producers should appreciate the clear delineation between using and not using robotic milkers. Despite these limitations, a common finding to most of the 8 technologies was that farms with ≥2 operators had a higher rate of adoption than single operator farms, which is likely confounded by herd size. It was also common to find no difference in adoption by gender; however, this finding requires some explanation. Farms were not segregated by those operated solely by females or males; rather, 93% of female operators were managing alongside male operators; therefore, it is difficult to parse the effect of gender. Similarly, operator age also had a marginal effect on the adoption of most technologies with the exception being smartphones/tablets and computers/laptops. This lack of age effect is likely related to 75% of dairies having multiple operators, who by Statistics Canada’s definition are responsible for farm management decisions. Farming in Canada is still very much a family enterprise; therefore, the operators undoubtedly represent multiple generations, which conceals the effect of age on the adoption of technologies. Regarding the use of smartphones/tablets, there was a clear trend for younger operators to be more intensive users of these devices; however, this may be related to these devices being personal use items. Overall, adoption of smartphones/tablets and computers/laptops was higher in the dairy industry compared to the Canadian cow-calf industry (26), which may reflect dairy operators being more comfortable with computers and software applications.

While there were statistical differences in the estimates of the mean for each AMS parameter, the measure of effects was negligible for gender, number of operators per farm, and operators’ age. The only determinants of significance were geographical region and herd size. The estimates of the means by geographical region show that dairies in western Canada and Quebec had the highest adoption of AMS compared to Ontario and the Atlantic region. These relationships, however, are probably confounded
by other management practices, such as housing. Automated milking systems are not used in tie-stall (pipeline) systems, a housing practice that is much more common in Quebec (41%) and Ontario (31%) and rarely used in the Atlantic region (3%) or western Canada (2%) (27). Furthermore, only 7% of Canadian herds milked > 80 cows using a pipeline system and average herd size is greatest in western Canada (27). There are multiple factors that favored the adoption of AMS in western Canada; however, these same factors should have been barriers to adoption in Quebec. As previously noted, the adoption of all technologies by the Quebec dairy producers could be related to a greater diffusion of information. In addition, Quebec’s all technologies by the dairy industry. Clearly, some technologies were of greater diffusion of information. In addition, Quebec’s average herd size is ~62 milking animals (24), which is the approximate capacity of most AMSs. Automatic milking systems technology, therefore, is a very good fit for many of Quebec’s dairies, which not only alleviates labor constraints but may also increase their competitiveness. A Canadian study reported that AMSs reduced the amount of time spent each day on milking activities by 62%, while increasing milk yield (28). Although the adoption of AMSs remains relatively low, both economics and demographics are important drivers for the increased adoption of AMSs, which should be evident by the next census in 2021.

Biosensors are a cost-effective means of monitoring an animal’s physiology and/or environment and are considered by some to be the 4th revolution in agriculture (29). The concept of integrating nanotechnologies or molecular diagnostics into wearable biosensors, which provide data in real-time, is no longer a futuristic construct (30). Rather, technologies are currently being used to monitor health, reproduction, metabolic parameters, milk production, and as an aid in genomic selection (31–37). The breadth of these technologies underscores the challenges that Statistics Canada will encounter when attempting to gather technology data from across all agricultural sectors. Fortunately, Canada has a cohort of collaborative dairy researchers located in all regions of the country who have the means to investigate the adoption of novel dairy management practices and technologies. A case in point is the 2015 National Dairy Study, which captured detailed benchmarking data on all facets of dairy production: health, welfare, management, and production (38).

While the Census of Agriculture data have their limitations, they also have some notable strengths. Specifically, they capture data from all dairy producers and farms, eliminating biases associated with surveys. Second, the data can be analyzed in conjunction with the Census of Population data, thereby providing data on the demographics of the dairy operators. For the current study, only 5 farm and farming operator characteristics were chosen; however, a similar analysis could have been performed using a range of other parameters such as farm income, land base, and farm ownership.

This study provided an overview of the adoption of technologies by the dairy industry. Clearly, some technologies were of particular relevance to the dairy industry, whereas others were more applicable to dry-land farming and other livestock commodity groups. This was the first time that Statistics Canada dedicated a section of the census to technologies, and therefore the current study provides a baseline for future census data.

References

New Products
Nouveaux produits

DOGORA Launches Medical Snuggie for Dogs and Cats

A DOGORA first! An innovative new garment provides safety and comfort after abdominal surgeries. The DOGORA Medical Snuggie is a comfortable alternative or companion to the standard plastic cone. It gives dog and cat owners peace of mind after their pet undergoes any abdominal surgeries such as neuters, spays and obstructions; ensuring the bandage is completely covered and the wound is healing properly. It can also be used to cover skin irritations, tumor extractions and front limb amputations. Made with high-quality cotton and spandex, the Medical Snuggie provides a comfortable, breathable and washable garment to help prevent your pets from tampering with surgical stitches while they convalesce.

“The DOGORA Snuggie fits comfortably, while keeping your dog feeling warm, secure and calm after surgery,” adds Dr. Kafai, DVM, Ph.D., from his 24-hour Animal Hospital in Thornhill, Ontario. “It is frequently used within the clinic and has received positive feedback from clients. Pet owners love the DOGORA Medical Snuggie.”

The DOGORA Medical Snuggie slips easily over the pet’s head and front paws. Two buttons fasten the Medical Snuggie behind the tail. Owners can keep it buckled on when their pet is at home and roll it halfway to the stomach when Nature calls.

Made from 94% cotton and 6% spandex for warmth and breathability, the DOGORA Medical Snuggie is machine washable. It can also be repurposed and worn after the wound has healed to keep pets cozy and comfortable for years to come.

Contact: Nicholas Mozas, CEO, DOGORA Inc. Toronto, Ontario; e-mail: info@dogora.ca; website: www.dogora.ca
Article

Outcome following surgical stabilization of distal diaphyseal and supracondylar femoral fractures in dogs


Abstract — Signalment, clinical features, fixation techniques, complications, and outcome for dogs presenting with distal diaphyseal and supracondylar femoral fractures were retrospectively reviewed. A total of 45 dogs with unilateral femoral fractures were included. Supracondylar femoral plates were the most popular method of fixation. However, various fixation techniques resulted in favorable outcomes in most dogs with 19/45 cases achieving full function and 22/45 achieving acceptable function. Degree of fracture comminution did not appear to affect complication rate or be a surrogate for worse clinical outcome.

Résumé — Résultats de stabilisation chirurgicale de fractures fémorales diaphysaires distales et supracondylaires chez le chien. Une étude rétrospective portant sur le signalement, la présentation clinique, les techniques de réduction de fracture, les complications et les résultats de chiens atteints de fractures fémorales supracondyliennes et diaphysaires distales a été réalisée. Quarante-cinq chiens présentant une fracture fémorale unilatérale ont été inclus au total. Les plaques fémorales supracondyliennes représentaient la méthode d’ostéosynthèse la plus courante. Diverses techniques de fixation ont abouti à des résultats favorables dans la majorité des cas, avec 19/45 cas récupérant une fonction complète et 22/45 une fonction considérée acceptable. Le degré de comminution de la fracture n’apparaissait pas comme étant un facteur de risque de complication ou étant associé à des résultats défavorables.


Introduction

Canine femoral fractures are the most common appendicular fracture, comprising 45% of all long-bone fractures and 20% to 25% of all fractures seen in small animals (1,2). Of these, distal femoral extra-articular fractures can be described as either supracondylar (6% of femoral fractures) (i.e., non-physeal fractures of the distal metaphyseal region) or distal physeal (18% to 21% of femoral fractures) (2,3). Supracondylar femoral fractures are most commonly reported in skeletally mature dogs (4,5). The topography of the canine femur with distal femoral procurvatum in concert with a naturally occurring isthmus at the level of the distal femoral metaphysis in chondrodystrophic breeds appears to predispose these breeds to this type of fracture (2,4). Limited bone stock of the distal femur, proximity of a high motion joint (i.e., stifle), fracture comminution and procurvatum offsetting the distal femur caudal to the diaphysis may cumulatively present challenges for internal fixation (2,4,5).

Canine distal femoral diaphyseal and supracondylar fractures have a low incidence of occurrence (3). Multiple fixation strategies are suggested for these fractures (2,6) including the use of bone plates (7), interlocking nails (8), Kirschner wires, Rush pinning, lag screw fixation, intramedullary rods (9), and external skeletal fixation (10). However, a distinction is not made...
between supracondylar or physeal (i.e., Salter-Harris) fractures in some reports, making interpretation of the outcome and any complications as a function of exact fracture configuration challenging (9). Furthermore, a case series reviewing the use of supracondylar femoral plates (Veterinary instrumentation, Sheffield, UK) in the context of distal femoral fracture stabilization is lacking. Roch and Gemmill (11) reported use of these plates for stabilization after distal femoral wedge osteotomy, in the context of medial patellar luxation. Supracondylar plates have been designed with the assistance of finite element analysis to be used as bridging plates across comminuted fractures, with the aim of minimal contouring and maximizing the number of cortices engaged within the distal femoral fragment, which is offset caudally relative to the distal femoral shaft (12). Two plate designs have evolved (Veterinary instrumentation, Sheffield, UK); the supra-condylar plate (SCP), which has screw holes distributed throughout the whole length of the plate (Figure 1a), and the supra-condylar osteotomy plate (SCOP), which incorporates a bridging plate segment without screw holes (to be laid over the fracture/osteotomy site), increasing the area moment of inertia of the implant in that segment (Figure 1b).

The purpose of this retrospective multicenter case series was to describe the signalment, clinical features, fixation techniques, complications, and outcomes for dogs presenting with distal diaphyseal or supracondylar femoral fractures.

Materials and methods

Medical records of dogs presented between 2007 and 2018 for surgical treatment of distal femoral and supracondylar fractures at 12 referral centers in the UK and 2 referral centers in Australia were obtained for review. Cases were included in the study if complete clinical records, pre-operative and post-operative radiographic imaging, and clinical and radiographic follow-up were available for review. The term supracondylar has been used previously to define the distal metaphyseal region of the femur (2). The authors are unaware of a methodology that can be used to confidently identify the boundaries of the distal femoral metaphysis, which cannot be outlined using anatomic landmarks. In our study, fractures were first classified as distal femoral (1). Of these, fractures were defined as supracondylar if they were found to be proximal to the distal femoral physis (in skeletally immature animals) and/or extra-articular (in skeletally mature animals) but still within the distal femoral segment. The quadrate method as described by Unger et al (1) whereby a square representing the widest portion of the distal femur was templated onto each radiograph, was used to define the distal femoral segment. Fractures were classified as distal diaphyseal if proximal to the distal femoral segment but still within the distal third of the femur, according to the measurements made on pre-operative radiographs (Figure 2). The middle of oblique and transverse fractures, the broadest part of the wedge for wedge fractures and the center of the area of comminution for comminuted fractures were used to define fractures as either supracondylar or distal diaphyseal (1). Physeal (Salter-Harris) fractures were not included in the study.

Complications were classified using Cook et al (13) proposed criteria in terms of the timescale of their occurrence as perioperative (before surgery, during surgery, and up to 3 mo after surgery), short-term (between 3 and 6 mo after surgery), midterm (6 to 12 mo after surgery), or long-term (more than12 mo after surgery). Complications were further classified as either catastrophic (when a complication or associated morbidity had caused permanent unacceptable function, was directly related to death, or was the cause for euthanasia), major (when a complication or associated morbidity required further surgical or medical treatment, based on current standards of care, to resolve), or minor (when not requiring additional surgical or medical treatment to resolve). Clinical outcome was evaluated based on the data recorded by the attending surgeon at the last revisit or based on information gathered from the owners at the time of data collection. Clinical outcome was classified in terms of time frame as perioperative (pre-, intra- and up to 3 mo post-surgery), short-term (> 3 to 6 mo post-surgery), midterm (> 6 to 12 mo post-surgery), and long-term (> 12 mo post-surgery).

Figure 1. a — Supra-condylar plate (SCP). Plate designs from top to bottom: 3.5-mm broad long left plate, 3.5-mm narrow long left plate, 2.7-mm left plate, 2.4-mm left plate, 2.0-mm long left plate, 2.0-mm left plate. b — Supra-condylar osteotomy plate (SCOP). Plate designs from top to bottom: 3.5-mm left plate, 2.7-mm left plate, 2.4-mm left plate, 2.0-mm left plate.
post-surgery). Clinical outcome was subsequently subjectively classified as dogs having achieved full function (restoration to, or maintenance of, full intended level and duration of activities and performance from pre-injury or pre-disease status, without medication), acceptable function (restoration to, or maintenance of, intended activities and performance from pre-injury or pre-disease status that is limited in level or duration and/or requires medication to achieve) or unacceptable function (all other outcomes) (13).

Results
Forty-five dogs with unilateral femoral fractures were eligible for inclusion in the study. A median number of 4 cases (range: 1 to 6) was collected from each referral center. The median age of the study population at the time of surgery was 2 y 3 mo (range 0 y 3 mo to 9 y 10 mo). Median body weight (BW) was 9.1 kg (range: 2.15 to 50 kg). Twenty-nine dogs were male (13 of which were neutered) and 16 were female (7 of which were neutered). Breeds represented in the study population were: cross-breed (n = 6), cocker spaniel (n = 4), 3 each of Staffordshire bull terrier, Jack Russell terrier, Chihuahua, border terrier, bichon frise, 2 each of pug, Maltese terrier, border collie, and 1 each of the shih tzu cross Maltese, Rottweiler, Pomeranian cross, lhasa apso, Labrador retriever, Jack Russell terrier cross, husky, greyhound, dachshund, cockapoo, boxer, Belgian shepherd, working cocker, and beagle. Fracture etiologies were recorded in 39/45 cases (Appendix 1, available from the corresponding author) and included road-traffic accident (20/45), fall from height (11/45), and leg entrapment (3/45). Thirty-two dogs had right femoral fractures and 13 had left femoral fractures.

Eighteen dogs were diagnosed with supracondylar femoral fractures and 27 with distal diaphyseal fractures. Fracture configuration comprised 15 comminuted, 15 transverse, and 15 oblique. Twenty-one of the 45 dogs suffered adjunctive orthopedic and/or soft tissue injuries (Table 1).

Fixation methods employed for fracture stabilization comprised a predominance of lateral plating, used in 27 dogs. Of those, femoral supracondylar plates were used in 18/27 dogs, locking-compression plates (LCP; Synthes, West Chester, Pennsylvania, USA) in 4/27 dogs, dynamic-compression plates (DCP) in 2/27 dogs, a locking reconstruction plate (VetLOX Titanium plate; Freelance Veterinary, Somerset, UK) in 1/27 dogs, a notched locking T-plate (Synthes) in 1/27 dogs and a broad locking TPLO plate (Synthes) in 1/27 dogs. Plate-rod fixation was used in 9 dogs, with LCP plates used in 4/9 dogs, DCP plates in 3/9 dogs, a supracondylar plate in 1/9 dogs, and a string-of-pearls plate (Orthomed UK, Halifax, West Yorkshire, UK) in 1/9 dogs. Crossed-arthrodesis wires were employed as the main method of fixation in 4/45 dogs, external skeletal fixation was employed in 3/45 dogs, and bilateral plating (with either 2 string-of-pearls plates in 1 dog or with an LCP medially and supracondylar plate laterally in another dog) in 2/45 dogs (Figure 3). Further details are presented in Appendix 1.

In the 20 dogs in which a supracondylar plate was employed (either in isolation or in combination with other implants), 2.0-, 2.7-, or 3.5-mm plates were used. In 12 cases a supracondylar plate (SCP) and in 8 cases a supra-condylar osteotomy plate (SCOP) were used. Supracondylar plates were used as the primary method of fixation in 18/45 dogs (excluding a case in which a supracondylar plate was combined with an IM pin, and a case in which a contralateral LCP plate was added). Of these 18 cases, 3 comminuted fractures, 6 oblique fractures, and 9 transverse fractures were recorded; 10 being supracondylar and 8 distal diaphyseal. In 3 of these 18 cases, a single intrafragmentary arthrodesis wire was also placed, and in 1 case crossed arthrodesis wires were also placed, either to maintain fracture reduction during surgery or as adjunctive fixation (Appendix 1). Supracondylar femoral plates were used without any adjunctive fixation in 14 cases (Figure 3a).
Table 1. Concurrent injuries listed by dog.

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Breed</th>
<th>Trauma type</th>
<th>Other injuries</th>
<th>Fracture location and configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 y 5 mo</td>
<td>FN</td>
<td>Springer spaniel</td>
<td>RTA</td>
<td>Pneumothorax</td>
<td>Left, distal diaphyseal, comminuted</td>
</tr>
<tr>
<td>1 y 11 mo</td>
<td>FN</td>
<td>Beagle</td>
<td>RTA</td>
<td>Vertebral subluxation of T8-T9, with suspected compression fracture of the body of T9. Damage to the articular facets and dorsal spinous process was not seen and no neurological deficits were apparent. Subluxation of the 9th right rib head.</td>
<td>Right, distal diaphyseal, transverse</td>
</tr>
<tr>
<td>11 mo</td>
<td>MN</td>
<td>Jack Russell terrier</td>
<td>Hit by falling log</td>
<td>Fracture of left acetabulum, left ischium, and left pubis.</td>
<td>Left distal, diaphyseal, comminuted</td>
</tr>
<tr>
<td>1 y 1 mo</td>
<td>F</td>
<td>Cockapoo</td>
<td>RTA</td>
<td>Right coxofemoral luxation, bilateral sacroiliac luxation, right ilial body fracture, left ischiatic fracture, and pubic symphysis separation.</td>
<td>Right, distal diaphyseal, comminuted</td>
</tr>
<tr>
<td>3 y 4 mo</td>
<td>M</td>
<td>Chihuahua</td>
<td>RTA</td>
<td>Comminuted fracture/avulsion of the right calcaneus, loss of viability of skin over dorsal aspect of the right pes.</td>
<td>Right, distal diaphyseal, transverse</td>
</tr>
<tr>
<td>9 mo</td>
<td>MN</td>
<td>Crossbreed</td>
<td>RTA</td>
<td>Laceration between digits IV and V.</td>
<td>Right, distal diaphyseal, oblique</td>
</tr>
<tr>
<td>3 mo</td>
<td>M</td>
<td>Boxer</td>
<td>Fall from height</td>
<td>Fracture of the right femoral head capital physis with minimal displacement or apparent instability.</td>
<td>Right, supracondylar, oblique</td>
</tr>
<tr>
<td>1 y</td>
<td>M</td>
<td>Pomeranian-cross</td>
<td>RTA</td>
<td>Bladder rupture. Right ischial fracture, multiple pubic fractures, right ilial body fracture.</td>
<td>Left, distal diaphyseal, transverse</td>
</tr>
<tr>
<td>2 y 11 mo</td>
<td>FN</td>
<td>Crossbreed</td>
<td>RTA</td>
<td>Left sacroiliac luxation, bilateral pubic fractures, left ischial fracture.</td>
<td>Right, supracondylar, transverse</td>
</tr>
<tr>
<td>4 mo</td>
<td>F</td>
<td>Pug</td>
<td>Mild unknown trauma</td>
<td>Suspected Salter-Harris type V of the ipsilateral distal femoral physis.</td>
<td>Right, supracondylar, oblique</td>
</tr>
<tr>
<td>9 mo</td>
<td>M</td>
<td>Bichon frise</td>
<td>RTA</td>
<td>Mid-diaphyseal, oblique, right tibial fracture, right coxofemoral luxation, bilateral right sacroiliac luxation and multiple pelvic floor fractures.</td>
<td>Right, supracondylar, transverse</td>
</tr>
<tr>
<td>3 y 1 mo</td>
<td>MN</td>
<td>Crossbreed</td>
<td>Fell from height</td>
<td>Pulmonary contusions and mild pneumothorax.</td>
<td>Right, supracondylar, oblique</td>
</tr>
<tr>
<td>4 y 1 mo</td>
<td>MN</td>
<td>Border terrier</td>
<td>Hit by metal rod</td>
<td>Small puncture wound on the right hock.</td>
<td>Right, distal diaphyseal, comminuted</td>
</tr>
<tr>
<td>4 y 1 mo</td>
<td>MN</td>
<td>Dachshund</td>
<td>RTA</td>
<td>Multiple pelvic floor fractures, right ischiatic tuberosity fracture, left cranial ischiatic fracture.</td>
<td>Right, supracondylar, oblique</td>
</tr>
<tr>
<td>3 y</td>
<td>M</td>
<td>Crossbreed</td>
<td>RTA</td>
<td>Right ischial fracture, pelvic floor fractures, left ilial body fracture.</td>
<td>Right, supracondylar, oblique</td>
</tr>
<tr>
<td>3 y 10 mo</td>
<td>FN</td>
<td>Maltese terrier</td>
<td>RTA</td>
<td>Right coxofemoral luxation, right sacroiliac luxation, bilateral pubic fractures and right ischiatic fracture.</td>
<td>Left, distal diaphyseal, oblique</td>
</tr>
<tr>
<td>7 y</td>
<td>MN</td>
<td>Maltese</td>
<td>RTA</td>
<td>Left trochanteric fracture, laceration left inguinal region.</td>
<td>Right, supracondylar, comminuted</td>
</tr>
<tr>
<td>3 y 6 mo</td>
<td>MN</td>
<td>Rottweiler</td>
<td>Fell out of moving vehicle</td>
<td>Non-displaced right ischial fracture, incidental OCD lesion of medial femoral condyle seen at surgery.</td>
<td>Right, distal diaphyseal, comminuted</td>
</tr>
<tr>
<td>8 mo</td>
<td>MN</td>
<td>Border terrier</td>
<td>RTA</td>
<td>Laceration lateral aspect of the right thigh.</td>
<td>Right, distal diaphyseal, comminuted</td>
</tr>
</tbody>
</table>

M — male; MN — male neutered; F — female; FN — female neutered; RTA — road-traffic accident; OCD — osteochondritis dissecans.

Outcome
All cases had at least 1 post-operative consultation and radiographs with a veterinary surgeon. Radiographic follow-up had a median duration of 7 wk (range: 2 to 28 wk) and clinical follow-up for a median duration of 8 wk (range: 4 to 208 wk). Clinical and radiographic follow-up data allowed for attribution of a perioperative outcome in all cases, short-term outcome in 9 cases, medium-term in 3 cases, and long-term in 1 case. Nineteen of the 45 cases were deemed to have achieved full function at their last recorded follow-up, 22 had achieved acceptable function, and 4 unacceptable function. Of those dogs in which SCP/SCOP was employed, 9/20 cases were deemed to have achieved full function, 10 had achieved acceptable function, and 1 had unacceptable function at their last recorded
Among cases in which supracondylar plates were used as the primary method of fixation, 9/18 dogs achieved full and 9/18 achieved acceptable function.

A total of 16 postoperative complications were recorded in 14 dogs. Catastrophic complications were recorded in 4 dogs, 2 of which were diagnosed with quadriceps contracture, defined as an inability to flex the stifle with concurrent tarsal extension and flexed digits on the operated limb. The third dog with a recorded catastrophic complication suffered failure of the initial fixation with 4 crossed arthrodesis wires (later revised with a supracondylar plate). A fourth dog had proximal migration of the intramedullary pin, inserted as part of a plate-rod construct and was still severely lame at the last recorded follow-up (19 wk after surgery). Major complications were recorded in 6 cases. These included worsening of pre-existing medial patellar luxation requiring corrective surgery (in 2 cases), surgical site infection with ipsilateral septic arthritis of the stifle (in 1 case), external skeletal fixator pin discharge (in 1 case), patellar desmitis (in 1 case) and screw loosening requiring removal (in 1 case). Minor complications were recorded in 6 cases and included pin tract discharge without the need for any intervention (in 1 case), edema in the operated limb (in 1 case), limb shortening due to premature closure of the distal femoral physsis without associated lameness (in 1 case) and screw loosening that did not require surgical removal (in 1 case). All recorded complications were classified as “perioperative” with regard to the time frame of their occurrence, with the exception of the case in which screw migration requiring screw removal was detected. The latter was classed as “long-term,” having occurred 13 mo after surgery.

Of the 20 dogs in which SCP/SCOP was employed, 4 postoperative complications occurred; 1 catastrophic (quadriceps contracture and IM pin migration), 2 major (patella luxation and screw loosening requiring removal), and 1 minor (screw loosening as an incidental finding not requiring removal). An SCP plate was used in both cases in which screw loosening occurred. In total, 2 of the 14 dogs that had a SCP/SCOP plate applied as sole method of fixation had recorded complications, accounting for a rate of complications of 2/14 (14.3%).

**Discussion**

To the authors’ knowledge, this multicenter study describes the largest case series of canine distal diaphyseal/supracondylar fractures to date and the only series evaluating the use of the SCP/SCOP in the context of femoral fracture repair. No complications were recorded in the 3 cases of comminuted fractures in which SCPs were used in bridging mode, suggesting the implant performs adequately in a scenario of comminution, as did other fixation strategies reported in this manuscript. Single screw loosening was recorded in 2 cases and although both fractures healed uneventfully, 1 screw did require surgical removal. A recent *in vivo* biomechanical study on the effect of bicortical or monocortical locking screws on a mid-diaphyseal femoral fracture gap model (14), reported no screw loosening or screw pull-out with locking screws compared to a 70% incidence of screw pull-out when cortical screws were used (15). Distal femoral locking plates are also available (New Generation Devices, Glen Rock, New Jersey, USA) and it is plausible that the use of a locking plate and screws could have reduced the risk of screw loosening.
Our case series has an overall rate of complications of 31.1%. Previously published case series documenting the use of internal fixation for non-articular fractures in dogs reported complication rates that varied between 5% and 37% (16–20). Pin migration occurred in 2/9 plate-rod cases in our series, in both instances necessitating pin removal. Pin associated complications (with pin migration being the most frequently reported), requiring a form of intervention have been reported in 9% to 19% of plate-rod repairs (16–18).

Quadriceps contracture was reported in 2 cases in this case series. Young dogs with distal femoral fractures appear to be predisposed (21). However, both cases reported herein were adult dogs with comminuted fractures. The presence of comminution, and as such, due to a higher energy injury, more adjunctive soft tissue damage and more callus formation rather than age could have been a predisposing facture to contracture development in our cases.

Linear LCP or DCP plates were used to repair 13 fractures. Given the limited 3-dimensional contouring that such plates can tolerate, the use of this fixation strategy may involve either over-reducing the distal fracture to increase the bone stock available for screw placement distally (2) or helical plating (22). Over-reduction of the distal fragment could predispose to misalignment of the patellar and quadriceps mechanism (2,5). Interestingly, in our series, iatrogenic de novo patellar luxation was not a recorded complication. However, worsening of pre-existing medial patellar luxation, requiring surgical intervention, was recorded in 2 cases. Possible etiologies to explain this complication could include lateral distal femoral soft tissue dissection at the time of fracture repair, malreduction of the distal femoral fragment, or postoperative quadriceps muscle atrophy affecting either the magnitude or direction of force through the patellofemoral joint.

Our study has limitations inherent in its retrospective nature. When assessing outcome, we opted for the “last observation carried forward” method, which has limitations in interpretation of outcome (23,24). Given the short duration of follow-up in some of the cases it is plausible that some could have developed undocumented mid- to long-term complications that could have significantly affected outcome (25,26). It is equally plausible that, should there have been short-, mid- and long-term follow-up available for all cases, some of the cases with “acceptable” outcome could have been allowed the necessary time to recover full function and as such, outcome in our series could be negatively biased. Similarly, the presence of adjunctive polytrauma in our case series (21/45) makes it difficult to discern the precise contribution of each individual injury to the final outcome recorded. The short duration of follow-up also precluded a radiological analysis of the time to complete fracture healing in all cases. Contribution of case material from multiple referral hospitals treated by multiple surgeons also introduced variation in surgeon experience and postoperative management between cases.

In summary, this case series documents the use of multiple fixation strategies for the management of supracondylar and distal diaphyseal femoral fractures in dogs. Communion was often present, but this did not appear to result in a poorer outcome, neither did whether the fracture was distal diaphyseal or supracondylar. Complication rates when SCP/SCOP plate fixation was used were comparable to those for other fixation strategies.

Acknowledgments

We acknowledge Veterinary Instrumentation, Sheffield, UK, for the assistance given towards the acquisition of the supracondylar osteotomy plate photographs.

References


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 • cvmajinsurance.com
Effect of intravenous fluid warming on core body temperature during elective orthopedic procedures

Robert B.E. Brady, William T. Poppell

Abstract — The effects of intravenous (IV) fluid warming on core body temperature in a group of dogs undergoing an elective orthopedic procedure was studied. An IV fluid warmer was used alone or in conjunction with forced warmed air to determine the individual or additive effects of IV fluid warming. These effects were compared to those in dogs with no heat support or those with only forced warmed air in a randomized prospective study design. The conclusion was that IV fluid warming had no effect on the maintenance or preservation of core body temperature in this population of dogs, and that, as previous reports have shown, forced warmed air decreased the rate of heat loss during anesthetic procedures. One possible explanation for the lack of benefit is the location of the fluid warmer in relation to the patient. To our knowledge, this is the first study to examine the effects of IV fluid warming on core body temperature in dogs undergoing an elective orthopedic procedure.

Résumé — Effet du réchauffement du liquide intraveineux sur la température corporelle centrale durant des procédures orthopédiques électives. Les effets du réchauffement du liquide intraveineux (IV) sur la température corporelle centrale dans un groupe de chiens soumis à une procédure orthopédique électrique furent étudiés. Un réchaud à fluide IV était utilisé seul ou conjointement avec de l’air chaud forcé afin de déterminer les effets individuels ou additifs du réchauffement du liquide IV. Ces effets furent comparés à ceux de chiens sans support de chaleur ou ceux avec uniquement de l’air chaud forcé dans une étude prospective randomisée. La conclusion était à l’effet que le réchauffement du liquide IV n’avait aucun effet sur le maintien ou la préservation de la température corporelle centrale dans cette population de chiens, et que, tel que démontré par des études antérieures, de l’air chaud forcé diminuait le taux de perte de chaleur durant les procédures anesthésiques. Une explication possible pour l’absence de bénéfice serait la localisation du chauffe liquide relativement au patient. À notre connaissance, ceci constitue la première étude à examiner les effets du réchauffement du liquide IV sur la température corporelle centrale chez des chiens soumis à une procédure orthopédique électrique.


Introduction

Hypothermia associated with anesthesia occurs in an estimated 83% of veterinary patients (1). Body heat is lost during anesthesia as a result of conduction, convection, radiation, decreased vasomotor tone and thermoregulatory function, inhalation of cold anesthetic gases, and evaporation through application of skin disinfectants (2). Core body temperature is a fundamental vital sign and is to be monitored closely in all anesthesia patients (3,4). Hypothermia in the canine patient is ill-defined and ranges from a core body temperature at or below 36.5°C to 37.5°C (5,6). Inadvertent perioperative hypothermia (IPH) is a well-known complication of both general and neuraxial anesthesia and is associated with increased risk of infection, cardiac arrhythmias, prolonged recovery times, coagulopathy, morbidity, and increased length of hospitalization (7–9). Anesthesia depresses thermoregulatory mechanisms which are responsible for maintaining body temperature within a certain window, termed the “interthreshold range.” A widening of the interthreshold range, as occurs under anesthesia, alters the body’s activation point for corrective mechanisms which maintain body temperature within its set range (6–10). For example, if an animal’s interthreshold range is 38.0°C to 39.0°C under general anesthesia, it will widen to approximately 36.0°C to 41.0°C under general anesthesia. Should hypothermia occur, thermoregulatory mechanisms would not be activated until core body temperature falls below 36.0°C. Risk factors for development of hypothermia under anesthesia include reduced body fat, increased surface area:body mass ratio (e.g., puppies), underlying systemic disease, age (geriatric or neonatal), and multiple anesthetic drugs that contribute to vasodilation and or hypothalamic
depression (5,11,12). Anesthetic drugs can predispose patients to IPH by disruption of hypothalamic thermoregulatory centers as well as blockade of effenter neurons involved in homeostatic reflexes, such as shivering (10,13,14). A body temperature of less than 34.4°C leads to loss of thermoregulatory function, decreased shivering, and reduced hypothalamic activity, further exacerbating heat loss (15).

During the induction phase of anesthesia, vasodilation facilitates the flow of large volumes of blood to the periphery, where heat is lost to the surrounding environment through conduction, convection, and radiation. This accounts for up to 80% of heat loss during the first hour of anesthesia (2,16–19). Maintaining normothermia during the perioperative period is critical for ensuring fast recovery from anesthesia and avoiding the deleterious effects of hypothermia. The greatest reduction in core body temperature occurs during the first hour of anesthesia (2,20). This suggests that early intervention in the perioperative period may be key in preventing perioperative hypothermia.

Forced warmed air is the most effective method of reducing the rate of core body temperature loss in humans (21,22) and in veterinary patients (23–25) and will be used as the gold standard in this study. The most accurate, albeit invasive, assessments of core body temperature in veterinary patients are obtained via thermistors placed in the esophagus, urinary bladder, and caudal vena cava, while in human medicine, core body temperature measurement within the pulmonary artery is the gold standard (26–28). In addition, both rectal and auricular thermometry are reliable methods for evaluating core body temperature (29). However, 1 study showed greater variability between auricular temperature readings compared to rectal thermometry which provided temperature readings within 0.5°C of the pulmonary artery temperature (30). Rectal temperature closely correlates with more invasive core body temperature measurements, and its noninvasive nature makes it a convenient method of monitoring body temperature during surgery (29,30).

Several methods of intraoperative warming have been evaluated including heating pads, warmed blankets, warm water bottles/rice bags, and forced warmed air (23–25). However, no previous studies have evaluated the effectiveness of IV fluid warming. Active heating devices carry the risk of thermal injury. Some techniques, such as warmed fluid bags/rice bags, increase conductive loss of heat once they cool thereby worsening hypothermia (33). As with many facets of anesthesia, a multi-modal approach may be warranted to support core body temperature preservation while decreasing the risk for thermal injury and/or hyperthermia in patients. In light of all this, we hypothesized that intravenous fluid warming, as instructed by the manufacturer, will be ineffective in reducing the rate of heat loss, while forced warmed air will slow the rate of heat loss during anesthesia.

**Materials and methods**

**Animals**

Forty-eight client-owned adult large breed dogs were included in the study, which ran from September 2018 to June 2019. All owners provided written informed consent at the time of surgery to be included in the study. Inclusion criteria consisted of healthy, skeletally mature dogs, 2- to 8-years of age, of good body condition, BCS 4/9 to 6/9, which were undergoing an elective orthopedic procedure. These procedures included tibial plateau leveling osteotomy ($n = 42$), medial patellar luxation repair ($n = 1$), primary fracture repair ($n = 2$), open reduction of lateral elbow luxation ($n = 1$), hip toggle placement ($n = 1$), and a corrective osteotomy ($n = 1$). Exclusion criteria included patients with any known underlying chronic or metabolic disease, preoperative temperatures $> 39.5°C$ or $< 37.5°C$, patients requiring significant intraoperative treatment for anesthetic complication leading to additional drug administration or repeated fluid bolus administration, and dogs with abnormalities on pre-operative blood analysis consistent with chronic or metabolic disease. Of the 48 dogs which met eligibility criteria for the study none were excluded and all patient data were reported up to 105 min under anesthesia, with 47 patients’ data reported to 120 min.

**Experimental design**

This investigation was a prospective randomized study. A power analysis indicated that 8 subjects per group were needed to reach 90% power with an effect size of 1.0°C. A research randomizer (www.randomizer.org) was used to assign each patient number to its respective treatment group at the onset of the trial. A single investigator was responsible for all patient data collection. All patients received the same anesthesia protocol, consisting of IV catheter placement followed by fentanyl (West-Ward, Eatontown, New Jersey, USA), 1 mg/kg body weight (BW), IV, then diazepam (Hospira, Lake Forest, Illinois, USA), 0.25 mg/kg BW, IV and propofol (Zoetics, Kalamazoo, Michigan, USA), 4 mg/kg BW, IV, to effect for induction of anesthesia. The patients were then connected to an isoflurane vaporizer with an O$_2$ flow rate of 2 L/min. Lactated Ringer's solution (Baxter, Deerfield, Illinois, USA) was started at a rate of 5 mL/kg BW per hour. In all pelvic limb procedures, epidural morphine (West-Ward), 0.1 mg/kg BW, was administered followed by a fentanyl (Hospira) CRI of 7 µg/kg BW per hour for the duration of anesthesia. Cefazolin (Hikma Farmaceutica, Eatontown, New Jersey, USA), 22 mg/kg BW, IV, was given 30 min before initial incision and every 90 min thereafter. Patients were then transported to the radiology suite for pre-operative radiographs followed by sterile preparation, surgery, post-operative radiographs, and recovery. All heating interventions were paused during transport for all patients due to a lack of mobile electricity sources for the active warming devices used.

Animals were randomized to 1 of 4 treatment groups: Group 1 — control group with no heat support; Group 2 — IV fluid warmer only (Midmark i-warm Fluid warmer, Dayton, Ohio, USA) at 40.5°C, 170 cm from fluid warmer to patient (as per manufacturer recommendations); Group 3 — forced warmed air (Cocoon blanket, Care Essentials, North Geelong, Australia) at 43.9°C; and Group 4 — IV fluid warmer and forced warmed air. At the time of induction, a baseline rectal temperature was obtained via a rectal thermometer; this was followed by rectal temperature recordings every 15 min thereafter. Heart rate (HR), respiratory rate (RR), ETCo$_2$, SPO$_2$, Gas %, O$_2$ flow rate, ECG, fluid boluses, and anesthetic plane...
were also monitored. If a patient’s core body temperature in either the control group or the warmed IV fluids only groups fell below 36.1°C, forced warmed air was added. Monitoring of temperature and active warming were discontinued during transport to recovery. The ambient temperature in the hospital and operating room suite was maintained at 21.1°C.

**Statistical analysis**

A commercial statistical package (SPSS Version 21; IBM, Armonk, New York, USA) was used for all statistical analyses. An analysis of variance (ANOVA) was used to compare the 4 treatment groups’ signalment along with Chi-square analysis on gender of patients. Z-scores were used to ensure normality of data in the progression of body temperature over time. A group by time repeated measures analysis of covariance (ANCOVA) with a Huynh-Feldt correction was conducted to determine the statistical significance of each treatment group compared to the control and adjusted using Bonferroni corrections with a statistical significance of $P < 0.05$. Polynomial contrasts were also utilized to test the linear trends across time for each group compared to control.

**Results**

Patient characteristics and fluid rate were compared among the 4 groups (Table 1). Fluid rate, age, BCS, and BW were not significantly different among the 4 groups. The groups did not differ significantly with respect to the number of intact patients ($\chi^2 = 4.24; P = 0.237$) nor with respect to gender ($\chi^2 = 4.67; P = 0.198$).

Body temperatures were recorded at baseline and at 15-minute intervals during the surgical procedure. Summary statistics for body temperatures are provided in Table 2. All patients were monitored for a total of 120 min, with the exception of a single patient which was monitored for 105 min. The interaction effect shown in Table 2 for all groups indicates that body temperatures varied differently over time depending on the type of heat support provided ($F (9, 114) = 2.38, P = 0.017$).

Our results suggest that forced warmed air is the most effective heat support [$F (4.17, 79.17) = 8.55, P < 0.001$] with or without being combined with warmed IV fluids. Figure 1 displays the slower drop in body temperature among patients which received forced warmed air support. The slope of the control group was $-0.03$ compared to the slope of the warmed air group ($-0.01$) illustrating a slower rate of core body temperature loss in the warmed air group. The clinical significance of this is unknown at this time and further investigation is warranted.

**Discussion**

Our study results are consistent with previous reports, suggesting that forced warmed air is superior to other warming methods in

---

**Table 1.** Mean (SD) values for patient characteristics and fluid rates.

<table>
<thead>
<tr>
<th>Variable</th>
<th>1 Control</th>
<th>2 Warmed IV</th>
<th>3 Forced Warmed Air</th>
<th>4 Both</th>
<th>F</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>6.17 (2.3)</td>
<td>5.50 (2.4)</td>
<td>5.08 (2.2)</td>
<td>4.92 (2.2)</td>
<td>0.72</td>
<td>0.544</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>37.02 (7.7)</td>
<td>32.55 (5.7)</td>
<td>33.41 (7.9)</td>
<td>34.10 (8.7)</td>
<td>0.79</td>
<td>0.509</td>
</tr>
<tr>
<td>Body condition score&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.17 (0.6)</td>
<td>4.83 (0.4)</td>
<td>4.67 (0.7)</td>
<td>4.42 (0.5)</td>
<td>4.05</td>
<td>0.213</td>
</tr>
<tr>
<td>Fluid rate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>177.17 (49.8)</td>
<td>162.25 (28.3)</td>
<td>166.50 (39.5)</td>
<td>169.67 (43.6)</td>
<td>0.28</td>
<td>0.838</td>
</tr>
</tbody>
</table>

<sup>a</sup> Scale of 1 to 9.

<sup>b</sup> mL/h.

<sup>F</sup> = F-value.

---

**Table 2.** Group by time repeated measures analysis of covariance on body temperature during surgery.

<table>
<thead>
<tr>
<th>Group</th>
<th>Time</th>
<th>Group × Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>df</td>
</tr>
<tr>
<td>All groups</td>
<td>2.55</td>
<td>3, 38</td>
</tr>
<tr>
<td>Post-hoc control versus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warmed IV</td>
<td>0.15</td>
<td>1, 18</td>
</tr>
<tr>
<td>Forced warmed air</td>
<td>4.63</td>
<td>1, 19</td>
</tr>
<tr>
<td>Both treatments</td>
<td>1.85</td>
<td>1, 17</td>
</tr>
</tbody>
</table>

Note: Huynh-Feldt correction was applied to the ANCOVA; Bonferroni adjustment was applied to post-hoc significance levels.

<sup>F</sup> = F-value.

<sup>df</sup> = Degrees of freedom.

---

**Figure 1.** Body temperatures during surgery for the 4 groups.
reducing the rate of loss of core body temperature during surgery. While the current study did not investigate other warming methods, such as water blankets, heating pads, or warm water bottles, the literature is consistent that the gold standard for warmth support is forced warmed air. This allowed us to have a control of no heat support and the gold standard treatment of forced warmed air (21–25). As hypothesized, the current study shows no benefit in using warmed intravenous fluids as directed by the manufacturer, who recommends placing the warmer directly downstream from the fluid pump.

The biggest limitation in the current study is the 170 cm of fluid line between the warmer and the patient, leading to possible loss of heat through convection and radiation as the fluids move through the line. Further investigation into varying locations of the fluid warmer device in relation to the patient are warranted, as placement of the fluid warmer closer to the patient may lead to greater retention of warmth within the fluid line, thereby increasing the benefit to the patient. However, a location too close to the patient may lead to thermal injury to the vasculature and care must be taken to avoid this potential complication during study design. Another limitation is the variance in thermometer depth and lack of consistent control over insertion depth. The current study was able to control for multiple variables to create as homogeneous a population as possible by controlling age, weight, BCS, length of anesthesia, ambient temperature, O₂ flow rate, and procedure type being performed in our study population was the TPLO (89%).

Core body temperature maintenance is vital to patient health during the perioperative and intraoperative period, especially during the first hour of anesthesia as this is the period of greatest heat loss. Fluctuations in body temperature can affect many autonomous body systems including metabolism, peripheral vascular resistance, respiratory centers, interthreshold widening, leading to anesthetic complications such as hypotension, perpetuation of hypothermia, drug metabolism/effectiveness, and prolonged recovery. Early intervention may be a key factor we are missing, as many veterinary patients undergo a period of time without heat support before and during the induction and surgical preparation phase as well in some cases until sterile draping has been completed. This initial phase of heat loss is mostly attributed to anesthetic drugs and gases that suppress the hypothalamus and, in turn, inhibit the patient’s inherent temperature regulatory mechanisms (3,5,7). Other causes include decreases in heat as a byproduct of metabolism, muscle contraction/tone, widening of the interthreshold range, and peripheral vasodilation (10,11). For our investigation, all patients were subject to the same anesthetic protocol in an effort to keep these known anesthetic effects constant throughout the data collection process.

Monitoring body temperature is imperative during anesthetic procedures, as low body temperatures decrease the effectiveness of commonly used drugs during anesthesia including fluid boluses, glycopyrrolate, dopamine, dobutamine, and norepinephrine (31–33). Hypothermia also reduces the dose requirement of anesthetic gas and decreases solubility of said gases, leading to longer recovery from anesthesia after inhalants are discontinued (33). Maintenance of core body temperature becomes more difficult as patient size decreases, in part due to an increase in body surface area to weight ratio. These smaller patients lose more heat per unit body weight through conduction, convection, and radiation as a result of peripheral vasodilation caused by anesthetic and peri-anesthetic drugs. These effects are compounded when the thoracic or abdominal cavities are opened. Investigating modalities to aid in the maintenance of patient’s core body temperature in larger dogs will also benefit smaller dogs, which are more prone to complications arising from hypothermia. Even in the face of active heating, a large proportion of anesthetized animals experience hypothermia to some degree, including 75% of patients in this study recording at least 1 temperature < 37°C. It may be necessary to incorporate a multi-modal approach to active warming of patients in hopes of preserving core body temperature and associated physiologic function without increasing the risks of thermal injury. A key to this approach would be earlier intervention, including more research on pre-warming of patients via various warming devices or possibly starting warmed intravenous fluids some time before anesthetic induction coupled with avoiding drugs such as acepromazine whenever possible. By incorporating a multi-modal approach to active warming, we may also be able to reduce the amount of thermal injury to patients by not relying on a single warming modality, such as warmed blankets, pads, forced warmed air at higher heat settings.

In conclusion, the current study showed no improvement in patients’ ability to maintain core body temperature with the addition of an IV fluid warmer device in large breed dogs undergoing elective orthopedic procedures. The most common procedure performed in our study population was the TPLO (89%). Patients in which forced warmed air was used showed a statistically significant ability to reduce loss of core body temperature compared with both the negative control and fluid warmer only groups, although 75% of patients experienced a drop in body temperature below 37°C. Further investigation into the optimal location of the fluid warming device in relation to the patient, as well as possibly initiating warmed IV fluids before induction is warranted. Future studies should include other subject pools including open cavity surgeries and smaller patients.

References
Incidence of incisional complications after exploratory celiotomy in equids affected with enterolithiasis

Albert Torrent Crosa, Scott A. Katzman, Maureen E. Kelleher, Jorge E. Nieto, Isabelle Kilcoyne, Julie E. Dechant

Abstract — This study reports the prevalence of and risk factors for incisional complications in equids after ventral midline celiotomy for enterolithiasis. This study covered the years 2008 to 2015 and included 72 equids. Enteroliths were removed from the ascending or descending colon through 1 or more enterotomies. Complications were defined as surgical site infection and/or incisional hernia formation. Follow-up by telephone questionnaire or medical records determined that 10/72 (13.9%) equids experienced complications, with 6/72 (8.3%) developing a surgical site infection and 5/72 (6.9%) a hernia. Seven of ten were presented for chronic abdominal discomfort (> 24 hours), and 8/10 had right dorsal colon and pelvic flexure enterotomies. All equids that developed an incisional hernia and 4 with surgical site infection had enteroliths > 15 cm diameter removed from the right dorsal colon. Antimicrobial powder applied to the ventral midline incision during closure significantly reduced incisional complications. Removal of > 15 cm diameter enteroliths from the right dorsal colon may predispose to postoperative incisional complications.

Introduction

Enterolithiasis is a significant cause of abdominal pain in equids, with abdominal pain developing secondary to partial or complete obstruction of the ascending colon (AC) descending colon (DC), or transverse colon (TC). Prevalence of enterolithiasis has been reported to range from 1.7% to 15.1% in certain geographical regions of the United States, particularly in California, Florida, and Texas, and occurs sporadically in other parts of the world (1–4). Most often, horses are presented for mild to moderate intermittent abdominal discomfort (5–7) or a history of recurrent colic (4), but others are presented with signs of acute, severe abdominal pain (8). Surgical removal...
through ventral midline incision with subsequent enterotomy is the treatment of choice, and successful removal was reported as early as 1877 (8,9).

Success rates following surgical removal of enteroliths are good to excellent (2,10), with short-term survival ranging from 94% to 96.2% (4,11), and long-term survival from 85% to 92.5% (4,10,11). Nevertheless, exploratory celiotomy in equids is not without risk for potential complications, with incisional complications being one of the most commonly reported problems following ventral midline celiotomy (12).

Several studies have reported incisional infection as a complication following exploratory celiotomy, with an incidence ranging from 2.7% to 42% (13,14). Pre- and peri-operative factors identified as predisposing factors for postoperative incisional complications include anamnesis, signalment, and several pre-, intra-, and postoperative variables (12,13,15–30). Incisional infection, dehiscence, and hernia formation have been reported to be of particular concern following enterotomy (12). However, other studies did not support the finding that enterotomy influenced the development of incisional complications (11,15,17,18,31).

Several studies reported that ventral abdominal hernia formation was most common in equids that had developed postoperative incision drainage or infection (18,22,32). In 1 study, equids that experienced an incisional infection were 17.8 times more likely to develop a hernia compared to equids that did not develop infection (18). In another study, purulent incisional drainage preceded development of a hernia in 48% of cases (33). Furthermore, the odds of incisional hernia formation were 62.5 times greater for horses that had incisional drainage after surgery, and incisional drainage and herniation negatively influenced survival (34).

Regarding enterolithiasis, incisional complications following exploratory celiotomy have been reported, with a prevalence between 12.9% and 44.1% (4,35). However, investigating specific risk factors associated with incisional complications was not the focus of these studies. One study found no statistical significance between location of enteroliths (AC or DC) and incidence of incisional complications, although more complications developed when enteroliths were removed from the DC (11).

To our knowledge, specific pre-, intra-, and postoperative factors contributing to incisional complications following enterolith removal have not been investigated. The objectives of this study were to report the prevalence of incisional complications following enterolith removal through ventral midline celiotomy, determine if there is increased risk for incisional complications following AC enterotomy compared to DC enterotomy performed for enterolith removal, determine whether the risk for incisional complications increased with increased number of enterotomies, and determine if enterolith size and location of enterotomy influenced the incidence of incisional complications in equids following enterolith removal. We hypothesized that the overall rate of incisional complications would be low for horses with enteroliths removed via ventral midline celiotomy, that the incidence of incisional complications would be similar when enteroliths were removed from either the AC or DC, and that increasing the size and number of enterotomies necessary for removal of enteroliths would be associated with an increased rate of incisional complications.

Materials and methods

Case selection
Medical records from the William R. Pritchard Veterinary Medical Teaching Hospital at the University of California-Davis were reviewed to identify equids that underwent exploratory celiotomy for enterolithiasis affecting the AC, DC, and/or TC between January 1, 2008, and June 30, 2015. A tentative diagnosis of enterolithiasis was made if 1 or more radiopaque spherical structures were identified on a complete abdominal radiographic study, with definitive diagnosis made following identification of 1 or more enteroliths during exploratory celiotomy.

Equids were included in the study if they recovered from anesthesia, survived > 4 mo after surgery, and follow-up information was available.

Medical records review
Pre-operative data collected included signalment, body weight, physical examination findings, results of complete blood cell count, serum biochemistry and peritoneal fluid analysis, and results of abdominal radiography. Duration of colic signs was recorded and considered acute for equids displaying signs of abdominal discomfort of < 24 h and chronic for cases displaying signs for > 24 h.

Intra-operative data collected included duration of surgery, length of ventral midline incision, location of enteroliths (AC, DC, and/or TC), additional lesions discovered at surgery, hypoxemia (PaO₂ < 65 mmHg), or hypotension during anesthesia (MAP < 65 mmHg for > 15 min), and quality of recovery. Additional intra-operative data collected included suture material used for subcutaneous closure, topical administration of an antimicrobial following closure of the linea alba and type of incisional protection applied for recovery from anesthesia.

Postoperative data collected included duration of hospitalization and administration of systemic antimicrobial and anti-inflammatory medications, development of colic, fever, and results of hematologic evaluation when available. Incisional complications were defined as persistent incisional drainage with or without positive bacterial culture which was considered indicative of surgical site infection, and hernia formation.

Surgical technique
Prior to surgery, an IV catheter was inserted into the left jugular vein using aseptic technique. All equids were administered parenteral broad-spectrum antimicrobials and tetanus prophylaxis 30 min before induction of general anesthesia. Flunixin meglumine (Intervet, Madison, New Jersey, USA), 1.1 mg/kg body weight (BW) IV, was administered unless the horse had already received an NSAID 6 to 8 h before surgery.

Following induction of anesthesia and orotracheal intubation, equids were mechanically ventilated, and anesthesia was maintained using isoflurane in 100% oxygen. Equids were placed in dorsal recumbency and hair was removed from the ventral abdomen using electric clippers. For intact males and geldings, the prepuce was cleaned, packed with gauze and sutured closed.
or closed with towel clamps. Preparation of the skin for each member of the surgical team consisted of a 5-minute scrub of the hands and forearms with a scrub brush using 4% chlorhexidine gluconate (BD E-Z Scrub 107; Becton, Dickinson and Company, Franklin Lakes, New Jersey, USA) followed by application of an 85% ethyl alcohol-based rub (Sterillium Rub; Medline Industries, Northfield, Illinois, USA).

Following aseptic preparation of the ventral abdomen, an iodine impregnated adhesive drape (Ioban; 3M Health Care, St. Paul, Minnesota, USA) was applied and the surgical site draped routinely. A ventral midline incision was created using a #10 scalpel blade, beginning at the umbilicus and extending cranially. The incision was carried through the subcutaneous tissues and was lavaged with sterile 0.9% irrigation saline. A new #10 scalpel blade was used to incise the linea alba.

The large colon was exteriorized and placed on a colon tray (Colon Tray; Kimsey Welding Works, Woodland, California, USA). An enterotomy was created at the pelvic flexure (PF) and contents of the AC were evacuated. When size permitted, enteroliths within the TC or right dorsal colon (RDC) were mobilized to the PF enterotomy and removed. Larger enteroliths located in either the RDC or TC were mobilized as far orad as possible and removed through a second enterotomy created at the antimesenteric border of either the RDC or left dorsal colon (LDC). Enteroliths located within the DC were removed through an enterotomy created through the antimesenteric band. All enterotomies were closed in 2 layers using #2-0 USP polydioxanone (PDS; Ethicon, Somerville, New Jersey, USA). A full thickness simple continuous pattern was placed and oversewn in a Cushing pattern. The colon was replaced in the abdomen and intra-abdominal lavage performed using sterile 0.9% irrigation saline prior to abdominal closure. The linea alba was closed in a simple continuous pattern using #3 USP polyglactin 910 (Vicryl; Ethicon) followed by lavage with 0.9% irrigation saline. In most cases, 1 g of cefazolin (Cefazolin; Apotex, Weston, Florida, USA) powder was applied topically to the incision before closure of the subcutaneous tissue and skin based on surgeon preference. The subcutaneous tissues were closed in a simple continuous pattern using #2-0 USP polydioxanone (Ethicon) or #2-0 USP poliglecaprone acid (Ethicon). The skin was closed with nonabsorbable stainless steel staples (Vet One, MWI Animal Health, Boise, Idaho, USA). The incisions were measured using the metric measurement markings on the scalpel blade handle at the end of surgery. A sterile bandage was placed over the incision and consisted of either a 50 × 30 cm rolled cotton sterile disposable surgical towel (Medline) or antimicrobial impregnated roll gauze (AMD Kerlix, Covidien, Plymouth, Minnesota, USA) secured with #2 USP polypropylene (Ethicon) or gauze placed over the incision and secured using an iodine impregnated adhesive drape (Ioban; 3M Health Care). Recovery from anesthesia was assisted using a head and tail rope in all but 2 cases.

**Postoperative care**

Following recovery from anesthesia, equids were admitted to the intensive care unit for monitoring and treatment. Equids were immediately allowed free access to water, with food withheld for 6 to 12 h. Crystalloids (2 to 4 mL/kg BW per hour) were adminis-
if the data were normally distributed, and Wilcoxon rank-sum test, if the data were not normally distributed. Similarly, categorical variables were compared between equids with and without incisional complications using χ² test or a Fisher’s exact test, as appropriate. Significance was set at P ≤ 0.05 for all tests. Statistical analyses were performed using commercially available statistical analysis software (SAS 9.4, SAS Institute, Cary, North Carolina, USA). Descriptive statistics are reported as range [mean ± standard deviation (SD)].

Results

Seventy-two equids met the inclusion criteria. There were 29 Quarter Horses, 12 Arabians, 10 American Paint Horses, 4 Appaloosas, 4 Thoroughbreds, 2 each of Aztecas, Morgans, Tennessee Walking Horses, Friesians, and 1 each of Peruvian Paso, National Show Horse, American Miniature Horse, and miniature donkey. Ages ranged from 4 to 33 y (mean: 13.89 ± 7.5 y). There were 32 geldings (44%), 30 mares (42%), and 10 intact males (14%). Body weight ranged from 87 to 658 kg (mean: 486.2 ± 90.6 kg).

Thirty (41.7%) equids were presented for evaluation of acute abdominal pain and 37 (51.4%) for chronic abdominal pain. Five equids (6.9%) were presented for elective abdominal radiographs and were not exhibiting signs of abdominal discomfort on admission but were presented with a history suggestive of enterolithiasis including episodic abdominal discomfort, anorexia, passage of soft feces, or passage of small enteroliths in manure.

Seventy equids had a complete digital radiographic study of the abdomen performed at hospital admission and 1 horse was presented with abdominal radiographs taken by the referring veterinarian. The other equid was not radiographed and exploratory celiotomy was performed immediately following initial evaluation due to intractable abdominal pain. In this case, enterolithiasis was diagnosed during abdominal exploration.

A single or multiple enteroliths were identified radiographically in 65 equids (65/71, 91.6%). Radiography failed to identify enteroliths in the remaining 6. For the 64 equids that had evidence of enterolithiasis on radiographs obtained at our institution, the approximate diameters of enteroliths were measured in 61 using dedicated medical imaging software (SAS 9.4; SAS Institute). The diameters of enteroliths ranged from 4.5 to 27.8 cm (mean: 17.2 ± 4.7 cm). The diameter of enteroliths could not be measured in the remaining 3 equids due to indistinct margins.

Length of the ventral midline incision was recorded for 68 equids, and ranged from 15 to 40 cm (mean: 28.1 ± 5.9 cm). Nine equids were hypotensive during general anesthesia (MAP < 65 mmHg) for > 15 min. Two of these equids developed incisional complications. Total surgery time was recorded in 71 cases and ranged from 70 to 200 min (mean: 127.6 ± 30.5 min). Surgical time was > 120 min in 38 of these cases and included 8 equids that developed 1 or more incisional complication. Forty-four equids had a single enterolith located in either the RDC (n = 19), TC (n = 12), or DC (n = 13). Fourteen equids had multiple enteroliths located in the RDC and 1 had 3 enteroliths located in the TC. In 11 equids the enteroliths were identified in multiple locations throughout the AC, TC, and DC including RDC and DC (n = 5), RDC and TC (n = 3), LDC and RDC (n = 2), and LDC, RDC, and DC (n = 1). The location of enteroliths was not recorded in 2 equids. Nine equids were presented with a concurrent right dorsal displacement of the large colon and 1 with a concurrent large colon sand impaction. No ischemic lesions were observed in any of the equids included in this study.

Among 72 equids, 71 had PF enterotomy performed to empty the colon and facilitate mobilization of enteroliths to a portion of the colon safer for removal. Specifics regarding enterotomies performed for enterolith removal were recorded in 69 cases. In 9 equids, a solitary enterolith was removed through a single enterotomy. In 8 of these cases the enterolith was manipulated from the RDC to the PF enterotomy. In 1 equid PF enterotomy was not performed and the enterolith was removed through an enterotomy performed in the DC. A second enterotomy was created for enterolith removal in 57 equids following PF enterotomy. Of these, 38 enterotomies were performed in the RDC, 15 were performed in the DC, and 4 were performed in the LDC. Three equids with multiple enteroliths required a total of 3 enterotomies. Two had enterotomies performed in the PF, RDC, and DC, and 1 had enterotomies performed in the PF, LDC, and DC. The number of enterotomies was not reported for 3 equids.

The duration of postoperative hospitalization ranged from 2 to 13 d (mean: 4.7 ± 1.9 d). Ten equids (13.9%) developed 1 or more incisional complication and all weighed > 400 kg. Seven of ten were presented for evaluation of chronic abdominal pain. Postoperative incisional complications occurred in 6 equids (8.3%) diagnosed with SSI and 5 equids (6.9%) that developed incisional hernias. One equid with confirmed SSI also had an incisional hernia. Three equids had SSI definitively diagnosed on microbial culture performed during postoperative hospitalization and in the remaining 3 a presumptive diagnosis of SSI was based on persistent serosanguinous or purulent incisional drainage which began after hospital discharge. For the 3 horses that had microbial culture performed, bacterial isolates included colonies of *Staphylococcus* sp., *Enterococcus faecium*, *Escherichia coli*, and *Bacteroides fragilis*. In each of these cases treatment included establishment of adequate incisional drainage, continued local wound care, and administration of systemic antimicrobials until incisional drainage resolved. For the 3 cases with presumed SSI diagnosed after hospital discharge, administration of systemic antimicrobials prescribed by referring veterinarians and local wound care resulted in resolution of clinical signs.

For the 5 equids that developed incisional hernias, the defect in the body wall was detected between 1 and 5 mo following hospital discharge. More Quarter Horses (n = 3) developed an incisional hernia than did other breeds, but Quarter Horses were initially overrepresented in this population and this finding was not statistically significant. In 2 equids, hernias were managed successfully using an abdominal support bandage, and no treatment was deemed necessary in 2 equids. For the remaining equid, surgical repair was recommended due to the size of the hernia.

Eight of ten equids with incisional complications had an enterotomy performed in the RDC following PF enterotomy for removal of an enterolith measuring > 15 cm in diameter. Of these, 4 developed an incisional hernia as a sole complication, 3 developed an SSI as a sole complication (2 confirmed,
1 presumptive) and 1 developed a hernia following SSI (confirmed). The remaining 2 with SSI (presumptive) had enteroliths removed through DC enterotomy following PF enterotomy. Cefazolin powder (Cefazolin; Apotex, Weston, Florida, USA) was applied topically to the incision following closure of the linea alba in 39 of 72 cases. Eight of ten equids that developed incisional complications did not have a topical antibiotic applied during closure of the ventral midline incision. Topical application of an antimicrobial powder (Cefazolin; Apotex) to the incision following closure of the linea alba was significantly associated ($P = 0.02$) with a reduced occurrence of incisional complications. A statistically significant association was not found for any other pre-, intra-, or postoperative continuous or categorical variables evaluated in the study.

Thirty-one equids recovered with the incision protected using a stent bandage. Twenty-three had a sterile blue towel sutured over the incision, 5 had an antibiotic impregnated dressing sutured over the incision, and in 3 the type of stent bandage was not recorded. Thirty-one equids recovered with the incision protected using sterile gauze and an iodine impregnated adhesive drape placed over the incision. Type of incisional protection employed for recovery from anesthesia was not recorded in the remaining 10 equids.

**Discussion**

In the current study, horses undergoing exploratory celiotomy for removal of enteroliths had an overall incisional complication rate of 13.9%, with 8.3% SSI and 6.9% hernia formation rates respectively. Pre-operative reported factors that have been associated with increased risk of SSI include body weight > 300 kg (12); longer duration of colic signs (> 8 to 24 h) before presentation at a referral center (24); and the nature of the emergency surgical procedure (12). Intra-operative variables such as hypovolemia, hypoxemia, poor tissue perfusion (12,27), increased duration of surgery (19) and anesthesia (24,25), creation of an enterotomy and draping technique to isolate the enterotomy site (23), contamination of the abdominal cavity during surgery (12,15), length of the incision (29), quality of recovery from general anesthesia (17), and administration of a topical antibiotic during closure of the abdominal incision (23) have all been shown to influence the occurrence of incisional complications.

In the current study, no statistically significant increase in incisional complications was identified when comparing the different locations or number of enterotomies (AC compared to DC) created for enterolith removal. Furthermore, size of enteroliths was not significantly associated with an increased risk for incisional complications. However, 8 of the equids that developed incisional complications had an enterolith > 15 cm removed through an enterotomy performed in the RDC.

All equids that developed incisional complications weighed > 400 kg, in 8/10 surgical time was > 2 h, in 8/10 a topical antimicrobial was not applied to the incision during wound closure and 7/10 were presented for a chronic episode of abdominal discomfort (> 24 h).

At our institution, it is standard for surgeons to prepare the skin with a 5-minute scrub using 4% chlorhexidine gluconate followed by application of an 85% ethyl alcohol-based rub before exploratory celiotomy. A recent study evaluated pre-operative hand preparation using chlorhexidine applied using either the scrub side or sponge side of a disposable sponge/scrub brush, a chlorhexidine/alcohol based rub, or an alcohol based rub alone (36). The authors of that study concluded that while all 4 preparations adequately reduced bacterial counts on the skin, an alcohol based rub alone was less effective than products containing chlorhexidine. Furthermore, given the residual effects of chlorhexidine, these findings may be of further significance when performing exploratory celiotomy and extended surgical times may be encountered.

In the current study, the only factor significantly associated with a reduced occurrence of incisional complications was the topical application of an antimicrobial to the incision following closure of the linea alba and before closure of the subcutis and skin ($P = 0.02$). Cefazolin is a broad-spectrum first-generation cephalosporin with activity against Gram-positive and Gram-negative bacteria that have been commonly isolated from ventral midline incisional infections in horses, including *Staphylococcus* spp., *Streptococcus* spp. and *E. coli* (34). Thirty-nine equids had cefazolin powder applied topically following closure of the linea alba and 33 did not. Eight of the 33 cases that did not have cefazolin powder applied subsequently developed 1 or more incisional complication. Based on these results, the authors recommend application of cefazolin powder during closure of ventral midline celiotomy incisions.

A recent study reported that the development of SSI does not appear to be solely related to bacterial contamination of the incision peri-operatively, and that various bacterial isolates will be cultured pre-, intra-, and post-surgery without the development of an SSI (37). Also, the authors of that report state that the development of an SSI is multifactorial and influenced by other factors including hematogenous spread of bacteria. In the current study, ventral midline incisions were only cultured if evidence of SSI was present which is standard practice at our institution. This is because development of SSI is not necessarily related to bacterial isolates present without concurrent signs of an SSI. Based on this recent study (36), a positive bacterial culture obtained during or after surgery should be interpreted cautiously if no overt signs of SSI are present.

In the current study, the rate of SSI was low and incisional hernia formation was similar to previous reports (4,11,18,35). It is difficult to make comparisons between the current study and previous reports on SSI and hernia formation, due to temporal and spatial differences, pre-, intra-, and postoperative variables, and indications for exploratory celiotomy. This study specifically evaluated a relatively systemically healthy subset of equids requiring exploratory celiotomy for correction of a non-strangulating gastrointestinal lesion.

A recent study reported that a 3-layer closure of a ventral midline incision was protective compared to a 2-layer closure (28). Closure of the skin incision with staples was associated with increased incisional complications in 1 study (25), whereas other authors were unable to demonstrate a significant effect of the use of skin staples on the incidence of incisional drainage (31). In the current study, all ventral midline incisions were closed in
3 layers (linea alba, subcutaneous tissues, and skin). The linea alba was closed with #3 USP polyglactin 910, and in the 67 cases for which it was reported, the subcutaneous tissues were closed with either #2-0 USP poliglecaprone acid (n = 46) or #2-0 USP polydioxanone (n = 21) and skin with nonabsorbable stainless steel staples. No association was identified between incisional complications and suture material used for closure of the subcutis.

An additional risk factor associated with the development of incisional complications following exploratory celiotomy is trauma to the incisional edges while manipulating the gastrointestinal tract (15,16,20). Manipulation and mobilization of enteroliths from the point of obstruction to a suitable location for removal may cause iatrogenic trauma to the edges of the incision.

Incisional infection and subsequent hernia formation are of concern after enterotomy (12,15), in particular when enteroliths cannot be mobilized to a location distant from the ventral midline incision before enterotomy (7). This can be due to the size of the enterolith exceeding the diameter of the colon through which mobilization is being attempted, and can be compounded by anatomic restrictions limiting mobility of certain segments of colon. One study found an association between enterotomy and an increased risk of incisional infection (20), and another study reported a 20% occurrence of incisional hernia formation after ventral midline celiotomy with enterotomy (12). However, other studies did not find any association between incisional complications and enterotomy performed as part of the procedure (11,15,17,18,31,34).

In the current study, only 1 of the 5 equids that developed an incisional hernia experienced incisional infection before hernia formation, suggesting that risk factors for incisional hernia following enterolith removal may not be associated with earlier signs of incisional complications. It has also been reported that incisional herniation may be attributed to factors such as uncontrolled early postoperative exercise, suture material failure, inadequate anatomic reconstruction, or violent postoperative recovery (17). However, none of these factors were reported in any of the cases reported here that developed hernias.

In a previous report, location of enteroliths (AC or DC) did not significantly affect the number of postoperative complications (11). In that report, incisional complications were among the most frequent short-term postoperative complications encountered, with an increased frequency for enteroliths located within the DC compared with the AC. In the current study, 8/10 equids that developed incisional complications had an enterotomy performed in the AC and only 2 had enterotomy performed in the DC, which contrasts with the aforementioned report. This finding may have been due to the large diameter of enteroliths (> 15 cm) in the 8/10 equids that developed incisional complications. Larger enteroliths are more difficult to mobilize to an intraluminal location distant from the primary surgical field and thus enterotomy is more likely to contaminate the celiotomy incision.

Contamination of unprotected ventral midline incisions during anesthetic recovery was found to be an important risk factor for the development of incisional drainage following colic surgery (21). In our experience, a sutured stent bandage is more reliable than an adhesive incise drape in maintaining a protective barrier against incisional contamination during recovery from anesthesia. In the current study the type of incisional protection applied was not found to be significantly associated with the development of incisional complications.

Limitations of the current study include its retrospective nature, the limited total number of equids that met the inclusion criteria with even fewer of those that went on to develop incisional complications, and that follow-up was dependent on owner information in most of the cases. While application of a topical antimicrobial during closure of ventral midline celiotomy was the only factor found to be statistically significant regarding a reduced risk for incisional complications in the current study, the specific reason for application in each case was not investigated. Therefore, factors which may have contributed to the decision to apply a topical antimicrobial such as surgical time, length of incision, number and location of enterotomies and surgeon preference, among others, may have been confounders as they were not included in analysis.

Additional limitations include lack of standardization (i.e., different suture materials used to close the subcutaneous tissues and different methods used to protect the incisions for recovery related to surgeon preference), presence of multiple surgeons, lack of a control group, or that the distance between the enterotomy performed for enterolith removal and the ventral midline incision was not recorded.

In conclusion, the overall prevalence of incisional complications following removal of enteroliths was low (13.9%), and the application of antimicrobial cefazolin powder in the incision following closure of the linea alba had a statistically significant effect in reducing the rate of incisional complications. Furthermore, proper surgical technique with an emphasis on meticulous draping of the enterotomy site is critical, especially when dealing with large enteroliths, which may increase the risk for incisional complications following exploratory celiotomy. Owners should be aware of an increased risk of incisional complications when large size enteroliths are observed in preoperative radiographs.

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.
Teleconsulting in the time of a global pandemic: Application to anesthesia and technological considerations

Daniel S.J. Pang, Jessica M. Pang, Opal-Jane Payne, Frazer M. Clement, Terrie Faber

Abstract — As a result of the various restrictions associated with the current COVID-19 pandemic, the practice of veterinary telehealth is likely to grow substantially. One area in which high quality care can be maintained while respecting physical distancing is teleconsulting, which describes the relationship between an attending and off-site consulting veterinarian. This guide uses a dentistry case to illustrate the provision of real-time anesthesia consulting, with a focus on the technological considerations central to facilitating live, 2-way video-communication. Case selection, teamwork, and patient safety are also discussed.

Résumé — Téléconsultation en temps de pandémie globale : application à l’anesthésie et considérations technologiques. Comme résultats des différentes restrictions associées à la présente pandémie de COVID-19, la pratique de télésanté vétérinaire est appelée à croître considérablement. Un domaine dans lequel des soins de haute qualité peuvent être maintenus tout en respectant la distanciation physique est la télédentisterie, qui décrit la relation entre un vétérinaire traitant et un vétérinaire consultant hors-site. Ce guide utilise un cas de télédentisterie pour illustrer les exigences de consultation en temps réel pour l’anesthésie, avec une emphase sur les considérations technologiques essentielles pour faciliter une communication vidéo bidirectionnelle en direct. La sélection de cas, le travail d’équipe et la sécurité du patient sont également discutés.

Can Vet J 2020;61:1092–1100

Introduction

Telehealth is a rapidly emerging area of veterinary medicine, the growth of which is likely to be accelerated during the current severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and the coronavirus 2019 (COVID-19) pandemic. Telehealth is an umbrella term that describes “all uses of technology to deliver health information, education or care remotely” (1). Under this umbrella, there is a host of “tele-” terms describing specific aspects of telehealth, such as telemedicine, teletriage, telemonitoring, and teleconsulting (1). The most important of these is “telemedicine,” a term that is frequently misunderstood and variably defined (2,3).

Telemedicine is similarly defined by the Canadian Veterinary Medical Association (CVMA) and the American Veterinary Medical Association (AVMA) as the practice of veterinary medicine at a distance, or between sites, using telecommunication technology to exchange medical information (1,4). Critically, telemedicine must occur within a valid veterinary-client-patient-relationship (VCPR), as it relates to the practice of veterinary medicine. Within Canada, each province and territory has its own definition of a VCPR, but there is broad overlap such that core principles are shared (5, page 11).

In contrast, teleconsulting describes the relationship between an attending veterinarian (who has a VCPR) and a consulting veterinarian who is providing advice. The attending veterinarian remains responsible for the veterinary medical care of the animal, unless the consulting veterinarian is providing medical advice or expertise directly to the animal owner, in which case the consulting veterinarian becomes the attending veterinarian and is required to meet the licensing requirements of the jurisdiction in which the animal is located and have a valid VCPR (4).

The purpose of this review and guide is to share recent experiences with providing teleconsulting services for anesthesia support, with a focus on considerations surrounding technology, case selection, communication, and teamwork.
Dentistry case example

A 13-year-old, 9 kg, neutered male Shih Tzu cross dog was presented for general anesthesia and referral dental surgery to complete dental work that was aborted due to concerns about anesthesia. The dog had been anesthetized 3.5 mo previously for a dental procedure at the referring veterinary hospital but the anesthesia was terminated shortly after induction due to respiratory complications (increased abdominal effort associated with radiographic diagnosis of left cranial and caudal lung lobe atelectasis; cause undetermined, suspected endobronchial intubation). Atelectasis had resolved when radiographs were repeated 3 d later. The dog also had a history of dysplasia and osteoarthritis in multiple limbs and an increased respiratory effort (panting) with prolonged exertion. A complete blood cell count and serum biochemistry were completed on the morning of the aborted procedure. Abnormalities included a mild erythrocytosis [RBC: 9.3 × 10^12/L], reference range (RR): 5.8 to 9.01 × 10^12/L] and a moderate elevation in alkaline phosphatase (ALP) (401 U/L, RR: 23 to 212 U/L). The increased ALP was attributed to enzyme induction due to chronic administration of a low-dose of prednisolone for inflammatory bowel disease.

Physical examination findings and blood analysis on the morning of surgery included a moderate tachycardia (144 beats/min), erythrocytosis (packed cell volume 64%, RR: 36.6% to 54.5%), total protein within reference range (74 g/L, RR: 36.6% to 54.5%), hypoglycemia (blood glucose: 3.4 mmol/L, RR: 3.89 to 7.95 mmol/L), and a nervous but calm demeanor. There was no history of coughing, cyanosis, syncope, stridor, or stertor before or after the anesthetic episode. An American Society of Anesthesiologists (ASA) physical status classification of 2/5 was assigned.

The day before the procedure, a successful trial (~20 min) of the videoconferencing equipment to be used for the procedure was performed, which also provided the opportunity to try various camera positions. The videoconference started at 0950. A smartphone (iPhone 7; Apple, Cupertino, California, USA) was mounted on a mobile IV stand in the dental suite and the consulting anesthetist used a laptop computer (MacBook Air 11-inch; MacOS v10.15.3, Apple) with built-in camera and microphone. A free videoconferencing platform was used (Zoom; San Jose, California, USA) with a unique call-in ID, and the Wi-Fi Internet connections were password protected at both locations. During the first 10 min, the dog was visually assessed, physical examination findings were discussed, and a plan for anesthesia was reviewed with the lead animal health technologist (AHT) anesthetist. The anesthetic considerations and potential interventions for erythrocytosis, as well as the procedures for avoiding and detecting endobronchial intubation were discussed in detail. The moderate tachycardia was attributed to the patient’s nervous demeanor.

A detailed procedural document was developed to help manage the case, including checklist items, to compensate for the limitations of teleconsulting (Appendix I, available from https://doi.org/10.7910/DVN/NIZ51Y).

The smartphone camera was initially positioned to provide a frontal view of the dog and 2 AHTs performing induction of general anesthesia. Salbutamol (Teva-Salbutamol HFA 100 µg/actuation; TEVA Canada, Toronto, Ontario), 200 µg, was administered via a pediatric aerosolizing chamber connected to a tight-fitting face mask, followed by IV fentanyl (50 µg/mL; Sandoz Canada, Boucherville, Quebec), 2 µg/kg body weight (BW), and 5 min of pre-oxygenation with 100% O₂ via a tight-fitting face mask. Instrumentation for an electrocardiogram (ECG) and with a pulse oximeter provided continuous monitoring and audible signals during induction with IV fentanyl (2 µg/kg BW), midazolam (5 mg/mL; Sandoz Canada Inc), 0.1 mg/kg BW, and alfaxalone (10 mg/mL; Alfaxan, Jurox Pty, Rutherford, NSW, Australia), 3 mg/kg BW, until endotracheal intubation was possible. Intubation was confirmed with bilateral thoracic auscultation during intermittent positive pressure ventilation (IPPV) and capnography.

Following intubation, the camera was positioned to provide a simultaneous view of the physiologic monitor, fluid pumps, ventilator bellows, and anesthetic machine. The lead AHT was in constant communication with the consulting anesthetist, providing feedback regarding anesthetic depth, physiologic status, and the dental procedure. The attending veterinarian (dentist) and other members of the healthcare team also provided feedback as needed (speakerphone function was used for communication).

The consulting anesthetist directed several interventions during the course of the anesthesia including volume resuscitation [Lactated Ringer’s Solution (Lactated Ringer’s Solution USP, Baxter, Mississauga, Ontario), IV bolus of 10 mL/kg body weight (BW) and Voluven (6% hydroxyethyl starch 130/0.4 in 0.9% sodium chloride, Fresenius Kabi Canada, Toronto, Ontario), 5 mL/kg BW, in addition to a 5 to 10 mL/kg BW per hour, IV maintenance rate of Lactated Ringer’s Solution], blood glucose management, adjustments of IPPV settings, and administration of analgesics both as boluses and variable rate infusions. Left and right infraorbital and inferior alveolar dental blocks were performed (1.5 mg of 0.5% bupivacaine HCl with epinephrine per site; TEVA Canada, Toronto, Ontario), 200 µg/mL; Vivacaine, Septodont, Cambridge, Ontario), 3 mg/kg BW, until endotracheal intubation was possible. Intubation was confirmed with bilateral thoracic auscultation during intermittent positive pressure ventilation (IPPV) and capnography.

The duration of the procedure was approximately 3 h. The lead AHT and consulting anesthetist formulated a recovery and extubation plan in advance of turning off the isoflurane vaporizer. For recovery, the camera was repositioned to face the dog, showing a view of its head (in sternal recumbency), with audible Doppler ultrasound, ECG, and pulse oximeter monitoring, along with oxygen administration by mask. The consulting anesthetist directed the recovery phase and timing of extubation, in the presence of the attending veterinarian. Remote continuous observation continued for a further 10 min post-extubation. The consulting anesthetist remained available by telephone for the remainder of the day and was notified by text message when the patient was discharged to its owner. Post-procedure follow-up was provided by the attending veterinarian, AHT, and consulting anesthetist by telephone.

The videoconference quality was adequate for communication and visualization; however, several minor problems were encountered. There were 6 interruptions in the video feed, each
Table 1. General considerations when setting up a teleconsultation with a specific example illustrated using the Zoom videoconferencing platform.

<table>
<thead>
<tr>
<th>General considerations</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device</td>
<td>Operating system and Zoom software up-to-date on cell phone (in operating room) and laptop (with teleconsultant)</td>
</tr>
<tr>
<td>Power (chargers, sockets)</td>
<td>Confirmed available (day before during test call)</td>
</tr>
<tr>
<td>Positioning (mounting/field of vision)</td>
<td>Mounting cell phone on portable IV stand tested day before (height and field of view)</td>
</tr>
<tr>
<td>Video capture</td>
<td>Minimum resolution ≥ 720 p, frame rate &gt; 30 fps</td>
</tr>
<tr>
<td>Video viewing</td>
<td>Minimum 1 MP (e.g., 1334 × 750 pixels), frame rate &gt; 30 fps</td>
</tr>
<tr>
<td>Security (passwords, virus, etc.)</td>
<td>Password-protected cell phone and laptop</td>
</tr>
<tr>
<td>Recording capability</td>
<td>Not performed (requires consent from participants). Paper anesthetic record maintained</td>
</tr>
<tr>
<td>Storage memory</td>
<td>Not used (no recording)</td>
</tr>
<tr>
<td>Spare device?</td>
<td>Smartphone [with alternative (FaceTime) videoconferencing software installed]</td>
</tr>
<tr>
<td>Network</td>
<td>&gt; 5 to 10 Mbps</td>
</tr>
<tr>
<td>Security (Wi-Fi password, VPN)</td>
<td>Password-protected Wi-Fi network (all locations)</td>
</tr>
<tr>
<td>Data transfer rate up + down to Internet</td>
<td>Cell phone data (3G) available as backup</td>
</tr>
<tr>
<td>Backup connectivity (mobile data/wired?)</td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td>Zoom: video conferencing with option to switch to voice-only as needed to improve connectivity. Additional communication available via live chat function.</td>
</tr>
<tr>
<td>Features (video, voice, screenshare, multi-participant)</td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>Free</td>
</tr>
<tr>
<td>Security (encryption, limiting participants)</td>
<td>Zoom: unique session ID, password required to join session, “waiting room” function enabled (host controls who joins the session), session “locked” by host once all participants have joined (prevents additional parties joining), screen sharing capabilities controlled by host. End-to-end encryption provided.</td>
</tr>
<tr>
<td>Reliability</td>
<td>Assessed during a test call the day before</td>
</tr>
<tr>
<td>Accounts/numbers/handles to be used</td>
<td>Login and connection tested during test call</td>
</tr>
<tr>
<td>Preparation tests</td>
<td>Performed ≥ 1 day before procedure</td>
</tr>
<tr>
<td>Dry run call (same numbers/handles, devices, networks, locations)</td>
<td>Test using planned location and monitoring equipment (ability to see monitor screen)</td>
</tr>
<tr>
<td>Instrument legibility</td>
<td>As above</td>
</tr>
<tr>
<td>Image and sound quality</td>
<td></td>
</tr>
<tr>
<td>Check switchover to backup device/network</td>
<td>Check backup cell phone number is correct and signal service is good at both locations</td>
</tr>
</tbody>
</table>

Information provided in the example is for illustrative purposes. Due to the rapid pace of advances in technology, performing a test call is always recommended and the security features of videoconferencing platforms should be confirmed before use.

Discussion

Telehealth and telemedicine are well-established concepts in human medicine, emerging in the early 20th century and enjoying a rapid increase in use in the 1990s with the advent of Internet access combined with decreasing costs of technology for capturing and transmitting digitized data (6–8). In veterinary medicine, reports of telemedicine and telehealth emerged in the 1990s, but they have not yet experienced the same growth as in human medicine (2,9–11). A lack of familiarity and perhaps comfort with technologies available may be slowing this growth (2).

A recent, albeit small survey of veterinarians in clinical practice (n = 76 respondents), found that approximately 1/3 of respondents hardly ever/never used telehealth (n = 27/76) or telemedicine (n = 26/76) and use of videoconferencing for communication was low (n = 10/76) (2). Approximately 17% (n = 9/54) of respondents stated that telehealth and telemedicine were the same thing, reflecting its frequent interchangeable use in the human literature. Over 100 definitions of telemedicine have been identified in the human literature (3). It should be noted that the sample surveyed may not be representative of...
the profession [more than 75% of respondents were ≥ 40 y old and most (60%) were male)]. Interestingly, those surveyed were selected based on association with a veterinary college’s distributed clinical year program, potentially impacting exposure of the next generation of veterinarians to telehealth.

Telemedicine has been successfully applied to all phases of human anesthetic practice, from pre-operative consultations, through intra-operative monitoring to post-operative and intensive care monitoring (12). The earliest reports of remote monitoring of general anesthesia in real time (“synchronous”) (9) described the application of both purpose-built devices for collecting and transmitting information where data transmission speeds were limited (see Technology) and the use of existing telecommunications (13–15).

The use of real-time telemedicine contrasts with a store-and-forward (“asynchronous”) approach with which most veterinarians are familiar. The store-and-forward approach commonly applies to teleconsulting for diagnostic imaging, in which data are collected and stored by the attending veterinarian, then forwarded for evaluation (7). The greatest challenge of real-time applications is a time-sensitive dependency on technology.

While the basis of this paper was the stimulus to meet a demand for anesthesia support within the constraints of the current pandemic, telehealth has an important role to play in accessibility to veterinary and human healthcare (remote settings, limited numbers of general practitioners and specialists) (2,9,12,15).

The remainder of this discussion describes specific considerations and challenges in performing teleconsulting in real time with video; a summary table illustrates the key points provided (Table 1).

**Technology**

Historically, both general purpose videoconferencing software and purpose-built systems have been successfully used (13,14). Key considerations in equipment and platform selection are cost, data security, and performance. In human medicine, particularly for surgery but also for pre-operative anesthesia consulting, dedicated towers incorporating video cameras, microphones, and electronic (often modular) instruments (electronic stethoscopes and otoscopes, and fiberoptic cameras) are available (12,16). For supervised surgery (“telementoring”), these are often combined with teleslavor capabilities (being able to indicate landmarks and features on the surgeon’s monitor) (16). These units have relatively high upfront and maintenance costs, currently precluding their use in veterinary medicine. In contrast, the combination of a video camera (e.g., smartphone), monitor (e.g., laptop computer/tablet), and videoconferencing platform, as described in the presented case, is suitable for most veterinary needs.

In recent years, streaming video and Internet video call/conferencing services have become very popular, driving huge investments in related technologies. Affordable consumer devices now have good quality cameras, microphones, and displays with processors capable of efficiently encoding and decoding “high-definition” video. Large investments in fixed and mobile Internet access continue to drive down the cost of device connectivity while improving performance. Meanwhile multiple services compete to provide good quality, reliable, and easy-to-use software for setting up and running video and voice calls and multi-participant conferences.

**Video capture**

Options for video (and sound) capture include static and mobile video cameras. As technology has advanced, smaller handheld devices provide an acceptable level of quality, removing the need for additional hardware and software to connect a standalone video camera to a computer for transmission. The inherent advantage of using a video camera built into a device capable of transmission reduces options to laptop computers, tablets, and smartphones. For laptops and tablets, most popular devices all have “high-definition” or “ultra-high-definition” (>1080 pixels) video cameras, recording at 24 to 60 frames per second (fps), with similar specifications for current smartphones.

Smaller devices have the advantages of portability, availability, and ubiquity, enabling ad-hoc consultations. Smartphones or other devices with mobile connectivity as well as Wi-Fi can be used in a wider variety of locations and provide a built-in backup communication channel. Mobile phone Internet in the US and Canada is currently used by around 80% of the population, making phones highly accessible and potentially capable of supporting video and sound transmission for teleconsulting (17,18).

Whether hand-held or affixed to a mobile stand (as described in the reported case), portability has the advantage of using a single device to easily capture different areas of the room, as needed. In some instances, it could be advantageous to have simultaneous unrestricted views of the patient and physiologic monitor, requiring 2 devices and a means of transmitting 2 video streams (13). Early reports, in which transmission capabilities were limited to satellite phones (data transfer rates of 64 Kbps), maximized use of available bandwidth by pairing a single video camera (on operating field) with physiologic data fed directly into a purpose-built device for data integration and transmission (14).

**Video transmission**

There are numerous considerations regarding video transmission, including data transfer rate, videoconferencing platform, and data security. The ability to view and provide timely input on viewed information depends on the achievable data transfer rate (sometimes referred to as bandwidth or connection speed). With high quality video, data transfer rates < 128 Kbps are associated with greater technical difficulties; lag or latency in

---

**Table 2. Sample residential Internet service.**

<table>
<thead>
<tr>
<th>Time of day</th>
<th>Ping (ms)</th>
<th>Download speed (Mbps)</th>
<th>Upload speed (Mbps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0730–0800</td>
<td>5 to 18</td>
<td>46.1 to 90.2</td>
<td>40.8 to 68.4</td>
</tr>
<tr>
<td>1200–1300</td>
<td>11 to 14</td>
<td>90.2 to 90.3</td>
<td>70.6 to 72.4</td>
</tr>
<tr>
<td>1500–1600</td>
<td>2 to 18</td>
<td>48.6 to 90.2</td>
<td>16.9 to 72.0</td>
</tr>
<tr>
<td>1730–1830</td>
<td>14 to 19</td>
<td>87.8 to 90.2</td>
<td>72.0</td>
</tr>
</tbody>
</table>

Data are ranges following daily testing during the week (Mon–Fri) by a co-author (DP) in his home. Ping speed reflects connection quality to server 100 km away. Data collected with speedtest.net. Note: Data reflect distance/number of connections.
video and audio (16). Modern residential wired or wireless Internet connections are typically capable of upload and download rates much higher than this, enabling higher video resolutions and frame rates (Table 2). Videoconferencing platforms provide minimum recommended rates ranging from 1.5 to 2 Mbps, for example (19). Minimum rates assume the minimum of 2 devices are in use, with a higher transfer rate required if more devices are conferencing.

As data transfer rates have rapidly increased over time (Edholm’s Law), delays in video transmission have subsequently decreased so that delays with current networks are in the millisecond range (16). In a simulated surgery study, delays in excess of 500 ms were associated with surgical delays and errors (20). Importantly, these delay times are 1-way, that is the transmission time in 1 direction (e.g., from surgical suite to viewer), and do not consider the additional time to respond, a consideration during teleconsulting. For interactive voice or video calls, 1-way mouth-to-ear delays of < 150 ms are recommended to avoid a perceptible degradation in quality of experience to participants (21).

Advertised Internet data transfer rates are usually considerably higher than achievable rates as a result of network congestion and other factors (Table 2). For a connection between 2 devices, the slowest link in the chain, perhaps a weak local Wi-Fi network or lower upload rate, will limit the achievable data transfer rate. The ping time between 2 devices measures the current round-trip delay at the network level, indicating a lower limit on video/voice delay (Table 2).

Videoconferencing services and applications commonly measure and react to changing network conditions, improving or degrading video and voice quality in order to maintain a call with acceptable delays (22).

Wired network connections (e.g., Ethernet) provide reliable data transfer at high rates with low delays but may be awkward for portability and positioning. Mobile data connections (2.5G/3G/4G/5G) may offer a useful connectivity alternative with acceptable data transfer rates and delays, though subject to variable signal quality and commonly at greater cost than a fixed Internet connection (23).

Disconnections during videoconferencing have been infrequently reported in the literature, with 1 study (using Wi-Fi) reporting 7 disconnections, totalling 10 min out of 279 min of anesthesia teleconsulting time, none of which affected care (24). The experiences in the reported case highlight the possibility of technical problems. Many users will have prior experience with communication issues and may naturally anticipate the potential need to reconnect, drop to voice only, or try another communications channel. Given the possibility of technical problems or failures, having an alternative method of communication is strongly recommended (13,25). In the case described, the backups included an alternative videoconferencing platform

---

**Table 3. Selected applications for videoconferencing.**

<table>
<thead>
<tr>
<th>Platform</th>
<th>Encryption</th>
<th>Secure login</th>
<th>Free?</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skype</td>
<td>Y, chat stored on company servers</td>
<td>Password</td>
<td>Y</td>
<td>Being replaced by MS Teams</td>
</tr>
<tr>
<td>Skype for Business</td>
<td>Y, end-to-end possible</td>
<td>Password</td>
<td>N</td>
<td>Can control participants joining calls and lock calls (preventing people joining)</td>
</tr>
<tr>
<td>Zoom&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>Optional end-to-end when using application</td>
<td>Password</td>
<td>N</td>
<td>Limited to users of Office365 suite</td>
</tr>
<tr>
<td>Microsoft Teams&lt;sup&gt;b&lt;/sup&gt;</td>
<td>End-to-end</td>
<td>Password, multifactor authentication</td>
<td>N</td>
<td>Accepts inputs from auxiliary wired and wireless signals (e.g., physiologic monitor, electronic stethoscope). Data transmitted on private global network</td>
</tr>
<tr>
<td>WhatsApp</td>
<td>End-to-end</td>
<td>Optional (depends on device security)</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>FaceTime</td>
<td>End-to-end</td>
<td>Optional (depends on device security)</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>REACTS&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Y</td>
<td>Password</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>KARL STORZ VisitOR1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Y</td>
<td>Password</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>KARL STORZ Viewpoint&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Y</td>
<td>Password</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>TeamViewer&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>Y</td>
<td>Password</td>
<td>N</td>
<td></td>
</tr>
</tbody>
</table>

Note: Data based on information collected during week of April 27, 2020. Technology changes frequently and users should check that current provisions meet their needs.

<sup>a</sup> Opt-in security features available, including password protection and waiting room (users joining call can be screened before access is provided).

<sup>b</sup> HIPAA compliant (additional subscription service required for MS Teams).

<sup>c</sup> Provides remote screen sharing. Voice support must be provided separately.

<sup>*</sup> Software and private global network can be accessed from supported personal devices.
(Facetime, Apple) and telephone. Additionally, in the described case, a trial was conducted the day before the planned case, facilitating familiarization with the technology and software.

An important consideration that is well-described in the human medical literature, but minimally in the veterinary literature, is security of data during transmission and potential breaches of confidentiality (7,11,12,14,25,26). On involved devices and networks, basic security mechanisms such as making use of passwords, antivirus software, password protected and encrypted Wi-Fi, and other security hygiene methods should be implemented.

There are several methods available to protect data in transmission, including the use of dedicated, legally compliant services, encrypted videoconferencing platforms, and Virtual Private Networks (VPN). In North America, legally compliant services have been designed to comply with human healthcare regulations to protect the privacy and security of health information such as the US Health Insurance Portability and Accountability Act of 1996 (HIPAA), which cover the secure transfer and storage of data (records, images, and video) (27–29). Their development and maintenance come at a cost, which is recouped from users, limiting current adoption in veterinary medicine. When based on a suite of dedicated hardware, initial and ongoing maintenance costs are high, though there may be a role in centers wishing to provide regular remote support (27). Systems centered on software that can be accessed through personal devices (smartphones, laptops, tablets) come at a lower cost, with ongoing payments used to support continued development and maintenance (28).

Existing videoconferencing platforms vary considerably in the levels of security available, reflecting how communications are accessed, transmitted, and stored (Table 3). Hosting servers dedicated to videoconferencing on-site is cost-prohibitive and hosted services are generally used provided they meet legislated security requirements (30). Many services provide built-in encryption of data. Some services claim to provide “end-to-end” (device-to-device) encryption of data, where the service itself is unable to decrypt the transported data. However, as a service user, it is not generally possible to be certain whether end-to-end encryption is actually applied, in which jurisdiction(s) servers are located, how data are routed, how new software versions behave or how operating company policies change. In some instances, videoconferencing platforms can be compliant with health regulations for management of patient data, but this is typically a paid service and may require a contract between the provider and user (31).

VPNs are used by organizations to allow remote sites and workers to connect to their private internal networks over the public Internet using encrypted connections. General purpose VPN services aimed at consumers securely connect their devices to the public Internet. These consumer VPNs give a degree of local privacy and anonymity, but do not protect data traversing the Internet unencrypted when it leaves the VPN. For public videoconferencing services reached over the Internet, using a consumer VPN to access them does not give significant extra security. Dedicated services use encrypted connections directly between applications running on devices and the systems implementing the service, giving a good degree of security assuming the service provider is trusted (27,28).

An alternative approach to dedicated services and videoconferencing platforms, is to use a hybrid setup, in which physiologic monitor screens can be shared remotely and voice calling provided through an alternative means such as telephone (32). Though less convenient than a single package for video and voice, this may be suitable for occasional use.

**Video viewing**

Minimum requirements for video viewing are not well-established in telehealth. Several papers have discussed different aspects of display quality, though these largely focus on specific specialty requirements, which tend to exceed the specifications needed for synchronous teleconsulting (33,34). Screen resolutions of approximately 0.75 MP (1024 x 768 pixels) have been used successfully for surgical telementoring and limited applications in veterinary radiology (16,35).

Screen size is a further consideration, with surgeons remotely supervising laparoscopy favoring monitor screen sizes > 10” over a 5” smartphone (36). This may have added importance if more than 1 window is displayed concurrently (e.g., physiologic monitor and room view). A more general statement can be made regarding frame rates, with 30 to 60 fps perceived as smooth to the human eye, with a minimum acceptable threshold of 15 fps (37). As fps rate decreases, there is a longer delay between frames with the risk of the scene appearing “jittery” with moving objects jumping between points rather than moving smoothly (as in reality) (37).

**Patient selection and risk**

In the current COVID-19 pandemic, the CVMA considers veterinary practice and services essential (38) and at the time of writing, all provinces and territories classify veterinary practice and services as essential. In some cases, veterinary care has been restricted as emergency or urgent care. The Alberta Veterinary Medical Association does not currently make this distinction but states that: “What [veterinary] practices must provide is a safe environment for both their veterinary staff and clients.” (ABVMA members bulletin, April 16, 2020). The argument in favor of performing the described case was based on a welfare concern from dental disease and high likelihood of pain. Untreated dental disease is an animal welfare issue and, in many cases, dental treatment should not be considered an elective procedure (39). The practice was able to follow provincial guidelines on physical distancing, barring clients from entering the practice, and appropriate use of personal protective equipment (PPE). The considerations for providing teleconsulting versus in-person support for this case were primarily centered on minimizing the number of personnel in the workplace when appropriate support could be provided remotely, and the perceived anesthetic risk of the case. It is currently unknown how synchronous teleconsulting affects procedural risk for a patient. General considerations, which apply to all cases (patient selection, teamwork, client communication), are discussed in this and the following sections within the context of teleconsulting.
As a specialty, anesthesia recognized the contribution of human medical error to patient morbidity and mortality before it was more widely appreciated and human error is now correctly viewed within the context of a systems approach to understanding and preventing adverse events (see Teamwork) (40–45). Furthermore, a large part of anesthesia management is preventive: patient stabilization before anesthesia, real-time interpretation of physiologic data and early intervention to prevent or limit adverse effects. Together, this proactive, rather than reactive, approach improves peri-operative stability and outcomes. In contrast, many of the basic technical skills employed by anesthetists do not require advanced training and can be performed by a competent general practitioner or registered AHT.

The risks associated with general anesthesia are multifactorial, and are variably influenced by species, age, and health status among other factors. In this case, ASA physical status classification (including absence of indication for invasive blood pressure monitoring and acceptable cardiopulmonary status) and client comfort with the procedure played an important role in case selection. Cases in which the ASA physical status classification was > 2, or when clients were uncomfortable with the lack of in-person support, were recommended for referral or delayed. Additionally, training, experience, and proficiency are considerations when teleconsulting, as the physical act of delivering anesthetic care is dependent on the attending veterinarian and AHT. In this case, the patient was referred because of anesthetic complications during a dental procedure that was left uncompleted. A definitive cause of the complications was never elucidated and having an anesthesiologist teleconsulting was considered prudent.

The consulting anesthetist in this case was residency-trained and had extensive clinical and teaching experience in academic and private veterinary hospitals. The consultant had previously worked with the attending veterinary dentist but had no experience with the healthcare team in that particular hospital setting prior to the first videoconference trial. As described in the presented case, and reflected in the literature, complications can be well-managed with a well-prepared and trained team (13,14). There is some indication that having more than one person dedicated to anesthetic monitoring (“cross-monitoring”) can aid in early detection of abnormalities (13).

**Teamwork**

For the reported case, the veterinary care team comprised the attending veterinarian and 3 AHTs (one dedicated to the dental procedures, one dedicated to anesthesia, and the third providing support as necessary). The team composition allowed a clear division of labor and responsibilities between dental procedures and anesthesia, similar to practice in an academic center (or larger referral centers). As with any surgical procedure conducted by a multidisciplinary team, there is a risk of errors and adverse events, particularly when personnel are less familiar with one another or communication is poor (41,42). Additionally, the delivery of anesthesia depends on interactions between anesthetist, patient, personnel, and equipment (43–45). These interactions are frequently “tightly coupled,” so that even small changes in 1 part of the system can have a rapid, direct, and major impact on the patient (43,45).

An initial case planning discussion by videoconference served the dual purpose of testing the technology (13), ensuring pertinent patient information (history and current health status) had been clearly communicated and allowing the 2 anesthetists (AHT responsible for anesthesia and consulting anesthetist) to establish a working relationship. The attending veterinarian participated in the planning videoconference and approved of the proposed plan before the procedure. The role of telehealth during preoperative patient evaluation in human anesthesia has become widespread (12,46). In this case, the AHT responsible for anesthesia (under the direct supervision of the attending veterinarian) had examined the patient and was able to discuss current physical findings.

Given the critical role of communication in medical and veterinary error and adverse events (in which harm occurs to patients or personnel), the initial videoconference was a key part of case preparation (47). The establishment of a shared mental model (shared mission and plan to achieve it), flattening of any hierarchy between the 2 anesthetists, structured communication, and minimal use of slang/jargon all contribute to clear, timely communication and a consequent reduction in errors and adverse events (42,48,49). The consulting anesthetist used a checklist that consisted of sequential steps outlined in an anesthetic planning document that was shared and discussed with the lead AHT anesthetist 4 d before the procedure. The same document was used as a guide to review the physical examination and blood analysis findings on the morning of the procedure, ensure the anesthetic machine had been leak-tested and the correct circuit was prepared, review pre-medication and induction drug calculations/volumes and sequence of drug administration, review salbutamol administration and pre-oxygenation techniques, and finally intubation equipment preparedness and plan.

During the procedure, all discussion between the consulting anesthetist and AHT anesthetist took place in the presence of the attending veterinarian (speakerphone function was used) and it was clear from the working relationships established that the attending veterinarian maintained primary responsibility for patient care. Teleconsulting is subject to the restrictions of the VCPR and any existing legal framework surrounding consultation in a specific jurisdiction.

**Client communication**

Client consent for anesthesia teleconsulting was obtained by the attending veterinarian as per the established VCPR. The consulting anesthetist had a telephone conversation with the client in the week before the procedure, during which the patient’s clinical history, current health status, and teleconsulting plan were reviewed. The limitations of remote versus in-person anesthesia support and specific anesthetic considerations relating to the patient were discussed in detail, including that ultimate case responsibility and decision-making rested with the attending veterinarian. The client was encouraged to contact the consulting anesthetist with follow-up questions or concerns as needed. The owner was very satisfied with the service provided and with the follow-up communication.
Overall, following discussion between the attending veterinarian and owner, it was felt that the risk was manageable and acceptable.

Future
It is anticipated that telehealth will continue to grow and evolve in veterinary medicine, with this occurring at an accelerated rate under the selection pressure of the current pandemic. Important considerations during this period will be the maintenance of a distinction between telemedicine and other branches of telehealth, accepted means of establishing a VCPR, optimizing use of available technology, awareness of technological limitations (particularly data security) and the potential adoption of videoconferencing suites and platforms dedicated to telehealth. When done well, telehealth promises a host of benefits including maintaining adequate veterinary services during times of restricted access and movement, remote access to general and specialist services, support for isolated communities (clients and veterinarians) and underserved populations, and reduced client and patient travel for pre- and post-procedural follow-up (2,9,50).

Conclusion
This report shows that anesthesia teleconsulting can be successfully implemented, including the management of anesthetic complications. While there are numerous technological aspects to consider, the performance of existing technology and communications networks can be harnessed to provide a positive experience for all parties and facilitate high quality patient care.

Acknowledgments
The authors thank Dr. P. Buote DVM (Alberta Veterinary Medical Association) and J. Hahn (KARL STORZ Endoscopy-America) for helpful discussions during the drafting of this paper.

References
Influence of abdominal elevation on radiographic measurements of the thoracolumbar interspinous spaces in asymptomatic horses

Charlène Pigé, Isabelle Masseau, Alvaro G. Bonilla

Abstract — The objective of this study was to determine if abdominal elevation could induce radiographically visible widening of the interspinous spaces in the thoracolumbar region of standing sedated horses and facilitate the surgical approach to the region. Radiographs centered on T13 and T18 were taken while applying different degrees of tension on a wide strap placed under the abdomen of 7 healthy horses. Then, the interspinous spaces between T11 and L2 were measured following a standardized method. The interspinous spaces widen radiographically between T11 to L2, except for T18–L1. Thus, the reported technique could potentially facilitate the surgical approach for horses with impinging and overriding dorsal spinous processes.


Impinging and overriding of the spinous processes (IORDSP) is one of the most common reasons for thoracolumbar pain in sport horses and is commonly managed with surgery (1–4). Lateral recumbency reportedly facilitates the surgical approach to the region by allowing widening of the interspinous spaces secondary to relaxation of the epaxial musculature (3). Nevertheless, most surgical techniques to treat IORDSP are performed with the horse standing to avoid the risks associated with general anesthesia (5–7). Moreover, a low head and neck position, which has also been reported to increase the width of the interspinous spaces, is contraindicated in standing surgery due to hemodynamic and respiratory concerns (8). Thus, an alternative system that can widen the interspinous spaces in standing animals may facilitate the surgical approach in affected horses and warrants investigation.

It is well-known that abdominal elevation produces thoracolumbar flexion (9). This flexion may potentially lead to widening of the thoracolumbar interspinous spaces. However, to the authors’ knowledge, no studies have documented this change. Based on the “bow-and-string” model, we hypothesized that a slight abdominal elevation on standing horses could reduce tension on the thoracolumbar column and subsequently increase the width of the interspinous spaces (10). The aim of this study was to determine if applying a slight abdominal elevation to healthy standing horses would lead to widening of interspinous spaces and mimic the widening observed radiographically between spinous processes in lateral recumbency (3). This study was conceived as a proof of concept study before recruiting horses affected with IORDSP for standing surgery. The project was approved by the Animal Use Ethics Committee of the University of Montreal.

Seven mares from the teaching herd of the University of Montreal were recruited for the study. All mares had a normal physical examination, showed no clinical signs of back pain, and
Thoracolumbar motion was deemed normal; however, none of the mares were in active work.

For the study, horses were placed in standing stocks and were lightly sedated with detomidine hydrochloride and butorphanol tartrate, both at 0.01 mg/kg body weight (BW), IV. A 173-cm long × 51-cm wide leather strap was attached to one of the stock’s sidebars. The strap was then positioned under the horse’s abdomen, with the cranial aspect of the strap placed immediately caudal to the xyphoid process. The other end of the strap was held by 1 or 2 assistants (Figure 1). Assistants wore appropriate radiation safety equipment consisting of lead apron, thyroid shield, leaded gloves, and glasses and dosimeters. The mares were continually monitored by 1 of the investigators to ensure that they stood squarely on all 4 feet, preventing lateroflexion or rotation of the spine. The animals were also continuously monitored for any signs of discomfort (anxiety or respiratory distress) during the procedure. During the procedure, horses’ heads were positioned on a head support to allow a neutral head and neck position (horse’s mouth at the level of the shoulder) based on the reported influence of head and neck position on interspinous space measurements (Figure 1) (8). In addition, this neutral stance is commonly favored during standing surgery to improve patient balance and avoid complications while the horse is sedated.

Three series of 2 consecutive radiographs of the spinous processes centered on T13 and T18, both marked with barium paste on the dorsal midline, were taken while applying various degrees of tension on the abdominal strap and consequently obtaining different degrees of abdominal elevation:

i) Tension 0 (T0): No abdominal elevation

ii) Tension 2 (T2): Maximum abdominal elevation achieved for each horse

iii) Tension 1 (T1): T2 divided by 2

This region of interest was chosen due to the higher prevalence of IORDSP identified around the anticlinal vertebra (T15) (3,4,6). The abdominal elevation obtained using the abdominal strap was extrapolated to centimeters from a centimeter scale on the stock’s sidebar and a centimeter scale on the edge of the strap (Figure 1).

All radiographs were acquired using a mobile X-ray machine (Practix Convenio; Philips Medical Systems, Hamburg, Germany). For each of the 3 positions described, left to right latero-lateral radiographs centered on T13 and T18 spinous processes were taken. The exposure values used were 83 kV and 28 to 32 mAs for the T13-centered radiograph and 90 to 95 kV and 45 to 55 mAs for the T18-centered radiograph, according to the horse’s size. No body parts of the operator were exposed to the primary X-ray beam at any time. The dosimeters of the operator did not record any radiation above the allowed occupational limit of 1 mSv annually. The digital cassette (CR HD5.0 General, 35 × 43 cm; Agfa HealthCare NV, Mortsel, Belgium) was held perpendicular to the X-ray beam and as close as possible to the horse to minimize image distortion by magnification.

Following acquisition of the image, radiographs were anonymized to ensure unbiased radiographic evaluation of the horse and the degree of tension used by the investigators. Since X-ray beam angle has been shown to influence interspinous...
space width located 3 positions away from the X-ray beam center (11), our radiographic measurements were limited to between T11 and T16 for projections centered on T13 and between T15 and L2 for projections centered on T18. Note that the space T15–16 was measured in both radiographs.

Prior to performing interspinous space width measurements, a single observer (CP) applied landmarks (P1, P2) on each radiographic projection for standardization purposes. Subsequently, each of the 3 observers took 2 separate sets of measurements as follows (Figure 2): a first line (D1) representing the width of the spinous processes of a given vertebra at the level of its most caudal aspect and a second line (D2) which was drawn by extending the line D1 to the cranial edge of the following caudal vertebra. Next, the interspinous space width or D3 was directly calculated by an Excel file (D3 = D2 − D1) used to record measurements. The width of each interspinous space (D3) was then divided by the width of the spinous process of the cranial vertebra (D1) to obtain a D3 measurement (D3c) corrected for magnification, allowing objective comparison of measurements performed at T0, T1 and T2.

An intra-class correlation coefficient was used to determine the intra- and inter-observer agreement on interspinous space width measures. Data recorded by the 3 observers were used to determine the effect of abdominal elevation (T0, T1, T2) on widening of the interspinous spaces using a repeated measures linear model.

Intra- and inter-observer agreement was excellent for radiographs centered on T13 and good for those centered on T18. Radiographic measurements revealed that the mean value of the interspinous spaces from T11 to L2 was significantly higher at T1 and T2 versus T0, except for the interspinous spaces T15–T16 and T18–L1 on radiographs centered on T18. For radiographs centered on T13, maximum manual abdominal elevation (T2) allowed an average increase or widening of the interspinous spaces from T11 to T16 between 50% and 80% from baseline (T0). These percentages are equivalent to an increase in width of the interspinous spaces from T11–T16 ranging on average from 2.7 mm to 5 mm. For radiographs centered on T18, the widening obtained at T2 from T16 to T18 and L1–L2 was between 15% and 103% from baseline (T0) which corresponds to an increase ranging on average from 1.4 mm to 2.2 mm.

As hypothesized, the use of a large leather strap to manually elevate the abdomen in standing horses resulted in radiographically visible widening of the interspinous spaces between T11 to L2, except for the interspinous space T18–L1. Our interspinous space measurements were made at the level of the most caudal aspect of the spinous processes for standardization purposes, but if we consider the anatomy of the region, thoracolumbar flexion should widen the interspinous spaces further dorsally where contact between adjacent spinous processes tends to start in affected horses (2). This study only included asymptomatic horses and results may vary in horses affected with IORDSP where ligament fibrosis and boney remodeling are present. Nonetheless, lateral recumbency has been reported to widen the interspinous spaces and facilitate surgical access in horses with IORDSP where those changes are present (3).
Radiographic measurement of the interspinous spaces is commonly used during the diagnosis of IORDSP and several measuring techniques have been reported in foals and adults (8,11–13). Nonetheless, these measurements can be affected by lateral recumbency, head and neck position, or radiographic beam position (3,8,11). We decided to develop our own standardized measurement protocol that could be applicable to all spinous processes regardless of their shape (8,11–13). We decided to standardize the location at which each observer would perform the interspinous space measurement to prevent a second measuring variable (observers may measure the interspinous space at slightly different locations) but this may have artificially affected our intra- and inter-observer agreement. In addition, this is a novel measuring technique and therefore, its repeatability has not been tested previously.

Berner et al (8) reported the influence of head and neck position on the interspinous spaces between thoracic spina
c processes in healthy horses. They showed that a low head and neck position resulted in widening of the interspinous spaces. However, the information reported is insufficient to draw comparisons with our study and we were unable to determine whether the widening obtained by lowering the head and neck was similar to the widening obtained with the abdominal strap. Nevertheless, we decided to maintain the head and neck in a neutral position during our study since this position would best mimic the resting stance preferred for a sedated horse while back surgery is being performed.

The technique used to elevate the abdomen was well-tolerated in all horses and easy to replicate. Horses were lightly sedated allowing them to stand squarely and preventing vertebral rotation during image acquisition (8). However, the personnel required, and the method used to obtain abdominal elevation may be limiting factors for clinical cases. If the technique used herein is to be applied during interspinous ligament desmotomy (ISLD) or partial ostectomy of the spinous processes (ISLO) in standing horses, a method of abdominal elevation not requiring 1 or 2 assistants to maintain the tension on the abdominal strap would be desired.

The lack of significant differences between T15–T16 and T18–L1 on radiographs centered on T18, and the variability among observers for measurements caudal to T16 could be in part attributed to the pronounced noise provided by scattered radiation on radiographs obtained in this region (centered on T18). Radiography of the equine thoracolumbar spine is technically challenging and often requires radiographic equipment with high outputs (75 to 120 kV and 100 to 250 mAs) to obtain high quality diagnostic images (2). The requirement for Stocks with side bars to perform our study forced us to use a mobile X-ray machine with limited output and consequently, suboptimal penetration of the spinous processes in the thicker thoracolumbar region. The blurred margins of the caudal thoracolumbar spinous processes occasionally made it difficult to obtain accurate measurements on radiographs centered at T18. This limitation led to a lower inter- and intra-observer agreement on radiographs centered at T18, and hindered our ability to determine whether contact was present between adjacent spinous processes. Retrospectively, this is an important limitation of our study and could be responsible for the lack of significant widening of 2 interspinous spaces measurements on radiographs centered on T18. Alternatively, the lack of significant interspinous space widening in the caudal thoracolumbar region could be attributed to intrinsic properties of the body in this region (9).

There were other limitations in this study. Recruited horses had no clinical signs related to IORDSP and we were unable to predict the amount of interspinous space widening necessary to facilitate the surgical access to the region. From a surgical point of view, we believe that an increase of 3 mm or more would be enough to facilitate the introduction of a rigid scalp blade or Metzenbaum scissors during ISLD. This degree of widening was achieved in 4/7 horses between T11–L2. Therefore, future studies are needed to determine whether widening of the interspinous spaces using abdominal elevation with the reported technique will be enough to facilitate the surgical approach in standing horses with IORDSP and the absolute value in mm required to subjectively facilitate the surgery.

In conclusion, this proof of concept study demonstrated that manual abdominal elevation increases the interspinous space width between T11 and L2, except for T18–L1, in horses asymptomatic for back pain and has potential clinical relevance. Nonetheless, further investigations are needed to validate the technique in horses affected with IORDSP. In such cases, a high capacity X-ray unit, able to achieve 75 to 120 kV and 100 to 250 mAs, should be used to provide clear vertebral margins and subsequent accurate measurements on radiographs centered on T18.

Acknowledgment

The authors thank G. Beauchamp from the College of Veterinary Medicine of the University of Montreal for performing the statistical analysis.

References


Answers to Quiz Corner
Les réponses du test éclair

1. B) Panosteitis affects larger breed dogs and is associated with estrus.

B) La panostéite affecte les chiens de grande race et est associée à l’œstrus.

2. E) Heartworm is not transmitted from fleas or lice, nor may it be ingested through milk. The mosquito only transmits L3.

E) Le ver du cœur n’est pas transmis par les puces ou les poux, ni par l’ingestion de lait. Les moustiques transmettent seulement les larves L3.

3. D) The most likely diagnosis is scrotal hernia.

D) Le diagnostic le plus probable est une hernie scrotale.

4. A) The other choices may cause one or two of the clinical signs but not all of them, particularly the lymphadenopathy.

A) Les autres choix peuvent causer un ou deux des signes cliniques mentionnés mais pas tous, particulièrement la lymphadénopathie.

5. E) Serum antibody enzyme-linked immunosorbent assay (ELISA) and fecal culture of subclinical carriers of Mycobacterium avium subspecies paratuberculosis are insensitive (30% to 50%). The incubation period for the disease is measured in years, during which time fecal shedding and environmental contamination occur. The organism is tolerant of most environments and is thought to live for up to 12 months outside of the host. The clinical signs of the disease are pronounced and not easy to mistake: profuse, watery, green diarrhea, extreme weight loss, and normal appetite.

E) L’essai d’immunoabsorption enzymatique (test ELISA) et la culture des fèces des porteurs subcliniques de Mycobacterium avium ssp. paratuberculosis sont insensibles (30-50%). La période d’incubation pour la maladie se mesure en années, durant lesquelles l’excrétion fécale et la contamination de l’environnement ont lieu. L’organisme est tolérant à la plupart des environnements et on croit qu’il vit jusqu’à 12 mois à l’extérieur de l’hôte. Les signes cliniques sont évidents et spécifiques : diarrhée aqueuse abondante de couleur verte et perte de poids extrême malgré un appétit normal.
Save the Date!

2021 CVMA CONVENTION, JULY 22–25, 2021

Calgary, Alberta
Ixodes scapularis ticks and Borrelia burgdorferi on Prince Edward Island: Passive tick surveillance and canine seroprevalence

Alexandra H. Foley-Eby, Christine Savidge, Vett K. Lloyd

Abstract — Ticks and canine sera were submitted by veterinarians from Prince Edward Island over a 15-month period spanning 3 tick seasons. The objective of the study was to determine the infection prevalence of Borrelia burgdorferi, a causative agent of Lyme disease, in the province’s ticks and the seroprevalence in its dogs. It was found that 97.8% (n = 368) of ticks submitted were Ixodes scapularis, a species capable of transmitting Borrelia burgdorferi; 10.3% of these ticks [95% confidence interval (CI): 3.6% to 17.0%] were infected. Provincial canine seroprevalence for the 199 submitted samples was estimated at 3.0% (95% CI: 1.0% to 5.1%).

Résumé — Ixodes scapularis et Borrelia burgdorferi sur l’Île-du-Prince-Édouard : Surveillance passive des tiques et séroprévalence canine. Des tiques et du sérum canin furent soumis par des vétérinaires de l’Île-du-Prince-Édouard durant une période de 15 mois couvrant trois saisons de tiques. L’objectif de l’étude était de déterminer la prévalence d’infection à Borrelia burgdorferi, un agent causal de la maladie de Lyme, dans les tiques de la province et la séroprévalence chez les chiens. Il fut trouvé que 97,8 % (n = 368) des tiques soumises étaient Ixodes scapularis, une espèce capable de transmettre B. burgdorferi; et que 10,3 % de ces tiques [intervalle de confiance de 95 % (CI) : 3,6 % à 17,0 %] étaient infectées. La séroprévalence canine provinciale pour les 199 échantillons soumis était estimée à 3,0 % (CI 95 % : 1,0 % à 5,1 %).

Lyme borreliosis, or Lyme disease, is a spirochetalis transmitted by Ixodes spp. ticks (1). The agents of Lyme disease are members of the genus Borrelia, collectively known as the Lyme borreliosis group. The most common Lyme borreliosis species in North America is Borrelia burgdorferi sensu stricto. Ixodes scapularis and Ixodes pacificus are the only 2 species of ticks routinely monitored for B. burgdorferi in Canada and I. scapularis is the vector most commonly found in the Atlantic provinces (1).

Borrelia burgdorferi infections cause disease in dogs, other animals, and humans. Dogs which are infected seroconvert, which can be detected using traditional immunoassays such as enzyme-linked immunosorbent assay (ELISA) and Western blot (2). Previous studies have suggested that most, but not all, B. burgdorferi-infected dogs are asymptomatic; however, for a portion of infected dogs the outcome of infection is serious (2). As the behaviors of dogs put them at a higher risk of exposure than their human companions, dogs make a sensitive sentinel species to predict human infections (3). Both of these reasons emphasize the value of monitoring canine exposure to tick-vectored pathogens in a given area.

Ixodes scapularis was first found on Prince Edward Island (PEI) in 1989 and the first isolation of B. burgdorferi in Atlantic Canada took place in PEI in 1992 (4,5). There has been limited published research focused on Lyme disease on PEI since its initial documentation over 25 y ago. The report of ticks on migratory bird species on the island (6) and the absence of deer, the primary host for adult female ticks, has led to the assumption that only adventitious ticks are present on the island. However, PEI does possess abundant mid-sized wildlife and agricultural ruminants, which could act as adequate hosts for adult ticks, so short- or long-term support of tick populations cannot be excluded (7,8). Regardless of the origin of the ticks, previous studies have shown that ticks can be present in sufficient numbers to pose a health risk even in the absence of deer (7,8).

This study focussed on identifying the risk of Borrelia burgdorferi infections to dogs on PEI. This was accomplished by passive surveillance of the island’s ticks and a canine serological study, supported by the participation of local veterinary clinics. This study was approved by the animal care committees at both Mount Allison University and the University of Prince Edward Island.
In September 2016, letters were sent to 13 mixed or small-animal primary care veterinary practices across PEI, inviting them to participate in research investigating the presence of tick and *Borrelia* species in the province. Eleven of those clinics indicated interest and were provided with consent forms for collecting canine sera and ticks from their patients. Between October 2016 and January 2018, 445 ticks and 199 serum samples were submitted to Mount Allison University (Sackville, New Brunswick) for testing. This period spanned 3 tick seasons: Fall 2016 (Sept 2016–Jan 2017), Spring 2017 (Feb 2017–Aug 2017), and Fall 2017 (Sept 2017–Jan 2018). Ticks were not recovered in all months.

Ticks were tested for *Borrelia* species infection as described previously (9). Briefly, ticks were photo-documented and morphologically identified to species, life stage, sex, and state of engorgement using the key developed by Keirans and Litwak (10) and the University of Rhode Island’s TickEncounter Resource Center’s tick engorgement resource (11). Ticks were washed in ethanol and cut in half longitudinally; half of each sample was archived in the tick bio-bank at Mount Allison University while the other half was used for DNA extraction (9). DNA from the ticks and any internal microorganisms was extracted using the AquaGenomic kit (MultiTarget Pharmaceuticals, Colorado Springs, Colorado, USA) following the manufacturer’s instructions. DNA was then subjected to nested polymerase chain reaction (PCR) to amplify the *FlaB* and *OspA* genes from *B. burgdorferi*: 40 cycles for both inner and outer primers for each gene, GoTaqGreen taq polymerase (Promega Corporation, Madison, Wisconsin, USA), annealing temperatures 55°C and 58°C for outer and inner primer sets, respectively, extension times 45 s (9). Negative controls were included with each set of amplifications. Amplicons were detected by agarose gel electrophoresis and amplicons of the correct size (outer primer amplicons 503 bp and 487 bp and inner amplicons of 447 bp and 350 bp for *FlaB* and *OspA*, respectively) were considered positive indicators for these genes. Information on the species, sex, life stage, and state of engorgement and *Borrelia* sp., if found, for each tick was returned to the veterinary practice from which the sample was submitted.

The detection of 1 amplicon, but not both, was communicated to the participating veterinary clinics as such results can identify other species of pathogenic *Borrelia* species (12); however, only those samples for which both amplicons could be detected were considered positive for surveillance purposes and are reported here. Tick infection prevalence was calculated for each tick season to obtain a mean infection prevalence with 95% confidence interval (CI).

For canine serological testing, participating clinics were asked to avoid dogs vaccinated against *B. burgdorferi* (to avoid cross-reactivity on Western blots) and to select patients presented for routine surgeries, avoiding selecting animals showing clinical signs of infection. Each sample was tested using the SNAP 4Dx Plus Test (IDEXX Laboratories, Westbrook, Maine, USA), a form of C6 ELISA. Each test was run and interpreted according to the manufacturer’s protocol. Enzyme-linked immunosorbent assay seropositivity prevalence was calculated for each tick season to obtain a mean infection prevalence with 95% CI. In addition, ELISA-positive samples, each with an accompanying negative sample from the same clinic, were tested by immunoblotting (Western blotting) using commercially prepared *B. burgdorferi* IgG Marblot Western blot strips (Trinity Biotech Bray, County Wicklow, Ireland) to provide information on possible regional differences in seroreactivity to specific *B. burgdorferi* antigens, as has been noted in humans (13). The immunoblots were processed as described by the manufacturer with the exception that an alkaline phosphatase-labeled sheep polyclonal secondary antibody to dog IgG (Abcam Cambridge, United Kingdom, ab112837;1:50,000 dilution) was used in order to detect canine antibodies and the immunoblot strips, both positive and negative, were incubated in the sera overnight at 4°C, for convenience. To quantify seroreactivity, using imaging software, the gray value as a measure of band intensity, of each *B. burgdorferi*-indicative band (bands 18, 23, 28, 30, 39, 41, 45, 58, 66 and 93 kDa) from ELISA-negative samples was averaged and compared to bands from ELISA-positive samples. Any sample in which 5 or more of the *B. burgdorferi* significant bands were darker than the average produced by the ELISA-negative bands was considered positive. Two-sample t-tests were

![Tick species recovered by passive surveillance on Prince Edward Island from October 2016 to January 2018.](image)
performed to compare the gray values of each significant band between ELISA-positive and ELISA-negative samples.

In total, 445 ticks were submitted, but data from samples unaccompanied by a submission data form and those removed from animals that had travelled out-of-province in the previous 2 wk were eliminated. After the data were filtered, 368 ticks remained that were presumably encountered in PEI. Of these samples, 97.8% (n = 360) were *I. scapularis*. Other recovered species included *Dermacentor variabilis* (n = 2), *Haemaphysalis leporispalustris* (n = 4), *Rhipicephalus sanguineus* (n = 1), and *Ixodes cookei* (n = 1) (Figure 1).

Location information provided on submission forms was used to identify the areas from which ticks were recovered. The 4 Federal Electoral Districts of PEI, which represent similar human populations, so presumably also canine populations (14), are shown in Figure 2. Of the *I. scapularis* collected on PEI, 19.7% (n = 71) were from Egmont, 16.9% (n = 61) from Malpeque, 11.9% (n = 43) from Charlottetown, and 51.4% (n = 185) from Cardigan. A Chi-square test with uniform distribution as the null hypothesis, indicated that this distribution differed significantly from a uniform distribution (x² = 138.78, P < 0.00001, α = 0.05). The number of *I. scapularis* recovered from Cardigan was greater than the number recovered in any other district (Figure 2).

Infection prevalence of *B. burgdorferi* in *I. scapularis* ticks passively collected on PEI was calculated at 10.3% (95% CI: 3.6% to 17.0%; 37 positive ticks), with an additional 8.9% (32) of ticks testing positive for only 1 of the 2 target genes. A logistic regression was performed to detect whether the district, serving as a categorical independent variable, had an effect on the positive/negative test result for its ticks, a binary response/dependent variable. No significant difference was found suggesting a largely uniform distribution of infection in ticks among districts.

In total, 7/199 canine serum samples were seropositive for *Borrelia* using the C6 ELISA. This test also detects the tick-vectored pathogens, *Anaplasma* or *Ehrlichia*, and mosquito-vectored heartworm. No seroreactivity to *Anaplasma* or *Ehrlichia* was detected; 1 heartworm positive result was found in a dog that had recently traveled to New Brunswick. One of the *Borrelia* seropositive samples was submitted without an accompanying submission form, leaving the dog’s travel history and home district unknown, so that sample was excluded. This gives an amended *Borrelia burgdorferi* seroprevalence in PEI dogs of 3.02% (6/198; 95% CI: 0.97% to 5.09%). Seropositive dogs were found in every district. A logistic regression detected no significant effect of district (serving as a categorical independent variable) on whether a dog was seropositive (a binary response/dependent variable).

All 7 seropositive sera were also assessed by subsequent Western blot. Two-sample t-tests detected significant differences between the means of the band intensity (gray values) for each significant band (band 18 P < 0.0001, 23 P < 0.0001, 28 P < 0.0005, 30 P < 0.01, 39 P < 0.005, 41 P < 0.05, 45 P ≤ 0.0001, 58 P < 0.0005, 66 P < 0.001 and 93 kDa P < 0.001) between ELISA-positive and ELISA-negative samples. The significant differences for these antigens between the positive and negative sera suggest that the results were not the product of false-positive or negative ELISA results. No out-of-province travel in the previous 2 mo was indicated on the accompanying completed forms for the 6 dogs with positive sera. However, some studies have shown that dogs may remain seropositive for more than a year (2), so some of

![Figure 2. Number of *Ixodes scapularis* ticks recovered from each of the 4 federal electoral districts of Prince Edward Island [inset: Elections Canada (14)], shown, left to right, from the northwest to the southeast.](image-url)
the dogs in this study could have been infected out-of-province if there had been prior travel. Nevertheless, given the number of ticks recovered from dogs on PEI during this time period and the prevalence of tick infection, it seems likely that most of these dogs represent infections acquired on the island.

Results from passive surveillance of ticks on PEI showed that *I. scapularis* is the most commonly recovered species, representing 97.8% of submitted ticks. Other species, both those normally resident in Canada and those presumably introduced from further afield, were also recovered on the island. *Ixodes scapularis* is the primary vector for transmission of *B. burgdorferi* in the eastern part of Canada. Molecular testing showed that 10.3% of those ticks were infected with *B. burgdorferi*. This study also identified a potential bias in tick populations towards eastern parts of the province. Proximity of the eastern regions to New Brunswick and Nova Scotia (13 and 23 km away, respectively), both of which are considered high-risk areas for Lyme disease (15), and the movement of birds among provinces may be responsible for the higher tick density in these areas. However, despite the approximately equal population in eastern PEI relative to other regions on the island, more vigilant tick collection and/or submission in this region might also explain this increased tick recovery. The tick and canine sera collection period in this study encompassed 2 fall and 1 spring tick seasons; a longer study period would allow monitoring of annual differences in tick abundance, species composition, distribution, infection prevalence, and canine seroprevalence. Understanding the origin of the ticks on PEI might not only explain current patterns, but also help to predict future changes. Additionally, monitoring *Borrelia* species infections in wildlife populations would help determine if *Borrelia burgdorferi* and other species are being maintained in enzootic cycles.

The number of ticks recovered during the 15-month period of this study, the 10% infection prevalence, and the canine seroprevalence serve to suggest that, while lower than in neighbouring provinces, there is a current risk of Lyme disease to both the canine, and by extension, human residents of PEI. The willingness and enthusiasm shown by the veterinarians of Prince Edward Island who chose to participate in this study suggest that their community is already aware of the risk of Lyme disease to their patients and that they are actively searching for ways to address this risk. It also suggests that the veterinary community will be key to ongoing awareness among the island’s human population. Informing clients that infected ticks are present and posing a health risk for both dogs and humans on PEI and educating clients on the availability of vaccines, tick prevention, removal, and testing are key to minimizing the cases of canine Lyme disease and alerting humans to the threat of tick-vectored diseases.

**Acknowledgments**

We thank the veterinarians and staff of the participating clinics as well as members of the public for supporting this study. This study was funded by Natural Sciences and Engineering Research Council (NSERC) Discovery Grant to VKL, a New Brunswick Innovation Foundation (NBIF) STEM grant to AHF-E, and IDEXX Laboratories, in the form of SNAP 4DxPlus® test kits.

**References**

Left-sided dacryostenosis in a dog

Jamey Erjavec

Abstract — A 1.5-year-old neutered male black Labrador retriever dog was presented to a referral teaching hospital for evaluation of chronic, continuous, mucoid discharge and associated conjunctivitis of the left eye. Nasolacrimal flush revealed a patent duct on the right side but not on the left side. Computed tomography (CT) with a dacryocystogram identified severe stenosis or atresia of the left nasolacrimal duct. The patient was referred to a veterinary ophthalmologist for a reconstruction of the left nasolacrimal system. Ultimately, a conjunctivobuccostomy was performed and resolved all ocular clinical signs.

Key clinical message:
Dacryostography, a procedure in which the lacrimal punctum is cannulated, and iodinated contrast is instilled into the nasolacrimal system was combined with CT to enable excellent visualization and evaluation of the nasolacrimal canal.

Résumé — Dacryosténose unilatérale gauche chez un chien. Un chien Labrador noir mâle castré âgé de 1,5 ans fut présenté à un hôpital vétérinaire d’enseignement pour évaluation d’un écoulement mucoïde chronique continu associé à une conjonctivite de l’œil gauche. Un rinçage naso-lacrymal a révélé un canal fonctionnel du côté droit mais pas sur le côté gauche. Un examen par tomodensitométrie (CT) avec un dacryocystogramme identifia une sténose sévère ou une atrésie du canal naso-lacrymal gauche. Le patient fut référé à un ophtalmologiste vétérinaire pour une reconstruction du canal naso-lacrymal gauche. Ultimement, une conjonctivobuccostomie fut réalisée et a permis de résoudre tous les signes cliniques oculaires.

Message clinique clé :
La dacryostographie est une procédure par laquelle le punctum lacrymal est canulé, et du milieu de contraste iodé est instillé dans le système naso-lacrymal combiné avec l’examen par CT a permis une excellente visualisation et évaluation du canal lacrymal.

A 1.5-year-old male neutered black Labrador retriever dog was referred to the Atlantic Veterinary College (AVC) in September 2019 because of continuous discharge from the left eye over a 1-year period. In June 2019, the dog was examined by a referring veterinary ophthalmologist and was diagnosed with bilateral ectropion, a mucin deficiency of the left eye, gray-green and mucoid ocular discharge, associated conjunctivitis, a lipid deposit in the ventral aspect of the cornea in the left eye, and persistent pupillary membranes in the 5 o'clock position of the left eye. No anomalies of the right eye were identified. The ophthalmic examination also revealed that both the superior and inferior lacrimal puncta were present bilaterally, the caniculi associated with the puncta were patent, the right nasolacrimal duct was patent, but the left duct was obstructed. Mucopurulent debris was eliminated from the nasolacrimal caniculi of the left eye during this flush. The dog was referred to the AVC for computed tomography (CT) imaging of the head. A CT scan with intravenous contrast study was performed and results revealed that the lacrimal glands were normal bilaterally, with no evidence of an inflammatory lesion or mass-like lesion to explain the left nasolacrimal duct obstruction. The proximal left nasolacrimal canal was noted to be mildly enlarged compared to the right, but this was felt to be an incidental conformational finding. Upon review of the imaging findings, a repeat CT scan with dacryocystography was recommended for optimal evaluation of the nasolacrimal ducts.

At presentation to the AVC in September 2019, the dog was bright, alert, and responsive, but mildly anxious. The dog was in good body condition and no abnormal findings were seen on physical examination, apart from left-sided epiphora (Figure 1). At this time, the dog was receiving tobramycin and dexamethasone ophthalmic solution (Tobradex, 0.3%/0.1%; Novartis Atlantic Veterinary College, University of Prince Edward Island, Charlottetown, Prince Edward Island.
Address all correspondence to Jamey Erjavec; e-mail: jerjavec@upei.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.
Pharmaceuticals Canada, Dorval, Quebec), q6h, cyclosporine (Optimmune, 0.2%; Intervet/Merck Animal Health, France), q12h, and oclacitinib (Apoquel, 5.4 mg; Zoetis, Kirkland, Quebec), q24h. Ophthalmic examination by a second veterinary ophthalmologist confirmed the previously noted anomalies. No anomalies were detected with the neuro-ophthalmic examination. Results of Schirmer tear tests, fluorescein stain uptake, and tonometry were all within normal limits, with the exception of a negative Jones test from the left nostril. Flushing of the nasolacrimal system of both eyes under general anesthesia confirmed patency of the inferior and superior puncta bilaterally via the canaliculi, a patent right nasolacrimal duct, patent upper and lower left canaliculi, and obstruction of the left nasolacrimal duct. A CT scan of the head with dacryocystography was performed under the same general anesthesia (1).

For the dacryocystogram procedure, an 18-gauge catheter was placed in the superior lacrimal punctum of each eye. Contrast medium (3 mL) was flushed through the right upper lacrimal punctum, canaliculi and nasolacrimal duct, and contrast medium was observed to exit the right nostril. The same procedure was attempted through the left upper punctum; however, contrast medium was seen leaking from around the catheter and not at the level of the left nostril. The CT scan revealed a patent right nasolacrimal system with contrast medium surrounding the right nasal turbinates. As for the left side, a small amount of contrast medium was detected in the mid to dorsal left nasal cavity and filling of the proximal left nasolacrimal canal with most of the contrast medium superficially on the left side of the head/face. These findings were consistent with an atresia or severe stenosis of the left nasolacrimal canal and a patent right nasolacrimal canal. Each upper lacrimal punctum was flushed with 9 mL of sterile saline and 1 mL of neomycin sulfate, dexamethasone, and polymyxin B sulfate solution (Maxitrol, 3.5 mg/g/0.1%/6000 U/g; Novartis Pharmaceuticals, London, UK) after the procedure to remove any residual iodine, decrease inflammation, and prevent infection.

T reatment options discussed with the owners included medical management of the epiphora, or surgical correction of the left nasolacrimal duct by a veterinary ophthalmologist. The owners requested a dacryocystorhinostomy, as this was recommended to be the most effective surgical treatment. The dog was taken to the referring veterinary ophthalmologist for this procedure. This surgery entailed that a skin incision be made under the eye and lateral to the nose (2,3). A small hole is made into the bone and a passage is surgically created by implanting a polythene tube from the lacrimal sac to the nasal cavity, creating a permanent fistula. The tube is removed 8 wk after the procedure. Dacryocystorhinostomy was chosen over other surgical options to preserve the functional portions of the dog’s nasolacrimal system. For the procedure, the dog was anesthetized, and the left eye was flushed with a dilute iodine solution and a drop of topical anesthetic [Proparacaine hydrochloride solution (Alcaine, 0.5%; Novartis Pharmaceuticals)] was placed in the conjunctival fornix. The upper lacrimal canalicus of the left eye was flushed with fluorescein stain using a 24-gauge catheter placed in the superior punctum. The stain was noted to exit the lower punctum but not the left nostril. The same procedure was repeated with the catheter in the lower punctum of the left eye while pressure was placed on the superior punctum of the same eye to try to force the stain to exit the nose. This was repeated a few times and the nose was carefully examined through the left nostril. On nasal inspection, a region of reddened nasal tissue was observed but there was no drainage of fluid or foreign material from the left nostril. Next, an olive-tipped nasolacrimal...
cannulation wire with tubing was attached into the left lower lacrimal punctum and directed through the nose. It was not possible to push the wire through to create an opening out of the left nostril. The procedure was then repeated using the upper punctum. The bluntness of the olive-tip and the fine nature of the wire prevented a recreation of an opening out of the left nostril. At this time, the nasolacrimal system was re-flushed through the lower punctum while this wire remained in place in the upper punctum and a piece of foreign material that appeared consistent with a grass awn was removed from the lower punctum. The wire was then removed from the upper punctum and nose, and the nasolacrimal system was flushed 2 more times. No additional foreign material was noted, and the fluorescein stain was still not exiting the left nostril.

Due to the surgical findings, the surgical approach was revised and a conjunctivobuccostomy was performed. An 18-gauge needle was used to recreate a draining path from the mid-lower conjunctival sac/fornix of the left eye and into the mouth along the lateral aspect of the upper teeth. Next, a piece of 0.033-mm tubing (Micro-Renotane; Braintree Scientific, Braintree, Massachusetts, USA) was placed retrograde through the needle from the mouth to the inner lower eyelid and the needle was removed. The tubing was sutured to the skin at the medial canthus of the lower eyelid of the left eye (Figure 2A) and to the inside of the mouth (Figure 2B) with non-absorbable suture. It was recommended that the tube remain in place for at least 8 wk to minimize the risk of scarring or stenosis of the new tear drainage path. Should the tubing become dislodged before 6 to 8 wk, there would be a higher risk of the tear duct system becoming non-functional. There was mild bleeding from the lower punctum of the left eye and from the left nostril during surgery, and a few drops of blood were noted from the left nostril during recovery. The dog was sent home on 7 d of oral meloxicam (Metacam, 1.5 mg/mL; Boehringer Ingelheim, Danbury, Connecticut, USA), 15 d of amoxicillin and clavulanic acid (Clavaseptin, 500 mg; Vétoquinol, Lavaltrie, Quebec), and topical gatifloxacin (Zyman, 0.3%; Bristol-Myers Squibb, St. Laurent, Quebec), topical nepafenac (Nevanac, 0.1%; Alcon, Mississauga, Ontario) and topical tear supplement (Theoloz Duo, 3% trehalose/0.15% sodium hyaluronate; Thea, Newcastle-under-Lyme, UK) until the first post-operative recheck 14 d after surgery. The dog was sent home with an E-collar to prevent rubbing of the left eye. It was recommended that the E-collar remain on at all times until the tubing was removed.

One month after surgery, the dog developed a non-painful, firm swelling over the left cheek. The dog was restarted on oral meloxicam and clavulanic acid for 15 d. The client was also advised to apply a warm compress to the area 3 times/day for 1 wk for 15 min each time. The swollen area never drained and resolved during that 1-week period.

There has been no in-person follow-up since the 1-month post-operative recheck. The dog’s tubing stayed in place for 5 wk after surgery. At 3 mo after surgery, the dog was off all medications and had no recurrent eye infections. There was minimal tearing in the left eye compared to the right eye, and the client had not called to indicate any concerns once the swelling had resolved.

Discussion

Diseases of the nasolacrimal system are common in small animal medicine. They are most often categorized as problems with drainage of tears resulting in epiphora (4). Epiphora may be caused by congenital absence or occlusion of the lacrimal puncta, congenital or acquired obstruction of the nasolacrimal duct, or inflammation/infection of the nasolacrimal duct (dacycystitis) (4). Imperforate puncta are the most common congenital abnormalities seen in dogs; imperforate upper puncta are commonly asymptomatic, whereas imperforate lower puncta usually result in epiphora. Dacryostenosis or atresia of the nasolacrimal system is less common and more difficult to correct. Though rarely reported in dogs and cattle, it is more commonly reported in horses and human infants (5–8).

Given the age, duration, and ocular findings in this dog, the top differential diagnosis for improper drainage of tears was congenital absence, or failure of the nasolacrimal duct to fully canalize. Between days 22 and 26 of gestation, the surface ectoderm that lines the groove of the maxillary process should become buried in mesenchyme as a column of cells. These cells should form a cord with 2 proximal ends and 1 distal end; these become the inferior and superior puncta and the nasal opening, respectively. This cord should eventually hollow to form a patent duct between the eye and the nostril. Failure of this hollowing results in congenital nasolacrimal malformations (5).

Computed tomography was chosen over standard radiographic analysis of the nasolacrimal duct because it produces a 3D image, whereas radiographs only produce a 2D image. Furthermore, at least 2 radiograph views must be taken and contrast medium must be injected into the nasolacrimal duct to ensure visualization of the nasolacrimal system as there are many overlying structures in the skull, and an abnormality or foreign material could easily be missed due to superimposition of the images (9). Computed tomography can better highlight soft tissue structures, which were believed to be the underlying cause of the dog’s abnormal duct (dacyrostenosis or atresia).

To facilitate the drainage of tears in patients with abnormal nasolacrimal systems, surgical intervention is required to create a patent communication between the lacrimal sac and the nasal cavity (dacycystorhinostomy); the conjunctival fornix to the nose (conjunctivohinostomy); the conjunctival fornix to the maxillary sinus (conjunctival maxillary sinusotomy); or the conjunctival fornix to the oral cavity (conjunctivobuccostomy) (5,10). A dacycystorhinostomy approach can be challenging because the lacrimal sac is poorly developed in dogs and cats and covered partially by the lacrimal bone and ocular muscles (5). A conjunctivohinostomy is an easier approach because in a dacycystorhinostomy, the periosteum and maxillary bone must be incised and there are variable amounts of hemorrhage reported when entering the nasal cavity (5). A conjunctivobuccostomy was performed in this dog because it is technically easier than the other approaches and reduces the risk of hemorrhage given that the facial bones are not involved (5).

In summary, a CT scan with intravenous contrast study was not adequate for diagnosing the condition in the dog herein,
but a CT scan with dacryocystogram gave optimal imaging of the nasolacrimal system. It allowed for full visualization of the abnormal duct, ruling out obstructive inflammation (dacryocystitis) or a mass-like lesion; this in turn, gave the owners all the information needed to make the decision to move ahead with surgical correction. There are many different surgical approaches available for this condition, with conjunctivobuccostomy being ideal in this dog given the easier technical approach and reduced risk of hemorrhage. Success of the procedure depends on not having dislodgement of the tubing before 6 to 8 wk after surgery, which can result in scarring and further obstruction of the duct. Given the reduced tearing of the left eye and lack of recurrent eye infections, this surgery was deemed a success in this dog. Removal of the foreign body from the tear duct system appeared to play a significant role in reducing the dog’s ocular signs.

Acknowledgments
I thank Dr. Chantale Pinard and Dr. Cheryl Cullen for being the primary veterinarians on this case, and for their contributions and guidance during the writing of this case report.

References
The Art of Private Veterinary Practice
L’art de la pratique vétérinaire privée

Fixed and flexible practice communication

Myrna Milani

ormally, members of Drs. Lacombe and Odetti’s staff and client base use a combination of fixed and flexible orientations in their communication with others. They do this based on their awareness of which form is likely to produce the desired results under those circumstances. For example, Dr. Lacombe often has fixed preferences regarding the best treatments for specific problems based on his long experience. If the client objects to the treatment, he is apt to feel annoyed. On the other hand, younger Dr. Odetti does not share his partner’s orientation. She recognizes that different treatment options for the same problem may be valid under certain circumstances.

Their individual orientations could create communication problems for the practice owners. However, just because they feel strongly about their personal preference does not undermine their respect for the other or the other’s approach. They also recognize that, just because they lean toward one orientation more than the other, does not mean they cannot adopt the alternate approach if they believe it will benefit their patients and clients.

For example, Dr. Lacombe considers Ms. Tanaka the ideal client because she always does whatever he tells her to do to help her animals. Moreover, Ms. Tanaka takes pride in her ability to do exactly what the veterinarian tells her to do. However, when her cocker spaniel does not respond to treatment as Dr. Lacombe expected, he does not know what bothers him more: the animal’s lackluster response to the oral medication or the slight hesitancy that replaces his client’s normal can-do spirit when she brings her dog in again. Feeling he does not know her well enough to ask if something is troubling her, he prescribes another course of the medication he believes will work the best.

Nonetheless, the case continues to bother him. Was the drug he felt so sure about no longer the best treatment for the dog’s relatively common problem? Had the dog become resistant to the drug? Had he missed something? Should he ask his client to bring the dog in for a comprehensive work-up even though he knows her finances are limited? Why did his long-time client seem uncomfortable in his presence? What had changed?

In this situation, the client and the practitioner developed a successful working relationship based on their mutual determination to do the best for the animal. The veterinarian was determined to prescribe the treatments he believed were the best for the animal based on his knowledge and experience. His client was equally determined to ensure that her animal received those treatments exactly as directed by the veterinarian.

Like Dr. Lacombe, most practitioners would consider this clinician-client relationship a match made in heaven — until something changed. In this case, the client felt so proud of her working relationship with the practitioner that she felt embarrassed to tell him that her rheumatoid arthritis increasingly made it difficult for her to medicate her dog as directed. She also felt sure the treatment regimens he prescribed for her animals were the best ones, which is what she wanted for them. And she also valued his good opinion of her and did not want to jeopardize their working relationship. But most important to her, she felt uncomfortable sharing details about her intermittent physical limitations with him.

Although working with practitioners with fixed ideas regarding the best treatment may inspire clients who prefer this degree of certainty, it can create problems if the treatment does not work for the client or the animal for some reason. Sometimes this results in the practitioner blaming the client for the treatment’s failure. Other times, the opposite occurs: the client blames the practitioner for prescribing a treatment program they could not implement as directed. Either way, the result may be a communications disaster. Some clients may feel so disenchanted with the practitioner they go to another practice. Other times, they stay in the practice but request appointments with another veterinarian in it.

Ms. Tanaka believed that she and Dr. Lacombe had reached an impasse. Unlike when they agreed on their respective roles, she no longer believed she could meet his expectations. At the same time, he sensed that his tried and true approach no longer worked for her for some reason. However, neither of them believed discussing this was professional or appropriate.

Dr. Milani is a behavior and bond practitioner, teacher, and author of several books on the interaction of animal behavior, health, and the human-animal relationship.

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.
Although she felt disloyal to the veterinarian, she opted to schedule her next appointment with his partner rather than move to a new practice.

Fortunately, the two veterinarians respected each other and wanted the best for the client and her animals. While Ms. Tanaka initially dreaded encountering Dr. Lacombe at the veterinary clinic, he always greeted her with a smile and a positive comment about her dog or cat. While she sometimes found Dr. Odetti’s options confusing compared to Dr. Lacombe’s black and white “This is what I want you to do” presentations, she also found the younger woman’s presence less intimidating. That, in turn, made it easier for the client to confide her concerns about her own medical condition and how this could impact her animals’ well-being. Ms. Tanaka soon realized that, while she liked Dr. Lacombe’s direct approach to what she should do relative to her animals, she preferred the options Dr. Odetti gave her when it came to dealing with her intermittent problems treating them.

Once this rapport was established, Dr. Odetti asked for the client’s permission to add a note to her animals’ records regarding her condition. Though it would mean sharing that information with the other veterinarians should she be unavailable herself, it would ensure that the client could implement any treatments prescribed for her animals. She also assured Ms. Tanaka that, although the veterinarians in the practice had different communicating styles, the animals’ health was everyone’s first priority. They all recognized that, just as their patients’ needs could change, so could their clients’.

In this pre-COVID-19 scenario, the veterinarians accept their own, their colleagues’, and their clients’ preferred communication approaches and the benefits and costs of each. They also recognize that their clients have their own orientations and tend to gravitate to practitioners who share these. At the same time though, they acknowledge that client orientations may change. When this happens, initially they may feel miffed if the client chooses another veterinarian in the practice. But they do not blame the new practitioner for the client’s choice.

In the current COVID-19 era, much has changed and continues to change on a daily basis. Practice owners, staff members, and clients all may be coping with physical or mental health-, home-, and work-related changes. Even those in areas relatively untouched by the virus may be facing economic or other losses precipitated by the pandemic.

“I used to feel comfortable formulating the best treatment for patients and expecting my clients to do their parts. Most of them did and I never gave it a second thought,” Dr. Lacombe wistfully recollects. “But now clients who previously would do whatever I asked no longer can for legitimate reasons. As a practice-owner, I understand their dilemma and know how frustrating it can be. The practice currently cannot afford the salary increases we’d planned because of decreased revenues. We had to postpone the purchase of the new equipment we planned to buy at the beginning of the year. For the first time, I daily find myself scrambling to find options that will meet everyone’s needs: family, staff members, clients. I wish I had Dr. Odetti’s skill at this!”

Meanwhile, Dr. Odetti is discovering that her own orientation has its downside, too.

“Yes, I still want to give my clients options,” she admits. “But doing that takes time and right now implementing and updating procedures designed to protect staff and client health while ensuring animal health and welfare is my top priority. I have so much going on in my head, I can’t even give my closest loved ones the attention they deserve. Sometimes I wish I had Dr. Lacombe’s ability to focus strictly on the animal’s problem, tell the client what they need to do, and send them on their way!”

Dr. Odetti also faces clients who perceive her as a sympathetic listener to whom they could pour out their problems as in the past. These were energy-vampires in the best of times. In times when family, friends, co-workers, and other clients may want her support for far more serious problems, she finds these clients bothersome.

Most practitioners have a client communication style that works for them as well as most of their clients. Experienced practitioners may have honed this skill over the years. Novice ones may adapt and change theirs based on client responses as needed. Most veterinarians also recognize that other practitioners will have different styles that some clients prefer and this is normal. However, thanks to COVID-19, all practitioners must accept that, regardless how successful their client communication orientations may be, the best ones always remain a work in progress.
Avoid the pitfalls of a corporate offer

Considering a corporate sale?
Partner with the industry leader to maximize your transaction

Douglas C. Jack
Partner | VetLaw™

519-383-4438 | simmonsinc.com
Practice Valuations • Practice Sales • Buyer Agency • Sale Facilitation

Considering selling your practice?
Consider VetCare—a Canadian Practice Acquirer.

Amy Ma
Business Development Manager
604-363-0972
1-855-838-7888
amy@vet-care.ca

Practice Valuations • Practice Purchase
Practice Sale • Practice Management

Dr. Frank Richardson, DVM, MBA
Veterinary Management Consultant

PO Box 176
Western Shore, Nova Scotia
B0J 3M0
Phone: (902) 531-2617
E-mail: frank.richardsondvm@gmail.com
Fax: (902) 531-2618

Canadian Integrated Supplier of Veterinary Equipment & Digital Radiography Solutions

CX Digital & Dental X-Ray
CX Underwater Treadmills
CX Infusion Pumps/Monitors
CX Cages & Cat Condos
CX Assisi Loop – Anti-inflammation
CX Centrifuges
CX Sanitization
CX Lighting/Treatment Rooms

227G Brunswick Blvd.
Pointe-Claire, Quebec
1-877-440-4494
csr@uxr.ca

De rech Canada’s Veterinarians
Get your message into

The Canadian Veterinary Journal
For more information contact:
Laima Laffitte
Advertising and Sponsorship Consultant
Tel.: (613) 673-2659
Fax: (613) 673-2462
e-mail: laffitte.on@sympatico.ca

FOR PERSONAL USE ONLY
Cleans Teeth with the Ease of a Spray

THE LEBA III DIFFERENCE

LEBA III works with the saliva. No brushing required. Spray in the mouth, not on the teeth. Used daily, it stimulates good flora and combats bad bacteria keeping the teeth clean and the gums healthy.

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

Used by veterinarians since 1994.

Email: tellus@lebalab.com    Office tel: 1-519-542-4236
To contact us, call toll free: 1-866-532-2522
WHAT IF...

A PROBIOTIC COULD HELP ANXIOUS DOGS FEEL CALMER?

Introducing Purina® Pro Plan Veterinary Supplements™ Calming Care with *Bifidobacterium longum* (BL999), a probiotic strain shown to help dogs maintain calm behaviour. In a blinded crossover design study, 90% of dogs showed an improvement in displaying anxious behaviours such as jumping, pacing, and spinning*:

- Helps dogs cope with external stressors like separation, unfamiliar visitors, novel sounds, or changes in routine and location
- Helps dogs maintain positive cardiac activity during stressful events, promoting a positive emotional state
- Helps blunt cortisol response to anxious events and supports a healthy immune system

For more information, visit [www.proplanveterinarydiets.ca](http://www.proplanveterinarydiets.ca) or call us at 1-866-844-VETS (8387). Have a case Consult? We are here to help. Contact our Canadian Veterinary Nutrition team at canadavetconsult@purina.nestle.com.