Radiation safety practices among Canadian equine veterinary workers during diagnostic procedures with portable X-ray equipment

Equations used to develop commercial dog food feeding guidelines and Canadian owner feeding practices in 2018

Evaluation of intravenous T-61 as a euthanasia method for birds

In extruded feline diets, thiamine degraded at a similar rate when stored at –20°C, compared to room temperature

Evaluation of commercial probiotics for antimicrobial resistance genes

Forensic submissions in a diagnostic pathology practice: A 10-year review

Myoclonus and hypersensitivity of the hind limbs and tail with urinary retention following neuraxial administration of morphine in a cat

Autologous tunica vaginalis communis flap for repairing an abdominal wall hernia in a dog

Standing laparoscopic abdominal lavage using a suction-irrigation device in 2 horses with primary suppurative peritonitis

Bacterial meningitis after dental extraction in a 17-year-old horse

Suspected primary pure red cell aplasia in a 4-month-old intact male mixed breed Bernese mountain dog
ONE AND DONE™

NexGard SPECTRA™ is the first and only once-monthly soft chew to protect against all of the following:

- Ticks
- Fleas
- Intestinal worms
- Heartworm
- Lyme disease

Canada’s #1 preventative pet product*

* Data on File (Impact Vet YTD June 2020). NexGard SPECTRA™ is a trademark of the Boehringer Ingelheim Group, used under license. One And Done™ is a trademark of the Boehringer Ingelheim Group. ©2021 Boehringer Ingelheim Animal Health Canada Inc. All rights reserved.
Why We Joined the VetStrategy Network

Respect for the Practice’s Heritage

“VetStrategy understands the importance of maintaining our hospital’s culture and respecting what we have achieved.”

Dr. Glynis Newman, Dr. Sylvie Abrioux and Dr. Jennifer Chan
Hillside Veterinary Hospital
VICTORIA, BRITISH COLUMBIA

DO YOU KNOW WHAT YOUR PRACTICE IS WORTH?

VALUATIONS ARE FREE AND CONFIDENTIAL*

• Continue to have the freedom to practice medicine your own way
• Maintain your hospital’s heritage and culture
• Enjoy administrative and management support

You were made to save animals. We take care of the rest.

Let’s start the conversation today.
sellmypractice@vetstrategy.com • vetstrategy.com
The Scotia Professional Plan for Veterinarians.

You’ve worked hard to get where you are today and we can help ensure your ongoing success. The Scotia Professional® Plan lets you manage your professional and personal banking with a customized suite of products and services, preferred rates, and the support of a dedicated Healthcare Specialist. Think of it as your faithful financial companion.

To learn more, visit your nearest Scotiabank branch or visit scotiabank.com/professionals.
## SCIENTIFIC RUBRIQUE SCIENTIFIQUE

### ARTICLES

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>349</td>
<td>Radiation safety practices among Canadian equine veterinary workers during diagnostic procedures with portable X-ray equipment</td>
<td>Alexandra F. Belotta, Monique N. Mayer, Cheryl L. Waldner, Kate Robinson, Narinder Sidhu, James Carmalt, Chris D. Bell, Niels K. Koehncke</td>
</tr>
<tr>
<td>357</td>
<td>Equations used to develop commercial dog food feeding guidelines and Canadian owner feeding practices in 2018</td>
<td>Katja A. Sutherland, Cara Cargo-Froom, Adronie Verbrugghe, Anna Kate Shoveller</td>
</tr>
<tr>
<td>374</td>
<td>In extruded feline diets, thiamine degraded at a similar rate when stored at $-20^\circ$C, compared to room temperature</td>
<td>Bianca DiSabatino, Jacqueline M. Parr, Georgia Kritikos, Gabrielle Monteith, Adronie Verbrugghe</td>
</tr>
<tr>
<td>379</td>
<td>Evaluation of commercial probiotics for antimicrobial resistance genes</td>
<td>Rachel M. Baumgardner, Ana Berreta, Jamie J. Kopper</td>
</tr>
<tr>
<td>384</td>
<td>Forensic submissions in a diagnostic pathology practice: A 10-year review</td>
<td>P. Nick Nation</td>
</tr>
</tbody>
</table>

### CASE REPORTS

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>389</td>
<td>Myoclonus and hypersensitivity of the hind limbs and tail with urinary retention following neuraxial administration of morphine in a cat</td>
<td>Masako Fujiyama, Justin Lavallée, Kerrie Lewis, Tanya Duke-Novakowski</td>
</tr>
<tr>
<td>393</td>
<td>Autologous tunica vaginalis communis flap for repairing an abdominal wall hernia in a dog</td>
<td>Yusuke Ozai, Akiko Uemura, Ryou Tanaka, Seijirow Goya</td>
</tr>
<tr>
<td>397</td>
<td>Standing laparoscopic abdominal lavage using a suction-irrigation device in 2 horses with primary suppurative peritonitis</td>
<td>Nicola C. Cribb, Luis G. Arroyo, Ludovic Bouré</td>
</tr>
<tr>
<td>403</td>
<td>Bacterial meningitis after dental extraction in a 17-year-old horse</td>
<td>Stefanie Arndt, Isabelle Kilcoyne, Colleen M. Heney, Talia S. Wong, K. Gary Magdesian</td>
</tr>
<tr>
<td>408</td>
<td>Suspected primary pure red cell aplasia in a 4-month-old intact male mixed breed Bernese mountain dog</td>
<td>Iris To, Patrick R. Boelsterli, Julie J. Walter, Bronwyn E. Rutland</td>
</tr>
</tbody>
</table>

### QUIZ CORNER

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>329</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Formulating quality compounds since 2001.

Prescribe with confidence.

1-866-794-7387  www.svprx.ca
## Contents Table des matières

### FEATURES RUBRIQUES

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors/Editors</th>
</tr>
</thead>
<tbody>
<tr>
<td>321</td>
<td>Contributing to <em>The Canadian Veterinary Journal</em>; we’re all in this together!</td>
<td>John Kastelic, Tim Ogilvie</td>
</tr>
<tr>
<td>325</td>
<td>VETERINARY MEDICAL ETHICS DÉONTOLOGIE VÉTÉRINAIRE</td>
<td></td>
</tr>
<tr>
<td>413</td>
<td>Blame the pandemic: Why you need to raise your fees for 2021</td>
<td>Darren Osborne, Chris Doherty</td>
</tr>
<tr>
<td>415</td>
<td>Corrosive client communicators</td>
<td>Myrna Milani</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors/Editors</th>
</tr>
</thead>
<tbody>
<tr>
<td>373</td>
<td>Small Animal Surgery. 5th edition</td>
<td>Samantha Gwillim</td>
</tr>
</tbody>
</table>

### NOTICES ANNONCES

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors/Editors</th>
</tr>
</thead>
<tbody>
<tr>
<td>383</td>
<td>New Products</td>
<td></td>
</tr>
<tr>
<td>402</td>
<td>Index of Advertisers</td>
<td></td>
</tr>
<tr>
<td>417</td>
<td>Classifieds</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors/Editors</th>
</tr>
</thead>
<tbody>
<tr>
<td>331</td>
<td>NEWS NOUVELLES</td>
<td>Heather Broughton, Sophie Perreault</td>
</tr>
</tbody>
</table>
For personal use only

The Canadian Veterinary Journal
La Revue vétérinaire canadienne

359 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.veterinairescanada.net

© Canadian Veterinary Medical Association 2021
L’Association canadienne des médecins vétérinaires 2021

The Canadian Veterinary Journal is indexed or abstracted in:
La Revue vétérinaire canadienne est indexée ou ses articles sont résumés dans:
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 Animal Practice, Veterinary Bulletin, Veterinary Reference Service, Veterinary Update.

Photo by/Photo de: Gwen Roy, Saskatoon, Saskatchewan

Typesetting/Typographie
AN Design Communications
Printed by/Imprimé par
Dolloc Print Solutions Group
Ottawa, Ontario
ISSN 0008-5286

Subscriptions (2021). Annual: Canada $225 + applicable GST or HST, foreign $240 US; institutional $295. 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.


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.

Co-Editors-in-Chief/Co-rédacteurs en chef
Dr. John Kastelic, Calgary, Alberta
Dr. Tim Ogilvie, Springbrook, Prince Edward Island
Associate Editors/Rédacteurs associés
Dr. Murray Jelinski, Saskatoon, Saskatchewan
Dr. Wayne McDonell, Guelph, Ontario
Feature Editors/Rédacteurs des chroniques
Dr. Jangi Bajwa, Burnaby, British Columbia
Dr. Tim Blackwell, Fergus, Ontario
Dr. Myrna Milan, Charleston, New Hampshire
Dr. Lynne Sandmeyer, Saskatoon, Saskatchewan
Dr. Debbie Stoewen, Ayr, Ontario
Assistant Editors/Rédacteurs adjoints
Dr. Aylin Atilla, Calgary, Alberta
Dr. Marco Costa, Saint-Hyacinthe, Quebec
Dr. Robert Friendship, Guelph, Ontario
Dr. Luis Gaiero, Guelph, Ontario
Dr. Emily John, Charlottetown, Prince Edward Island
Dr. Ron Johnson, Guelph, Ontario
Dr. Shawn McKenna, Charlottetown, Prince Edward Island
Dr. Shannon Martinson, 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
Laima 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

318 CVI / VOL 62 / APRIL 2021
CVMA’s partnership with The Personal gives you access to customized home and auto coverage and licensed advisors who will tailor your policy to your specific needs. That means less stress and more peace of mind.

We’ve got your back. Get a quote today.

thepersonal.com/cvma
1-888-476-8737

La Personnelle désigne La Personnelle, compagnie d’assurances. Certaines conditions, exclusions et limitations peuvent s’appliquer. L’assurance auto n’est pas offerte au Manitoba, en Saskatchewan ni en Colombie-Britannique, où il existe des régimes d’assurance gouvernementaux.

Nous sommes là pour vous. Demandez une soumission.
lapersonnelle.com/acmv
1 888 476-8737
Everyday decision

Extraordinary impact

Choosing to vaccinate against diseases with Nobivac® is just the beginning of something greater. It’s a decision towards making the world a healthier place for pets and people.

Learn more about protecting your patients with Nobivac® vaccines. Contact your Merck Animal Health sales representative.

Nobivac® Protection unites us.

Nobivac® is registered trademark of Intervet International B.V. Used under license. MERCK® is a registered trademark of Merck Sharp & Dohme Corp. © 2021 Intervet Canada Corp. All rights reserved. CA-NOV-2-102000001
Editorial
Contributing to *The Canadian Veterinary Journal*: we’re all in this together!

Contribuons tous ensemble à *La Revue vétérinaire canadienne*!

---

The Canadian Veterinary Journal (*The CVJ*) has an enviable track record of consistently generating a monthly publication since January 1960. Past issues are available in the PubMed Central Archive (https://www.canadianveterinarians.net/cvj-cjvr-classified-ads/cvj-pubmed-archives).

You can search this database looking for subjects, authors, trends, scholarly evidence, and practical clinical discussions. In this rich resource, you may find the critical information you need to manage a case, follow national issues, or prepare an upcoming clients’ night presentation.

*The CVJ* is an important record of veterinary medicine in Canada. A “digital stroll” though past issues reveals the *Journal*’s antecedents and its changes over time; detailing how our profession has grown and transformed over the last 6 decades. Obviously, there are countless articles, case reports, and columns, including many ideas and experiences shared by numerous practitioners. In the News sections, there are pictures and descriptions of those who reached certain milestones or were recognized for specific achievements. In addition, there is also documentation of many who have been leaders in veterinary practice, worked in academia or government/regulatory positions, or served on provincial, regional or national organizations. One thing that has not changed, and in fact has greatly expanded, is that the journal represents the collective effort of many persons.

As Co-Editors, our duties include sustaining and expanding the traditions and values of *The CVJ*. In our opinion, all Canadian veterinarians remain lifelong students of the art and science of veterinary medicine. Furthermore, we have collective responsibilities to widely share information; in other words, if it is not recorded, it effectively did not happen! No matter how good the surgical procedure that we perform, the novel and successful way we have solved a veterinary medical mystery, or the uniqueness of a clinical trial, it is incumbent on us to share those experiences. Furthermore, those should not just be disseminated within a single case or presentation, but shared within the profession as a whole.

Therefore, it is incumbent on us to continue to contribute to the traditions and values of *The CVJ* and *La Revue vétérinaire canadienne* in all ways possible. The ultimate goal is for each of us to contribute to the profession in order that the achievements of *The CVJ* and *La Revue vétérinaire canadienne* become the envy of veterinary professionals worldwide.

---

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.
orally or through training others, but also by contributing to the scientific literature. Therefore we should create a written record of our activities and experiences for the benefit of ourselves, our colleagues and future veterinarians.

That leads us to expand on 2 messages contained in our inaugural editorial (1). First, is an open invitation for more authors to submit manuscripts to The CVJ, in any of our journal categories, as described in the Instructions for Authors (https://www.canadianveterinarians.net/cvj-cjvr-classified-ads/cvj-instructions-authors).

If you are a new or junior author, please do not hesitate to contribute; rest assured that we are more than willing to advise, assist, and mentor you in the process.

Second, we offer further encouragement to seasoned authors to not only continue to submit manuscripts, but to help grow our cohort of reviewers. Peer review is an essential component of the process of getting articles into the journal; we know from personal experience that this activity is also a learning opportunity for the reviewers. Being recognized for this service should enhance CVs for tenure and promotion, as well as being valuable to the reviewer for continuing education, and the honing of critical thinking skills.

As our immediate-past Editor-in-Chief, Dr. Carlton Gyles eloquently stated: “While rigorously addressing science issues, The CVJ will continue to recognize the value of ideas and information that lie outside the realm of traditional controlled studies. These include experience and astute clinical observation. Changes we make will be driven by our goal of always improving our service to our diverse profession and the public at large” (2).

In closing, we remind you that key objectives of The CVJ are to promote the art and science of veterinary medicine, and the betterment of animal, human, and environmental health. Your new Co-Editors-in-Chief are strongly committed to pursuing these goals and we extend a warm, and sincere invitation for you to be part of our collective success.

References

John Kastelic and Tim Ogilvie

long de leur carrière. Nous avons tous la responsabilité de diffuser largement l'information; autrement dit, si un événement n’est pas documenté, c’est comme si rien ne s’était passé! Peu importe la qualité de l’intervention chirurgicale pratiquée, la manière novatrice et efficace par laquelle un mystère médical vétérinaire a été résolu ou le caractère unique d’un essai clinique, il nous incombe de partager ces expériences – et de le faire non seulement par la communication orale ou par la formation d’autres personnes, mais aussi en contribuant à la littérature scientifique. On doit laisser des traces écrites de nos activités et de nos expériences dans notre propre intérêt, mais aussi dans celui de nos collègues vétérinaires actuels et futurs.

Cela nous amène à revenir sur deux messages contenus dans notre premier éditorial (1). Premièrement, nous lançons une invitation ouverte pour que plus d’auteurs soumettent des manuscrits à La RVC, dans toutes les catégories d’articles de la revue conformément aux directives à l’intention des auteurs (https://www.veterinaresacanada.net/cvj-cjvr-classified-ads/cvj-instructions-authors).

N’hésitez pas à contribuer même si vous avez peu ou pas d’expérience comme auteur; soyez assurés que nous serons heureux de vous conseiller, de vous assister et de vous encadrer au cours du processus.

Deuxièmement, nous souhaitons encourager les auteurs chevronnés à continuer à soumettre des manuscrits, mais aussi à contribuer à titre de réviseurs. L’exemple par les pairs est un élément essentiel du processus de publication des articles dans La RVC; nous savons par nos expériences personnelles que cette activité est également une occasion d’apprentissage pour les réviseurs. La révision parait bien sur un curriculum vitae pour l’obtention d’un poste de professeur ou d’une promotion, tout en étant précieuse pour la formation continue et le perfectionnement de la pensée critique.

Comme notre prédécesseur le Dr Carlton Gyles l’a affirmé avec éloquence (2) : « Tout en étudiant rigoureusement les enjeux scientifiques, La RVC continue de reconnaître la valeur des idées et de l’information qui se trouve en dehors du domaine traditionnel des études contrôlées. Cela inclura l’expérience et des observations cliniques perspicaces. Les changements que nous apporterons seront motivés par notre objectif de continuellement améliorer le service à notre profession et au grand public. »

En terminant, nous vous rappelons que les principaux objectifs de La RVC sont de promouvoir l’art et la science de la médecine vétérinaire ainsi que l’amélioration de la santé des animaux, des humains et de l’environnement. Vos nouveaux corédacteurs en chef sont fermement résolus à poursuivre ces objectifs et nous vous invitons chaleureusement et sincèrement à participer à notre succès collectif.

Références

John Kastelic et Tim Ogilvie
We have long shared the belief that the best patient care comes from championing hospitals in their local communities and supporting the practices and culture that have made them successful.

We bring our 25 years of experience across 1,200+ global hospitals - here to preserve, respect and grow your practice while maintaining your unique identity and collaborating with like-minded professionals.

We believe in empowering veterinarians and their teams with deeper resources so they can do more of what’s already working.

Combining our strengths gives us the opportunity to make a lasting and positive impact on the profession, our people, and the care of animals.

Join Us. Stay You.

Join us in building something wonderful.
connect@nvacanada.ca

A Canadian community dedicated to you.
Surround yourself with a comprehensive solution

IDEXX 360 is a diagnostic partnership that offers your practice the flexibility and access to industry-leading testing, tools, and care innovations that provide you a complete view of your patient’s health.

Build your suite of analyzers at no charge and keep your practice at the forefront of care.

Visit us at idexx.ca/360program
An ethicist’s commentary on psychoactive drug traces found in dog urine

The case as described fails to indicate whether the drug combination found in the dog’s urine represents any threat to the health and well-being of the animal. While marijuana can probably be viewed as no more dangerous to dogs than to people, fentanyl as an opiate is extremely dangerous to both groups. Regarding human use of marijuana, it does not seem reasonable to routinely expect a veterinarian to serve as a whistleblower, particularly when society has declared marijuana to be legal.

On the other hand, as a health practitioner, it is well within your moral authority to share knowledge of a dangerous drug or drug combination with a client, especially when the client may be medically naïve. It is unclear how the dog has acquired the drug. Thus, there is nothing wrong with warning the client regarding the danger of fentanyl being deliberately or inadvertently fed to the animal. The fact that an acquaintance of yours had a son die of fentanyl overdose is a legitimate reason for your concern, further augmented by the dog displaying unusual neurological signs. I would rather have a client angry at me than risk an animal being poisoned.

Humans who voluntarily take psychoactive drugs usually have some idea of what to expect. Animals do not and may experience fear at the resulting disorientation — yet another reason to be careful with animals and drug intake.

Bernard E. Rollin, PhD

Question de déontologie du mois —
Janvier 2021

Depuis la légalisation de la marijuana au Canada, votre pratique rurale a observé un nombre croissant de cas d’intoxication par la marijuana chez les chiens. Comme les signes cliniques chez les chiens affectés ne sont pas pathognomoniques et que les propriétaires sont souvent réticents à fournir une anamnèse complète, vous avez trouvé des tests de dépistage de drogues dans l’urine en vente libre pratiques pour établir un diagnostic. Tard dans la journée, on vous emmène un chien présentant des signes neurologiques inhabituels. Sa température, son pouls et sa respiration sont normaux. L’anamnèse fournie ne vous donne pas d’information utile. Vous décidez de vérifier la présence de résidus de drogues dans l’urine du chien. Le test démontre la présence de marijuana et de fentanyl. Normalement, vous n’êtes pas du genre à juger le choix des gens en matière de drogues récréatives; cependant, le fils d’une de vos connaissances est récemment décédé d’une surdose de fentanyl. Quelles sont vos responsabilités professionnelles dans une telle situation?

Question soumise par Stephen Scott,
Perth Veterinary Clinic, Perth, Ontario

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.
Selective breeding in agricultural animals has resulted in significant increases in productivity. These strides in productivity have been associated with reductions in animal welfare. Laying hens face injurious feather pecking and weak, easily fractured bones; broilers experience leg lameness and sudden death syndrome; dairy cattle have shortened longevity, hoof and leg lameness, and increased incidence of mastitis. These welfare reductions result from both modern housing and production methods as well as heritable traits. With a limited pool of production genetics, farmers are at the mercy of breeding strategies that they have little power to change, forcing them to manage the resulting pathologies. Recognizing that welfare-influencing traits are heritable, do genetics companies have a moral duty to select for variants that will improve animal welfare? In a free market system, can one expect any genetics company to voluntarily prioritize animal well-being over demands for productivity?

Submitted by Megan Allore, Montreal, Quebec

L’élage sélectif des animaux de ferme a entraîné des augmentations considérables de la productivité. Cette hausse de la productivité a par contre été associée à une baisse du bien-être animal. Que ce soit le picage et les os fragiles sujets aux fractures chez les poules pondeuses, la boiterie due à des problèmes de pattes et le syndrome de mort subite chez les poulets de chair, ou encore la baisse de la longévité, la boiterie associée à des troubles des membres et des ongles ou la fréquence accrue de mammité chez les bovins laitiers, ces impacts sur le bien-être animal résultent à la fois des méthodes modernes de logement et de production ainsi que de traits héréditaires. Avec un pool génétique limité, les agriculteurs sont à la merci de stratégies de sélection qu’ils n’ont pas le pouvoir de changer, et qui les obligent à gérer les pathologies qui en découlent. Reconnaissant que des traits ayant un impact sur le bien-être sont héréditaires, les entreprises de génétique ont-elles le devoir moral de sélectionner des variants qui amélioreront le bien-être animal? Dans un système de libre marché, peut-on s’attendre à ce qu’une entreprise de génétique priorise volontairement le bien-être animal par rapport aux demandes en matière de productivité?

Question soumise par Megan Allore, Montréal, Québec
SAVI
Stewardship of Antimicrobials by Veterinarians Initiative

Supporting decision-making by Canadian veterinarians on prudent antimicrobial use

Visit SAVI.vet to learn more and share your insight
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.
1. Which of the following is most correct concerning urine pH?
   A. It is acidic in carnivores, and alkaline in herbivores.
   B. It is alkaline in carnivores, and acidic in herbivores.
   C. It is alkaline in both carnivores and herbivores.
   D. It is acidic in both carnivores and herbivores.

2. West Nile virus is primarily transmitted via which of the following?
   A. Deer flies
   B. Ticks
   C. Snails
   D. Fleas
   E. Mosquitoes

3. Hypopyon is defined as which of the following?
   A. Blood within the anterior chamber
   B. White blood cells within the anterior chamber
   C. Inflammatory cells adherent to the corneal endothelium
   D. Protein suspended within the anterior chamber

4. The most common clinical sign observed in horses with chronic renal failure is which of the following?
   A. Weight loss
   B. Fever
   C. Tachypnea
   D. Tachycardia
   E. Urine incontinence

1. Lequel des énoncés suivants est le plus juste à propos du pH de l’urine?
   A. Il est acide chez les carnivores et alcalin chez les herbivores.
   B. Il est alcalin chez les carnivores et acide chez les herbivores.
   C. Il est alcalin chez les carnivores et les herbivores.
   D. Il est acide chez les carnivores et les herbivores.

2. Le virus du Nil occidental est transmis principalement par lequel des vecteurs suivants?
   A. Mouches du chevreuil
   B. Tiques
   C. Escargots
   D. Puces
   E. Moustiques

3. Laquelle des définitions suivantes décrit l’hypopyon?
   A. Sang dans la chambre antérieure
   B. Globules blancs dans la chambre antérieure
   C. Cellules inflammatoires adhérant à l’endothélium cornéen
   D. Suspension de protéines dans la chambre antérieure

4. Lequel des signes cliniques suivants est le plus commun chez les chevaux souffrant d’insuffisance rénale chronique?
   A. Perte de poids
   B. Fièvre
   C. Tachypnée
   D. Tachycardie
   E. Incontinence urinaire
5. Which of the following statements is true concerning acute pulmonary edema and emphysema (fog fever)?
A. The pathogenesis involves the conversion of the amino acid L-tryptophan to 3-methyl indole by rumen microbes.
B. It is most common in feedlot cattle late in the feeding period.
C. Bovine respiratory syncytial virus is the etiological agent.
D. This disease is most common when sheep and cattle are grazed together.
E. Administration of long-acting antimicrobials is the treatment of choice.

5. Lequel des énoncés suivants est vrai à propos de la pneumonie interstitielle atypique (œdème et emphysème pulmonaires aigus) des bovins?
A. La pathogénie implique la conversion de l’acide aminé L-tryptophane en 3-méthyl-indole par les micro-organismes du rumen.
B. Cette maladie est plus commune chez les bovins à l’engrais à la fin de la période d’affouragement.
C. Le virus respiratoire syncytial bovin est l’agent étiologique.
D. Cette maladie est plus commune lorsque les ovins et les bovins broutent ensemble.
E. L’administration d’antimicrobiens à longue durée d’action est le traitement de choix.

(See p. 412 for answers./Voir les réponses à la page 412.)
Recapping the 2021 Students of the Canadian Veterinary Medical Association (SCVMA) Symposium

At the beginning of 2020, Peyton Tam, Symposium organizer, 3rd year Ontario Veterinary College (OVC) student, and senior SCVMA representative, gathered a Symposium Committee to plan a traditional “in-person” conference with the intended venue of the Ontario Veterinary College. Peyton and her team had envisioned and planned exciting social events and tours to proudly showcase their school to veterinary students from the other Canadian colleges. However, SARS-CoV-2 had other plans; as Canada and indeed much of the world went into “lockdown” due to the COVID-19 pandemic, Peyton had a difficult decision to make, either cancel the conference entirely or plan the first-ever virtual SCVMA Symposium.

Peyton and her team boldly wiped the slate clean and planned a virtual conference! Over the next 8 months, Peyton and her team held many online meetings and learned how to use new Instagram post by @elizabethfuturevet, a Canadian student attending the University of Glasgow.

Publication Instagram de @elizabethfuturevet, une étudiante canadienne fréquentant l’Université de Glasgow.

Recapping the 2021 Students of the Canadian Veterinary Medical Association (SCVMA) Symposium

Bilan du Symposium des étudiants de l'Association canadienne des médecins vétérinaires (ÉACMV) de 2021

Au début de 2020, Peyton Tam, étudiante de 3e année de l’Ontario Veterinary College (OVC), représentante des ÉACMV et organisatrice du Symposium, a mis sur pied un comité pour planifier l’événement traditionnel qui devait avoir lieu en personne à l’OVC. Peyton et son équipe prévoient proposer des activités sociales divertissantes et des excursions captivantes pour présenter fièrement leur école aux étudiants des autres facultés de médecine vétérinaire canadiennes. Mais le SRAS-CoV-2 avait d’autres plans… Alors que le Canada et une grande partie du monde entraient en confinement en raison de la pandémie de COVID-19, Peyton a eu une décision difficile à prendre : annuler complètement l’événement ou organiser le tout premier Symposium virtuel des ÉACMV.

Peyton et son équipe ont audacieusement choisi la deuxième option et tout recommencé de zéro! Au cours des huit mois

2021 SCVMA Symposium organizer, Peyton Tam, anxiously awaiting the start of the lectures.

L’organisatrice du Symposium des ÉACMV de 2021, Peyton Tam, attend impatiemment le début des conférences.
and quickly evolving online platforms to host this large-scale event. Everything had to be altered. Normally, conference “swag bags” would be picked up in person, but this year Peyton and her team took on the challenge and shipped 300 conference swag bags to the 5 veterinary schools across the country. On January 15, 2021, their hard work yielded the first virtual SCVMA Symposium and it was a smashing success!

Events started Thursday night with many students coming together for an online social night to mingle in breakout rooms and play online games. It was nice to socialize and meet new people because this was the first time many of us had had the opportunity to do so since the onset of COVID-19 restrictions. Across numerous time zones, the online lectures started Friday very early for some and late afternoon for others. There were 21 lectures in total, of which students could choose 3 to attend. The wide range of topics included exotic mammal emergency medicine, 3-D printing in vet med, and life hacks for new graduates, among many others. During lunch, Purina hosted a virtual meeting where students had a chance to ask questions concerning veterinary diets. Wet labs began after the lunch break and normally, all students would don their scrubs and lab coats before digging in. This year, the wet labs were completed from the comfort of home and filled with case studies, suture pattern practice, radiographic interpretations, and tick identification.

To finish the day, students were encouraged to get up and get preceded by a suture practice wet lab.

To finish the day, students were encouraged to get up and get preceded by a suture practice wet lab.

To finish the day, students were encouraged to get up and get preceded by a suture practice wet lab.

To finish the day, students were encouraged to get up and get preceded by a suture practice wet lab.
active by joining one of the many fun virtual fitness classes such as Zumba, yoga, kickboxing or Pilates.

The next day started with short opening remarks by the CVMA President-Elect Dr. Louis Kwantes. Following Dr. Kwantes, Dr. Christina Tran, the Past-President and Founding Board Member of the Multicultural Veterinary Medical Association (MCVMA), was the first keynote speaker. Dr. Tran spoke about how as vet students we need to reflect on our past, make deliberate and intentional actions in our present, and effectively plan for our future. She also touched on the lack of diversity, equity, and inclusion in our profession, and one of the ways we can overcome this is by empowering younger generations to become veterinarians through outreach mentor programs such as League of VetaHumanz and This Is How We “Role.” Dr. Tran's presentation was followed by Dr. Adam Little, co-founder of GoFetch and Professor of Practice at Texas A&M College of Vet Medicine. He spoke about how leaps in technology are influencing and enabling changes in the veterinary profession and our current model of pet care. He explained client needs are quickly diversifying; therefore, embracing technology and programs such as PetDesk and Loom can help to elevate not only the quality-of-care vets can provide, but also the overall efficiency of the practice. The conference concluded with a few closing remarks from Peyton Tam expressing her profound appreciation to the organizing committee, speakers, and attendees for making this unique conference a success.

It was a tremendous accomplishment. While the pandemic detrimentally impacted the plans of what no doubt would have been a great “in-person” conference, there were several unique benefits to the pandemic’s disruption of the normal conference procedures. One positive outcome is that online conferences are significantly cheaper to host than traditional conferences. As a result of the reduced cost, and with the continued support of our amazing sponsors (National Veterinary Associates, Vivid Insurance, Banfield Pet Hospital, Pro Concepts, Purina, CVMA, Hill’s, OVMA, OVC Pet Trust, and Ward & Uptigrove), registration was complimentary for all Canadian veterinary students. Free registration and staying at home with no travel costs made this conference extremely accessible to every Canadian veterinary student who wanted to attend. As a result, the 2021 SCVMA Symposium had the highest attendance of any Symposium — a total of 526 students! Of the 526 attendees, 30 were students from the CVMA International Student Affiliate Program representing the University of Glasgow (Scotland), University of Edinburgh (Scotland), and Massey University (New Zealand). This was only possible due to the online nature of the conference and the accessibility that it provided.

“One Conference, One Community, One Health” was the chosen theme for the 2021 SCVMA Symposium, and this theme could not have been more appropriate. Each of us had been going through many of the same struggles, as our lives both in and out of school had been upended. The COVID-19 pandemic had a peculiar unifying effect on the Canadian veterinary student body and the 2021 SCVMA Symposium was the point of convergence where this became apparent to all. We realized that we are all going through the same things, and together we’ll get through it. This discovery alone made it special and memorable.
The 2022 SCVMA Symposium is being held at the University of Calgary Faculty of Veterinary Medicine in Calgary, Alberta. We are looking forward to welcoming you all and building on the learnings and relationships that 2021’s outstanding hosts delivered. If you are interested in learning more, please contact the CVMA (symposium@cvma-acmv.org).

(by Kelcey King, WCVM, Class of 2022)

SCVMA New Graduate Survey Report: Class of 2020

Each year, the Students of the Canadian Veterinary Medical Association (SCVMA) surveys recent graduates from the 5 Canadian veterinary schools. The goal of this survey is to better understand the current conditions in the Canadian veterinary workplace, specifically for new graduates. For 2020, we had 115 participate in the survey with a response rate of 35%. The results below are for DVM students, recent graduates, and the veterinary profession to view. Please note, not every participant responded to every question.

The respondents were asked to describe the location where they grew up, as well as the college from which they graduated.

Figure 1. Location of where students were primarily raised (n = 113).

Le thème choisi pour le Symposium des ÉACMV de 2021, « Une réunion, une communauté, une santé », n’aurait pas pu être plus approprié. Nous vivions tous sensiblement les mêmes difficultés, car nos vies à l’école et en dehors de l’école avaient été bouleversées. La pandémie de COVID-19 a eu un effet rassembleur particulier sur les étudiants en médecine vétérinaire canadiens, et le Symposium des ÉACMV de 2021 a été le point de convergence où cela est devenu évident pour tous. Nous avons réalisé que nous traversions tous la même épreuve, et que nous nous en sortirions ensemble. Ce constat a rendu l’événement encore plus spécial et mémorable.

L’édition de 2022 du Symposium des ÉACMV aura lieu à la Faculté de médecine vétérinaire de l’Université de Calgary, en Alberta. Nous sommes impatients de vous y accueillir et de tirer parti des apprentissages acquis et des relations nouées par les hôtes exceptionnels de l’édition de 2021. Si vous souhaitez en savoir plus, n’hésitez pas à communiquer avec l’ACMV (symposium@cvma-acmv.org).

(par Kelcey King, WCVM, promotion de 2022)
Parmi les répondants qui vivaient en ville ou en banlieue, environ 34 % provenaient de villes de moins de 50 000 habitants, tandis que les autres provenaient de villes de plus de 200 000 habitants.

Figure 2. Établissement d'enseignement d'obtention du diplôme (n = 110).

Employement data

Graduates were questioned about their current positions, search methods used to secure employment, and other various queries. A total of 82% of respondents secured their job prior to graduating, with the majority continuing to work with the same employer. Out of 78 respondents, 92% are still working within the veterinary field, whereas the remainder are not, due to COVID-19 restrictions, the current job market, or taking time away from the profession.

Figure 3. Job search methods that resulted in employment (n = 71).

Données relatives à l’emploi

Les diplômés ont été interrogés sur leur poste actuel, les méthodes de recherche utilisées pour trouver un emploi et divers autres sujets. Au total, 82 % des répondants ont décroché un emploi avant d’obtenir leur diplôme, la majorité continuant de travailler avec le même employeur. Des 78 répondants, 92 % travaillaient toujours dans le domaine vétérinaire; les autres ne travaillaient pas dans le domaine en raison de restrictions liées à la COVID-19 ou des conditions du marché du travail actuel ou parce qu’ils souhaitaient prendre une pause.

Figure 3. Méthodes de recherche d’emploi ayant mené à l’embauche (n = 71).
The figure below shows the current employment type for new graduates within the veterinary profession. Most graduates are employed in a private clinical practice and overall, 44% of new graduates indicated they were very satisfied with their current job.

**Figure 4.** Current employment type for new graduates within the veterinary profession (*n* = 78).

<table>
<thead>
<tr>
<th>Employment Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private clinical practice</td>
<td>95%</td>
</tr>
<tr>
<td>Internship/residency</td>
<td>1%</td>
</tr>
<tr>
<td>Industry/Commercial</td>
<td>0%</td>
</tr>
<tr>
<td>Government (Federal/Provincial/Territorial or Municipal)</td>
<td>4%</td>
</tr>
</tbody>
</table>

The figure below indicates the amount of time respondents spend treating various animal species.

**Figure 5.** Average amount of time graduates spent treating various animal species (*n* = 87).

<table>
<thead>
<tr>
<th>Animal Species</th>
<th>Average Time (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogs</td>
<td>44</td>
</tr>
<tr>
<td>Cats</td>
<td>36</td>
</tr>
<tr>
<td>Horses</td>
<td>13</td>
</tr>
<tr>
<td>Cattle — dairy</td>
<td>5.5</td>
</tr>
<tr>
<td>Cattle — beef</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
</tr>
<tr>
<td>No contact with animals</td>
<td>3</td>
</tr>
<tr>
<td>Small ruminants</td>
<td>2</td>
</tr>
<tr>
<td>Caged pets and birds</td>
<td>1</td>
</tr>
<tr>
<td>Poultry</td>
<td>1</td>
</tr>
<tr>
<td>Cattle — veal</td>
<td>0.6</td>
</tr>
<tr>
<td>Swine</td>
<td>0.4</td>
</tr>
<tr>
<td>Farmed game</td>
<td>0.1</td>
</tr>
</tbody>
</table>

**Income and compensation data**

Respondents (*n* = 74) indicated their average annual base salary is $79,727. The average annual base salary for graduates currently employed in a residency or part of an internship (*n* = 22) is $33,795.

**Données sur le revenu et la rémunération**

Les répondants (*n* = 74) ont indiqué que leur salaire de base annuel moyen était de 79 727 $. Chez les diplômés en cours d’internat ou de résidence (*n* = 22), le salaire de base annuel moyen était de 33 795 $.
Figure 6. Province/Territory of employment (including those employed in residency or part of an internship) and average annual base salary ($n = 88$).

<table>
<thead>
<tr>
<th>Province/Territory</th>
<th># of respondents</th>
<th>Ave. base salary ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alberta</td>
<td>13</td>
<td>66 653</td>
</tr>
<tr>
<td>British Columbia</td>
<td>8</td>
<td>78 750</td>
</tr>
<tr>
<td>Manitoba</td>
<td>2</td>
<td>78 750</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>2</td>
<td>51 650</td>
</tr>
<tr>
<td>Newfoundland and Labrador</td>
<td>2</td>
<td>88 000</td>
</tr>
<tr>
<td>Northwest Territories</td>
<td>1</td>
<td>100 000</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>1</td>
<td>75 000</td>
</tr>
<tr>
<td>Nunavut</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>Ontario</td>
<td>28</td>
<td>71 821</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>1</td>
<td>63 000</td>
</tr>
<tr>
<td>Quebec</td>
<td>23</td>
<td>58 152</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>7</td>
<td>69 143</td>
</tr>
<tr>
<td>Yukon</td>
<td>0</td>
<td>NA</td>
</tr>
</tbody>
</table>

Figure 7. Average school-related debt upon graduation sorted by school over the last 3 years ($n = 73$).

<table>
<thead>
<tr>
<th></th>
<th>2020</th>
<th>2019</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVC</td>
<td>$144 222 $(n = 9)</td>
<td>$143 353 $(n = 17)</td>
<td>$116 917 $(n = 12)</td>
</tr>
<tr>
<td>FMV</td>
<td>$35 762 $(n = 21)</td>
<td>$22 333 $(n = 3)</td>
<td>$23 636 $(n = 22)</td>
</tr>
<tr>
<td>OVC</td>
<td>$67 682 $(n = 22)</td>
<td>$73 469 $(n = 32)</td>
<td>$49 500 $(n = 23)</td>
</tr>
<tr>
<td>UCVM</td>
<td>$64 000 $(n = 6)</td>
<td>$41 611 $(n = 11)</td>
<td>$53 000 $(n = 10)</td>
</tr>
<tr>
<td>WCVM</td>
<td>$103 733 $(n = 15)</td>
<td>$56 904 $(n = 51)</td>
<td>$49 690 $(n = 29)</td>
</tr>
</tbody>
</table>

Out of 90 respondents, 91% of new graduates are following the same career path they intended ($n = 82$). Reasons a graduate decided not to continue in veterinary medicine included a lack of positions available in their desired location of practice, changes in their personal life, changes in interest during study and unavailability of internships.

New graduate veterinarians work an average of 43 hours per week ($n = 90$). Furthermore, on average, they work with 8 full-time veterinarians and 3 part-time veterinarians, though answers were quite variable.

Figure 6. Province/territoire d’emploi (y compris pour les internats et les résidences) et salaire de base annuel moyen ($n = 88$).

<table>
<thead>
<tr>
<th>Province/territoire</th>
<th>Nombre de répondants</th>
<th>Salaire de base moyen ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alberta</td>
<td>13</td>
<td>66 653</td>
</tr>
<tr>
<td>Colombie-Britannique</td>
<td>8</td>
<td>78 750</td>
</tr>
<tr>
<td>Manitoba</td>
<td>2</td>
<td>78 750</td>
</tr>
<tr>
<td>Nouveau-Brunswick</td>
<td>2</td>
<td>51 650</td>
</tr>
<tr>
<td>Terre-Neuve-et-Labrador</td>
<td>2</td>
<td>88 000</td>
</tr>
<tr>
<td>Territoires du Nord-Ouest</td>
<td>1</td>
<td>100 000</td>
</tr>
<tr>
<td>Nouvelle-Écosse</td>
<td>1</td>
<td>75 000</td>
</tr>
<tr>
<td>Nunavut</td>
<td>0</td>
<td>ND</td>
</tr>
<tr>
<td>Ontario</td>
<td>28</td>
<td>71 821</td>
</tr>
<tr>
<td>Île-du-Prince-Édouard</td>
<td>1</td>
<td>63 000</td>
</tr>
<tr>
<td>Québec</td>
<td>23</td>
<td>58 152</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>7</td>
<td>69 143</td>
</tr>
<tr>
<td>Yukon</td>
<td>0</td>
<td>ND</td>
</tr>
</tbody>
</table>

Figure 7. Dette moyenne liée aux études au moment de l’obtention du diplôme, par école, au cours des trois dernières années ($n = 73$).

<table>
<thead>
<tr>
<th></th>
<th>2020</th>
<th>2019</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVC</td>
<td>$144 222 $(n = 9)</td>
<td>$143 353 $(n = 17)</td>
<td>$116 917 $(n = 12)</td>
</tr>
<tr>
<td>FMV</td>
<td>$35 762 $(n = 21)</td>
<td>$22 333 $(n = 3)</td>
<td>$23 636 $(n = 22)</td>
</tr>
<tr>
<td>OVC</td>
<td>$67 682 $(n = 22)</td>
<td>$73 469 $(n = 32)</td>
<td>$49 500 $(n = 23)</td>
</tr>
<tr>
<td>UCVM</td>
<td>$64 000 $(n = 6)</td>
<td>$41 611 $(n = 11)</td>
<td>$53 000 $(n = 10)</td>
</tr>
<tr>
<td>WCVM</td>
<td>$103 733 $(n = 15)</td>
<td>$56 904 $(n = 51)</td>
<td>$49 690 $(n = 29)</td>
</tr>
</tbody>
</table>

Sur 90 répondants, 91% suivent le cheminement de carrière qu’ils avaient prévu ($n = 82$). Les raisons pour lesquelles certains diplômés ont décidé de ne pas poursuivre en médecine vétérinaire comprenaient un manque de postes disponibles dans le lieu de pratique souhaité, des changements dans leur vie personnelle, des changements d’intérêt pendant les études et la non-disponibilité d’internats.

Les nouveaux diplômés travaillent en moyenne 43 heures par semaine ($n = 90$). De plus, ils travaillent en moyenne avec 8 médecins vétérinaires à temps plein et 3 médecins vétérinaires à temps partiel, bien que les réponses soient assez variées.
Figure 8. Method of compensation received by respondents ($n = 88$).

- **Straight salary**: 17%
- **Base salary plus a percentage of your gross earnings or billings**: 83%

Figure 9. Professional benefits received by graduates in addition to their base salary. Respondents had the option of checking more than one ($n = 88$).

<table>
<thead>
<tr>
<th>Professional benefit</th>
<th># of respondents</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuing education fees</td>
<td>77</td>
<td>88</td>
</tr>
<tr>
<td>Payment of licensing fees</td>
<td>77</td>
<td>88</td>
</tr>
<tr>
<td>Health insurance</td>
<td>61</td>
<td>69</td>
</tr>
<tr>
<td>Dental insurance</td>
<td>53</td>
<td>60</td>
</tr>
<tr>
<td>Malpractice insurance</td>
<td>52</td>
<td>59</td>
</tr>
<tr>
<td>Clothing allowance</td>
<td>42</td>
<td>48</td>
</tr>
<tr>
<td>Payment of fees for voluntary professional association membership (e.g. AAHA, CVMA, OVMA, AMVQ)</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Sick leave/compassionate leave</td>
<td>33</td>
<td>38</td>
</tr>
<tr>
<td>After-hours/on-call premiums</td>
<td>32</td>
<td>36</td>
</tr>
<tr>
<td>Continuing education travel expenses</td>
<td>31</td>
<td>35</td>
</tr>
<tr>
<td>Life insurance</td>
<td>31</td>
<td>35</td>
</tr>
<tr>
<td>Cellphone</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>Disability insurance</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>Vehicle allowance/transportation expenses</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Pension</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Profit sharing</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Other retention measures</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
**Other**
Graduates were asked about their toughest challenges as a new graduate; responses ranged from mental health issues to trouble finding employment to trouble practically applying theoretical knowledge. However, a few trends stood out that are listed in order of decreasing prevalence:
1. COVID-19
2. Lack of confidence
3. Time management
4. Client communication
5. Lack of mentorship

Additionally, respondents were asked if they are currently a member of at least 1 of a variety of professional organizations and affiliations. *Please note that all new grads practicing in Canada automatically become a CVMA member until the end of the graduating year.*

**Figure 10.** Professional organizations and affiliations listed by respondents (n = 69).

On behalf of the Students of the Canadian Veterinary Medical Association, I thank members of the graduating Class of 2020 that took the time to respond to our Annual Graduate Survey!

(by Katie McQueen, Atlantic Veterinary College, Class of 2023)

**Divers**
Les répondants ont été interrogés sur leurs plus grandes difficultés en tant que nouveaux diplômés; les réponses allaient des problèmes de santé mentale à trouver un emploi en passant par l’application pratique des connaissances théoriques. Cependant, quelques tendances se sont dégagées; elles sont énumérées ci-après par ordre décroissant de fréquence :
1. COVID-19
2. Manque de confiance en eux
3. Gestion du temps
4. Communication avec les clients
5. Manque de mentorat

On a demandé aux répondants s’ils étaient membres de diverses organisations professionnelles. *Veuillez noter que tous les nouveaux diplômés qui exercent au Canada deviennent automatiquement membres de l’ACMV jusqu’à la fin de l’année d’obtention de leur diplôme.*

**Figure 10.** Organisations professionnelles dont les répondants sont membres (n = 69).

Au nom du Comité des étudiants de l’Association canadienne des médecins vétérinaires, je tiens à remercier les diplômés de la promotion de 2020 qui ont pris le temps de répondre à notre sondage annuel!

(par Katie McQueen, Atlantic Veterinary College, promotion de 2023)
2021 CVMA Convention — July 22–25
Early Bird Registration Closes April 30, 2021

The CVMA Convention is less than 3 months away! Spring into action; if you have not already registered, you can take advantage of the early bird savings on registration until April 30.

Dr. Alexander Reiter, a Diplomate of the American Veterinary Dental College (AVDC) and European Veterinary Dental College (EVDC) and Professor and Chief of Dentistry and Oral Surgery at the University of Pennsylvania’s small animal hospital, will present 5 lectures on companion animal dentistry on Friday, July 23. Dr. Reiter will review Oral Inflammation in Cats; Techniques of Tooth Extraction; Jaw Fractures and Oral Soft Tissue Trauma; Staging and Treatments of Oral Tumors; and will review Examples of Oral and Maxillofacial Reconstruction.

Dr. Gordon Atkins, Past-President of the American Association of Bovine Practitioners, will teach attendees in the Ruminant Conformation track on Friday, July 23 about the following topics: normal conformation and weight distribution characteristics of each claw of the bovine foot; the advantages and disadvantages of various claw trimming techniques; basic function of robotic milking systems and the required cow conformational characteristics necessary for trouble free milking; and help attendees identify the importance of proper pre-milking prep, as well as teat size and shape to avoid severe teat trauma in robotic milking systems.

Dr. Herman Barkema, Professor Epidemiology of Infectious Diseases at the University of Calgary Faculty of Veterinary Medicine and Cumming School of Medicine will be presenting 2 sessions within the Public Health track on Friday, July 23, covering the following: Antimicrobial Resistance: Why Veterinarians and Animal Owners should be Concerned; and, One Health: Exploring the Next Steps in Canada.

Keep an eye out for speaker spotlights on the CVMA social media channels.

Visit the CVMA website to register before the early bird deadline of April 30, 2021 to receive the discounted registration fees. We look forward to seeing you whether in-person or virtually at the 2021 CVMA Convention.

(by Sarah Cunningham, Manager, Conventions, CVMA)
La Semaine nationale de l’action bénévole est une excellente occasion d’honorer les médecins vétérinaires, les techniciens en santé animale, les étudiants et toutes les autres personnes qui offrent leur temps et leur expertise pour concrétiser divers projets de l’Association canadienne des médecins vétérinaires (ACMV) soutenant la profession vétérinaire au Canada.


Plus de 600 bénévoles soutiennent le travail de l’Association, par leur implication au sein du Comité exécutif, du Conseil, des divers comités permanents et des groupes de consultation et de travail, ou encore par la révision des articles pour nos publications. CVSMA’s volunteers take time from their demanding schedules to act as ambassadors in media interviews and represent the CVMA and the veterinary profession on 27 external boards, associations, legislative and policy-making groups, both in Canada and abroad.

Volunteers on the Animal Welfare Committee (AWC) advocate and promote animal welfare to the animal industry, government, and the public. During 2020, the AWC reviewed and revised a number of position statements in preparation for member discussion, including: Humane Slaughter of Farm Animals; Euthanasia; Free-Roaming Owned, Abandoned, and Feral Cats; Elective and Non-Therapeutic Veterinary Procedures for Cosmetic or Competitive Purposes (Formerly Cosmetic Alteration); Partial Digital Amputation (Onychectomy or Declawing) of Non-Domestic Felids Kept in Human Care; Use
of Animals in Science; Humane Mass Depopulation of Animals; Trapping of Fur-Bearing Animals; Use of Lead Fishing Sinkers and Lead Shot in Canada.

Members of the National Issues Committee (NIC) provide leadership and advocacy on national veterinary issues affecting the profession. During 2020, the NIC reviewed and revised position statements in preparation for member discussion, including: Complementary and Alternative Veterinary Medicine; and Surgical Procedures Performed on Animals. The NIC has also developed and launched SAVI: The Stewardship of Antimicrobials by Veterinarians Initiative to pilot a national veterinary antimicrobial use (AMU) stewardship system aimed at enhancing veterinary decision-making with respect to AMU. SAVI is comprised of mutually supporting stewardship and data collection elements, with a 4-year project lifecycle (2019–2023).

The CVMA is also working with the Canadian Food Inspection Agency and other stakeholders to share and promote information to prevent African Swine Fever from infecting Canadian swine. As well, the Association has offered the federal government the assistance of its Canadian Veterinary Reserve, comprised of volunteer veterinarians who can be deployed in case of a major foreign animal disease or civil emergency involving animals.

The Business Management Advisory Group (BMAG) helps the CVMA with one of its 3 priorities; “A successful career, a balanced life.” These volunteers provide guidance and input into the Business Management Program’s objectives with the goal of fostering CVMA members’ personal and professional well-being.

Each year volunteers on the Communications Advisory Group help choose the theme and slogan for the annual Animal Health Technology/Veterinary Technician Program Accreditation Committee (AHTVTPAC) work to identify and promote standards and accreditation for animal health technologist and veterinary technician programs. The AHTVTPAC constantly reviews accreditation standards in collaboration with the accredited programs in Canada and partners such as the American Veterinary Medical Association, to remain current with rapidly changing requirements and evolving needs in veterinary practice.

non urgentes et non thérapeutiques à des fins esthétiques ou compétitives (au paravraparin antigènes cosmétiques), l’amputation partielle des doigts (onychectomie, dégâffrage) des félinés non domestiques et des autres carnivores non domestiques gardés par des humains; l’utilisation des animaux à des fins scientifiques; la dépopulation de masse d’animaux de manière non cruelle; le piégeage des animaux à fournir; et l’utilisation du plomb pour la chasse et la pêche au Canada.


Les bénévoles du Groupe consultatif de la gestion commerciale appuient l’ACVM dans sa mission d’accomplir l’une de ses trois priorités, c’est-à-dire d’aider ses membres à avoir une carrière prospère et une vie équilibrée. Ils fournissent des conseils et des orientations conformément aux objectifs du programme de gestion commerciale dans le but de favoriser le bien-être et professionnel des membres de l’ACVM.

Chaque année, les bénévoles du Groupe consultatif des communications aident à choisir le thème et le slogan de la campagne annuelle de la Semaine de la vie animale et s’impliquent dans la préparation et la mise en œuvre de la campagne. Ils apportent leur expertise et leur vision aux efforts de sensibilisation de l’ACVM dans les médias sociaux – chaque mois, l’ACVM partage une image et un message sur les médias sociaux pour faire connaître davantage les problèmes de santé et de bien-être des animaux et renseigner les propriétaires d’animaux sur ce qu’ils peuvent faire pour aider ou pour prévenir les maladies.

Les bénévoles du Comité de perfectionnement professionnel contribuent au développement professionnel continu des membres de l’ACVM et de tous les médecins vétérinaires. Le programme scientifique, les ateliers et les activités du Congrès annuel de l’ACVM permettent aux médecins vétérinaires et aux autres membres de l’équipe vétérinaire d’améliorer la pratique professionnelle et de réseauter avec des pairs de partout au Canada.

Les bénévoles du Bureau national des examinateurs aident à l’administration des examens menant à l’obtention du permis d’exercice au Canada, participent au processus d’agrément des écoles de médecine vétérinaire et examinent et évaluent les titres...
The CVMA’s Canadian Veterinary Reserve (CVR) is a national, volunteer membership of qualified Canadian veterinarians who make themselves available to rapidly assist governments in responding to outbreaks of foreign animal disease and other large-scale emergencies and disasters affecting animals.

The volunteers of the Editorial Committee oversee the operation and editorial content of The Canadian Veterinary Journal and the Canadian Journal of Veterinary Research. These 2 publications could not exist without the volunteer contribution of the dedicated editors and numerous peer reviewers.

The Students of the CVMA (SCVMA) Committee and the Student Liaison Advisory Group (SLAG) link the CVMA with student veterinarians and faculty members at Canada’s 5 veterinary colleges. In 2020, the SCVMA Committee planned the 2021 SCVMA Symposium with the theme “One Conference, One Community, One Health,” organized by the Ontario Veterinary College, and hosted virtually due to the pandemic.

The Veterinary Wellness Advisory Group’s objective is to develop and promote veterinary wellness initiatives and programs at a national level to complement provincial programs and help groups and provinces in expanding their own wellness initiatives. The Advisory Group continues to add content to the CVMA website and highlights relevant resources under the categories of Emotional and Mental Health, Physical Health, and Veterinarian Wellness. The CVMA Mentoring Program is another program that is closely linked to member wellness.

The CVMA’s achievements are due to the devotion of our many volunteers. We sincerely thank you for donating your time and expertise; your love in motion!

de compétence au nom de certains des organismes provinciaux de réglementation de la médecine vétérinaire.

Les bénévoles du Comité d’agrément des programmes de technologie en santé animale et de techniques vétérinaires travaillent à évaluer et à promouvoir l’agrément des programmes de formation des technologues et techniciens en médecine vétérinaire. Ils examinent constamment les normes d’agrément en collaboration avec les responsables des programmes agréés au Canada et des partenaires tels que l’American Veterinary Medical Association, afin de rester au courant des exigences et des besoins en constante évolution dans la pratique vétérinaire.

La Réserve vétérinaire canadienne (RVC) de l’ACMV est un groupe national de médecins vétérinaires canadiens qualifiés volontaires qui se rendent disponibles pour aider rapidement les gouvernements à répondre aux éclissions de maladies animales exotiques et à d’autres urgences ou catastrophes de grande envergure touchant les animaux.

La Réserve vétérinaire canadienne (RVC) de l’ACMV est un groupe national de médecins vétérinaires canadiens qualifiés volontaires qui se rendent disponibles pour aider rapidement les gouvernements à répondre aux éclissions de maladies animales exotiques et à d’autres urgences ou catastrophes de grande envergure touchant les animaux.

Les bénévoles du Comité de la rédaction supervisent le fonctionnement et le contenu éditorial de La Revue vétérinaire canadienne et de la Revue canadienne de recherche vétérinaire. Ces deux publications ne pourraient exister sans la contribution bénévole des rédacteurs dévoués et des nombreux réviseurs.

Les bénévoles du Comité des étudiants de l’ACMV (SCVMA) et du Groupe consultatif de liaison avec les étudiants assurent le lien entre l’ACMV et les étudiants et les membres du corps professoral des cinq écoles de médecine vétérinaire du Canada. En 2020, le Comité des ÉACMV a organisé le Symposium des ÉACMV de 2021 à l’Ontario Veterinary College. L’événement, qui avait pour thème « Une réunion, une communauté, une santé », a eu lieu virtuellement en raison de la pandémie.

Le Groupe consultatif sur le bien-être des vétérinaires a pour mission d’élaborer et de promouvoir des initiatives et des programmes de mieux-être vétérinaire à l’échelle nationale pour compléter les programmes provinciaux et aider les associations provinciales de médecins vétérinaires et les autres parties prenantes à accroître leur offre d’initiatives et de programmes de mieux-être. Il continue d’ajouter du contenu au site Web de l’ACMV et met en évidence les ressources pertinentes concernant la santé émotionnelle et mentale, la santé physique et le mieux-être des médecins vétérinaires. Le Programme de mentorat de l’ACMV est un autre programme étroitement lié au bien-être des membres.

Les réalisations de l’ACMV sont attribuables au dévouement de ses nombreux bénévoles. Nous vous remercions sincèrement de donner votre temps, de partager votre expertise, et de nous faire bénéficier de votre amour en action!
World Veterinary Day is April 24, 2021

World Veterinary Day takes place globally on April 24, 2021. This event highlights and promotes the different facets of work performed by veterinarians all over the world, and raises awareness of their contributions to improve animal health and welfare, as well as public health. Each year, a different theme is selected by the World Veterinary Association (WVA) and the World Organisation for Animal Health (OIE), the event organizers. The theme of World Veterinary Day 2021 will be released soon.

We thank all members of the veterinary team, including technicians, field and industry veterinarians, and those working in academia, the government, and research for the valuable contributions you make to animal health and welfare every day.

Training Video Available to All

A radiation safety training video designed to improve worker safety during manual restraint of animals for diagnostic radiography is available to all interested parties. The video is 7 minutes long and focuses on the proper use of body, thyroid, hand, and eye protection. In a prospective, observational study at the Veterinary Medical Centre, Western College of Veterinary Medicine, it was found that worker safety behaviors were significantly improved after viewing the video. The open-access video is available in English (https://vimeo.com/380783835), French (https://vimeo.com/418119385), Spanish (https://vimeo.com/418153230) and Portuguese (https://vimeo.com/475520997).


La Journée vétérinaire mondiale est le 24 avril 2021

La Journée vétérinaire mondiale sera célébrée partout dans le monde le 24 avril 2021. Cet événement vise à mettre en lumière et à promouvoir les différentes facettes du travail effectué par les médecins vétérinaires du monde entier et à sensibiliser le public au rôle que joue la profession vétérinaire dans l’amélioration de la santé et du bien-être des animaux et dans la protection de la santé publique. Chaque année, un thème différent est choisi par la World Veterinary Association (WVA) et l’Organisation mondiale de la santé animale (OIE), les organisateurs de l’événement; celui de la Journée vétérinaire mondiale de 2021 sera bientôt dévoilé.

Nous remercions tous les professionnels vétérinaires, y compris les techniciens, les vétérinaires en pratique et dans l’industrie, ainsi que ceux qui travaillent en enseignement, au gouvernement et en recherche, pour les précieuses contributions que vous apportez chaque jour à la santé et au bien-être des animaux.


A client suspects her dog, who’s been listless all day, has gotten into some antifreeze. They’re 5 minutes away from your clinic. You’re the only veterinarian in the building and it’s been a while since you treated ethylene glycol toxicity. You know there’s probably a good resource on your bookshelf, but where? And can you find it in time to be prepared?

In these moments, speed matters.

Instead of the bookshelf, you ask Sofie. Within seconds, your mobile Sofie app finds a succinct reference with a diagnostic algorithm, a step-by-step review of several possible scenarios and treatment protocols with drug doses. You take a few minutes to refresh yourself. The dog arrives in lateral recumbency, but with protocol and drugs ready, you act. Despite the stress of the moment, you confidently manage the patient, the client, and the emergency simultaneously.

This is a typical story, shared with us by users of LifeLearn Sofie, the artificial intelligence (AI)-driven medical search tool that aggregates the best veterinary medical information from textbooks, proceedings, and journal articles. Essentially, your virtual DVM assistant — the kind of assistant that I wish I’d had when I was in practice!

LifeLearn is an Affinity partner with the CVMA and a benefit of membership. In addition to Sofie, LifeLearn offers other products (WebDVM, ALLYDVM, ClientEd, and PetNurse). LifeLearn, Inc. optimizes client communications, maximizes efficiency, and improves profitability.
Back in 1989 BC (before computers!), my little desk in the corner of my 750 square-foot clinic was regularly covered with textbooks, journals, and course notes. Fresh out of school, I was constantly searching for lists of differentials, diagnostics, and drug/treatment information; challenging cases meant a lot of pulling books and flipping pages to find answers. I can't help but wonder how much time I would have saved if a medical search tool like LifeLearn Sofie had been at my disposal.

Unlike the supercomputer of yesteryear that occupied a whole room, the power of AI is now in the palm of your hand, and so is your access to critical medical information at the point of need, but not just any information. LifeLearn Sofie’s medical information comes from sources that are not available on the open web but not just any information. LifeLearn Sofie’s medical information comes from sources that are not available on the open web through a Google search. Sofie contains more than 25 of the best proprietary textbooks, such as Tilley’s 5 Minute Veterinary Consult, Côté’s Clinical Veterinary Advisor and Ettinger’s landmark Textbook of Veterinary Internal Medicine, along with years of proceedings from VMX and practical journal articles from Today’s Veterinary Practice.

More than just a search engine, LifeLearn Sofie uses IBM Watson’s artificial intelligence software to perform natural-language searches in order to return the most relevant information. This means, searches aren’t just based on keywords but on their context within the library sources. Almost instantly, you can retrieve drug doses, adverse effects, and interactions; access lists of differential diagnoses, clinical diagnostic or treatment protocols, and algorithms; identify step-by-step emergency procedures; and confirm clinical signs and prognosis. Sofie reduces your search time to mere seconds, and as we all know in this business, seconds matter.

Medical information when you need it, confidence in your decisions, and the chance to optimize your workflow. That’s what LifeLearn Sofie offers. Anything else is just BS (before Sofie)!

CVMA members enjoy a 10% savings on LifeLearn products. For more information visit (www.lifelearn.com)." LifeLearn is a valued partner of the CVMA. To view a listing of all partners, visit (www.canadianveterinarians.net/member-benefits/exclusive-discounts-valued-partners).

(by Mark Stephenson, DVM, Chief Veterinary Officer, LifeLearn Animal Health)

LifeLearn is a partner of the ACMV and offers the rabais to its members. In addition, LifeLearn offers other products such as WebDVM, ALlYDVM, ClientEd and PetNurse to help you optimize your communications with your clients and maximize the efficiency and productivity of your practice.

In 1989 (the prehistoric age of computers), my little desk in a coin of my clinic of 750 square feet used to be a constant place for me. I was constantly searching for lists of differentials, diagnostics, and drug/treatment information; challenging cases meant a lot of pulling books and flipping pages to find answers. I can't help but wonder how much time I would have saved if a medical search tool like LifeLearn Sofie had been at my disposal.

Unlike the supercomputer of yesteryear that occupied a whole room, today’s power of AI is now in the palm of your hand, and so is your access to critical medical information at the point of need, but not just any information. LifeLearn Sofie’s medical information comes from sources that are not available on the open web but not just any information. LifeLearn Sofie’s medical information comes from sources that are not available on the open web through a Google search. Sofie contains more than 25 of the best proprietary textbooks, such as Tilley’s 5 Minute Veterinary Consult, Côté’s Clinical Veterinary Advisor and Ettinger’s landmark Textbook of Veterinary Internal Medicine, along with years of proceedings from VMX and practical journal articles from Today’s Veterinary Practice.

More than just a search engine, LifeLearn Sofie uses IBM Watson’s artificial intelligence software to perform natural-language searches in order to return the most relevant information. This means, searches aren’t just based on keywords but on their context within the library sources. Almost instantly, you can retrieve drug doses, adverse effects, and interactions; access lists of differential diagnoses, clinical diagnostic or treatment protocols, and algorithms; identify step-by-step emergency procedures; and confirm clinical signs and prognosis. Sofie reduces your search time to mere seconds, and as we all know in this business, seconds matter.

Medical information when you need it, confidence in your decisions, and the chance to optimize your workflow. That’s what LifeLearn Sofie offers. Anything else is just BS (before Sofie)!

CVMA members enjoy a 10% savings on LifeLearn products. For more information visit (www.lifelearn.com).” LifeLearn is a valued partner of the CVMA. To view a listing of all partners, visit (www.canadianveterinarians.net/member-benefits/exclusive-discounts-valued-partners).

(by Mark Stephenson, DVM, Chief Veterinary Officer, LifeLearn Animal Health)
National Pet ID Week is April 17 to 23, 2021
Semaine nationale de l’identification des animaux de compagnie du 17 au 23 avril 2021

National Pet Identification Week provides veterinarians with an opportunity to review the steps clients can take to ensure their pet has the best chance of being recovered should the animal become lost. All pets need reliable forms of identification.

It is estimated that 1 in 3 pets will go missing at some point in their life and a large proportion of animals in shelters are lost animals. Getting those pets back home can reduce shelter crowding and free up valuable resources and kennel space for truly homeless animals.

The Canadian Veterinary Medical Association (CVMA) supports the permanent identification of animals and recommends the use radio-frequency identification (RFID) products (microchips, transponders) that conform to the International Standards Organization (ISO) standard of technology. Read the CVMA’s Microchip Animal Identification position statement under the Policy & Advocacy tab of the website.

The CVMA recommends veterinarians use RFID products that have been successfully reviewed by the National Animal Companion Coalition (NCAC) and appear on the NCAC list of recognized products on the NCAC website (www.ncac-cnac.ca).

La Semaine nationale de l’identification des animaux de compagnie offre aux médecins vétérinaires l’occasion de passer en revue les mesures que les clients peuvent prendre pour maximiser les chances que leur animal soit retrouvé s’il se perd. Tous les animaux ont besoin d’un moyen fiable de les identifier.

On estime qu’un animal de compagnie sur trois sera perdu à un moment ou à un autre au cours de sa vie, et qu’une grande proportion des animaux dans les refuges sont des animaux perdus. Pouvoir réunir ces animaux avec leur propriétaire pourrait réduire la surpopulation des refuges et libérer des ressources précieuses et de la place pour les animaux qui sont véritablement sans propriétaire.


L’ACMV recommande aux médecins vétérinaires d’utiliser des produits d’IRF qui ont été testés avec succès par la Coalition nationale sur les animaux de compagnie (CNAC) et qui figurent sur la liste de produits reconnus par la CNAC publiée sur son site Web (www.ncac-cnac.ca).
CVMA Annual Source Guide
Guide annuel des ressources de l’ACMV

The Canadian Veterinary Medical Association (CVMA) Source Guide is one of many CVMA member benefits. The CVMA Source Guide is your national professional association’s reference resource, with a comprehensive list of member benefits and privileges, animal welfare and national issues position statements, and awards and honors information recognizing colleagues’ achievements. You can also use this guide to connect with peers, colleagues, and classmates. The CVMA Source Guide contains a listing of CVMA boards, committees and representatives, national and international veterinary medical associations, veterinary colleges, and national species-specific groups.

Our predecessors created the CVMA to give Canada a strong national professional association and now you too must be committed and involved in moving the veterinary profession forward. We encourage you to get involved; visit the CVMA website and read timely veterinary news, read the CVMA’s monthly e-newsletter Online from 339, attend our annual CVMA Convention, follow the CVMA on Twitter and Instagram, like the CVMA Facebook page, read The Canadian Veterinary Journal and Canadian Journal of Veterinary Research, participate in the CVMA’s annual awareness campaign Animal Health Week, provide feedback on matters of national importance by commenting on proposed position statements through the CVMA’s online member consultations, and/or volunteer on a CVMA committee.

The CVMA is committed to publishing accurate contact information and encourages all members to login to cvma.member365.com to verify their preferred mailing address. If any member wishes for the CVMA to publish an alternate address, or should they wish not to have their contact information included in the Source Guide, please e-mail (admin@cvma-acmv.org) or call toll free 1-800-567-2862 prior to June 1, 2021.

L’ACMV a créé le Guide des ressources de l’Association canadienne des médecins vétérinaires (ACMV) pour offrir à ses membres un des nombreux avantages de l’ACMV. Vous y trouverez des références de votre association professionnelle nationale, ainsi que des listes complètes des avantages et privilèges offerts aux membres, des énoncés de position sur le bien-être animal et les enjeux nationaux, et des récompenses et prix remis à des membres méritants pour souligner leurs réalisations.


Nos prédécesseurs ont créé l’ACMV pour donner au Canada une association nationale professionnelle forte, et maintenant, vous devez vous aussi vous engager et vous impliquer dans l’avancement de la profession vétérinaire. Nous vous encourageons à le faire en visitant le site Web de l’ACMV pour consulter les actualités vétérinaires, en lisant l’infolettre mensuelle de l’ACMV En direct du 339, en assistant au Congrès annuel de l’ACMV, en suivant l’ACMV sur Twitter et Instagram, en aimant la page Facebook de l’ACMV, en lisant La Revue vétérinaire canadienne et la Revue canadienne de recherche vétérinaire, en participant à la campagne de sensibilisation annuelle de la Semaine de la vie animale organisée par l’ACMV, en donnant votre opinion sur des questions d’importance nationale, en commentant les ébauches d’énoncés de position lors des consultations en ligne des membres de l’ACMV, ou en vous joignant à l’un des comités de l’ACMV.

L’ACMV s’efforce de publier des coordonnées exactes; par conséquent, elle encourage tous les membres à se connecter à cvma.member365.com pour vérifier leur adresse postale. Si vous souhaitez qu’une adresse différente soit publiée ou que vos coordonnées n’apparaissent pas dans le Guide des ressources, communiquiez avec nous par courriel (admin@cvma-acmv.org) ou au numéro sans frais 1-800-567-2862 avant le 1er juin 2021.
Radiation safety practices among Canadian equine veterinary workers during diagnostic procedures with portable X-ray equipment

Alexandra F. Belotta, Monique N. Mayer, Cheryl L. Waldner, Kate Robinson, Narinder Sidhu, James Carmalt, Chris D. Bell, Niels K. Koehncke

Abstract — The objective of this study was to report observed radiation safety practices among equine workers using portable X-ray units at 3 veterinary practices in Canada. Practice 1 was comprised of equine field service workers from an academic institution, whereas Practices 2 and 3 were comprised of workers from private equine referral practices. Out of 2969 exposure-worker observations, protective aprons were worn for > 99% (2968/2969), thyroid shields for 87% (2584/2969), and eyeglasses for 10% (310/2969). The cassette was held by hand for 97% (1078/1114) of observations, and the X-ray unit was held by hand for 100% (1293/1293) of observations. Gloves were used for 54% (606/1114) and < 1% (5/1293) of observations involving cassette holders and X-ray tube operators, respectively. Use of gloves was more frequent among technologists than DVMs (P = 0.004), and among workers in Practices 1 and 3 than in Practice 2 (P < 0.001). In conclusion, given that workers commonly hold cassettes and X-ray tubes by hand, improvement in shielding use is needed. Consideration should be given to specific behavior recommendations in radiation regulations.

Résumé — Pratiques de radioprotection chez les travailleurs vétérinaires équins canadiens pendant les procédures de diagnostic avec un équipement de radiographie portable. L’objectif de la présente étude était de rapporter les pratiques de radioprotection observées chez les travailleurs équins utilisant des appareils de radiographie portatifs dans trois pratiques vétérinaires au Canada. La pratique 1 était composée de travailleurs équins sur le terrain d’une institution universitaire, tandis que les pratiques 2 et 3 étaient composées de travailleurs sur le terrain issus de pratiques de référence équines privées. Sur 2969 observations de travailleurs exposés, des tabliers de protection ont été portés pour > 99% (2968/2969), des écrans thyroïdiens pour 87% (2584/2969) et des lunettes pour 10% (310/2969). La cassette a été tenue à la main pour 97% (1078/1114) des observations et l’unité de radiographie a été tenue à la main pour 100% (1293/1293) des observations. Des gants ont été utilisés pour 54% (606/1114) et < 1% (5/1293) des observations impliquant des porteurs de cassette et des opérateurs de tubes à rayons X, respectivement. L’utilisation de gants était plus fréquente chez les technologues que chez les vétérinaires (P = 0,004) et chez les travailleurs des Pratiques 1 et 3 que ceux de la Pratique 2 (P < 0,001). En conclusion, étant donné que les travailleurs tiennent généralement des cassettes et des tubes à rayons X à la main, une amélioration de l’utilisation du blindage est nécessaire. Il faudrait tenir compte des recommandations de comportement spécifiques dans les règlementations relatives aux rayonnements.
Introduction

Exposure to chronic low levels of ionizing radiation is an occupational hazard in veterinary medicine because of the potential for carcinogenesis and other health risks (1). Canadian federal guidelines on radiation protection in veterinary medicine recommend that personnel use all protective devices available and keep as far away from the X-ray beam as practicable at all times (2). In addition, the guidelines recommend that the X-ray tube and cassette should never be held by hand, and that a dosimeter should be worn underneath a protective apron by personnel who routinely participate in radiographic procedures (2). Notwithstanding the federal guidelines, from a regulatory point of view, radiation health and safety in Canada is largely (and in the case of the exposures in this study) under provincial jurisdiction and employers must follow provincial radiation safety acts and regulations. For many provinces, non-nuclear ionizing radiation regulations require that worker exposures be kept as low as reasonably achievable and specify annual occupational dose limits, but do not specify or mandate behaviors to achieve optimization of worker protection.

The use of portable X-ray equipment in the clinic and field is common among equine practitioners in Canada. Diagnostic radiography of the equine patient is challenging due to the size and temperament of the patient, which creates a physical hazard for the worker. Obtaining diagnostic quality radiographs in a timely manner while using mechanical devices to hold the X-ray tube and cassette is difficult. Lead shielding is heavy, and in the case of gloves, may interfere with a worker’s ability to hold equipment. These challenges may lead to a gap between radiation safety guidelines and the reality of equine radiography in the clinic and in the field. Previous studies have noted that hand-holding of the X-ray tube and cassette are common practices during equine radiography (3,4), and low use of hand shielding by equine veterinarians has been reported (5). However, to the authors’ knowledge, there are no studies in the veterinary literature investigating the observed frequency of these behaviors during equine radiography.

The objective of this prospective observational study was to report observed radiation safety practices among equine veterinary workers during examinations with portable X-ray equipment in 3 workplaces in Canada, and to investigate the association of risk factors with workers’ safety behaviors.

Materials and methods

Study design and population

The investigation was designed as a prospective, observational study. The study population was comprised of equine field service workers from an academic institution (Practice 1), and workers from 2 private equine referral practices in Canada (Practices 2 and 3). Worker types included doctors of veterinary medicine (DVMs), veterinary technologists/technicians (VTs), DVM/VT students, and staff. Workers at the academic institution were observed between April 25, 2019 and September 11, 2019, whereas workers at both private practices were observed for a 2-week period; one practice from July 2 to 17, 2019 and the second from August 19 to September 5, 2019. Workers voluntarily consented to participate in this study and consent forms were signed following invitation to participate. Workers were given the option to withdraw from the study at any time and were informed that their identity would not be disclosed. The study was considered to be exempt from review by the Behavioral Research Ethics Board, University of Saskatchewan, according to Article 2.5 of the Tri-Council Policy Statement (TCPS): Ethical Conduct for Research Involving Humans (BEH ID 668).

Data collection

A post-doctoral DVM directly observed the workers during acquisition of radiographs in the clinic and in the field and positioned a 360° video camera to record worker behavior and use of personal protective equipment (PPE) (Figures 1–3). All video recordings were examined by the post-doctoral veterinarian.

Data collected for each radiographic study included anatomical location (lower extremity, upper extremity, body), administration of sedatives before imaging and location of exposure (whether the study was performed in the field or in a clinic). Regarding anatomical location, lower extremity included studies distal to the elbow and stifles, whereas upper extremity included studies of the shoulder, elbow, and stifles; body included studies of the head, spine, and thorax. A radiographic study was considered a set of radiographic images, including 1 or more views, of a single anatomical location. For each X-ray exposure, the total number of exposures and the number of exposures sent to the Picture Archiving and Communications System (PACS) were recorded.

Since multiple workers were present for each X-ray exposure, individual worker observations were summarized as unique imaging exposure-worker observations (for example, 1 imaging exposure with 3 workers present would result in 3 unique imaging exposure-worker observations).

For each exposure-worker observation, worker task (X-ray tube operator, cassette holder, horse restrainer), worker type (DVM, VT, DVM/VT student, staff), worker use of shielding (protective apron, securely closed thyroid shield, gloves on both hands, eyeglasses), and worker use of a dosimeter were summarized. Data collected for both X-ray tube operators and cassette holders included whether mechanical devices were used to hold the X-ray tube or cassette as opposed to equipment held by hand. Data collected only for X-ray tube operators included whether the X-ray tube was in contact with any part of the body or other than the hands during the exposure.

At the end of the observational period, workers were invited to complete a survey comprised of information regarding position [DVM, VT, DVM or VT student, staff, or other], number of years employed in the veterinary profession (≤ 5, 6 to 10, 11 to 20, or > 20), percentage of work with horses (100%, 75 to 100%, 50 to 75%, or < 50%), type of practice (academic or private), age group (> 45, 25 to 44, 18 to 24, or < 18 y), and gender. In addition, workers were asked about level of concern and knowledge about their radiation exposure in the equine setting using a 5-point scale (from 1 — not worried/not knowledgeable at all to 5 — very worried/very knowledgeable). For statistical analysis, the 5-point scale was condensed: scores...
of 1 or 2 were merged into a single group (I), and scores 4 or 5 were merged into another single group (III), and therefore answers were recategorized into 3 categories (I, II, and III). The total number of exposures performed for each study, the number of exposures sent to PACS, and the difference between these 2 numbers, were recorded.

### Statistical analyses

Radiation safety behaviors including X-ray tube in contact with body parts other than the hands, use of thyroid shields and protective gloves were summarized for each unique exposure-worker event. Potential risk factors for these behaviors included worker type (DVM, VT, or DVM, or VT student), radiographic study type (lower extremity, upper extremity, or body), location of exposure (study performed in the field versus in the clinic), sedation, level of concern about radiation exposure (I, II, III), and level of knowledge about radiation exposure (I, II, III). Because of the limited number of workers included as staff (n = 5), this category was removed from the analysis. No risk factors were investigated for frequency of protective apron use since workers wore an apron for > 99% of observations. In addition, no risk factors were investigated for frequency of use of lead eyeglasses since use was limited to pre-purchase examinations of 4 horses performed by 3 workers, leading to limited variability in that outcome.

Generalized estimating equations accounting for repeated measures for individual workers in various tasks were used to evaluate differences between categories. Safety behaviors were adjusted for Practices 1, 2, 3 in order to investigate potential effects of workplace culture on the behaviors. The model included a logit-link function, assumed a binomial distribution, and an autoregressive correlation structure. A multivariable model was built using stepwise, manual backwards elimination. Variables considered important confounders (P < 0.2) were retained in the model. Risk factors that were very highly correlated were examined in separate models. P-values < 0.05 were considered significant.

The total number of exposures and the number of exposures deleted or not sent to PACS were summarized for each study completed, for each patient examined. The effect of variables including study type, location of exposure, and sedation on those outcomes was investigated with generalized estimating equations using a log-link function and assuming a Poisson distribution.

All analyses were performed by an analytical epidemiologist using commercial software (Stata SE Version 16; StatCorp, College Station, Texas, USA).

### Results

#### Study population

Sixty-seven equine veterinary workers participated in this study. Characteristics of the study population included in the analysis are summarized in Table 1. Ninety-four percent of workers (63/67) reported their level of concern and knowledge about radiation exposure in the equine setting. Of those workers, level of concern was graded as 1 or 2 by 46% (29/63), as 3 by 33% (21/63), and as 4 or 5 by 21% (13/63). Level of knowledge was graded as 1 or 2 by 46% (29/63), as 3 by 33% (21/63), and as 4 or 5 by 38% (24/63) of workers.

### Summary of radiographic studies and direct observations

In total, 265 radiographic studies were performed on 101 horses, resulting in 1293 exposures. Of those exposures, 61% were performed in the field (787/1293) and 39% were performed inside a clinic (506/1293). Of all exposures, 79% (1019/1293) were acquired during radiographic studies of the lower extremity, 14% (183/1293) were acquired during studies of the upper extremity, and 7% (91/1293) were acquired during studies of the body. Data for individual workers were summarized as 2969 unique exposure-worker observations. Of all unique exposure-worker observations, 38% (1114/2969) involved cassette holders, 43% (1293/2969) involved X-ray tube operators, and 19% (562/2969) involved horse restrainers.
Factors associated with radiation safety behaviors

The results of the unconditional analyses are presented in Supplement 1; Tables 1–3 therein (http://hdl.handle.net/10388/13079).

In final multivariable analysis, workers were less likely to touch the X-ray tube with their hands only, as opposed to touching the tube with hands and other body parts, for studies of the upper extremity (versus studies of the lower extremity, OR: 0.25) (Table 3).

In final multivariable analysis, use of a thyroid shield was significantly less likely among workers involved as X-ray tube operators and horse restrainers than workers involved as cassette holders [odds ratio (OR): 0.53, and OR: 0.34, respectively] and significantly more likely among DVM or VT students than DVMs (OR: 4.14) (Table 4). Use of a thyroid shield was significantly less likely for studies of the upper extremity than studies of the lower extremity (OR: 0.63) and significantly more likely for studies of the body than studies of the lower extremity (OR: 3.34). Use of a thyroid shield was significantly more likely in Practice 2 versus Practice 3 (P < 0.001).

Comparison of frequencies of glove use was not performed between horse restrainers and the 2 other tasks of worker because none of the horse restrainers wore gloves. In the final multivariable analysis, frequency of use of protective gloves was significantly more likely among VTs (versus DVMs, OR: 5.24) (Table 5). Use of gloves was significantly less likely among workers in Practice 2 and Practice 3 versus Practice 1 (OR: 0.01 and OR: 0.69, respectively). Use of gloves was significantly more likely in Practice 3 versus Practice 2 (OR: 70.3, 95% CI: 9.10 to 545.30, P < 0.001).

Factors associated with number of exposures for each study

A significantly higher number of exposures was acquired during studies of the body in comparison with studies of the upper extremity (P = 0.004) and studies of the lower extremity (P = 0.03), as well as during studies performed inside the clinics in comparison with studies performed in the field (P < 0.001). A significantly higher number of exposures was deleted (not sent to PACS) during studies performed in a clinic in comparison to studies performed in the field (P < 0.001), whereas number of deleted exposures was not affected by study type and sedation (P > 0.12).

Discussion

Results from this study indicated that workers do not effectively protect their hands or eyes from ionizing radiation during portable equine radiography. Observed use of thyroid shielding, although higher than hand and eye shielding, was still suboptimal. Given the common practice of holding the X-ray tube and cassette by hand, workers are near one of the main sources of scattered X-rays (the horse), and shielding should always be used.

Generally, the hands are the closest body part of workers to the source of scattered radiation. Workers positioning the cassette not only did not maintain the recommended distance between themselves and the source of scattered radiation by using mechanical devices to hold the cassette, but also did not

### Table 3. Final multivariable model of the associations between risk factors of interest, and whether X-ray tube operators touched the X-ray tube with hands only were summarized for 1193 exposures from 262 studies on 98 horses by 45 workers.

<table>
<thead>
<tr>
<th>FP</th>
<th>Relative frequency</th>
<th>OR*</th>
<th>95% CI</th>
<th>P-valueb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hands only on tube</td>
<td>0.96 (1142/1193)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower extremity</td>
<td>0.96 (920/957)</td>
<td>Reference category</td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Upper extremity</td>
<td>0.93 (143/153)</td>
<td>0.25</td>
<td>0.13 to 0.50</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Body</td>
<td>0.95 (79/83)</td>
<td>0.54</td>
<td>0.22 to 1.30</td>
<td>0.17</td>
</tr>
<tr>
<td>Practice</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1 (508/508)</td>
<td>Non-estimable</td>
<td></td>
<td>0.15</td>
</tr>
<tr>
<td>2</td>
<td>0.92 (451/490)</td>
<td>0.21</td>
<td>0.02 to 2.16</td>
<td>0.19</td>
</tr>
<tr>
<td>3</td>
<td>0.94 (183/195)</td>
<td>Reference category</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CI — Confidence interval; DVM — Doctor of veterinary medicine; OR — Odds ratio; VT — Veterinary technologist/technician.

* Calculated using logistic regression adjusted for repeated measures within individual workers.

b Significant P-values are bolded.

Cassette holders used an extensor pole to hold the cassette as opposed to holding it by hand for 3% of exposure-worker observations (36/1114). X-ray tube operators held the X-ray tube by hand for all observations (1293/1293) as opposed to using a mechanical device. In addition, workers holding the X-ray tube touched the X-ray tube with their hands only for 88% of observations (1142/1293) and touched the X-ray tube with other body parts as well as their hands (when supporting the tube with chest or thighs) for 4% of observations (51/1293). For the remaining 8% of observations (100/1293), this behavior was not recorded because visibility was blocked by the positioning of the workers relative to the observer and video camera. Frequencies of use of PPE as well as frequencies of use of a portable equine radiography. Observed use of thyroid shielding, although higher than hand and eye shielding, was still suboptimal. Given the common practice of holding the X-ray tube and cassette by hand, workers are near one of the main sources of scattered X-rays (the horse), and shielding should always be used.

Generally, the hands are the closest body part of workers to the source of scattered radiation. Workers positioning the cassette not only did not maintain the recommended distance between themselves and the source of scattered radiation by using mechanical devices to hold the cassette, but also did not
use protective gloves for a substantial amount of exposures. Frequency of use of protective gloves by the X-ray tube operators was very low and significantly lower compared to cassette holders. The lower use of gloves by X-ray tube operators could be due to the perception that cassette holders are exposed to higher radiation doses than X-ray tube operators, due to their closer proximity to the source of scattered radiation. Although there is evidence that cassette holders may receive higher radiation doses than X-ray tube operators (4), that investigation was limited to radiographic studies of the distal extremity. It is possible that X-ray tube operators may be exposed to substantial backscattered radiation, in particular during radiographs of anatomical regions composed of thicker soft tissue and bony structures such as thorax, spine, shoulder, elbow, and stifle. Furthermore, X-ray tube operators may also be exposed to potential radiation leakage from the tube in addition to the scattered radiation from the patient (3), suggesting that the use of protective gloves by workers involved in this task is necessary to optimize their protection and keep radiation doses as low as reasonably achievable. The finding of the difference in glove use frequency between the 2 private clinics may have been due to the difference in workload between the 2 practices; the private practice with the lower frequency of glove use acquired over 3 times the number of radiographs in approximately the same interval as the private practice with the higher frequency of glove use.

The frequency of use of thyroid shields by equine workers in this study is concerning, given the high sensitivity of the thyroid gland to ionizing radiation (6) and the increased risk of development of thyroid cancer (7) and of autoimmune thyroid disease (8) among occupationally exposed individuals. The increased likelihood of thyroid shielding observed among DVM and VT students in contrast to DVMs may be explained by knowledge obtained in recent years of veterinary education. Veterinary students enrolled in the academic institution included

### Table 4. Final multivariable model of the associations between risk factors of interest, and whether thyroid shields were used summarized for 2969 exposures from 265 studies on 101 horses by 62 workers.

<table>
<thead>
<tr>
<th>Use of thyroid shield</th>
<th>Relative frequency</th>
<th>OR(^a)</th>
<th>95% CI</th>
<th>(P)-value(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cassette holder</td>
<td>0.91 (1014/1114)</td>
<td>Reference category</td>
<td>&lt; 0.001</td>
<td></td>
</tr>
<tr>
<td>X-ray tube operator</td>
<td>0.87 (1122/1293)</td>
<td>0.53</td>
<td>0.41 to 0.69</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Horse restrainer</td>
<td>0.8 (448/562)</td>
<td>0.34</td>
<td>0.25 to 0.46</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Worker</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DVMs</td>
<td>0.82 (1049/1272)</td>
<td>Reference category</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>VTs</td>
<td>0.86 (588/682)</td>
<td>1.33</td>
<td>0.6 to 2.95</td>
<td>0.49</td>
</tr>
<tr>
<td>DVM or VT students</td>
<td>0.93 (947/1015)</td>
<td>4.14</td>
<td>1.88 to 9.13</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Study</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower extremity</td>
<td>0.86 (1994/2307)</td>
<td>Reference category</td>
<td>&lt; 0.001</td>
<td></td>
</tr>
<tr>
<td>Upper extremity</td>
<td>0.85 (374/438)</td>
<td>0.63</td>
<td>0.49 to 0.82</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Body</td>
<td>0.96 (216/224)</td>
<td>3.34</td>
<td>1.62 to 6.86</td>
<td>0.001</td>
</tr>
<tr>
<td>Practice</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.9 (1212/1343)</td>
<td>Reference category</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.79 (986/1240)</td>
<td>1.04</td>
<td>0.5 to 2.17</td>
<td>0.92</td>
</tr>
<tr>
<td>3</td>
<td>1 (386/386)</td>
<td>Non-estimable</td>
<td>&lt; 0.001</td>
<td></td>
</tr>
</tbody>
</table>

\(\text{CI} — \text{Confidence interval}; \text{DVM} — \text{Doctor of veterinary medicine}; \text{OR} — \text{Odds ratio}; \text{VT} — \text{Veterinary technician and technologist.}\)

\(^a\) Calculated using logistic regression adjusted for repeated measures within individual workers.

\(^b\) Significant \(P\)-values are bolded.

### Table 5. Final multivariable model of the associations between risk factors of interest, and whether protective gloves were used summarized for 2969 exposures from 265 studies on 101 horses by 62 workers.

<table>
<thead>
<tr>
<th>Use of protective gloves</th>
<th>Relative frequency</th>
<th>OR(^a)</th>
<th>95% CI</th>
<th>(P)-value(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worker</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DVMs</td>
<td>0.13 (160/1272)</td>
<td>Reference category</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>VTs</td>
<td>0.2 (140/682)</td>
<td>5.24</td>
<td>1.69 to 16.20</td>
<td>0.004</td>
</tr>
<tr>
<td>DVM or VT students</td>
<td>0.31 (311/1015)</td>
<td>1.73</td>
<td>0.78 to 3.84</td>
<td>0.18</td>
</tr>
<tr>
<td>Practice</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.35 (476/1343)</td>
<td>Reference category</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.01 (9/1240)</td>
<td>0.01</td>
<td>0.001 to 0.08</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>3</td>
<td>0.33 (126/386)</td>
<td>0.69</td>
<td>0.24 to 1.96</td>
<td>0.49</td>
</tr>
</tbody>
</table>

\(\text{CI} — \text{Confidence interval}; \text{DVM} — \text{Doctor of veterinary medicine}; \text{OR} — \text{Odds ratio}; \text{VT} — \text{Veterinary technician/technologist.}\)

\(^a\) Calculated using logistic regression adjusted for repeated measures within individual workers.

\(^b\) Significant \(P\)-values are bolded.
in this study have radiation safety lectures in their second and third years, as well as orientation regarding use of PPE before start of clinical rotations in the 4th year. This education may have positively impacted their safety behavior and supports the concept that training and education of equine workers could improve their behavior. The higher frequency of thyroid shield use by cassette holders compared to X-ray tube holders could be due to the aforementioned concern about higher radiation exposure, because of the very close proximity to the horse when holding the cassette.

Equine workers in this study wore lead eyeglasses for approximately 13% of the observations performed by X-ray tube operators and cassette holders. However, this frequency should be carefully interpreted, since it was a result of only 3 workers who wore lead eyeglasses during 4 pre-purchase examinations performed at Practice 1. Possibly, these workers' awareness of being observed and of the main purpose of this study may have positively impacted their behavior leading to the increased frequency of use of lead eyeglasses (9). Although lead eyeglasses are not recommended by Canadian federal guidelines or required by provincial regulations, recent studies have shown that radiation doses leading to development of cataracts are lower than previously estimated (10). Those studies led to the reduction of the recommended annual occupational equivalent dose limit to the lens of the eye from 150 to 20 mSv/year by the International Commission on Radiological Protection in 2012 (11). Therefore, the authors of this study recommend use of lead eyeglasses during equine radiographic procedures and recommend consideration of this type of PPE in future regulatory guidance.

The practice of touching the X-ray tube with body parts other than hands was significantly more likely among workers involved in radiographic studies of the upper extremity and could be associated with difficulties in holding heavy X-ray tubes up in the air for these studies, as well as trying to hold the X-ray tubes still to prevent motion blur. Operators close to the X-ray tube are not only exposed to scattered radiation from the patient but also to potential radiation leakage coming from the X-ray tube (3). Holding the X-ray tube against body parts, such as the legs, will result in higher exposure to radiation leakage from the tube, in particular for workers not wearing PPE over the portion of their body that is in direct contact with the tube.

A body dosimeter was worn for only 25% of worker observations, and therefore recorded doses likely underestimate the actual exposures. The true frequency of use of dosimeters in this study may have been higher than we reported due to the observations being limited to the proper use of dosimeters over the top of clothing, at the level of the trunk, and facing outwards, rather than inside pockets. If dosimeters were inside pockets, they were not visible to the observer or to the video camera. Proper use of dosimeters should be enforced in order to have better estimates of workers' radiation doses.

Based on previous studies of doses to workers holding the X-ray tube and cassette by hand, it is unlikely that most workers would exceed the dose limits in provincial regulations (3,4). However, we found that workers are not optimizing their

Figure 1. Image obtained with a 360° video camera showing radiation safety practices by workers during a radiographic study of the fetlock of the right hind limb in a horse. The cassette holder (on the left) uses a mechanical device and keeps themselves as distant as possible from the source of scattered radiation (the limb) and the primary beam. Proper use of protective aprons by all workers including the X-ray tube operator (middle) and the horse restrainer (on the right) is also shown.

Figure 2. Image obtained with a 360° video camera showing the cassette holder (standing) during a radiographic study of the right hock of a horse. Although a mechanical device is not used to hold the cassette, the worker involved as a cassette holder properly wears protective gloves. In contrast, the right hand of the X-ray tube operator (sitting) is partially seen and protective gloves are not worn; therefore, this worker is not optimizing their protection.
radiation exposure. Nearly 80% of workers rated their level of worry about their radiation exposure in the equine setting as 3 or less on a 5-point scale (with 1 being not worried), and this lack of concern likely contributed to the suboptimal safety behaviors. Incorporating specific behavior recommendations, such as consistent use of PPE, in addition to annual dose limits may raise worker and employer awareness of the importance of these behaviors and to help achieve worker exposures that are truly as low as reasonably achievable should be considered for provincial radiation safety regulations. Based on the frequency of holding equipment by hand reported in this study, attention should be given to the use of protective gloves by both cassette holder and X-ray tube operators. As well, given our finding that workers remain close to the patient and frequently holding the X-ray tube and cassette by hand. It is important for manufacturers of portable X-ray tubes to be aware that these devices are being used as if approved for handheld use and to take this into consideration during product design, and possibly develop more user-friendly means of positioning the tube and cassette without holding by hand. Specific behavior recommendations in provincial radiation safety regulations should be considered to increase the use of shielding by workers.

Acknowledgments

The authors express appreciation to the Saskatchewan Health Research Foundation (SHRF) for the postdoctoral fellowship (Belotta). The authors also thank Dr. Shawn Mattson and the Moore Equine Veterinary Centre for participating in this study.

References

First Hybrid Convention in Canada for the Veterinary Profession

Times are changing, and so is the CVMA Convention

The CVMA is pleased to offer in-person and virtual passes for 2021. The Program will have over 110 hours of continuing education for you to attend either in Calgary or from the comfort of your home.

EARLY BIRD REGISTRATION CLOSES APRIL 30 2021

canadianveterinarians.net
Equations used to develop commercial dog food feeding guidelines and Canadian owner feeding practices in 2018

Katja A. Sutherland, Cara Cargo-Froom, Adronie Verbrugghe, Anna Kate Shoveller

Abstract — Feeding guidelines on commercial dog food packages provide a suggested starting point for food provision for dogs. The equations used to develop commercial dog food feeding guidelines and the owner feeding practices surveyed were examined in this study. The equations used to develop feeding guidelines and the energy density calculation method (Traditional Atwater or Modified Atwater equation) were investigated for 200 dry dog foods sold in Canada. Not all energy densities of products were calculated using the modified Atwater equation, a requirement if claiming compliance with the Association of American Feed Control Officials (AAFCO). Commercial feeding guidelines provide conservative estimates of pet dog energy needs. A survey of dog owners’ feeding practices was conducted, with 739 responses analyzed. Respondents generally took appropriate action to manage the weight of their dogs through both exercise and dietary management. Further investigation should explore how owners may be successfully managing their dogs’ weight without veterinary supervision.

Introduction
Dog obesity is a growing concern, with some estimates placing over 50% of the pet dog population in different geographical areas in this weight category (1). Maintaining a healthy body weight throughout life is key to preventing adverse health outcomes associated with obesity, such as diabetes and osteoarthritis (1). Quality of life and longevity may also be improved by preventing or treating obesity (2,3). Sufficient food provision is important to ensure lack of malnutrition and nutrient deficiencies resulting from underfeeding or a nutrient dilute diet formulation. Underweight dogs may also have a shorter survival time from the time of diagnosis of certain conditions compared to ideal weight or overweight dogs; lean body mass, however, improves survival time (4–6). The type and quantity of food that owners feed plays a role in a dog’s body weight throughout life. Understanding the owner’s influence on the maintenance of healthy body weight in dogs is critical for identifying what

Department of Animal Biosciences, Ontario Agricultural College (Sutherland, Cargo-Froom, Shoveller); Department of Clinical Studies, Ontario Veterinary College (Verbrugghe), University of Guelph, Guelph, Ontario N1G 2W1.

Address all correspondence to Dr. Anna Shoveller; e-mail: ashovell@uoguelph.ca

Dr. Verbrugghe is the Royal Canin Veterinary Diets Endowed Chair in Canine and Feline Clinical Nutrition at the Ontario Veterinary College.

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.
potential avenues exist to prevent and treat obesity; however, few investigations exist for dogs in Canada.

Pet foods sold in Canada must comply with the Consumer Packaging and Labelling Act and the Competition Act, and all nutritional adequacy claims should be substantiated. The Guide for the Labelling and Advertising of Pet Foods further details specific labelling standards, but these are not law and can be adopted voluntarily. The Association of American Feed Control Officials (AAFCO) uses the modified Atwater factors to calculate caloric density of pet foods; therefore, any pet food products with an AAFCO claim should also use this algorithm. The European Pet Food Industry Federation (FEDIAF), in contrast, uses the Atwater equation. There are other well-accepted methods of predicting energy density of pet foods (7–11).

In addition to the accurate prediction of caloric density, accurate prediction of energy requirements is used to predict food allowances. The algorithms used to predict energy requirements and then calculate food allowances, however, are not regulated by AAFCO and companies can use different algorithms depending on what the diet is intended for. A meta-analysis conducted by Birmingham et al (12) further highlighted the variation in maintenance requirements of adult dogs. Most pet dog owners feed their pets a commercial diet (13,14), so it is critical to develop sufficiently accurate systems for determining the energy density of food as well as the appropriate recommended intakes to maintain a healthy body weight. The United States National Research Council (11) presented many possible equations to predict the energy requirements of dogs based on factors such as age, breed size, housing, and activity.

The first objective of the study herein was to determine the methods used to calculate metabolizable energy density and feeding guidelines for Canadian commercial dry dog foods. We expected that all products would be calculating metabolizable energy density using the modified Atwater factors. Equations used to develop feeding guidelines for weight control and senior/low activity diets were expected to use lower energy requirement algorithms, while foods intended for active dogs would use moderate to high energy requirement algorithms. Finally, we predicted that energy equations used to develop feeding guidelines differ based on dog size and activity level but are not specific to particular breeds. The second objective was to explore the feeding practices of dog owners and gain insight into owners’ overall attitudes about weight management in dogs. We hypothesized that Canadian owners would be engaging in practices that are potential contributors to dog obesity.

### Materials and methods

#### Pet food product analysis

A review of dog food brands was conducted, with purposive selection of Canadian manufactured foods that had an AAFCO nutritional adequacy statement on the bag and at least 1 product per brand that met the inclusion criteria. Manufacturer and brand websites were used to collect information on the metabolizable energy content of foods, guaranteed analysis, and feeding guidelines for each product. Only extruded kibble and baked dry foods were considered. Products designated for a particular life stage or purpose (e.g., senior, toy breed, all life stages) were included. Weight control diets intended to maintain animals prone to weight gain were included, but diets explicitly for weight loss purposes were excluded. Therapeutic diets or veterinary exclusive foods were excluded to represent the range of products available to consumers that do not require veterinary oversight. Puppy diets were excluded.

The guaranteed analysis of each product was used to calculate the metabolizable energy content using the modified Atwater factors (15):

$$\text{Metabolizable energy} = [(3.5 \times \text{crude protein}) + (8.5 \times \text{crude fat}) + (3.5 \times \text{nitrogen-free extract})] \times 10$$

and traditional Atwater factors (16):

$$\text{Metabolizable energy} = [(4 \times \text{crude protein}) + (9 \times \text{crude fat}) + (4 \times \text{nitrogen-free extract})] \times 10$$

equations. Ash content of all diets was assumed to be 7% unless specified in the guaranteed analysis. The metabolizable energy stated on the product packaging was compared to both calculated metabolizable energy values. The percent error between the calculated and stated metabolizable energy was determined. The calculation method that yielded the smaller percent error was the method used by the manufacturer. If neither estimate yielded a percent error $\leq 8\%$ the method of metabolizable energy calculation was considered as unknown. This criterion was chosen to avoid assigning a calculation method when there was a large difference between the stated and calculated metabolizable energy, while recognizing that the guaranteed analysis does not represent true analytical values but a range to accommodate for nutrient density differences, and will result in some error when used as the basis of the calculation.

To determine the energy requirement equations that were used to calculate feeding recommendations for each product, the lowest and highest body weight (kg) in the feeding guidelines and the corresponding recommended food intake (cups) were used. The metabolizable energy density reported on each product (kcal/cup) was multiplied by the cups of food recommended to obtain the recommended total dietary metabolizable energy

### Table 1. Prevalence and frequency of use of 7 predictive equations for maintenance energy requirement as reported by the US NRC (11) to develop feeding guidelines for low and high body weight in 200 Canadian dry dog food products with a total of 584 recommended intakes.

<table>
<thead>
<tr>
<th>Equation label</th>
<th>US NRC equation (kcal/kg BW$^{0.75}$)</th>
<th>Usage for development of feeding guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low n (%)</td>
<td>High n (%)</td>
</tr>
<tr>
<td>E1</td>
<td>70</td>
<td>31 (10.7)</td>
</tr>
<tr>
<td>E2</td>
<td>95</td>
<td>60 (20.5)</td>
</tr>
<tr>
<td>E3</td>
<td>105</td>
<td>43 (14.7)</td>
</tr>
<tr>
<td>E4</td>
<td>130</td>
<td>55 (18.8)</td>
</tr>
<tr>
<td>E5</td>
<td>140</td>
<td>17 (5.8)</td>
</tr>
<tr>
<td>E6</td>
<td>180</td>
<td>15 (5.1)</td>
</tr>
<tr>
<td>E7</td>
<td>200</td>
<td>6 (2.1)</td>
</tr>
<tr>
<td>CD$^a$</td>
<td>—</td>
<td>65 (22.3)</td>
</tr>
</tbody>
</table>

$^a$ CD — could not be determined. BW — body weight.
allowance. This recommended metabolizable energy intake (kcal/day) was compared to the metabolizable energy intakes suggested by the US NRC (11) metabolizable energy requirement equations (Table 1). The NRC equation that provided the closest value to the product's labeled value, determined by a percent error calculation, was considered the equation that was used. Some products present guidelines in columns for varying levels of activity of the pet (e.g., less/more, low, average/normal, high activity). Where this was observed, the guidelines for average or normal activity were used. If no equation provided a value ≥10% of that of the product it was considered an unknown method of calculation [could not be determined (CD)].

Pet owner survey
This study was approved by the University of Guelph Research Ethics Board (REB #18-03-015). The survey included 36 multiple choice questions which were grouped by owner demographics and household makeup (9 questions); exercise routines of the dog(s) (3 questions); feeding practices (16 questions); and owner perceptions of body weight and self selection of their dog’s body condition score (BCS) based on pictographs (17) (7 questions). The first survey question was the consent form, which allowed agreeing participants to access the questions. Respondents were recruited between April 28 and July 8, 2018, inclusively. The online link to the survey was posted to social media and circulated by e-mail. Sharing of the link was encouraged. At no point was personal information collected, and respondents could withdraw from the survey or choose to not answer questions at any time. Respondents were required to be at least 18 y old and the owner of at least 1 dog.

Statistical analysis
Descriptive statistics for each question were reported as number of respondents per question, as well as actual counts and percentage of responses for each answer within each question. Data were analyzed with SAS software (version 9.4; SAS Institute, Cary, North Carolina, USA). The PROC FREQ command was used to analyze each question. A Chi-squared ($X^2$) test was used to compare predicted and actual values; predicted values were considered equal across all available options. Significance was declared at $P < 0.05$.

Results

Pet food product analysis
Product selection. Two hundred products from 44 brands were included. All carried an AAFCO statement that claimed the product meets the established nutrient concentrations for the product's target AAFCO profile. Products were categorized based on the purpose specified on the product packaging as follows: maintenance or all life stages with no breed size specified (68 products), senior or weight management (47 products), toy or small breed (36 products), large or giant breed (35 products), performance (8 products), or breed specific (6 products).

Metabolizable energy. Four foods were excluded from the metabolizable energy analysis because the necessary information was not available online. Reported metabolizable energy content ranged from 2973 to 4820 kcal/kg. The modified Atwater equation was the most frequently used method of calculating metabolizable energy content and was used for 59.2% (116/196) of products. The traditional Atwater equation was used for 38.8% (76/196) of products, rather than the AAFCO endorsed modified Atwater equation. The method of metabolizable energy density determination was undetermined for 2% (4/196) of products, due to the percent error for both equations being ≥8% or the percent error for both equations being equal.

Feeding guidelines. All 200 products were included in the analysis of feeding guidelines. Some products provided feeding guidelines with a range of intakes for a single weight. This resulted in a total of 584 recommended intakes that were compared to the US NRC equation recommended intakes. Of the 7 equations, the most frequently used US NRC equation was

---

**Figure 1.** Percent usage of 7 predictive equations for maintenance energy requirements as reported by the US NRC (11) for development of feeding guidelines within each product category identified in a review of 200 Canadian dry dog food products. E – Equation used; CD – cannot determine the equation used.
Table 2. Overview of demographics reported by Canadian dog owners participating in an online survey about dog owner feeding practices.

<table>
<thead>
<tr>
<th>Question</th>
<th>Frequency</th>
<th>Prevalence</th>
<th>X²</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q3. How many dogs do you own? (n = 739)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. 1</td>
<td>408</td>
<td>55.21</td>
<td>95.53</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. 2</td>
<td>200</td>
<td>27.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. 3</td>
<td>73</td>
<td>9.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. 4</td>
<td>36</td>
<td>4.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. 5+</td>
<td>22</td>
<td>2.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q4. With which gender do you predominantly identify? (n = 738)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Male</td>
<td>116</td>
<td>15.72</td>
<td>175.33</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. Female</td>
<td>601</td>
<td>81.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Non-binary or gender non-conforming</td>
<td>14</td>
<td>1.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Prefer not to say</td>
<td>7</td>
<td>0.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q7. What is your highest level of education? (n = 739)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. No schooling received</td>
<td>0</td>
<td>0.00</td>
<td>69.83</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. Some elementary school but no high school</td>
<td>0</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Some high school but no diploma</td>
<td>13</td>
<td>1.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. High school diploma or equivalent</td>
<td>64</td>
<td>8.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Vocational training</td>
<td>11</td>
<td>1.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Some college but no degree</td>
<td>63</td>
<td>8.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G. Some university but no degree</td>
<td>51</td>
<td>6.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H. College diploma</td>
<td>192</td>
<td>25.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. Bachelor’s degree</td>
<td>215</td>
<td>29.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>J. Master’s degree</td>
<td>82</td>
<td>11.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K. Doctoral degree</td>
<td>48</td>
<td>6.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q8. How many adults (18 years of age or over) reside in your household? (n = 737)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. 1</td>
<td>89</td>
<td>12.08</td>
<td>88.10</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. 2</td>
<td>483</td>
<td>65.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. 3</td>
<td>100</td>
<td>13.57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. 4+</td>
<td>65</td>
<td>8.82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q9. How many children (17 years of age or under) reside in your household? (n = 736)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. 0</td>
<td>545</td>
<td>74.05</td>
<td>187.30</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. 1</td>
<td>90</td>
<td>12.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. 2</td>
<td>75</td>
<td>10.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. 3</td>
<td>23</td>
<td>3.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. 4+</td>
<td>3</td>
<td>0.41</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

X² — Chi-squared.

E2 (24.7%; 144/584), followed closely by E3 (22.8%; 133/584); 19.9% (116/584) of the equations used were undeterminable. For low body weights specifically, the highest percentage of equations (22.3%; 65/292) was undeterminable, and the most frequently used equations were E2 (20.5%; 60/292) followed by E4 (18.8%; 55/292). For high body weights, the most frequently used equations were E3 (30.8%; 90/292) and E2 (28.8%; 84/292) (Table 1). Figure 1 shows the percentage use of each equation within each product category.

Pet owner survey
The results presented are based on data from the Canadian respondents (n = 739). The remaining respondents were non-Canadian (total N = 1032). Response totals vary per question as not all questions applied to all respondents, and partially completed surveys were analyzed.

Owner and pet demographics (Table 2). Most respondents identified as female (601/738; P < 0.0001; Q4) and owned 1 dog (408/739; P < 0.0001; Q3). Respondents were generally well-educated, with over 70% of respondents holding a college diploma or higher degree (537/739; P < 0.0001; Q7). Respondents primarily resided in households with 2 adults (483/737; P < 0.0001; Q8) and no children (545/736; P < 0.0001; Q9).

Exercise routines (Table 3). Most respondents’ dogs did not participate in organized or judged events (499/820; P < 0.0001; Q13). For daily exercise, owners most frequently reported that dogs received 30 to 60 min of walking (195/729), followed by 30 to 60 min of off-leash play (155/729; P < 0.0001; Q11). Approximately 1% of respondents report that their dog(s) received no outdoor exercise on an average day (7/729; P < 0.0001; Q12). Respondents largely considered their dogs to be “moderately active” (360/724; P < 0.0001; Q13).

Feeding practices (Table 4). Over 63% of survey respondents reported feeding their dog(s) at least some kibble (461/723; P < 0.0001; Q14), and of those that fed another kind of food in addition to kibble, a homemade diet was the most common (54/179; P = 0.0142; Q15). For owners who reported feeding no kibble at all, over 46% fed a commercial raw diet instead (121/261; P < 0.0001; Q16). Owners most frequently
responded “other” when asked how they decide the quantity of food to provide (258/713; \( P < 0.0001; Q24 \)), with the second most frequent response being that they did use the feeding guidelines on the product packaging (188/713; \( P < 0.0001; Q24 \)). Most respondents reported measuring the food provided (636/633; \( P < 0.0001; Q22 \)) and of those, most used some form of measuring cup (381/633; \( P < 0.0001; Q23 \)). Weighing food on a scale was the second most common measuring method (157/633; \( P < 0.0001; Q23 \)). Most owners reported that they adjusted the amount of food provided according to their dog’s weight (573/708; \( P < 0.0001; Q28 \)). Nearly 94% of respondents report feeding treats or table scraps at least occasionally (662/708; \( P < 0.0001; Q29 \)), but almost half report not adjusting the amount of food offered in a day when these are provided (307/654; \( P = 0.0155; Q30 \)).

**Table 3.** Overview of the exercise habits of dogs reported by Canadian dog owners participating in an online survey about dog owner feeding practices.

<table>
<thead>
<tr>
<th>Question</th>
<th>Frequency</th>
<th>Prevalence</th>
<th>( X^2 )</th>
<th>( P )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q11. For an average day, what would be the dominant exercise that your dog(s) perform(s)? If you have multiple dogs that perform different amounts of exercise, choose the level of exercise performed by the most active dog. (( n = 729 ))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Less than 30 minutes of walking</td>
<td>90</td>
<td>12.35</td>
<td>64.56</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. 30–60 minutes of walking</td>
<td>195</td>
<td>26.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. More than 60 minutes of walking</td>
<td>81</td>
<td>11.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Less than 30 minutes of jogging</td>
<td>0</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. 30–60 minutes of jogging</td>
<td>20</td>
<td>2.74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. More than 60 minutes of jogging</td>
<td>4</td>
<td>0.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G. Less than 30 minutes of off-leash play</td>
<td>42</td>
<td>5.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H. 30–60 minutes of off-leash play</td>
<td>155</td>
<td>21.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. More than 60 minutes of off-leash play</td>
<td>135</td>
<td>18.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>J. No outdoor exercise</td>
<td>7</td>
<td>0.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q12. Do(es) your dog(s) perform any of the following physical activities regularly (at least once a week when the activity is in season)? Select all those that may apply. (( n = 820 ))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Agility training</td>
<td>99</td>
<td>12.07</td>
<td>193.35</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. Herding</td>
<td>15</td>
<td>1.83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Racing</td>
<td>11</td>
<td>1.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Sled-pulling</td>
<td>13</td>
<td>1.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Hunting/Retrieval</td>
<td>38</td>
<td>4.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Other</td>
<td>145</td>
<td>17.68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G. None of the above</td>
<td>499</td>
<td>60.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q13. How active do you consider your dog(s)? If you have multiple dogs that vary in activity level, choose the level of activity of the most active dog. (( n = 724 ))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Inactive</td>
<td>37</td>
<td>5.11</td>
<td>40.94</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. Slightly active</td>
<td>152</td>
<td>20.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Moderately active</td>
<td>360</td>
<td>49.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Highly active</td>
<td>175</td>
<td>24.17</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( X^2 \) — Chi-squared.

Discussion

It was surprising that not all brands appear to use the modified Atwater method to calculate energy density, the only AAFCO approved method of calculating energy density, despite carrying an AAFCO statement on the label. The alternative is to determine the energy density through feeding trials. Both methods have inaccuracies, but the application of a standard method across the industry, either a calculation or experimental protocol, minimizes the ability to make superiority claims in addition to making it easier for owners to compare products and make informed decisions about their pet’s diet.

Due to the error generated when calculating energy density from the guaranteed analysis provided maximum and minimum values rather than analytical values from the proximate analysis, we assumed that larger percent differences between...
Q24. Do(es) your dog(s) receive any commercial treats (e.g., dental chews)? (n = 723)
   A. Yes, solely dental chews 282 39.00 28.53 < 0.0001
   B. Yes, majority dental chews 133 18.40
   C. Yes, minority dental chews 46 6.36
   D. No 262 36.24

Q28. When feeding your dog(s), do you: (n = 771)
   A. Free-feed (no measuring) 149 20.00
   B. Measure the food given 522 70.62
   C. Other 90 12.17

Q30. If on a given day you have provided treats or table scraps in addition to their regular diet, do you then change the amount of the regular diet offered that day? (n = 654)
   A. Yes 192 29.30 27.55 < 0.0001
   B. No 356 53.68
   C. Unsure 106 15.76

Table 4. Overview of owner reported diet provision and typical feeding practices of Canadian dog owners participating in an online survey about dog owner feeding practices.

<table>
<thead>
<tr>
<th>Question</th>
<th>Frequency</th>
<th>Prevalence</th>
<th>$X^2$</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q14. Do you feed your dog(s) a commercial dry dog food (kibble)? (n = 723)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Yes, solely kibble</td>
<td>282</td>
<td>39.00</td>
<td>28.53</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. Yes, majority kibble</td>
<td>133</td>
<td>18.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Yes, minority kibble</td>
<td>46</td>
<td>6.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. No</td>
<td>262</td>
<td>36.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q15. What do you feed your dogs in addition to kibble? (n = 179)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Commercial canned (wet) food</td>
<td>43</td>
<td>24.02</td>
<td>12.46</td>
<td>0.0142</td>
</tr>
<tr>
<td>B. Veterinarian-prescribed diet (dry or wet)</td>
<td>16</td>
<td>8.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Commercial raw diet</td>
<td>31</td>
<td>17.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Homemade diet</td>
<td>54</td>
<td>30.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Other</td>
<td>35</td>
<td>19.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q16. Which of the following do you feed your dogs (if you do not feed kibble)? (n = 261)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Commercial canned (wet) food</td>
<td>1</td>
<td>0.38</td>
<td>60.26</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. Veterinarian-prescribed diet (dry or wet)</td>
<td>56</td>
<td>21.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Commercial raw diet</td>
<td>121</td>
<td>46.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Homemade diet</td>
<td>59</td>
<td>22.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Other</td>
<td>24</td>
<td>9.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q17. How frequently is/are your dog(s) fed? (n = 721)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Once daily</td>
<td>69</td>
<td>9.57</td>
<td>199.95</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. Twice daily</td>
<td>550</td>
<td>76.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Three times daily</td>
<td>45</td>
<td>6.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. More than three times daily</td>
<td>7</td>
<td>0.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Food is always available</td>
<td>50</td>
<td>6.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Other</td>
<td>0</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q22. When feeding your dog(s), do you: (n = 716)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Free-feed (no measuring)</td>
<td>76</td>
<td>10.61</td>
<td>140.11</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. Measure the food given</td>
<td>636</td>
<td>88.83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Other</td>
<td>4</td>
<td>0.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q23. When measuring food, do you: (n = 633)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Measure using a non-scaled scoop or bowl</td>
<td>58</td>
<td>9.16</td>
<td>74.24</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. Measure using a measuring cup</td>
<td>381</td>
<td>60.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Weigh the food on a scale</td>
<td>157</td>
<td>24.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Other</td>
<td>37</td>
<td>5.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q24. How do you decide how much food to offer your dog(s)? (n = 713)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Veterinarian recommendation</td>
<td>133</td>
<td>18.65</td>
<td>27.70</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. Breeder recommendation</td>
<td>42</td>
<td>5.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Feeding guidelines printed on the bag or can</td>
<td>188</td>
<td>26.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Online food calculator</td>
<td>82</td>
<td>12.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Other</td>
<td>258</td>
<td>36.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q28. Do you alter the amount of regular diet given to your dog(s) based on the body weight of your dog(s)? (n = 708)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Yes</td>
<td>573</td>
<td>80.93</td>
<td>103.54</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. No</td>
<td>104</td>
<td>14.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Unsure</td>
<td>31</td>
<td>4.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q29. Do(es) your dog(s) receive any commercial treats or table scraps in addition to their regular diet? (n = 708)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Never</td>
<td>46</td>
<td>6.50</td>
<td>27.55</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. Rarely</td>
<td>128</td>
<td>18.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Sometimes</td>
<td>275</td>
<td>38.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Often</td>
<td>119</td>
<td>16.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Daily</td>
<td>140</td>
<td>19.77</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$X^2$ — Chi-squared.
calculated and stated metabolizable energy are due to differences in the diet’s fat content, as fat is the largest contributor to the traditional and modified Atwater equations. Three products’ traditional Atwater calculation and 10 products’ modified Atwater calculation, calculated from the products’ guaranteed analysis, exactly matched the metabolizable energy content stated on the package (0% error). This is interesting because the average analytical results of the nutrient concentrations should be used for these calculations, not the values provided in the guaranteed analysis. Using the maximum and minimum values may introduce more error and give an inaccurate estimate of the metabolizable energy content compared to the analytical values.

Generally, feeding recommendations could be determined from the energy density on packaging and the estimated daily energy requirement of dogs. For most recommendations, it was clear which US NRC equations had been used in development. Percent errors at higher body weights were often larger compared to the lower body weights. The reason for this is unclear, but it could be that alternate equations and exponents are being used at higher body weights, as some US NRC equations may underestimate energy requirements (12).

Overall, it appears that the equations most frequently used to develop feeding guidelines are those that provide a low to moderate estimate of maintenance energy requirements for a given body weight. It was expected that performance products

<table>
<thead>
<tr>
<th>Question</th>
<th>Frequency</th>
<th>Prevalence</th>
<th>X²</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q31. How important is it to you that your dog(s) remain(s) at a particular recommended weight? (n = 705)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Not at all important</td>
<td>9</td>
<td>1.28</td>
<td>112.74</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. Slightly important</td>
<td>42</td>
<td>5.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Moderately important</td>
<td>171</td>
<td>24.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Very important</td>
<td>483</td>
<td>68.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q32. If your dog(s) were to become overweight, would this concern you? (n = 705)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Not at all</td>
<td>2</td>
<td>0.28</td>
<td>149.16</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. Slightly</td>
<td>29</td>
<td>4.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Moderately</td>
<td>135</td>
<td>19.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Very much</td>
<td>539</td>
<td>76.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q33. If your dog(s) were to become underweight, would this concern you? (n = 706)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Not at all</td>
<td>1</td>
<td>0.14</td>
<td>155.48</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. Slightly</td>
<td>25</td>
<td>3.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Moderately</td>
<td>132</td>
<td>18.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Very much</td>
<td>548</td>
<td>77.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q34. If your dog(s) appeared to have gained weight, would you or those in your household do any of the following? Select all that may apply. (n = 1764)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Provide fewer treats or table scraps</td>
<td>489</td>
<td>27.72</td>
<td>39.24</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. Provide less of the regular diet</td>
<td>405</td>
<td>22.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Change diets</td>
<td>98</td>
<td>5.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Seek veterinary advice</td>
<td>236</td>
<td>13.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Change the exercise routine of the dog</td>
<td>497</td>
<td>28.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Other</td>
<td>39</td>
<td>2.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q35. If your dog(s) appeared to have lost weight, would you or those in your household do any of the following? Select all that may apply. (n = 1278)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Provide more treats or table scraps</td>
<td>64</td>
<td>5.01</td>
<td>78.03</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. Provide more of the regular diet</td>
<td>468</td>
<td>36.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Change diets</td>
<td>144</td>
<td>11.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Seek veterinary advice</td>
<td>483</td>
<td>37.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Change the exercise routine of the dog</td>
<td>74</td>
<td>5.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Other</td>
<td>45</td>
<td>3.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q36. Please select the image that best represents the body shape of your dog(s). Choose multiple if necessary, for multiple dogs. (n = 694)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. BCS 3</td>
<td>317</td>
<td>36.90</td>
<td>64.99</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>B. BCS 7</td>
<td>94</td>
<td>10.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. BCS 9</td>
<td>70</td>
<td>8.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. BCS 10</td>
<td>19</td>
<td>2.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. BCS 5</td>
<td>359</td>
<td>41.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

X² — Chi-squared, BCS — Body condition score.
would use the highest estimating maintenance energy requirement equations, but this was not observed. Senior/weight management products infrequently used equations that provided a high estimate of energy requirements (E5, E6, E7), which is in line with products promoting a lower calorie intake. The equations used to develop feeding guidelines do not appear to be influenced by what breed size the product is marketed for. Together, these data suggest that dog food product labels are typically providing a conservative estimate of maintenance energy requirements that should be a reasonable starting point for food provision, as labels state. It is possible that the industry compensates for the modified Atwater method under-predicting energy density by using lower predictions for maintenance energy requirements. If this were the case, the feeding guidelines provided may indeed be very close to meeting the actual maintenance energy requirements of pet dogs. It has been noted that the process behind label feeding recommendations is inexact, resulting in a large variability (18). Any feed intake is a starting point and should be adjusted based on reassessment of body weight and body condition score and health outcomes (19).

The goal of this survey was to gain insight into the feeding practices of dog owners and their perceptions of their dogs’ body weight and body condition score. The responses show that owners' reported concern for maintaining their dogs at an appropriate weight do align with the adjustments owners report that they would make to food, treat, and exercise provision if their dog(s) gained weight. Although respondents reported that they would be very concerned if their dog(s) became overweight, many would not prioritize seeking veterinary advice. This differs from previous findings indicating owners would seek veterinary advice first and are reluctant to decrease food or treat provision, which was veterinarians’ top advice (20,21). It also suggests that respondents understand the relationship between food, exercise, and their dog's weight, and that they might feel confident addressing weight gain themselves before visiting a veterinarian.

Estimates are limited for a Canadian context, but the prevalence of dog obesity observed in this study, as based on owner report of body condition score, is much lower than what has been observed previously in other countries (22,23). Asking owners to choose the body condition score of their animal using a body condition score chart introduces several potential issues. Recall bias is possible if the dog is not present while the owner completes the survey, and inaccuracies may result from the dog's shape differing from that in the pictographs. Owners are generally unreliable when estimating body condition score, even when using a body condition score chart (24). Underestimating or normalizing their dog’s body condition score may be indicative of an owner’s unwillingness to acknowledge obesity (24). One study showed that body condition score was accurately assessed by only half of dog owners, and 78% of those who incorrectly assessed had underestimated (18). Therefore, it is likely that at least some respondents underestimated their dog’s body condition score to result in the unexpectedly high proportion of dogs given a score of 3 or 5, especially considering dogs at a body condition score of 3 are in the underweight category. However, a body condition score of 3 is not necessarily a concern for sporting dogs, and it is possible that some respondents understand the value of being lean. It is also important to note that the circulation of this survey was done primarily via colleagues at the University of Guelph or social media groups that targeted owners of specific purebred dogs. Possibly, this method of distribution introduced a selection bias towards respondents who were more educated, and potentially more knowledgeable about and invested in their pet’s health. Owners in this study, however, placed a high importance on maintaining a healthy weight for their dogs, suggesting that they are largely appropriately managing their dog’s BCS in the home.

Nearly half of the respondents rated their dog(s) as moderately active, although we did not provide a description of this activity level out of interest in owners’ personal perception of dog activity. The high response rate for 30 to 60 min of off-leash play may encompass activities of widely varying intensity that owners interpret as off-leash play. Dogs with free yard access are prone to obesity (21), suggesting that owners inaccurately estimate or simply do not observe the actual amount of activity such dogs are voluntarily undertaking. A survey of Calgary dog owners found that while dogs living in attached housing, such as apartments, were walked more frequently than dogs with yard access, 43% of owners spent less than 150 min a week walking their dog, and very few owners exercise their dog at the level recommended for a given breed (25). Smaller breeds may be exercised less than medium or large breeds due to a lower perceived exercise requirement (26). In addition, product labels may provide feeding guidelines based on the activity level of the dog to be fed, for instance, “less active” and “more active,” a common observation in the feeding guidelines component of this study. When guidelines are presented in this way, owners may be led to overfeed due to an incorrect assessment of their dog’s true activity level.

Less than a third of respondents reported using feeding guidelines on a product package to determine how much to feed their dog. Of the options listed, veterinarian advice was the second most frequent way to determine how much food to give, unlike in other studies in which veterinarians were the primary source of nutritional information for owners (13,27). However, it is possible that veterinarians are not always emphasizing the importance of a healthy body weight out of discomfort addressing what is seen as a sensitive topic (28,29). A lack of body weight or body condition score discussion between client and veterinarian may prompt clients to seek information from less reputable sources or lead to a misunderstanding of the relationship between body weight and their dog’s overall health. The highest portion of respondents selected “other” when asked how they decide how much food to give, but it is unclear what these other methods are. It is possible this category includes such sources as the advice of other owners or pet retail staff, the Internet, adjusting food provision based on observation, or simply perceiving the dog as being hungry. Our survey, however, did not request this information. Future investigation should focus on the methods owners do use to determine how much to feed their dogs. Feeding a dog is often seen as a way to strengthen the human-animal bond, whereas denying food is viewed as a denial
of love (30). Indeed, owner reluctance to enroll in weight loss programs for their dogs has been attributed to an unwillingness to withhold food (24), highlighting the importance of owner engagement in the success of any veterinarian-prescribed weight management plan.

Although it is promising that most owners reported measuring their dogs’ food, many used a measuring cup to do so. It is easy to overestimate the portion size by up to 80% using a measuring cup, and this is exacerbated for smaller dogs with smaller food and energy requirements (31). Even greater inaccuracy, up to 152% overestimation, has been recently reported (32). Scales that measure grams are more accurate and allow easy adjustments to portions. This is important for dogs maintaining their weight, and to ensure dogs which need to lose weight are doing so at a healthy rate. About 25% of respondents in this study claim to use a scale, corresponding to the high value these owners place on keeping their dogs at an ideal weight. If owners know the daily food intake that their dog requires, this is an excellent option. However, for some owners who rely on feeding guidelines, knowing this food intake in grams may be difficult if the guidelines are only presented in cups. Many product packages offer feeding guidance in both grams and cups, but this is not always the case, and may present a challenge for owners who might be willing to make the switch to a scale but are unsure about how.

Respondents indicated a preference for feeding twice daily, perhaps contributing to the higher than anticipated proportion of dogs identified at an ideal body condition score (21). However, most respondents reported providing treats or table scraps at least sometimes, without adjusting that day’s portion of regular diet to account for extra calories. This estimate aligns with previous reports that nearly all dog owners provide some form of treats some of the time (13,20). Providing treats without altering the regular diet portion is a risk factor for dog obesity (31,33). This sample of owners did, however, claim to alter regular food provision based on their dog’s body weight, suggesting awareness of the need to balance energy intake and expenditure for weight maintenance.

In summary, respondents to this survey tended to place high value on maintaining a healthy body weight and body condition score for their dogs and claimed that they would take appropriate actions such as reducing treats, increasing exercise, or reducing food provision to combat weight gain, indicating awareness of the importance of healthy animal body weight. Canadian owners also appear to primarily be using sources other than commercial feeding guidelines and veterinary advice to determine how much food their dogs require. Investigation into what these specific methods are is important to determine how owners may successfully manage the BCS and overall health of their pets. Further studies should consider focusing on dog owners’ perceptions of pet food company feeding recommendations to determine the relationship these attitudes may have to pet health. Finally, we conclude that currently pet food companies are overall using the energy equations most practical for the dogs intended to be fed, but that there are instances of noncompliance with AAFCO regarding the method of calculating the energy density of the food.

Sondage économique auprès des propriétaires d’établissements: 3 raisons pour le soumettre

Les sondages génèrent gratuitement des rapports d’analyse comparative du rendement sur les revenus, les dépenses, les heures travaillées, les tarifs, le personnel et plus encore. Ces services coûtent des milliers de dollars ailleurs (p. ex., aux États-Unis). Tout ce qu’il faut au Canada est de soumettre un sondage.

1. Guide annuel des tarifs suggérés: Vos données aident à estimer les frais provinciaux requis pour couvrir les frais généraux et gagner votre revenu.
2. Rapport diagnostique individuel pour l’établissement: Prenez connaissance de la situation de votre clinique en ce qui a trait au budget, aux employés, aux tarifs et plus encore en consultant un rapport personnalisé confidentiel!
3. Estimation gratuite de la valeur de l’établissement: Découvrez la valeur de votre établissement aujourd’hui et d’une année à l’autre avec votre suivi de l’estimation de la valeur!

Vous trouverez des rapports économiques et des ressources pour la gestion d’une clinique ici: veterinairesaucanada.net/practice-economics/business-management
Evaluation of intravenous T-61 as a euthanasia method for birds
Bethany I. Baker-Cook, Antonietta L. Moritz, Danielle Zwueste, Karen Schwean-Lardner, Karen L. Machin

Abstract — The use of T-61 as a sole euthanasia agent for birds was investigated. Nine broiler chickens (Gallus gallus domesticus) were euthanized by intravenous T-61 and assessed for insensibility [brainstem reflexes: nictitating membrane reflex (NIC), palpebral blink reflex (PAL)], brain death [isoelectric electroencephalogram activity (EEG)], cessation of audible heartbeat, and abnormal electrocardiogram. Birds were considered dead when the heart rate was less than 180 beats/minute with an isoelectric EEG. No vocalization or wing flapping occurred. Both NIC and PAL were lost 10.5 s from start of injection and audible heartbeat ceased at 24.5 s. Latency to isoelectric activity was 16.6 s. All but 1 bird died within 60 s. Rapid induction of insensibility meant birds did not experience pain and distress within 10.5 s from start of injection and birds were not conscious during cardiac and circulatory arrest. Intravenous injection of T-61 is an effective and efficient euthanasia method for birds.

Résumé — Évaluation du T-61 intraveineux comme méthode d’euthanasie pour les espèces aviaires. La présente étude visait à évaluer l’utilisation du T-61 comme seul agent d’euthanasie pour les oiseaux. Neuf poulets de chair (Gallus gallus domesticus) ont été euthanasiés par injection intraveineuse de T-61 et évalués pour leur insensibilité [réflexes du tronc cérébral : réflexe de la membrane nictitante (NIC) et réflexe palpébral (PAL)], mort cérébrale [activité isoélectrique de l’électroencéphalogramme (EEG)], arrêt du rythme cardiaque audible et électrocardiogramme (ECG) anormal. Les oiseaux étaient considérés comme morts lorsque la fréquence cardiaque (ECG) était inférieure à 180 battements par minute avec un EEG isoélectrique. Aucune vocalisation ou battement d’aile ne s’est produit. Les réflexes NIC et PAL ont été perdus 10,5 s après l’injection et le rythme cardiaque audible a cessé à 24,5 s. La latence jusqu’à l’activité isoélectrique était de 16,6 s. Tous les oiseaux sauf un sont morts dans les 60 s. L’induction rapide de l’insensibilité signifiait que les oiseaux étaient incapables de ressentir de la douleur et de la détresse dans les 10,5 secondes suivant l’injection et que les oiseaux n’étaient pas conscients pendant un arrêt cardiaque et circulatoire. L’injection intraveineuse de T-61 est une méthode d’euthanasie efficace et efficiente pour les oiseaux.

Introduction
The word euthanasia is a Greek derivative of the terms good (eu) and death (Thanatos). In animals, it is implied that death occurs with minimal fear or pain (1). The American Veterinary Medical Association’s (AVMA) Guidelines for Euthanasia of Animals, Canadian Council on Animal Care (CCAC), Euthanasia of Animals used in Science, the European Commission Euthanasia of Experimental Animals, and the Minimum Standards for Wildlife Rehabilitation describe similar criteria for euthanasia: the euthanasia method should achieve rapid loss of consciousness and death, minimize stress and pain before unconsciousness, be reliable, irreversible, safe, and esthetically acceptable for the operator. These criteria apply to all species, including avian species. Published reports evaluating euthanasia methods in avian species are most often restricted to slaughter methods for commercially raised poultry; few exist on euthanasia of individual birds (1–3). Most accounts of euthanasia in birds, other than poultry, are in non-peer-reviewed
intravenous injection of a euthanasia solution (e.g., barbiturates and barbituric acid derivatives), as stated in the AVMA guidelines, is the only acceptable method that can be used without conditions in birds (1). There are other injectable solutions for euthanasia mentioned in the AVMA guidelines including potassium chloride, tributame, ultra-potent opioids, and T-61. T-61 is a nonbarbiturate, non-narcotic combination consisting of 3 compounds: embutramide (anesthetic), mebenzonium iodide (paralytic), and tetracaine hydrochloride (potent local anesthetic) (1,7). The anesthetic depresses cerebral activity, inhibiting consciousness and the respiratory control centers in the brain, whereas the curariform (paralytic) action of the drug induces circulatory and respiratory collapse (7,8), leading to death through hypoxia. Concerns with T-61 use are whether the paralytic actions occur before unconsciousness (1). Studies in dogs and rabbits have shown that loss of consciousness and motor activity occur at the same time, but that this can be influenced by rate of injection, producing situations in which dysphoria occurs (1,7,9,10). In addition, there are reports of muscular activity and vocalization during euthanasia with T-61 that have caused distress in personnel witnessing euthanasia, withdrawal of T-61 from the market in the United States (1,9), although T-61 is currently available in Canada and other countries (1). The CCAC guidelines (11) state that T-61 is not a recommended method of euthanasia in any species, although an animal care committee can approve its use. The CCAC guidelines emphasize that it should only be used intravenously, as there are concerns about the differential rates of absorption and onset of action of the active ingredients when administered by other routes (11). However, there is no cited research to support these claims. The AVMA lists T-61 as an approved euthanasia method for companion animals and wildlife; however, sedation before use is recommended (1).

Although the AVMA and CCAC guidelines promote the use of barbiturates and barbituric acid derivatives in birds, there are no published studies demonstrating that these drugs meet the criteria of a good death. There are anecdotal reports of vocalizing and wing and leg muscle activity after administering barbiturate euthanasia solution to a conscious bird (6), resulting in many practitioners using sedation or general anesthesia before euthanasia with pentobarbital (5,6). Alternatives to controlled barbiturates could be extremely beneficial for humane killing of poultry, wild birds, and within animal welfare facilities. T-61 offers these advantages, as it is a schedule III drug and therefore can be administered by non-veterinarians, veterinary technicians, and others, if they are appropriately trained (1). This drug has the potential to be used as a sole agent, whereas other injectable euthanasia solutions require prior use of a sedative or general anesthesia. These factors allow for immediate euthanasia in the field and wildlife rehabilitation situations, rather than prolonged suffering during transport to a veterinarian, making T-61 ideal for use in birds. In addition, T-61 is also more esthetic than many of the physical methods (7–9).

It is vital that euthanasia methods rapidly induce a loss of consciousness (insensibility). A conscious bird is aware and able to perceive and experience stimuli from within itself and its surroundings; these include negative states such as pain and distress (12,13). When rendered insensible, due to damage or disruption of the consciousness holding regions of the brain, consciousness is abolished, inhibiting the bird’s ability to experience negative effective states that may arise with euthanasia (14,15). To minimize potential suffering prior to unconsciousness, a short interval to insensibility is necessary. Brainstem reflexes, also called cranial reflexes, are tools used in research to evaluate insensibility (16–21). These reflexes, which include the palpebral blink and nictitating membrane reflex, evaluate the functional link between the cranial nerves and the brainstem (the consciousness holding region of the brain). If the brain stem functioning is impaired or disrupted, then the brainstem reflexes will be absent, indicating that the bird has been rendered insensible (13,22,23). A short interval to insensibility and brain death, before occurrence of respiratory and cardiac arrest, is required for death by intravenous T-61 injection to be a humane death.

This study was conducted to address the lack of scientific knowledge specific to the use of T-61 as a euthanasia agent in avian species. The hope was to dispel misinformation surrounding the use of T-61 in birds, as there is no published research with evidence supporting claims that T-61 is not an appropriate euthanasia agent for birds. The objective was to demonstrate that T-61 can be used to effectively euthanize an avian species, the broiler chicken, and with sufficient efficacy and efficiency to meet the criteria for a sole injectable agent for euthanasia.

Materials and methods

Animals

The University of Saskatchewan Animal Research Ethics Board approved the research (Protocol 19940248) and all birds were cared for as specified in the Canadian Council of Animal Care’s Guide to the Care and Use of Experimental Animals. Nine healthy 5-week-old mixed-sex broiler chickens (Gallus gallus domesticus) (mean weight: 1734 g) were used because research is available for comparative purposes. Birds were housed under commercial conditions recommended by the Aviagen management guide and fed a commercial broiler diet. All birds were tested on the same day.

Experimental procedure

Each bird was weighed individually and a 0.03 mg/kg body weight (BW) dose of T-61 (labeled dose for dogs) was calculated for each animal. The birds were placed on a towel and the electrocardiogram (ECG) and electroencephalogram (EEG) recording devices were placed as described subsequently. Birds were restrained manually in lateral recumbency and T-61 was injected into the right brachial vein. Injections were given slowly (6.1 ± 1.34 s, range: 4.5 to 8.4 s) with constant observation of the vein to ensure that the T-61 was not administered subcutaneously. Baseline ECG and EEG values were collected
for a minimum of 2 min before injection of T-61 and monitoring was continued after the end of injection until total cessation of cardiac activity on the ECG.

**Data collection**

*Reflexes.* Latency to insensibility was visually assessed using brainstem reflexes measured from start and end of T-61 injections to the time of their absence. The 2 brainstem reflexes assessed were the palpebral blink reflex and nictitating membrane reflex; these were assessed every 5 s. Palpebral blink reflex tested for a blink (closing of the eyelids) in response to the approach or touching of the cornea (22). The nictitating membrane reflex was tested for a blink (closing of the eyelids) in response to touching of the cornea (22). Brainstem reflexes were reassessed every 30 s to confirm absence of reflexes and to ensure reflexes did not return. When all brainstem indicators were absent, the brainstem was rendered non-functional and thus unable to maintain consciousness. The duration and latency to cessation of heartbeat was assessed by auscultation with a stethoscope (Littmann Classic, 3M; London, Ontario), with the lack of audible heartbeat recorded as the time of cessation of heartbeat. The birds were monitored for any activity such as vocalization, wing flapping, and muscle tremors or contractions. An ethogram with definitions of the reflexes is available in Table 1.

**Electroencephalogram.** The EEG recording electrodes, 27-gauge subcutaneous electrodes, were positioned immediately lateral to the comb and the reference electrodes were placed caudal to the external auditory meatus on the same side, in accordance with published techniques (24). The ground electrode was placed along the lateral aspect of the pelvis. Topical lidocaine (20 mg/mL; Zoetis Canada, Kirkland, Quebec), 1 or 2 drops, were applied to skin 10 min before electrode placement, to control pain.

Electroencephalograms were recorded using a portable neurodiagnostic system (Sierra Sumitt, Cadwell, Washington, USA). The high frequency filter was set to 100 Hz and the low frequency filter was set to 1 Hz. Baseline EEGs were recorded in all birds before the T-61 injection. Time to continuous isoelectric activity relative to the start and end of the injection was recorded in all birds. The EEG recordings were continued for a minimum of 10 s after isoelectric activity occurred, to ensure this was continuous and thus representative of brain death, and there was no sudden burst of high frequency activity after a transient period of isoelectric activity (24–26). Isoelectric activity was defined as the absence of observable positive or negative deflections from baseline, as determined by visual, qualitative assessment of recorded traces (24–27).

**Electrocardiogram.** Heart rate and electrical activity of the heart were monitored and recorded using Lead II with reusable ECG electrodes (MLA700) on a Powerlab system.

---

**Table 1.** Ethogram of reflexes and clinical indicators measured antemortem after T-61 injection.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Type of indicator</th>
<th>Meaning of indicator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palpebral blink</td>
<td>Cranial nerve V/VII</td>
<td>Brainstem dysfunction</td>
<td>Closing of eyelids (blinking) in response to approach or touching of cornea</td>
</tr>
<tr>
<td>Nictitating membrane</td>
<td>Cranial nerve V/IV</td>
<td>Brainstem dysfunction</td>
<td>Closure of the nictitating membrane in response to approach or touching of cornea and medial canthus</td>
</tr>
<tr>
<td>Cessation of heartbeat</td>
<td>Clinical indicator</td>
<td>Cardiac arrest</td>
<td>No audible heartbeat with auscultation</td>
</tr>
</tbody>
</table>

Adapted from references 13,21–23.

**Table 2.** Difference in latency to cessation of brainstem reflexes, audible heart beat and time to isoelectric activity (s) for 5-week-old broiler chickens (*Gallus gallus domesticus*) (N = 9) euthanized by intravenous T-61 injection.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean of difference</th>
<th>Standard deviation of difference</th>
<th>Standard error of difference</th>
<th>t-test</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>From start of injection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nictitating membrane</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isoelectric activity</td>
<td>−6.00</td>
<td>2.96</td>
<td>0.986</td>
<td>−6.09</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Heartbeat</td>
<td>−13.94</td>
<td>12.34</td>
<td>4.115</td>
<td>−3.39</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Palpebral blink</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isoelectric activity</td>
<td>−6.00</td>
<td>2.87</td>
<td>0.957</td>
<td>−6.27</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Heartbeat</td>
<td>−13.94</td>
<td>12.05</td>
<td>4.016</td>
<td>−3.47</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Heartbeat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isoelectric activity</td>
<td>7.94</td>
<td>13.17</td>
<td>4.389</td>
<td>1.81</td>
<td>0.11</td>
</tr>
<tr>
<td>From end of injection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heartbeat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isoelectric activity</td>
<td>8.70</td>
<td>13.05</td>
<td>4.350</td>
<td>2.00</td>
<td>0.08</td>
</tr>
</tbody>
</table>
and analyzed using LabChart 7.0 (AD Instruments, Colorado Springs, Colorado, USA). The ECG leads were attached to the patagium bilaterally and to the skin of the stifle joint on both legs, in accordance with published techniques (10). The skin and clips were covered with alcohol to enhance electrical conduction. Continuous ECG monitoring began before the injection of T-61, with the start and end times of injection recorded.

The ECG waveform data were analyzed using LabChart 7.0 (AD Instruments). Visual inspection of the ECG traces was used to determine normal and abnormal ECG, and heart rate in each bird. Heart rate was determined for each bird at 20, 40, 60, and 80 s. The ECG of 1 bird was removed from analysis of heart rate, as the trace was unreadable after 40 s. To determine heart rate, the waveforms were counted 5 s before the time stamp and multiplied by 12. Similar to the results of Coenen et al (28), the bird was considered to be dead when a heart rate less than 180 beats/min (bpm) measured by ECG was reached in conjunction with isoelectric EEG.

Statistical analysis
All reflex and clinical indicator data, and EEG data were checked for normality using the Shapiro-Wilk Normality test (PROC Univariate, SAS 9.4; SAS, Cary, North Carolina, USA) before analyses; none of the data were abnormal. Statistical comparison for differences between time to isoelectric activity, and to cessation of brainstem reflexes and audible heartbeat were performed using paired Student’s t-test via PROC t-test. Differences were considered significant when \( P \leq 0.05 \) and trends were noted when \( P \leq 0.10 \). Means and standard deviation were reported.

Results

Reflexes
No vocalization, wing flapping, muscle tremors, or contractions occurred during the experiment. The mean duration (as measured from start of injection) until occurrence of variables was nictitating membrane reflex ceased at 10.5 s (SD = 1.9, \( \bar{x} = 10 \), range: 8 to 13 s) and palpebral blink reflex at 10.5 s (SD = 1.9, \( \bar{x} = 10 \), range: 7 to 13 s), followed by the occurrence of continuous isoelectric activity at 16.5 s (SD = 1.9, \( \bar{x} = 17 \), range: 14 to 20 s), and the loss of audible heartbeat occurred at 24.5 s (SD = 13.2, \( \bar{x} = 25 \), range: 10 to 50 s).

Latency to the absence of nictitating membrane reflex was shorter than latency to isoelectric activity; \( t_w = -6.00 \text{ s, } P < 0.01 \) (Table 2). Similarly, the latency to absence of palpebral blink reflex was shorter than the latency to isoelectric activity; \( t_w = -6.00 \text{ s, } P < 0.01 \). The latencies of both nictitating membrane reflex and palpebral blink reflex were also shorter than the time to cessation of audible heartbeat; \( t_w = -13.94 \text{ s, } P < 0.01 \) and \( t_w = -13.94 \text{ s, } P < 0.01 \), respectively. A trend for a difference was seen for time from end of injection to isoelectric activity being shorter than the time from end of injection to cessation of audible heartbeat \((n = 8); \ t_w = 8.70 \text{ s, } P = 0.08 \).

Electroencephalogram
The mean duration of the baseline recording was 56 s (SD = 29.3, \( \bar{x} = 45 \), range: 29 to 126 s). The mean injection time was 6.9 s (SD = 1.8, \( \bar{x} = 7 \), range: 4 to 9 s). The mean time to continuous isoelectric activity from the start of the injection was 16.6 s (SD = 1.9, \( \bar{x} = 17 \), range: 14 to 20 s) and from the end of the injection was 9.7 s (SD = 2.1, \( \bar{x} = 10 \), range: 6 to 13 s). In 1 bird, the needle dislodged from the vein during the injection and the time to continuous isoelectric activity from the end of the injection could not be determined. No burst of high frequency activity occurred after isoelectric activity was first recorded. A representative EEG recording is depicted in Figure 1.

Electrocardiogram
All birds were observed to have an abnormal ECG (including but not limited to widening of QRS interval, ST segment elevation, T-wave inversion) within 3 s after the end of T-61 injection. No recovery of normal ECG complexes occurred after the start of ECG abnormalities. Within 20 s after the end of injection, 2 out of 8 birds had a heart rate of \( \approx 180 \text{ bpm} \). At 40 s, 6 out of 8 birds had a heart rate of 180 bpm or less. By 60 s, all but 1 bird had a heart rate of \( \approx 180 \text{ bpm} \), and the remaining bird had a heart rate \( < 180 \text{ bpm} \) at 80 s post-injection.

Discussion
This study showed that intravenous injection of T-61 as a sole agent is an effective, fast, and humane euthanasia agent for an avian species. The brainstem was rendered non-functional and to cessation of brainstem reflexes and audible heartbeat were performed using paired Student’s t-test via PROC t-test. Differences were considered significant when \( P \leq 0.05 \) and trends were noted when \( P \leq 0.10 \). Means and standard deviation were reported.

Figure 1. Electroencephalogram recording of a 5-week-old broiler chicken during euthanasia with T-61. The recording from the left side of the skull (L) is above the recording from the right (R). The gray arrow indicates when the injection was started and the black arrow indicates when the injection was completed.
injection and within 10 s after completing the injection. This is similar to times reported in horses euthanized with pentobarbital sodium (25). Loss of nictitating and palpebral blink reflex occurred earlier than isoelectric activity, indicating that birds were insensible for a period before brain death. Audible heartbeat ceased by 25 s, after both insensibility and brain death had occurred, indicating that the birds were not conscious of the occurrence of cardiac arrest and circulatory collapse. All but 1 bird were considered dead within 60 s, with the final bird dead within 80 s (as measured by the most conservative measure of a heartbeat < 180 bpm). The depression action of T-61 initially renders the brainstem incapable of maintaining consciousness and then causes complete, irreversible cessation of cerebral activity, rendering vital centers non-functional. These actions occurred before the combined effect of depression and paralytic action causing the heart to stop. Furthermore, when assessing brain electrophysiologic activity during euthanasia with pentobarbital sodium in horses, Aleman et al (25) hypothesized that the continuous isoelectric pattern of the brain occurred before the absence of electrocardiogram activity, therefore suggesting that the euthanasia method would be an effective and humane procedure. Our results showed that the sustained isoelectric EEG of brain death occurred before the absence of ECG activity, implying that T-61 as a euthanasia method in birds is an effective and humane procedure. Some concern has been shown about the occurrence of paralysis with T-61. Muscle activity was not measured in our experiment; however, using EEG and electromyography (EMG), Hellebrekers et al (9) reported that loss of muscle activity and brain death occurred at the same time in dogs and rabbits that were euthanized by T-61. The authors concluded that the presence of the muscle relaxant in this drug was not an ethical problem (9).

When evaluating euthanasia methods, the AVMA Panel on Euthanasia takes many factors into consideration, including the emotional effects on observers or operators. Use of T-61 has been reported to cause distress to operators euthanizing dogs, and because of these concerns, the drug was withdrawn from the market in the United States (1). T-61 has also been reported to induce convulsions in larger birds or poultry following intravenous, intracardiac, intrapulmonary, or intramuscular administration (7,29). However, during this study, each bird was observed for activity that may cause undue distress to observers and operators such as vocalizations, wing flapping, convulsions, or tremors, but no bird showed any of these clinical signs during or after the administration of T-61. An overdose of T-61 has been suggested to lead to overexcitement and/or convulsions, in mammals (8). In the authors’ clinical experience, convulsions have not been observed in any species of bird euthanized by intravenous T-61 injection and better clinical efficacy has been noted with higher doses (closer to 0.4 to 0.5 mg/kg BW). It should also be mentioned that safe and appropriate disposal of carcasses previously euthanized with T-61 is necessary, as secondary toxicity can occur in animals that consume the remains of animals euthanized with T-61 (1). Accidental intoxication with T-61 can occur in humans, with oral ingestion having the potential to cause digestive disorders and coma associated with cardiorespiratory failure (9).

Previous studies have recorded brainstem auditory evoked responses (BAERs) during euthanasia rather than just relying on the EEG to indicate brain death (25). This is because many agents used in euthanasia, such as barbiturates and propofol, can cause transient periods of isoelectric activity, followed by periods of high frequency activity (burst suppression) (30), which could be mistaken for brain death. In our study, it was not possible to record concurrent BAERs due to the physical limitations of evaluating chickens. The recordings were continued for a minimum of 10 s after the isoelectric activity was first recorded; however, no subsequent bursts of activity were noted. Furthermore, T61 contains embutramide, a potent opioid agonist, rather than a gamma-aminobutyric acid (GABA) agonist such as propofol and barbiturates (9). It is thus reasonable to conclude that an absence of cerebral activity and thus brain death was truly achieved.

Electrocardiographic activity continued in all birds after conversion to isoelectric EEG and past the detection of audible heartbeat, although always with an abnormal rate, rhythm, or waveform. Paul-Murphy et al (3) reported similar findings when sparrows were euthanized by intravenous pentobarbital and intrathoracic compression. Aleman et al (25) suggested that ECG activity occurring after brain death and undetectable heart sounds represent ineffective contraction with no cardiac output. No birds were observed to have recovery of normal ECG complexes after the onset of ECG abnormalities. Laying hens euthanized by pentobarbital showed brain death, defined by continuous isoelectric activity, within 20 s of euthanasia attempt (31), whereas in our study T-61 isoelectric activity occurred within 16.5 s. When comparing time to brain death in poultry species, time to brain death was shorter when euthanized by T-61 than with pentobarbital (31). This has also been reported in other species, with the time to brain death, as measured by isoelectric activity, being shorter in dogs euthanized by T-61 than by pentobarbital (9). When compared within the same species, T-61 results in brain death earlier than pentobarbital. Notably, neither the terminal/agonal gasp nor the vocalizations or wing and leg muscle activity reported to occur with pentobarbital euthanasia were observed for birds euthanized with T-61 (6,7,32).

Thoracic compression, also called rapid cardiac compression, a field technique used to euthanize small birds, was recently recommended as an effective euthanasia method for small birds (33). However, brain death with thoracic compression takes 19.0 to 88.5 s depending on the species (3), whereas with T-61 brain death occurred 16.5 s from the start of injection. Therefore, T-61 results in brain death earlier than thoracic compression, indicating T-61 is a more efficacious euthanasia method for birds.

Compared to commonly used methods for euthanizing chickens on-farm, T-61 results in brain death faster than gaseous euthanasia or manual cervical dislocation (MCD). Gaseous euthanasia with nitrogen or a combination of nitrogen and carbon dioxide resulted in isoelectric activity after 48.9 s and 34.2 s (32), whereas MCD took 171 s to isoelectric activity (31). These are both longer than the 16.5 s to isoelectric activity noted with T-61 in our study. The times to absence of the nictitating membrane and palpebral blink reflex, indicators of insensitivity, for 5-week-old broiler chickens euthanized by
MCD were 25.3 and 14.5 s, respectively (34), which indicates that T-61 is more effective in inducing both insensibility and brain death than MCD. Another on-farm euthanasia method, a non-penetrating captive bolt (the Zephyr), is faster at inducing insensibility, with both brainstem reflexes lost within 1.8 s (34). However, this method has a longer time to death (126 s) than T-61, measured as the amount of time until total cessation of movement (34). It is important to recognize that loss of consciousness likely occurred before brain death was detected in both these previous reports and in the current study. Further comparative studies using methods such as spectral analysis are warranted to investigate the relationship between loss of consciousness relative to brain death in euthanasia protocols. Additionally, convulsion and/or wing flapping occur with Zephyr, MCD and gaseous euthanasia (34), but do not occur with T-61 injection. Convulsions can be unpleasant for the operator and thus should be a factor when choosing an appropriate euthanasia method. Convulsion can also affect the condition of the cadaver and tissues of the bird post-euthanasia, which needs to be considered if using the body or tissues for research or other purposes.

Using broiler chickens as a model species, this experiment demonstrated that T-61 is effective for use in birds. Despite there being great variation within avian species, the authors’ clinical experience has shown T-61 to be effective for euthanizing a wide range of birds including but not limited to neonate layer chicks, turkeys, waterfowl, psittacines, raptors, and passerines. Furthermore, due to the limited avian-specific research on medication, and the limited number of medications licensed for birds (much less that are species-specific), it is common practice for drug use to be extrapolated from mammals and among species of birds. As many medications and injectable euthanasia solutions, including pentobarbital, are extrapolated among avian species (1), the evidence of T-61 effectiveness from this study can be extrapolated to other avian species. The authors reiterate that to overcome species variability, when extrapolating among species, and to provide effective euthanasia, higher doses of T-61 are recommended. The dosage must be sufficient to produce anesthesia followed by death. Therefore, users are also advised to monitor birds for muscle relaxation, loss of brainstem reflexes, and indications of anesthetic overdose; cardiac and respiratory dysrhythmia followed by cessation, and pale to cyanotic mucous membranes and skin. Further research investigating genera or order specific dosages is recommended. To conclude, T-61 is a reliable method for preventing convulsion can also affect the condition of the cadaver and tissues of the bird post-euthanasia, which needs to be considered if using the body or tissues for research or other purposes.

Using broiler chickens as a model species, this experiment demonstrated that T-61 is effective for use in birds. Despite there being great variation within avian species, the authors’ clinical experience has shown T-61 to be effective for euthanizing a wide range of birds including but not limited to neonate layer chicks, turkeys, waterfowl, psittacines, raptors, and passerines. Furthermore, due to the limited avian-specific research on medication, and the limited number of medications licensed for birds (much less that are species-specific), it is common practice for drug use to be extrapolated from mammals and among species of birds. As many medications and injectable euthanasia solutions, including pentobarbital, are extrapolated among avian species (1), the evidence of T-61 effectiveness from this study can be extrapolated to other avian species. The authors reiterate that to overcome species variability, when extrapolating among species, and to provide effective euthanasia, higher doses of T-61 are recommended. The dosage must be sufficient to produce anesthesia followed by death. Therefore, users are also advised to monitor birds for muscle relaxation, loss of brainstem reflexes, and indications of anesthetic overdose; cardiac and respiratory dysrhythmia followed by cessation, and pale to cyanotic mucous membranes and skin. Further research investigating genera or order specific dosages is recommended. To conclude, T-61 is effective as well as efficient and is suitable as a sole euthanasia agent for avian species. When injected intravenously as the sole euthanasia agent, it rapidly induces insensibility and brain death, ensuring the bird is unable to experience pain, distress, and the occurrence of cardiac arrest and circulatory collapse, and reliably results in death.

Acknowledgments
The authors thank John Ching, and the Western College of Veterinary Medicine for their help with the experiment. Antonietta L. Moritz was funded by the Interprovincial Summer Student Award at the Western College of Veterinary Medicine.

References
34. Baker BI. Assessing the efficacy and welfare impact of euthanasia methods for broiler chickens [PhD dissertation]. Saskatoon, Saskatchewan, University of Saskatchewan, Saskatoon, Canada, 2019.

Book Review
Compte rendu de livre

Small Animal Surgery. 5th edition


This book is divided into 4 sections: general surgical principles, soft tissue surgery, orthopedics, and neurosurgery. The text has information that would be useful for veterinary students including principles of asepsis and information on surgical equipment, suture selection, and patterns. I would expect the book would become more useful upon graduation as a good resource for a new graduate and eventually as a more experienced veterinarian, when presented with a novel surgery.

As a general practitioner working in a rural area, previous editions of this book have been an excellent first stop when presented with a surgical case not previously encountered. Although changes between editions seem minimal, this book has been updated with new features. The most notable of these include a more detailed section on general rehabilitation procedures after surgery, which is then followed up by individual examples of rehabilitation programs for the more common orthopedic procedures. Another nice feature includes highlighted boxes outlining anesthetic considerations for many of the surgery classes. These boxes are easily located and include commonly associated conditions, anesthetic protocols with multiple drug options, and recommended monitoring. The boxes also include an estimate of anticipated pain score and some examples of appropriate analgesia options. There is a new comprehensive chapter on neurologic examination with helpful pictures on testing. In addition to the physical textbook, an online version of the book is included with purchase. Other resources on the online book include a selection of discharge notes, as well as short videos on most of the surgeries which are very helpful for visualizing the procedures described in the text.

Overall, I think the book is a wonderful resource, especially for general practitioners with an interest in surgery; however, I am not convinced that updating from a previous edition is worthwhile if you already own one. I do really like that the physical book comes with access to an online version which is accessible both by computer or mobile phone.

Reviewed by Samantha Gwillim, BVMS BSc (Hons), Weir Veterinary Services, Lloydminster, Alberta.
In extruded feline diets, thiamine degraded at a similar rate when stored at −20°C, compared to room temperature

Bianca DiSabatino, Jacqueline M. Parr, Georgia Kritikos, Gabrielle Monteith, Adronie Verbrugghe

Abstract — Thiamine is an essential dietary nutrient in cats; however, studies on the stability of thiamine in pet food are limited. The objective of this study was to analyze thiamine concentrations in commercial feline extruded diets over time at room and freezing temperatures. Twelve diets were split in half and thiamine concentrations were assessed using fluorometry. One half of each diet was then stored at room temperature (24°C) and the other half was frozen (−20°C). Subsamples were analyzed at 2 other time points at 6-month intervals up to 1 year. Data were assessed using a mixed procedure (2-factor factorial model with factors time and treatment). Based on F-tests, thiamine concentrations decreased over time (P = 0.001), with no treatment*time interaction (P = 0.9534). In conclusion, regardless of treatment, thiamine degraded at a similar rate over time.

Introduction

Thiamine (vitamin B1) is a water-soluble vitamin that is naturally present in plant- and animal-based food sources including meat (beef, pork, fish), whole grains (brown rice, bran), and legumes. Thiamine is highly susceptible to degradation during processing through exposure to heat, neutral or alkaline pH, and oxidation (1–4). The presence of anti-thiamine compounds such as thiamine-degrading enzymes (in raw fish) and sulfites (used in meat preservation) can also result in large losses of the vitamin (5). To compensate for these losses, processed human foods such as breads and cereals are commonly fortified with a synthetic form of the vitamin (thiamine mononitrate) (1).

Thiamine is crucial in various biochemical pathways including glucose and amino acid metabolism, and neurotransmission (central and peripheral nervous system). Signs of deficiency can be vague and acute, related to heart and nervous system function, and can have life-threatening consequences (6). Thiamine is an essential nutrient in dogs and cats, as they cannot synthesize the vitamin. Therefore, they must consume adequate amounts of thiamine from their diet to prevent development of thiamine deficiency (6,7).
For formulation of diets, Canadian guidelines for industry follow the Association of American Feed Control Officials (AAFCO) recommendations, which are historically based on recommendations provided by the United States National Research Council (US NRC). According to thiamine requirements set forth by the US NRC, adult cats have a minimum adequate intake and minimum recommended allowance of 4.4 and 5.6 mg/kg, respectively on a dry matter basis (DMB) (8). There is currently no known safe upper limit for thiamine intake, due to lack of data (8). The AAFCO recommendation for commercial adult cat food is a minimum of 5.6 mg thiamine/kg daily on a DMB (9).

Thiamine deficiency in canned feline diets has recently become an area of concern; in 1 study, 13.3% of canned feline diets tested had thiamine concentrations below the AAFCO recommendation at the time of the study, despite having a nutritional adequacy statement indicating the diets were complete and balanced (10). In North America there have been numerous recalls of commercial pet foods due to thiamine deficiency involving canned, extruded, and raw feline diets (11). This may be due to thiamine's susceptibility to degradation during processing and storage conditions (1–4).

Pet owners may opt to purchase pet food in bulk as it is typically cheaper; however, cats may not consume the large quantity of food before it loses freshness or before the expiration date. Therefore, to preserve freshness and palatability, owners may choose to freeze the food for use later rather than store at the recommended room temperature. To the authors' knowledge, the potential for thiamine degradation in extruded feline diets stored at ambient and freezing temperatures over time has not been investigated. The objective of this study, therefore, was to examine rates of thiamine degradation in commercial extruded feline diets after 6- and 12-months of storage at freezing and room temperatures. It is hypothesized that because thiamine is sensitive to processing and the environment, freezing and thawing kibble may increase thiamine losses compared to room temperature storage, and that thiamine will degrade steadily with time.

Materials and methods

Diets

Twelve commercially available extruded feline diets were assessed in this study. Selection of diets was based on poultry as the major protein source, to avoid thiamine-degrading enzymes present in other ingredients, such as fish (1). Diets were purchased from pet stores in Guelph and Hamilton, Ontario, Canada in June 2017 with expiration dates no earlier than June 2018. Labeling information such as the AAFCO nutritional adequacy statement, guaranteed analyses, and ingredient lists were recorded.

Sampling and storage

Samples were obtained from 12 extruded feline diets following their purchase. Each diet was split in half after purchase. Subsequently, 1/2 of each diet was stored at room temperature (24°C) and the other half was frozen at −20°C. All samples were stored in airtight bags and room temperature samples were placed in opaque storage containers out of direct sunlight. The baseline subsamples were taken immediately after separation of the diets, before storage and treatment. Following this, subsamples of each half were analyzed at 2 additional time points in 6-month intervals (6- and 12-months). Frozen samples were thawed at room temperature before processing. All samples were taken in duplicate, equalling 48 samples per time point.

Analytical methods

All samples were sent to a commercial laboratory (Maxxam Analytics, Mississauga, Ontario), where thiamine and moisture concentrations were assessed according to AOAC methodologies 942.23 and 984.25, respectively (12).

Statistical analysis

Analyses were conducted using commercial statistical software (SAS 9.4; SAS Institute, Cary, North Carolina, USA). Assumptions of the analysis of variance (ANOVA) were assessed with examination of the residuals and a Shapiro-Wilk test. Non-normal data were log-transformed and assessed using a mixed procedure. The design was a 2-factor factorial method with time and treatment as factors. The main effects and 2-way interactions were included in the initial model with treatment, time, and treatment*time interaction. Diets were included as random factors in the model to account for differing thiamine concentrations. Replication came from the 2 measurements at each treatment and time combination. Sampling was done destructively at each time point; therefore, no repeated measures occurred. Data are expressed as geometric medians (back-transformed logs) with upper and lower limits.

Results

Seven diets were formulated to meet the AAFCO nutrient profiles for maintenance of adult cats, and 5 diets were formulated to meet the AAFCO nutrient profiles for all life stages of cats. Guaranteed analyses for all diets are presented in Table 1, and the average baseline sample analysis of moisture (%) and thiamine content (mg/kg) are presented in Table 2. Although all diets were manufactured following the AAFCO’s 2017 increase in dietary thiamine recommendations, 1 diet did not meet the minimum recommendation at any time point throughout the study and was subsequently removed from statistical analysis.

Based on overall F-tests, there were effects of treatment (P = 0.017) and time (P = 0.0010). However, there was no treatment*time interaction (P = 0.9534). Thiamine significantly decreased over time, regardless of treatment (Figure 1); baseline to 12 mo (P = 0.0052) and 6 to 12 mo (P = 0.0004). No differences were noted between baseline and 6 mo (P = 0.4164). Freezing temperature samples (26.28 mg/kg DMB) had significantly more thiamine than room temperature samples (24.68 mg/kg DMB) regardless of time (Figure 2).

Discussion

Nutritional adequacy statements for all 12 diets indicated they were formulated to meet the AAFCO recommendations for feline maintenance or all life stages (9). It was anticipated that the diets would contain various thiamine concentrations;
Table 1. Guaranteed analyses and AAFCO nutritional adequacy statement of 12 feline extruded diets on an as fed basis reported by manufacturer.

<table>
<thead>
<tr>
<th>Diet</th>
<th>AAFCO</th>
<th>CP, % min</th>
<th>CF, % min</th>
<th>CFr, % total</th>
<th>Moisture, % max</th>
<th>ME (kcal/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Adult cat</td>
<td>32.0</td>
<td>15.5</td>
<td>3.0</td>
<td>10.0</td>
<td>3710</td>
</tr>
<tr>
<td>b</td>
<td>Adult cat</td>
<td>40.0</td>
<td>13.5</td>
<td>4.8</td>
<td>12.0</td>
<td>4037</td>
</tr>
<tr>
<td>c</td>
<td>Adult cat</td>
<td>33.8</td>
<td>19.3</td>
<td>9.1</td>
<td>8.0</td>
<td>3702</td>
</tr>
<tr>
<td>d</td>
<td>Adult cat</td>
<td>38.0</td>
<td>16.0</td>
<td>6.0</td>
<td>10.0</td>
<td>3713</td>
</tr>
<tr>
<td>e</td>
<td>All life stages</td>
<td>30.0</td>
<td>11.0</td>
<td>4.0</td>
<td>12.0</td>
<td>3500</td>
</tr>
<tr>
<td>f</td>
<td>Adult cat</td>
<td>40.0</td>
<td>14.0</td>
<td>7.5</td>
<td>11.0</td>
<td>3580</td>
</tr>
<tr>
<td>g</td>
<td>Adult cat</td>
<td>40.0</td>
<td>18.0</td>
<td>4.0</td>
<td>10.0</td>
<td>3907</td>
</tr>
<tr>
<td>h</td>
<td>All life stages</td>
<td>30.0</td>
<td>20.0</td>
<td>3.0</td>
<td>10.0</td>
<td>4008</td>
</tr>
<tr>
<td>i</td>
<td>All life stages</td>
<td>43.0</td>
<td>19.5</td>
<td>3.0</td>
<td>9.0</td>
<td>4150</td>
</tr>
<tr>
<td>j</td>
<td>Adult cat</td>
<td>30.0</td>
<td>11.0</td>
<td>4.5</td>
<td>10.0</td>
<td>3300</td>
</tr>
<tr>
<td>k</td>
<td>All life stages</td>
<td>37.0</td>
<td>20.0</td>
<td>3.0</td>
<td>10.0</td>
<td>4020</td>
</tr>
<tr>
<td>l</td>
<td>All life stages</td>
<td>32.0</td>
<td>20.0</td>
<td>2.5</td>
<td>10.0</td>
<td>4604</td>
</tr>
</tbody>
</table>

AAFCO — Nutritional Adequacy Statement, Association of American Feed Control Officials; CP — crude protein; CF — crude fat; CFr — crude fiber; ME — metabolizable energy; min — minimum; max — maximum.

Table 2. Analysis of moisture (%) and thiamine content (mg/kg) of 12 feline extruded diets attained through averaging 4 baseline samples analyzed by a commercial laboratory.

<table>
<thead>
<tr>
<th>Laboratory analyses</th>
<th>Calculated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet</td>
<td>Moisture (%)</td>
</tr>
<tr>
<td>a</td>
<td>6.1</td>
</tr>
<tr>
<td>b</td>
<td>5.7</td>
</tr>
<tr>
<td>c</td>
<td>5.9</td>
</tr>
<tr>
<td>d</td>
<td>5.5</td>
</tr>
<tr>
<td>e</td>
<td>7.7</td>
</tr>
<tr>
<td>f</td>
<td>4.5</td>
</tr>
<tr>
<td>g</td>
<td>5.5</td>
</tr>
<tr>
<td>h</td>
<td>3.9</td>
</tr>
<tr>
<td>i</td>
<td>5.2</td>
</tr>
<tr>
<td>j</td>
<td>6.9</td>
</tr>
<tr>
<td>k</td>
<td>7.5</td>
</tr>
<tr>
<td>l</td>
<td>4.6</td>
</tr>
</tbody>
</table>

DMB — Dry matter basis.

however, 1 diet contained less than half the minimum recommended amount of thiamine according to the AAFCO 2017. The deficient diet was void of any known thiamine-degrading ingredients and was purchased at least 12 mo before the expiration date. Only 1 bag of the diet was tested; therefore, it is unknown if this was an isolated incident or if other bags were affected. Regardless, thiamine deficiency in a single bag is cause for concern, and the manufacturer was contacted with this important information. Conversely, another diet contained almost 30-fold the minimum amount of thiamine recommended by the AAFCO (9). The high concentration may be the manufacturer’s response to previous pet food recalls related to thiamine deficiency and likely results in an increased manufacturing cost.

For most cats, the sole source of nutrition is commercial pet food. Thiamine is an essential nutrient in cats; thus, cats fed a diet deficient in thiamine are at risk of developing a thiamine deficiency. Clinical signs of deficiency can occur within 2 wk of being fed a deficient diet, and cats present with anorexia, vomiting, seizures/convulsions, weakness, prostration, and if left untreated, eventually death (8,13–15). It is unknown if high dietary thiamine concentrations pose any benefits or risks to cats (8). Although thiamine is a water-soluble vitamin, whether a safe upper limit for dietary thiamine in cats exists is unknown and more research is required.

This study reported a significant effect of storage time on thiamine concentration in extruded cat food. Given that thiamine is a labile vitamin, it is easily degraded in foods when exposed to various elements (pH, oxidation, UV light) and storage conditions (ambient temperature, heat, freezing) (1,3,4). Significant thiamine loss occurs over time (10 d to 12 mo) when foods, such as spinach, canned tomatoes, and peaches, are stored at room temperature (16–18). Thiamine in food is particularly susceptible to degradation during processing due to exposure to heat, having reported losses of 50 to 85% with pelleting or extrusion and 50 to 60% with household cooking (19–21). The findings of the present study indicated that over a 12-month storage period, thiamine concentrations decreased over time at both room and freezing temperatures. On average, there was approximately 95% retention of thiamine from baseline to 12 mo for both treatments. Thus, the clinical relevance of the decline may be inconsequential as thiamine loss was low and no diet previously above the AAFCO recommendations became deficient. However, increased loss of thiamine may be expected with more prolonged storage.

That frozen samples had significantly higher thiamine concentrations throughout the study compared to room temperature samples is difficult to interpret since baseline samples were taken from the same bag and collected before treatment was applied, yet, baseline concentrations were significantly different. Based on this finding, combined with no significant treatment*time interaction ($P = 0.9534$), we inferred that, regardless of treatment, thiamine concentrations degraded at a similar rate over time and there is no difference between treatments.

Frozen storage of raw and processed foods is one of the fundamental methods of preservation for palatability and freshness. Thiamine stability in regard to storage at freezing temperatures has received little attention in the literature, and results are difficult to interpret, as the effects of both freezing and at least 1 other cooking method (blanching, canning, cooking) are
examined in many studies (22–25). In long-term freezer storage of meats, there were varying thiamine losses over time in chicken breast and legs, pork chops, pork loins, lamb chops, and beef patties (26–30). Based on assessments of frozen food over time, there are some indications that thiamine concentration may initially increase during storage or processing before declining, yet no mechanisms to explain this have been proposed (18,30–32).

Although there is much research on thiamine degradation in human foods during processing and various storage conditions, there is limited research on pet foods, especially on extruded diets. Mooney et al (33) reported more than 90% thiamine loss when exposed to an elevated temperature (50°C) for a 24-week interval, in order to mimic heat stress due to transport, although thiamine concentrations appeared to be relatively stable over a 24-month period in extruded pet food stored in environmentally controlled conditions at ambient temperature (20 to 22°C). In contrast, a summary of previous research examining thiamine retention in extruded dog and cat foods reported that retention after 18 mo of storage was 57.5% (34). Though a decrease in thiamine concentration over time was noted, storage conditions were not described. To the authors’ knowledge, there is currently no research investigating the effect of freezing on thiamine concentration in extruded cat foods, which was the focus of this study.

To determine the mechanism of action responsible for changes in thiamine concentrations in commercial extruded pet foods over time and under various storage conditions, a broader analysis of pet food is required, and limitations of this study’s design must be addressed. Future studies should sample at more time points for a longer study interval, collect samples from multiple bags and batches per diet, and analyze thiamine concentration in triplicate to account for variation with duplicate samples. Ideally 2 laboratory methods for thiamine analysis should be employed; however, this study used the most widely accepted method of thiamine analysis in commercial food, measuring thiamine concentration by fluorscence with a fluorimeter (AOAC 942.23; AOAC, Rockland, Maryland, USA). This method has specific quantification with a reportable detection limit of 0.01 mg/100 g (35). This study also stored room temperature samples in airtight opaque storage bins out of direct sunlight to limit the degradation of thiamine. Pet owners, however, may not store their pet’s food under such conditions. Current recommendations for storage of extruded pet food are to keep the food in its original package (to ensure lot and batch information is available in the event of a recall), within an airtight container (to prevent pest infestation), at room temperature, and out of direct sunlight (to ensure a stable temperature). In the present study there was a similar degradation of thiamine over time in both room temperature and freezing storage; however, further research is required to make recommendations for or against freezing extruded pet foods with respect to nutrient degradation or preservation.

References


Evaluation of commercial probiotics for antimicrobial resistance genes

Rachel M. Baumgardner, Ana Berreta, Jamie J. Kopper

Abstract — The objective of this study was to determine if transferable antimicrobial resistance (AMR) genes are present in commercial animal probiotics. DNA was extracted from 50 probiotics, tested for the presence of bacterial DNA, and analyzed by polymerase chain reaction (PCR) for the presence of 8 transferrable AMR genes, including tetracycline, erythromycin, aminoglycoside, sulfonamide, and trimethoprim. Samples that were positive by PCR were confirmed by genome sequencing. Forty-seven (94%) products contained bacterial DNA. Of these, 97% contained at least 1 AMR gene, and 82% contained 2 or more. These results indicate that further evaluation of the risk for transmission of these AMR genes may be warranted.

Introduction

The increasing emergence of antimicrobial resistant bacteria is considered a global health concern for humans and animals (1). Potential sources contributing to the development and spread of antimicrobial resistant pathogens include selective pressure due to both the widespread use and misuse of antimicrobials in both human and veterinary medicine, use for prophylaxis, and the use of antimicrobials for the promotion of growth (2).

Probiotics are defined as live microorganisms that when administered in adequate amounts confer a health benefit to the host (3). The threat of introducing antimicrobial resistance (AMR) genes to the gastrointestinal microbiota via probiotics has been recognized in Europe. The European Food Safety Authority has stated that the absence of acquired or potentially transferable resistance factors must be established for probiotics to be declared safe for human and animal consumption (4).

Similar regulatory testing is neither performed nor required for probiotics in the United States. Genes for AMR have been identified in commercially available probiotics marketed for humans (5). Recent work by these authors identified a transferable vancomycin resistance gene (vanA) in probiotics marketed for use in animals (6). However, to the authors’ knowledge, products marketed for veterinary species have not been evaluated for the presence of other transferable AMR genes. Thus, the objective of this study was to evaluate commercially available probiotics marketed for various animals for known AMR genes. We hypothesized that probiotics marketed for animals contain AMR genes detectable by polymerase chain reaction (PCR).

Materials and methods

Selection of probiotics

A list was compiled of commercially available probiotics marketed for animals and available for purchase by owners...
### Table 1. Summary of transferrable AMR genes detected in commercial probiotics.

<table>
<thead>
<tr>
<th>Species</th>
<th>Product</th>
<th>TetM</th>
<th>TetK</th>
<th>ErnB</th>
<th>ErnT</th>
<th>Aph(2)-I-D</th>
<th>Sal 1</th>
<th>Sal 2</th>
<th>dfpG</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>1&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>2&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>3&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>4&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>5&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Camels</td>
<td>7&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>8&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>9&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>10&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>11&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Dogs</td>
<td>12&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>13&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>14&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>15&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>16&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>17&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>18&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>19&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>20&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Goats</td>
<td>21&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Horses</td>
<td>22&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>23&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>24&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>25&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>26&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>27&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>28&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>29&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>30&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>31&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>32&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>33&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>34&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>35&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>36&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>37&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>38&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>39&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Multiple*</td>
<td>40&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Cats</td>
<td>41&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>42&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>43&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>44&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>45&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>46&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>47&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Totals</td>
<td>23</td>
<td>29</td>
<td>10</td>
<td>4</td>
<td>0</td>
<td>7</td>
<td>24</td>
<td>8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Gene's marked as + were identified in that product by AMR gene specific PCR and the PCR product was confirmed to match the gene of interest by sequencing. The total number of AMR genes identified in each product is listed in the column to the far right (total) and the total number of products with each AMR gene is listed in the bottom row (total). The letters indicate which extraction kit was utilized, as follows: * DNeasy PowerFood Microbial Kit (QIAGEN, Valencia, California, USA); DNeasy PowerSoil Pro Kit (QIAGEN); 4 QuantiFast PowerPC (QIAGEN). * Indicates which PCR had a visible product after repeating the reaction, as described in the Materials and methods. Products are:

1 — Achieve Pro Calf Paste (Huvepharma, Peachtree City, Georgia, USA); 2 — Bovine IGG Immuno-start 50 (Imu-Tek Animal Health, Fort Collins, Colorado, USA); 3 — Fastrack Ruminant Gel (Conklin Company, Kansas City, Missouri, USA); 4 — Manna Pro Calf Care (Mann Pro Products LLC, Chesterfield, Missouri, USA); 5 — Probiotics Ruminous Bull (Vet Plus, Menomonie, Wisconsin, USA); 6 — TDN Rooker Mini with Inulin (Vet Plus); 7 — Llama-enzyme (Alpacas All Natu, San Marcos, California, USA); 8 — Slow my Tummy (Alpacas All Natu); 9 — Golden Blend (Custom Milling, Davoboro, Georgia, USA); 10 — ProGuard (The Holistic Horse, Irving, California, USA); 11 — Trual Feed Supply (Laboratory Trual Italia, Udine, Italy); 12 — Dr. Lyon's Probiotic Daily (Dr. Lyon's LLC, Dana Beach, Florida, USA); 13 — Nutri-Vet Pre and Prebiotics Dog Soft Chews (Nutri-Vet Wellness, LLC, Boise, Idaho, USA); 14 — Probiotic instillorgar Dog (Vet Plus); 15 — Cane Digestion (CanePal Equine LLC, Plymouth, Mass., Massachusetts, USA); 16 — Tomlyn Pre and Pro for Dogs (Vertoquinol USA, Fort Worth, Texas, USA); 17 — Eukle Health & Nutrition (Equine SuperMax, California, USA); 18 — My Herbs (MyTems, Michigan, USA); 19 — My Herbs (MyTems, Michigan, USA); 29 — Digest Ultra Paste (SmartPal Equine LLC); 29 — The Missing Link Well Blend Senior (W.F. Young, East Longmeadow, Massachusetts, USA); 30 — Total Pre and Pro for Horses (Ramard, New Richmond, Ohio, USA); 31 — SmartGut Ultra (SmartPal Equine LLC); 32 — Exceed 5-Day (Med-Vet Pharmaceuticals, Eden Prairie, Minn., Minnesota, USA); 33 — Equa Bac Probiotic Oral Gel for Horses and Foals (Kane's Group, Savannah, Missouri, USA); 34 — Total Calm and GI Support for Horses (Ucle Health & Nutrition, Blufild, Missusissippi, USA); 37 — Senior Weight Accelerator Manna Pro (Manna Pro Products LLC, Chesterfield, Missouri, USA); 38 — Digest Ultra Paste (SmartPal Equine LLC); 39 — Probiotic MVP Equine (Med-Vet Pharmaceuticals); 40 — Fastrack (Conklin Company, Kansas City, Missouri, USA); 41 — Cattle Meal Replacement (Pet-Ag, Hampshre, Illinois, USA); 42 — Drs Foster and Smith Soft Chews for Cats (Drs Foster and Smith, Rhseller, Wisconsin, USA); 43 — Nature's Farmacy Catzymes Probiotic (Nature's Farmacy, Jasper, Georgia, USA); 44 — Neobiotic Probiotics for Cats (Drs Formulas, Huntington, California, USA); 45 — Probiotic Instillorgar Cat (Purina, Nennn, Wisconsin, USA); 46 — Verone Advita Probiotic (Skine) (WMI Animal Health); 47 — Probiotics for (Human), Carmel, Indiana, USA).
Table 2. Summary of PCRs used for AMR gene detection.

<table>
<thead>
<tr>
<th>Antimicrobial</th>
<th>Gene</th>
<th>Forward primer (5'→3')</th>
<th>Reverse primer (5'→3')</th>
<th>Product size (bp)</th>
<th>NCBI reference sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tetracycline</td>
<td>tetM (8)</td>
<td>GGT GAA CAT CAT AGA CAC GC</td>
<td>CTT GTT CGA GTT CCA ATG C</td>
<td>401</td>
<td>X90939</td>
</tr>
<tr>
<td></td>
<td>tetK (9)</td>
<td>GTC GCG ACA ATA GGT AAT AG</td>
<td>GCA ACT TCT TCT TCA GAA AG</td>
<td>278</td>
<td>NG_055987</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>ermB (10)</td>
<td>CAT TTA ACG ACG AAA ATG GC</td>
<td>GGA ACA TCT GTG GCA TCG CG</td>
<td>405</td>
<td>NG_047795</td>
</tr>
<tr>
<td></td>
<td>ermT (9)</td>
<td>TAT TGA GAT TGC TGG TTG AGG G</td>
<td>GGA TGA AAG TAT TCT CTA GGG ATT T</td>
<td>395</td>
<td>NG_047840</td>
</tr>
<tr>
<td>Aminoglycosides</td>
<td>aph(2')-Id (11)</td>
<td>GTG GTT TTT ACA GGA ATG CCA TC</td>
<td>CCC TCT TCA TAC CAA TCC ATA TAC TC</td>
<td>641 *</td>
<td></td>
</tr>
<tr>
<td>Sulfonamide</td>
<td>sul1 (12)</td>
<td>GCC AGG GTT TCC GAG AAG GTG GC</td>
<td>TGG TGA CGG TGT TCG GCA TTC TCA</td>
<td>790</td>
<td>AY444815</td>
</tr>
<tr>
<td></td>
<td>sul2 (12)</td>
<td>CGG CAT CGT CAA CAT AAC C</td>
<td>GTG TGG GGA TGA AGT CAG</td>
<td>722</td>
<td>KX900483</td>
</tr>
<tr>
<td>Trimethoprim</td>
<td>dfrG (13)</td>
<td>TTT CTT TGA TTG CTT CGA TG</td>
<td>CCC TTT TTG GGC AAA TAC CT</td>
<td>405</td>
<td>NG_047756.1</td>
</tr>
</tbody>
</table>

* Probiotic DNA did not have evidence of Aph(2')-Id based on PCR analyses and thus sequence comparison was not performed.

using common online sources. A random number generator (www.random.org) was used to select 50 products for further evaluation.

DNA extraction from commercial probiotics
The DNA from probiotics was extracted using one of several commercially available DNA extraction kits (QIAGEN, Valencia California, USA) (Table 1). Due to the heterogenous nature of probiotic substrates, multiple kits were used and the extraction determined to have the best DNA, based on quantity and purity indicators (i.e., A260:A280 ratio), was used for further analyses. The DNA concentration was quantified and quality was assessed using spectrophotometry (Nanodrop; Thermofisher, Waltham, Massachusetts, USA).

Extraction of DNA from positive control bacteria for AMR genes
Bacteria containing known AMR genes of interest were generously provided by the Center for Disease Control and Food and Drug Administration Antibiotic Resistance Isolate Bank (Centers for Disease Control, Atlanta, Georgia, USA) and propagated according to manufacturer recommendations. Subsequently, DNA was extracted using a commercial microbial DNA extraction kit (QIAGEN) according to the manufacturer's protocol. DNA concentration was quantified, and quality assessed using spectrophotometry (Nanodrop; Thermofisher).

Confirmation of the presence of bacterial DNA
The presence of bacterial DNA in each DNA extraction from the probiotics was assessed using a bacterial 16S rRNA PCR, as described (7), with the following modifications. Amplification was performed by an initial denaturation at 95°C for 3 min, then 25 cycles of denaturation at 95°C for 30 s, annealing at 50°C for 1 min, and extension at 72°C for 2 min. The final extension was performed at 72°C for 10 min, then the sample was held at 4°C until it was analyzed by gel electrophoresis. The PCR products were evaluated by gel electrophoresis in 2% agarose gel, stained with ethidium bromide, and visualized to evaluate for a corresponding 994 base pairs (bp) PCR product. Polymerase chain reactions that did not result in an amplicon were considered negative and excluded from further analyses.

Selection of AMR genes, PCR validation, and PCR of genes in probiotics
As listed in Table 2, previously published PCRs for 8 AMR genes that have demonstrated transferability were evaluated in this study: 2 tetracycline resistance genes (tetM, tetK), 2 erythromycin resistance genes (ermB, ermT), 2 sulfonamide resistance genes (sul1, sul2), 1 aminoglycoside resistance gene [Aph(2')-Id], and 1 trimethoprim resistance gene (dfrG). Selection of AMR genes was made based on previous reports of identifying these genes in human probiotics. All PCRs were performed with no-template negative control containing only Tris-borate-ethylenediaminetetraacetic acid (EDTA) buffer and according to the protocols provided in the citations, with the exception for dfrG (8–11). This PCR was modified to use the following conditions: amplification was performed by an initial denaturation at 94°C for 5 min, then 30 cycles of denaturation at 94°C for 30 s, annealing at 55°C for 30 s, and extension at 72°C for 45 s. The final extension was performed at 72°C for 7 min, then the sample was held at 4°C until it was analyzed by gel electrophoresis. The PCRs were validated using DNA extracted from the bacterial cultures with known AMR genes of interest, as described. The reactions were confirmed to have DNA product of the expected size using gel electrophoresis and PCR products were confirmed to correspond with the AMR gene of interest by comparison of known AMR gene sequences to PCR product sequences, as described below. Once PCRs had been validated with positive control DNA for the AMR genes of interest, the extracted DNA from probiotics was evaluated. Each PCR included a negative control as described above and a positive control, using the DNA extracted from the known isolates.

The PCR products were evaluated by electrophoresis in 2% agarose gel, stained with ethidium bromide and visualized for an appropriately sized PCR product for products without a corresponding band of interest, the PCR was repeated with the same parameters using 10 µL of the initial PCR as template, including 10 µL of the initial negative control and positive...
control. The second PCR was again evaluated by electrophoresis in 2% agarose gel, stained with ethidium bromide and visualized for an appropriately sized PCR product.

**Sequencing of amplified AMR genes**

Positive control and randomly selected probiotic PCRs with appropriately sized PCR products were enzymatically treated (ExoSap-it; Affymetrix Life Science Reagents, Waltham, Massachusetts, USA). Sanger sequencing samples were analyzed on a 3730XL DNA Analyzer (Applied Biosystems, Dublin, Ireland) at the DNA sequencing core facility, Laboratory for Biotechnology and Bioanalysis at Washington State University. Sanger sequencing of the treated PCR products was performed using the corresponding forward primer listed in Table 2 and a commercial mixture (Big Dye 3.1 reagent mix; Applied Biosystems). Sequence data were analyzed (Sequencher 5.2 Software; GeneCodes, Ann Arbor, Michigan, USA) and confirmed to represent the gene of interest by comparing the PCR product sequence to the known genetic sequence of the AMR gene of interest using the BLAST sequence analysis tool (https://blast.ncbi.nlm.nih.gov/Blast.cgi). The NCBI references for the reference AMR gene sequence used for comparison are provided in Table 2. Samples were considered positive for the AMR gene if they had both PCR product size consistent with the gene of interest and the sequence of the PCR product was confirmed to correspond with the AMR gene of interest.

**Results**

All PCRs for the AMR genes of interest were appropriately validated and confirmed to amplify DNA corresponding to the gene of interest based on sequencing analysis.

Of the 50 probiotic samples evaluated, 47 were confirmed to have bacterial DNA and were used for further analyses. The AMR genes identified in the 47 products are summarized in Table 1. Of the 47 products with successful extraction of bacterial DNA, 94% (44/47) had at least 1 AMR gene. All positive PCR products were confirmed to have the correct sequence. None of the products contained the aminoglycoside resistance gene evaluated in this study; however, at least 1 product contained each of the other genes that were evaluated. Of these products, 89% (42/47) contained more than 1 AMR gene, with 2 products containing 6 of the 8 genes evaluated in this study. The AMR genes for tetracycline (tetK) and sulfonamide (sul2) resistance were found most frequently, being present in 32/47 (68%) and 28/47 (60%) products, respectively.

**Discussion**

Results from this study supported our hypothesis and confirmed that most (94%) probiotics marketed for animals that were evaluated in this study contained at least 1 transferable AMR gene. The presence of multiple transferable AMR genes in most of the probiotics evaluated in this study is potentially concerning. First, there is no barrier preventing the transfer of AMR genes to the animal’s gastrointestinal microbiota which includes commensal, potentially pathogenic, and pathogenic bacteria. Furthermore, the transfer of AMR genes from probiotic bacteria to other species has been well-documented in vitro (12). Second, if AMR genes are present in commercial probiotics, the dose and frequency at which probiotics are routinely administered may result in frequent (perhaps daily) administration of AMR genetic material to residential gastrointestinal microbiota.

Interestingly, we only amplified bacterial DNA by PCR from 47 of the 50 chosen products, despite using numerous DNA kits and modifications. It is possible that those samples contained PCR inhibitors and did contain bacterial DNA. However, differences between label claims and actual contents in probiotics marketed for use in animals have been demonstrated repeatedly (13,14) including lack of culturable bacteria (13).

There are several weaknesses of this study that are worth consideration when interpreting the results. First, this study was qualitative, not quantitative; therefore, although we identified the presence of known transferable AMR genes in veterinary probiotics, the quantity of genetic material per dose of probiotic was not measured and was beyond the scope of this work. Quantitative information may be valuable when determining the risk of AMR gene transmission. Lacking culture to validate both bacterial viability and bacterial AMR gene content is another weakness of the study. Given that the presence of AMR genes in live bacteria is not a requirement for the genetic material to be transferred, we believe that these results are relevant and valuable without culture information. In addition, the identification of genotypic antimicrobial resistance does not always correspond to phenotypic resistance when the bacteria are cultured and in vitro minimum inhibitory concentrations of antimicrobials are evaluated (15). Future studies evaluating this as well as which micro-organisms contain the identified AMR genes are warranted. Next, AMR genes used in this study were chosen because they had been identified in other probiotics; however, this does not exclude the possibility of identifying additional AMR genes; this is an area in need of additional investigation.

In conclusion, 93% of the probiotics evaluated in this study contained at least 1 transferable AMR gene and 7 of the 8 AMR genes evaluated in this study were identified in multiple products. The identification of AMR genes in these widely used products warrants further evaluation and consideration.

**Acknowledgments**

This work was funded by Washington State University’s Department of Veterinary Clinical Sciences Graduate Student Research Grant and the Northwest Camelid Foundation.

**References**


*CVI / VOL 62 / APRIL 2021*

New Products
Nouveaux produits

Canada’s First Veterinary Licensed Methadone

Dechra Veterinary Products is pleased to announce Health Canada approval of Comfortan, an injectable 10 mg/mL methadone hydrochloride solution licensed for use in cats.

Methadone is a full mu-opioid agonist providing high analgesic efficacy suitable for moderate to severe pain. It produces dose-dependent analgesia and also has the added benefit of being an NMDA antagonist, which can reduce central sensitization.

Comfortan is licensed as a part of a premedication regimen for the control of post-operative pain associated with ovariohysterectomy and castration in cats. It has been shown that methadone can improve patient welfare in this specific context.1


Vetster Announces Official Launch as Innovative Telemedicine Platform for Pet Owners

Vetster, a Toronto-based company announced its official launch as an innovative pet wellness platform virtually connecting pet owners to a marketplace of licensed veterinary professionals for video, chat and voice enabled appointments. For those unable to visit their local clinics for timing reasons or due to the ongoing COVID-19 pandemic, Vetster provides cutting-edge telehealth convenience, assisting with overall wellness for your cat, dog or small animal.

Created by serial entrepreneurs, Mark Bordo and Regan Johnson, Vetster’s forward-looking marketplace currently has over 1800 licensed veterinary professionals throughout the United States and Canada that pet owners can select when booking an appointment. The platform’s filters allow consumers to sort through veterinarians and technicians that are in their area with availability that fits their needs and budget, including 24/7 appointment access.

“Vetster fills a gap within the industry, enhancing and expanding the healthcare experience for both pets and their owners through the use of telehealth,” said Mark Bordo, Co-Founder & Chief Executive Officer at Vetster. “Our platform changes the way people think about pet care and has become a simple solution for all pet’s needs.”

While veterinary telemedicine cannot replace the need to see a veterinarian in-person, Vetster works alongside your local veterinarian and aims to provide peace of mind to pet parents from the comfort of their homes. To learn more about Vetster and its services, visit: https://vetster.com
Forensic submissions in a diagnostic pathology practice: A 10-year review

P. Nick Nation

Abstract — The types of submissions presented for forensic purposes to a private speciality practice in veterinary diagnostic pathology over a 10-year period are reviewed in this article. Records of forensic submissions were analyzed for diagnostic conclusions which were then categorized for a potential breach of law. In 34 of 66 total submissions, death was due to a cause other than potential violation of law. In the remaining 32 submissions, good postmortem examination and description of findings was sufficient to provide the police and courts with the information required for their investigations. The findings are discussed with a view to dispelling the reluctance of many veterinary clinicians to accept forensic cases.

Introduction

The field of veterinary forensics has developed rapidly over the past 15 y. It now forms a small but significant part of many veterinary practices and is developing into a specialty area of practice. In addition to investigations related to provincial and federal laws concerning animal welfare and abuse, some other factors are contributing to this trend. Foremost among these factors is the recognition that animal cruelty and abuse is intimately linked to various forms of human abuse (1) and to antisocial personality disorder (2). Where animal abuse occurs, there is almost always one or more of spousal, child, or elder abuse (1). In addition, certain forms of animal abuse such as organized dog and cock fighting are often associated with the commission of drug and gun offenses (3). As companion animals become more and more identified as members of families, societal tolerance for abuse and neglect of animals is reduced, and there is increased pressure on police and the courts to investigate, prosecute, and provide harsher penalties for such crimes.

The author’s opinion, based on discussions with practitioners, is that the particular and special demands of forensic work, the length of time and detail such submissions require, the rigors of court appearances, and the risk of alienating clients make many veterinarians reluctant or entirely adverse to accepting such submissions. These fears are generally unfounded and there is an important role for veterinary clinical practices to play in the delivery of veterinary forensic services to society. The author’s experience is that the private practitioner is often the first line of contact in cases of animal neglect or abuse, and in addition to the clinical aspects of these situations, the practitioner can play a role in arranging supportive diagnostics, pathology, and preparation and interpretation of reports and documents for the courts.

The types of forensic submissions presented to a private veterinary diagnostic practice over a 10-year period are reviewed in this article. It is intended to show practitioners the spectrum of forensic submissions with which they might be presented.
in small animal practice, to provide some general guidance on approaching submissions in which death has occurred, and to reduce anxiety about accepting veterinary forensic submissions.

Materials and methods

Animal Pathology Services (APS) is a private veterinary practice in Edmonton, Alberta, which offers diagnostic anatomic pathology services to private practitioners and institutions by referral. Of each year’s submissions, a small proportion comes from various agencies that either investigate or are otherwise involved in legal aspects of animal welfare. For the purposes of this study, a submission was one in which 1 or more animals or samples were brought to APS for diagnostic purposes related to a specific problem. Forensic was defined as the application of scientific knowledge to the investigation of potential unlawful activity or matters of law, most often related to determining the cause of injury or death (4).

The records of APS over a 10-year period from January 1, 2010 to December 31, 2019 were reviewed, and submissions that came under this definition of forensic were retrieved and tabulated for this study.

Results

A total of 66 forensic submissions was received during the 10 y of records surveyed. Submissions were all presented for investigations under the Criminal Code of Canada (5), the Alberta Animal Protection Act (6), or as a result of proceedings either in progress or pending in civil court within the province of Alberta. These submissions included a total of 82 animals or animal tissues and 5 sets of documents for evaluation. The temporal distribution of submissions is presented in Figure 1 and the total number of samples broken down by species/type is presented in Figure 2. Most submissions consisted of a single animal or animal parts, but 8 consisted of 2 or more animals, the largest number being 13 rabbits in 1 submission.

Submissions came from various sources including the Edmonton Police Service (EPS, n = 41), Royal Canadian Mounted Police (RCMP, n = 7), law practices (n = 2), a Crown prosecutor (n = 1), veterinary practices (n = 2), Alberta Society for the Prevention of Cruelty to Animals (Alberta SPCA, n = 2), humane societies (n = 2), a private consultant (n = 1), Edmonton Fire Rescue Service (n = 2), and Edmonton Animal Care and Control (ACC, n = 6). In 34 (52%) submissions, the findings indicated that a condition other than a breach of law had occurred. Of these submissions, the most common was either the entire body or parts of a body of 1 or more cats that had been either killed or scavenged after death by coyotes. Overall 20 of these 34 submissions fell into this category accounting for a total of 22 individual animals. If the number of cats killed by coyotes is removed from the total (Figure 1, dark columns), a clear trend of increasing case numbers over the decade of the study is apparent (Figure 1, light columns). The remaining 14 submissions are summarized in Table 1.

The 32 submissions (48%) in which there was a potential breach of law represent the broad spectrum of cruelty of which humans are capable. These are summarized by type and species in Table 2. Only “need to know” information is provided by investigating officers and so complete background details of submissions are commonly unavailable to the consulting veterinarian. However, comments made by investigating officers indicated that at least 7 submissions occurred as the result of episodes of domestic strife including 3 of the 5 blunt force trauma and 2 of the 4 sharp force trauma (stabbing) submissions. Five were indicated to have resulted from episodes of violence originating from mental illness of which 3 were the first encounter of the affected individual with the police or the mental health system.

The ultimate disposition by the police and courts of most of the cases in which there was a potential breach of law is unknown to the author. In 4 cases, the prosecution and defense lawyers both agreed to accept the author’s report and a court appearance was not required. In 4 other cases, a subpoena was issued, and the author attended at court but legal proceedings prior to testimony being sought resulted in resolution of the case without an actual appearance. In 1 additional case, charges were

Figure 1. Number of submissions per year. The dark columns are yearly totals of submissions. The light columns are the yearly totals with the number of dismembered cats killed by coyotes removed from each total. The light columns reveal more accurately the general annual increase in forensic submissions with the annual variation in dismembered cats removed.

Figure 2. Number of samples by species. Note that these numbers reflect the narrow species caseload, which is that of a small animal diagnostic service, and it would likely have a broader species range with greater individual numbers if it were from a diagnostic service with a wider range of submissions.
The investigation process continues for several reasons. The submission received by the Alberta Humane Society (AHS) is then reviewed, along with all the relevant information. The AHS then decides whether a necropsy is required, and this is followed by the decision to discontinue the investigation. The submission is then sent to the forensic pathologist and the veterinary pathologist for examination.

The results of the investigation are then presented to the court, and the veterinary pathologist is required to testify. Several other cases are still under investigation, and the veterinary pathologist is required to present evidence. The veterinary pathologist is also required to present evidence in the courtroom, and the veterinary pathologist is required to present evidence in the courtroom.

In summary, over the 10-year period of this study, no actual court appearances requiring sworn testimony from the attending veterinarian resulted from any of the submissions examined.

Discussion

This review gives an overview of most of the types of forensic submissions involving dead animals or related samples that might be expected in either a small animal diagnostic laboratory or clinical practice. While the submissions described here are typical of those expected in an urban practice area, this overview is limited in that it does not include cases that occur in food animal or equine practice. Therefore, this is not a comprehensive review of all forensic submissions that would be seen in general veterinary medicine, or by a larger diagnostic laboratory. Clinical cases of abused or neglected animals that are treated and recover are likely much more numerous than those that die. In addition, the submissions described herein are selected by the submitting agencies based on their own investigative needs and are not an indicator of the total number of investigations in which there is death of animals. In Edmonton, based on discussion with investigating officers, it is estimated that there is an average of 2 investigations a month involving death of an animal in which the investigators decide that a necropsy is not required. Additionally, approximately 1 case every 2 mo involving dead animals requires broader clinical investigation and is referred to a practitioner skilled in such work. Therefore, for each submission of dead animals in this survey, it is estimated that there are 2 1/2 other forensic cases that were investigated in which animals had died.

This review is based largely on small animals. Large animal neglect and abuse investigations in Alberta are handled by the Alberta SPCA either directly or through local veterinary clinics. Situations in which there is no criminal neglect or violation of the Animal Protection Act are handled through the Alberta Farm Animal Care organization (AFAC). If AFAC perceives a violation, the file is referred to the Alberta SPCA.

The most common submission in this series was from cats that were either killed and dismembered by coyotes or dead cats scavenged by coyotes. This condition is the subject of a previous publication (7) in which 13 of the cats in this study were included. As noted in the results, if the number of cats killed by coyotes is removed from the temporal graph of forensic submissions (Figure 1) a distinct pattern emerges. Forensic submissions have regularly increased over the decade of this review. There are a number of reasons for this, including decreased societal tolerance for animal abuse, which results in more reporting to authorities, a greater awareness that animal cruelty early in life is associated with psychopathic/sociopathic behavior later on (8), increased police attentiveness to abuse in general, and, in Edmonton, reorganization of the way that investigation of abuse cases is coordinated. In 2018, the Edmonton Humane Society, which had been the main agency investigating animal abuse, decided to no longer handle such investigations. This forced a re-evaluation of how such cases should proceed, which resulted in a coordinated investigation protocol involving the EPS, ACC, and certain veterinary practitioners. This protocol became fully operational in 2019 and is reflected in the increased submission load in that year. Arising from this reorganization, all frontline officers of the EPS have now received in-service training related to animal abuse and its investigation.

Although it is not the purpose of this review to go into the clinical and pathologic details of the submissions examined, it is of note that fully half of the submissions in this series were due to natural events (e.g., coyote attacks) or traumatic accidents (e.g., motor vehicle accidents). With a necropsy guide (9), a few selected references (e.g., 3,7,10,11), and a thorough post-mortem examination, any veterinarian has the knowledge and ability to differentiate these conditions from abuse. For example, dismembered cats can relatively easily be classified as having suffered coyote predation and/or scavenging by identifying the typical massive trauma to the soft tissues of the neck despite little evidence of external trauma. Canine tooth puncture marks in the skin of the neck can be located and other features such as claws that are split at the ends with tufts of gray hair caught in between amid frayed strands of keratin identified (7). Additional signs of coyote predation include tufting of intact hairs along the edges of wounds, serrations of the edges of skin wounds and intestines, and colon cleanly stripped of mesentery and fat trailing from the carcass (7). Similarly, trauma due to automobile accidents can be distinguished from non-accidental

### Table 1. Submissions (minus coyote predation) with no offence in law.

<table>
<thead>
<tr>
<th>Species/sample</th>
<th>MVA†</th>
<th>Natural cause</th>
<th>Canid attack</th>
<th>Fire‡</th>
<th>Negative toxicology screen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dog</td>
<td>4</td>
<td>1</td>
<td>1 (2) (wolf)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Hare</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Cat</td>
<td>1</td>
<td>2</td>
<td>1 (13) (dog)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Rabbit</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>2</td>
</tr>
<tr>
<td>Meat†</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

† MVA — Motor vehicle accident.
‡ Death due to smoke inhalation.
§ Numbers in parentheses indicate number of animals in the submission.
¶ Suspected baits.

### Table 2. Submissions involving a possible legal offence.

<table>
<thead>
<tr>
<th>Finding</th>
<th>Submissions</th>
<th>Species (Number of submissions — animals)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neglect</td>
<td>5</td>
<td>Dog (4), Gerbil (1)</td>
</tr>
<tr>
<td>Stabbing</td>
<td>4</td>
<td>Dog (3), Cat (1)</td>
</tr>
<tr>
<td>Shock</td>
<td>1</td>
<td>Dog</td>
</tr>
<tr>
<td>Gunshot</td>
<td>4</td>
<td>Dog (3), Cat (1)</td>
</tr>
<tr>
<td>Beaten/blunt trauma</td>
<td>5</td>
<td>Cat (4–5), Macaw (1)</td>
</tr>
<tr>
<td>Hoarding</td>
<td>1</td>
<td>Cat (1–4)</td>
</tr>
<tr>
<td>Asphyxiation</td>
<td>1</td>
<td>Dog</td>
</tr>
<tr>
<td>Decapitation</td>
<td>1</td>
<td>Cat (1–2)</td>
</tr>
<tr>
<td>Crushed</td>
<td>1</td>
<td>Cat</td>
</tr>
<tr>
<td>Drowned</td>
<td>1</td>
<td>Cat</td>
</tr>
<tr>
<td>Thrown from balcony</td>
<td>1</td>
<td>Dog</td>
</tr>
<tr>
<td>Drug overdose</td>
<td>1</td>
<td>Dog</td>
</tr>
<tr>
<td>Document evaluation</td>
<td>5</td>
<td>Dog (3), oil well associated (2)</td>
</tr>
<tr>
<td>Speciation</td>
<td>1</td>
<td>Sheep</td>
</tr>
</tbody>
</table>
injury by the presence of a single massive blow and rib fractures restricted to one side of the thorax in the former condition, while there are usually multiple blows in various locations, rib fractures on both sides of the thorax and rib fractures of different ages in the latter situation (10). Such screening, which can be performed relatively quickly and requiring only gross postmortem examination, is of great benefit to the investigation in that it can eliminate those cases in which cruelty is unlikely and allow the investigators to concentrate on those in which it may be present. This prevents investigative and legal resources from being wasted on cases which are not in violation of federal or provincial legislation, which in the present series was in the neighborhood of half the submissions.

It is important to keep in mind that the postmortem findings by themselves rarely constitute the full set of evidence in the case. Postmortem findings must be evaluated in light of witness statements and other evidence from the scene. The police or animal control officer in charge of the investigation is the only person who will have all the evidence and full knowledge of the case at hand. The veterinarian will not only play a role in providing details of the necropsy but might be asked for an opinion on some matter related to the case that is affected by the result of the necropsy.

It is a good policy while working on these submissions to maintain sufficient skepticism such that any statements made by police, witnesses, or accused individuals be tested in light of the examination of specimens provided. An example is a submission from the Alberta SPCA in which a large Great Pyrenees dog was found dead in a roadside ditch in a country residential acreage area east of Edmonton. He had a rope around his neck and an area of abraded skin devoid of hair along one side. The person who found him was concerned that the dog had been dragged alive along the road by a vehicle, a reasonable assumption given the circumstances. Postmortem examination revealed death caused by a single massive blunt blow to the anterior thorax and healing fractures of several ribs along one side of the thorax. The rope around the neck was attached to a loose collar and there was no associated cutaneous or subcutaneous damage. No bleeding or other trauma was present in or under the abraded skin. The postmortem evidence was consistent with a motor vehicle accident, and most likely the skin abrasion and hair loss occurred after death when someone, most likely the driver of the vehicle, dragged the dog, which was quite heavy, off to the side of the road. The investigating constable located the owner who indicated that the dog was prone to running around the neighborhood and had been injured previously in a motor vehicle accident, hence the healing ribs. The dog had been tied up to stop his roaming, but had broken the restraining rope, explaining the rope attached to his collar. What had initially been suspected as a case of cruelty became, upon examination, an unfortunate automobile accident. Of significance are the healing rib fractures, often a marker of non-accidental injury (10), which in this animal was explained once the history was obtained from the owner. This illustrates how important it is to evaluate information obtained from the postmortem examination with information derived from the owner, witnesses, and investigators.

Veterinarians tend to be reluctant to accept forensic submissions. A study of Board-certified veterinary pathologists found that 44% of pathology specialists responding to a survey preferred not to accept forensic submissions and that 17% tried to avoid them because they did not wish to go to court (12). There does not appear to be any equivalent study of the attitudes of general veterinary practitioners to forensic submissions; however, in the author’s experience there are a number of reasons for an attitude of wariness toward such submissions. There is a perceived fear that individuals who are subject to legal proceedings may submit negative reviews or post malicious content on social media which negatively impacts a practice. Forensic cases require more attention to detail in reporting, and time is required in preparation for court which may not be fully billable. There is a fear of the adversarial process in court proceedings, often unreasonably heightened by television court dramas. Furthermore, there is a misconception that by accepting such cases, the practitioner is somehow taking sides, determining guilt and laying and prosecuting charges. These latter 3 concerns are completely unfounded. The veterinarian’s role is simply to provide knowledgeable information to those responsible for conduct of the law to assist the proper working of the legal system.

This survey should be reassuring to practitioners who are reluctant to accept forensic submissions. The role of the expert witness in forensic cases is not to lay or prosecute charges, but to aid the police and legal system in determining the facts of the matter under investigation. The veterinarian is to provide objective information and takes neither the side of the police, court, or accused. In the present survey, fully half of the submissions were due to natural events (e.g., coyote attacks) or traumatic accidents (e.g., motor vehicle accidents). With a thorough postmortem examination and the readily available reference material previously quoted, any veterinarian has the knowledge and ability to differentiate at least these 2 types of conditions from abuse. A little additional research will rapidly expand the clinician’s ability to assess other types of forensic submissions. Such an ability to at least screen forensic submissions in itself is of great benefit to an investigation in that it prevents investigative and legal resources from being wasted on cases which are not in violation of federal or provincial legislation and directs those resources to cases that are potential violations.

The submissions in this survey that remained after natural causes had been removed were almost all straightforward, requiring only a good postmortem examination, good description, and good documentation (9). In this survey, although several cases went to court, not a single submission in 10 y resulted in an actual court appearance by the author.

In summary, a review of forensic submissions over a 10-year period revealed that in 48% there was a potential breach of Canadian Criminal Law, or the provincial Animal Protection Act. Examination of forensic submissions allows rapid identification of those which justify concentration of resources by the investigating authorities, and those which do not, permitting more efficient use of investigative resources. While several submissions in this review became part of evidence that resulted in convictions of offenders in court, none required the attending veterinarian to personally present testimony in court. Submissions were such
that there is no reason that a clinical veterinarian with an interest in forensic medicine should have any reluctance to accept such submissions in their practice.

Acknowledgments
The author thanks Dr. Duane Landals for his comments on the manuscript, and Constables Ilka Cunningham and Ted Dyck of the EPS for providing background information on animal cruelty investigations.

References
Case Report  Rapport de cas

Myoclonus and hypersensitivity of the hind limbs and tail with urinary retention following neuraxial administration of morphine in a cat

Masako Fujiyama, Justin Lavallée, Kerrie Lewis, Tanya Duke-Novakovski

Abstract — An adult female domestic shorthair cat developed myoclonus, muscle rigidity, and hypersensitivity of the hind limbs and tail with urinary retention following neuraxial administration of morphine. Myoclonic contractions resolved following treatment with midazolam and a urinary catheter was placed until normal micturition returned. The cat was clinically normal 36 hours after neuraxial morphine injection. The cat underwent a second surgery without neuraxial morphine and control of postoperative pain required more intervention.

Key clinical message: Neuraxial morphine may cause myoclonus and urinary retention. The response to pharmacological treatment of myoclonus is varied, but a benzodiazepine drug may be effective.

Résumé — Myoclonie et hypersensibilité des membres postérieurs et de la queue avec rétention urinaire après administration neuraxiale de morphine chez un chat. Une chatte domestique à poils courts adulte a développé une myoclonie, une rigidité musculaire et une hypersensibilité des membres postérieurs et de la queue avec rétention urinaire après l’administration neuraxiale de morphine. Les contractions myocloniques se sont résolues après un traitement avec du midazolam et un cathéter urinaire a été placé jusqu’à ce que les mictions normales reviennent. Le chat était cliniquement normal 36 heures après l’injection neuraxiale de morphine. Le chat a subi une deuxième intervention chirurgicale sans morphine neuraxiale et le contrôle de la douleur postopératoire a nécessité plus d’intervention.

Message clinique clé : La morphine neuraxiale peut provoquer une myoclonie et une rétention urinaire. La réponse au traitement pharmacologique de la myoclonie est variée, mais un médicament à base de benzodiazépine peut être efficace.

Epidural and subarachnoid (neuraxial) administration of opioids can provide long-lasting analgesia by activation of opioid receptors within the dorsal horn of the spinal cord (1,2). Highly lipid-soluble opioids such as fentanyl have rapid onset, a localized segmental distribution, and short duration of action because of rapid uptake into the systemic circulation (1,2). Less lipid-soluble opioids such as morphine have a longer duration than more lipid-soluble opioids, although the time to onset can be 30 to 60 min after injection (1). Morphine can migrate cranially within the epidural or subarachnoid space before attaching to receptors and the analgesic effect can be present in dermatomes far from the site of injection (1). Morphine administered at the lumbosacral junction can be used for surgical procedures on more cranial parts of the body, not only for procedures performed on the hind limbs and tail (3,4). In cats, neuraxial morphine was reported to have isoflurane-sparing properties (5) and provided useful analgesia for up to 16 h (6). The risk of complications from neuraxial morphine have been previously reported and include pruritus (7–12), urinary retention (13–15), and rarely, myoclonus (14,16–19).

Case description

An adult female domestic shorthair cat weighing 3.2 kg was scheduled for surgical resection of multiple mammary masses. One month earlier, a complete blood (cell) count (CBC), biochemistry, and urinalysis performed by the referring veterinarian revealed increased blood urea nitrogen concentration [15.6 mmol/L; reference range (RR): 6.0 to 11.4 mmol/L] and isosthenuria (specific gravity: 1.015) with a normal creatinine concentration. The cat was rescued and in foster care; therefore, the medical history and exact age were unknown. During physical examination, age was determined to be approximately 7 to 10 y, mammary masses were identified, and bilateral mucopurulent ocular discharge due to eosinophilic keratitis was observed. Bilateral degenerative renal disease and nephroliths in the right kidney were observed through abdominal ultrasonography. Thoracic radiographs did not identify any pulmonary metastases.
The day before anesthesia and surgery, a 22-G, 2.5-cm over-the-needle catheter (BD Insyte; Becton Dickinson Infusion Therapy Systems, Sandy, Utah, USA) was aseptically secured in a cephalic vein. The blood urea nitrogen concentration measured with a commercial reagent stick (Axostix; Siemens Healthcare Diagnostics, Tarrytown, New York, USA) was 30 to 40 mg/dL (RR: 10.7 to 14.3 mmol/L). Intravenous (IV) fluid therapy (Normosol-R; Hospira, Saint-Laurent, Quebec), 3 mL/kg body weight (BW) per hour, was administered for 12 h and food was withheld for 8 h before anesthesia. Fluid therapy was continued throughout anesthesia and for 36 h into the postoperative period. The cat was premedicated with fentanyl citrate (Fentanyl Citrate Injection USP 0.05 mg/mL; Sandoz Canada, Boucherville, Quebec), 5 μg/kg BW, IV, and anesthesia was induced with alfaxalone (Alfaxan 10 mg/mL; Jurox Pty, Rutherford, Australia), 1.6 mg/kg BW, IV, and midazolam (Midazolam Injection 5 mg/mL; Sandoz Canada), 0.2 mg/kg BW, IV. Following application of lidocaine spray (10 mg/dose; Lidodan Endotracheal; Odan Laboratories, Pointe-Claire, Quebec) to the vocal cords, the trachea was intubated with a 3.5-mm OD cuffed endotracheal tube and the tube was connected to a Bain breathing system. Anesthesia was maintained with isoflurane (AErrane; Baxter, Mississauga, Ontario) delivered in oxygen (1 L/min) and fentanyl IV infusion was administered at a rate of 10 μg/kg BW per hour for intra-operative analgesia. The cat spontaneously breathed the isoflurane oxygen mixture during preparation for surgery. A piezoelectric crystal connected to a Doppler sound device was placed using ultrasound gel following removal of fur proximal to the right metatarsal pad to provide auditory indication of perfusion. Systolic, mean, and diastolic blood pressure were measured using an oscillometer (SunTech Medical V20; Morrisville, North Carolina, USA) with an appropriately sized cuff placed around the right antebrachium.

A morphine (Morphine sulfate injection USP, 10 mg/mL preservative-free, single use ampoule; Sandoz Canada) epidural was chosen for postoperative analgesia and was injected before surgery. The ampoule box was labelled preservative-free, but the listed nonmedicinal ingredients from the product monograph were: 0.1% sodium metabisulfite, with the pH adjusted with sodium hydroxide or sulfuric acid. Morphine (0.1 mg/kg BW) was withdrawn from a new vial using a filter needle (Filter Needle with 5 Micron Filter; Becton, Dickinson and Company, Franklin Lakes, New Jersey, USA) and diluted in 0.64 mL sterile 0.9% saline solution. The cat was positioned in sternal recumbency with the hind limbs pulled cranially. The fur was clipped from the lumbosacral area and the skin was aseptically prepared with chlorhexidine (Germi-Stat Gel 4%; Ceva Animal Health, Cambridge, Ontario). A 22-G, 3.8-cm spinal needle (Quincke spinal needle; Becton, Dickinson and Company, Mississauga, Ontario) was percutaneously inserted into the lumbosacral epidural space using standard technique (3,4). Once the needle tip was deemed to be within the epidural space, the styret was removed and wiped on the back of the glove to check for wet streaks of cerebrospinal fluid and discarded. There were no wet streaks, and neither was cerebrospinal fluid observed in the hub of the needle. The lack of resistance to injection technique was used to confirm needle tip position by injecting 0.3 mL sterile 0.9% saline from a 1-mL plastic injection syringe. Morphine was administered with no resistance to injection over approximately 60 s.

During the left radical mastectomy and ovarioectomy procedures, a side-stream capnometer of a physiological monitor (Datex Ohmeda Cardiopac 5; GE Healthcare, Mississauga, Ontario) was used to monitor; inspired and end-tidal carbon dioxide partial pressure, isoflurane, and oxygen concentration, and the respiratory rate was obtained from the capnometer. The monitor also displayed the base-apex electrocardiogram (lead II), lingual hemoglobin oxygen saturation and esophageal body temperature. A pneumatically driven time-cycled ventilator (Nuffield 200; Penlon, Abingdon, Oxford, UK) maintained end-tidal carbon dioxide between 35 and 45 mmHg (4.7 to 6.0 kPa). Boluses of fentanyl, 2 μg/kg BW, and ketamine (Ketalar 100 mg/mL; Bimeda-MTC Animal Health, Cambridge, Ontario), 0.25 mg/kg BW, IV were administered 15 min after the start of surgery. The mean arterial pressure was maintained in the range 70 to 100 mmHg using 1 bolus of glycopyrrolate (Glycopyrrolate Injection USP 0.2 mg/mL; Sandoz Canada), 0.01 mg/kg BW, IV, 2 boluses of ephedrine (Ephedrine sulfate USP 0.05 mg/mL; Sandoz Canada), 0.05 mg/kg BW, IV, fluid bolus, 10 mL/kg BW, IV, and dobutamine infusion (Dobutamine, Hospira Healthcare, Lake Forest, Illinois, USA), 3 to 7.5 μg/kg BW per minute, during the 2 h of surgery. Cefazolin with diluent (Cefazolin powder for injection USP 100 mg/mL; Fresenius Kabi Canada, Toronto, Ontario), 22 mg/kg BW, IV, was administered every 90 min from the start of surgery to the end. No major complications were observed during anesthesia and surgery. Total anesthesia time was 200 min and time from epidural injection to termination of isoflurane was 170 min.

During recovery from anesthesia and following tracheal extubation, myoclonic contractions of both hind limbs were observed, but were especially pronounced on the left hind limb. The tail and the hind limbs also had extensor rigidity, and the limbs were resistant to manual flexion. Hypersensitivity to tactile stimulation on both hind limbs and tail was also observed. The forelimbs and respiratory muscles were not affected, and the breathing pattern was normal. A bolus of dexmedetomidine (Dexdomitor 0.5 mg/mL; Zoetics Canada, Kirkland, Quebec), 0.5 μg/kg BW, IV, did not resolve the myoclonus or muscle spasms. A bolus of midazolam, 0.2 mg/kg BW, IV, successfully treated the myoclonus, and limb flexion was possible although mild muscle rigidity remained. A milder myoclonus pattern reappeared 5 min after injection of midazolam. Midazolam injection was repeated at the same dose and the extensor rigidity and myoclonic contractions stopped, although slight increased muscle tone remained. The cat otherwise appeared comfortable. Approximately 4 h later, a full bladder was palpated. Manual expression of the bladder was unsuccessful and cystocentesis was performed. The fentanyl infusion was continued overnight at a rate of 3 μg/kg BW per hour. During the 24 h following the end of anesthesia, the cat appeared to be photophobic. Eye lubricant was frequently applied and blepharospasm resolved over the following 24 h.
The following day after surgery, the cat was able to stand using her hind limbs but was unable to walk and still had urinary retention. Another cystocentesis was performed, the fentanyl infusion was stopped, and buprenorphine (Vetregesic Multidose, Ceva Animal Health), 0.02 mg/kg BW, IV, was administered. A 3.5-Fr 25-cm urinary catheter (Tomcat/Small Animal Catheter; MILA International, Florence, Kentucky, USA) was placed using a blind technique without sedation, the position was confirmed by radiography and urine was collected into a sterile bag over the next 24 h. Approximately 36 h following the injection of morphine, the cat was able to stand and walk normally. The urinary catheter was removed, and normal micturition was observed. On the third day after surgery, the cat was discharged to her foster home.

A right radical mastectomy was performed approximately 7 wk later and neuraxial morphine was not used. The blood urea nitrogen was 19.7 mmol/L and creatinine concentration was 120 μmol/L (RR: 78 to 178 μmol/L). No myoclonus or urinary retention was observed, but it appeared the cat had a higher degree of postoperative pain compared to the previous surgery. Fentanyl, dexmedetomidine, and ketamine infusions, required in the postoperative period.

Following the second surgery, the cat was regularly checked by the oncology service and was doing well up to 1 y afterwards. A chemistry profile and urinalysis measured 8 mo after the second surgery revealed continued elevated blood urea nitrogen (15.9 mmol/L) and isosthenuric urine, but the creatinine level had increased to 176 μmol/L. Sixteen months after the second surgery, the rescue organization said the cat was adopted into a new home and was doing well. Her kidney function is monitored by the family veterinarian and no adverse clinical problems were apparent, apart from recurrent, incidental urinary tract infection.

Discussion

A rare case of myoclonus and hypersensitivity with urinary retention in a cat with neuraxial morphine, without the confounding effect of a local anesthetic on the cause of urinary retention is described in this report. Pruritus can also occur in this cat was mostly dependent on elimination of morphine from the body. Myoclonus and muscle spasm have been reported following subarachnoid morphine in dogs (10,14,17) and in humans (18,19). In another cat, myoclonus and hypersensitivity occurred following subarachnoid injection of the same dose of morphine but which was combined with bupivacaine (16). Two boluses of ketamine, 0.05 mg/kg BW, were administered to treat myoclonus and appeared to reduce the severity of clinical signs; myoclonus resolved without further treatment 8 h later. Ketamine, however, failed to resolve myoclonus in a dog (10). Other drugs that have been unsuccessfully used to control myoclonus include acepromazine, other opioids, and μ-opioid antagonists (10,17). Dexmedetomidine did not successfully treat myoclonus in the cat in the present report. In 1 dog, diazepam appeared to have a short duration of effect in resolving myoclonus, and a subsequent bolus of diazepam further reduced the myoclonus for an extended period (10). Administration of midazolam to this cat produced a similar response. The first bolus had a short duration of effect, but a subsequent increment considerably reduced muscle spasm and myoclonus. It appears successful treatment with benzodiazepines might depend on appropriate dose rate and the effect could be prolonged using an IV infusion. However, in 1 dog, morphine became refractory to midazolam boluses; but the initial morphine dose was high (17). Other gamma aminobutyric acid (GABA) agonist drugs such as pentobarbital at a subanesthetic dose (3.2 mg/kg BW) have been used to successfully resolve myoclonus (14); but a similar dose was not successful in the dog with neuraxial morphine overdose (17). In that dog, isoflurane anesthesia with GABA agonists did not resolve myoclonus and skeletal neuromuscular paralysis with ventilatory and critical care support was used (17). Accidental overdose was considered unlikely in this cat because only one formulation of morphine is held in the clinic drug dispensing unit and the vial was checked before use.

The mechanism of action underlying myoclonus is unknown, but morphine is thought to activate non-opioid systems in the spinal cord including activation of serotonin and N-methyl-D-aspartate systems and disinhibition of GABA/glycine receptors (10,20). Multiple sites of action might explain the varied response to treatment. Accumulation of morphine-3-glucuronide can also cause neuroexcitation and renal disease can delay excretion (21). It is unknown whether the presence of renal insufficiency in this cat caused morphine-3-glucuronide accumulation, but this was considered unlikely. Accumulation is observed with chronic, systemic administration of morphine. The production of morphine-3-glucuronide is minimal in the central nervous system (21). In addition, cats have a poor ability to use glucuronidation to metabolize opioids (22). Myoclonus was observed during the recovery period in both the cat in the present report and the cat in a previous report (16); but in both cases, muscle rigidity or myoclonus may have been present earlier and surgical drapes may have prevented observation of this side-effect. Myoclonus was apparent during isoflurane anesthesia in 2 dogs (14,17) and in another dog, intense pruritus and hypersensitivity were first observed during the recovery period and followed by myoclonus (10). In common with other reported cases of myoclonus, full recovery from complications in this cat was mostly dependent on elimination of morphine from the body.

Urinary retention is a well-recognized complication of neuraxial administration of morphine and has been reported in dogs (13,14) and in a cat which also was unable to defecate (15). The mechanism of action is not fully understood but might involve opioid-induced inhibition of parasympathetic outflow resulting in detrusor relaxation and increase in bladder sphincter tone (23). Urinary retention has been treated with manual bladder expression (15) or urinary tract catheterization (13,14), until normal micturition returns. Other treatments have included administration of the muscarinic receptor parasympathomimetic
bethanechol (14,15) or the serotonin agonist cisapride, which also has parasympathomimetic properties (15). Opioid antagonists are also indicated for this complication but might also reduce opioid analgesia (24).

A high concentration of morphine in the subarachnoid space appears to increase the risk of myoclonus. In previous reports of myoclonus in animals (10,14,16,17), morphine was administered into the subarachnoid space and the dose adjusted accordingly. In dogs, the spinal cord usually ends at the vertebral level of L6–L7 and the dural sac ends at L7–S2 (25). In cats and small breeds of dog, these end points are 1 vertebra caudal and the risk of dural sac puncture is higher. The Quincke tip of the spinal needle has a long sharp bevel that may easily penetrate the dural sac allowing accidental dural puncture when using these needles for epidural injection. Although the risk of myoclonus from morphine injection is higher with subarachnoid injection, epidural morphine has been reported to cause myoclonus (26). In this cat, the position of the needle tip appeared to be within the epidural space, but inadvertent subarachnoid injection of morphine cannot be ruled out.

The morphine dose and diluent used in this cat were the same as previously evaluated in cats (5,6) and recommended for clinical use (3,4). Although the formulation is not intended for neuraxial use (3,4), although the formulation is not intended for neuraxial use (3,4), it has been used for many years at this institution. The morphine formulation and diluent used in this case were listed as preservative-free on the ampoule box, but the product monograph states the ampoules contain 0.1% sodium metabisulfite. The manufacturer adds sodium metabisulfite as an antioxidant to slow degradation of the morphine sulfate pentahydrate molecule. Other preservatives such as phenol and formaldehyde have been cited as a cause of neurotoxicity (27), but 0.1% sodium metabisulfite has not been reported to cause nerve damage in dogs or humans (28,29). Drug interactions with lidocaine or bupivacaine have also been cited as a potential cause of neurotoxicity (10), but morphine was administered alone in this cat.

The surgical procedures were similar, but without neuraxial morphine, postoperative pain was more difficult to control after the second mastectomy. Blepharospasm and photophobia were not considered to be due to neuraxial morphine and were more likely a result of pre-existing eye pathology, although mydriasis from μ-agonist opioids and anticholinergics can also cause photophobia in cats.

In conclusion, although neuraxial morphine can cause rare side-effects, this route of administration for morphine can provide effective analgesia. Prospective clinical studies or surveys might reveal useful information on true incidence of these side-effects. Following use of neuraxial morphine, urinary retention appears to be common and all animals should be observed for postoperative return of bladder function.

Acknowledgments

The authors thank the anesthesia and critical care staff for their help in caring for this cat.

References


Case Report  Rapport de cas

Autologous tunica vaginalis communis flap for repairing an abdominal wall hernia in a dog

Yusuke Ozai, Akiko Uemura, Ryou Tanaka, Seijirow Goya

Abstract — An 8-year-old, intact male miniature dachshund dog, weighing 8.6 kg, was presented with a soft swelling in the caudal abdominal region, including both sides of the groin area. Laparotomy revealed a severe caudal abdominal wall hernia with atrophy of the rectus abdominal muscle. The defect was repaired using a tunica vaginalis communis flap following a standard open prescrotal castration. There were no complications or recurrence of the hernia at 11 months after surgery. This surgical technique involves autogenous reconstruction, is easy to perform, and requires minimal dissection. The tunica vaginalis communis flap has potential clinical applications for repairing caudal abdominal wall hernias in male dogs.

Résumé — Lambeau de tunique vaginale autologue pour la réparation d’une hernie de la paroi abdominale chez un chien. Un teckel miniature mâle intact de 8 ans, pesant 8,6 kg, a présenté une enflure molle dans la région abdominale caudale, y compris des deux côtés de la région de l’aine. La laparotomie a révélé une hernie sévère de la paroi abdominale caudale avec atrophie du muscle abdominal droit. Le défaut a été réparé à l’aide d’un lambeau de la tunique vaginale aprés une castration prèscrotale ouverte standard. Il n’y a eu aucune complication ni récidive de la hernie 11 mois après la chirurgie. Cette technique chirurgicale implique une reconstruction autogène, est facile à réaliser et nécessite une dissection minimale. Le lambeau de tunique vaginale a des applications cliniques potentielles pour la réparation des hernies de la paroi abdominale caudale chez les chiens mâles.

I deally, hernias would be closed without the need for a flap or graft. However, if there is too much tension to achieve primary repair, then other methods of reconstruction should be pursued. The use of autologous tissue is the gold standard for abdominal wall reconstruction and is preferable to non-autologous methods for most cases of complicated hernia, with benefits such as inherent blood supply, reduced risk of infection, and diminished immune response (1,2). Muscular flaps reported to have potential for repairing caudal abdominal wall hernias including inguinal hernia, femoral hernia, and prepubic hernia, in dogs include the cranial sartorius muscle flap (3,4) and the rectus abdominus muscle flap (5). Also, a free autogenous thoracolumbar fascia graft has been used for the reconstruction of abdominal wall hernias in experimental studies (6,7), and a case report (8). There are some disadvantages, however, associated with the use of these muscle flaps and free grafts. For example, muscle transfers to the sites of the defect are limited to the use of selected muscles, and the techniques for repair can be highly invasive, due to the extensive surgical approach and wide incision necessary to obtain adjacent autologous tissues. Synthetic implants, such as polypropylene mesh, have the advantage of being readily available and easy tailored to the appropriate size and shape. However, using synthetic implants increases the risk of local infection, the formation of a fistula in some cases (1,9,10), and it may sometimes be necessary for such implants to be removed if they become infected or inflamed (10). Alternatively, porcine small intestinal submucosa has been reported as an absorbable mesh, and this has the advantage of being biocompatible and resistant to infection, although there are only a few clinical case reports of using porcine and canine small intestinal submucosa for reconstruction of abdominal wall defects and hernias (11–13).

Surgeons must decide how to reconstruct a large caudal abdominal hernia after considering the situation, such as whether the area is contaminated and local tissue strength...
and viability, as each option has its advantages and disadvantages. The tunica vaginalis communis is derived from the peritoneum and is composed of mesothelium and connective tissue (14). This tissue was experimentally used as a graft for repairing abdominal wall defects in rats (15), umbilical hernias in sheep (16), and urinary bladder wall defects in dogs (17). Autologous tunica vaginalis communis flaps have been previously used clinically in dogs; however, their use has been limited to perineal hernia repair (18), inguinal hernia repair (19), and perineal hernia repair as a free tissue graft (20).

The clinical application of an autologous tunica vaginalis communis pedicle flap for the repair of a caudal abdominal wall hernia in a dog is outlined in this report. This procedure may be simpler and more effective than conventional techniques using autologous tissue.

**Case description**

An 8-year-old, intact male miniature dachshund dog, weighing 8.6 kg, was referred to the Animal Medical Center at the Tokyo University of Agriculture and Technology for treatment of a suspected bilateral inguinal hernia. The dog had an approximately 1-month history of soft swelling in the caudal abdominal region, including both sides of the groin area. The dog had no history of open surgery or trauma. There were no clinical signs
associated with the hernia, such as abdominal pain, vomiting, depression, anorexia, or diarrhea. The results of complete blood cell count and serum biochemistry were within normal ranges. Abdominal radiographs showed herniation of the intestine through the abdominal wall (Figure 1). Bilateral inguinal hernias or a caudal abdominal wall hernia with large abdominal defects were suspected. The dog was surgically treated 16 d after the initial consultation.

Ampicillin sodium (Ampicillin Na injection; Kyoritsu Pharma, Tokyo, Japan), 30 mg/kg body weight (BW), IV, was administered to prevent infection, and butorphanol tartrate (Vetorphale; Meiji Seika Pharma, Tokyo, Japan), 0.2 mg/kg BW, IV, and midazolam hydrochloride (Dormicum injection 10 mg; Astellas Pharma, Osaka, Japan), 0.2 mg/kg BW, IV, were given for pain relief. Following pre-medication with atropine sulfate (atropine sulfate injection 0.5 mg; Nipro, Osaka, Japan), 0.05 mg/kg BW, SC, general anesthesia was induced with IV propofol to effect (Propofol injection 1% for animal use; MSD Animal Health, Tokyo, Japan). Anesthesia was maintained with isoflurane (Isoflurane for animal use; MSD Animal Health) after intubation. The dog was placed in dorsal recumbency, and a ventral midline approach was made extending from 2 cm caudal to the umbilicus to the pubis. The herniated organs were identified as omentum, intraabdominal fat, and small intestine. There was a large abdominal wall defect measuring 6 to 8 cm between the right and left external abdominal oblique muscles. Upon inspection, a tear at the myotendinous junction of the rectus abdominus muscle to the prepubic tendon was identified. The rectus abdominus muscle adjacent to the defect was atrophied and friable (Figure 2). It was difficult to close the abdominal wall defect without excessive tension due to the size of the defect. This surgical investigation revealed no inguinal hernia on either side.

The incision was extended caudally to perform the castration. The tunica vaginalis communis was incised along the greater curvature of the testis, and a standard open prescrotal castration was performed. The scrotal fat and fascia were carefully dissected from the tunica vaginalis communis to the level of the vaginal ring. Using Metzenbaum scissors, the incision previously made in the parietal vaginal tunic was extended distal to proximal (A) to open the tunic up into a fan-shaped sheet (B; arrows). The inherent blood supply of the flap was clearly visible (B; dashed arrow). The cranial side is to the left of the image.
These flaps were sutured to the prepubic tendon caudally. The cranial area of the abdominal wall defect was apposed primarily using simple interrupted sutures of 3-0 monofilament nylon with moderate tension (Figure 4). Subcutaneous tissues and the skin were closed using simple interrupted sutures. On the day after surgery, the dog had good activity and appetite although there was mild seroma formation at the surgery site. The dog was discharged the day after surgery. Skin sutures were removed on day 27 by the dog’s regular veterinarian and there was no seroma or swelling at this time. There were no complications or recurrence of the hernia at day 330, when the dog was assessed by its regular veterinarian.

Discussion

This case report, along with previous reports, support the use of the tunica vaginalis communis as an autologous flap in a caudal abdominal wall and perineal hernia repair (15–20). In this case, an autologous tissue was chosen to repair the caudal abdominal defect as there was concern that using non-autologous materials in a miniature dachshund dog might induce an immune response, according to a report that this breed has a high risk of foreign body-reactive granulomas (21). Compared to a free fascial graft, a pedicle flap has the benefit of an inherent blood supply and therefore may be less susceptible to dehiscence and infection (2). The cranial sartorius muscle flap and the rectus abdominus muscle flap might be suitable for repairing caudal abdominal wall defects; however, the successful use of a muscle flap depends on the surgeon’s familiarity with the vascular arrangement and anatomy of the muscle to be transposed (3), and these techniques require a wide incision and muscle dissection. When creating the tunica vaginalis communis flap, the vessels are readily identified on the visceral surface following castration; this allows the surgeon to easily identify a hypovascular area to be incised when opening the flap into a fan-shaped sheet. During these procedures we found that creation of the tunica vaginalis communis flap was straightforward. Therefore, we believe it is an achievable technique for both specialized surgeons and general practitioners. Additionally, the tunica vaginalis communis flap technique can be minimally invasive as it requires just a short additional incision of a few centimeters when performing castration. In this case, we extended the incision caudally to perform the castration and directly transposed the tunica vaginalis communis flap to the abdomen, but it is possible to make a separate skin incision and transpose the flap through the abdominal cavity (18).

The tunica vaginalis communis flap technique has a few limitations: it can only be performed in intact males with the owner’s consent to performing castration and the transposed region can only include the caudal abdominal area. This report demonstrates that the tunica vaginalis communis flap can be successfully used to repair a prepubic tendon rupture and can offer advantages over other local flaps or prosthetics in caudal abdominal hernia repair.

Acknowledgment

We thank Dr. Kotomi Sato for assistance in providing anesthesia for this case.

References

Case Report  Rapport de cas

Standing laparoscopic abdominal lavage using a suction-irrigation device in 2 horses with primary suppurative peritonitis

Nicola C. Cribb, Luis G. Arroyo, Ludovic Bouré

Abstract — The use of a laparoscopic suction-irrigation device in 2 standing horses for lavage of the abdomen for the treatment of primary suppurative peritonitis is reported. Two horses were presented with a 1- to 2-week history of weight loss. Abdominocentesis revealed highly elevated total nucleated cell count. Peritoneal lavage systems were placed in both horses, but complications prevented adequate lavage. Both horses underwent standing laparoscopy; the dorsal abdomen was explored and the abdomen was profusely lavaged, using a suction-irrigation device. The procedure was efficient and allowed adequate visualization of the dorsal abdomen and lavage. A successful outcome was achieved in both cases.

Key clinical message:
Lavage of the abdomen of horses with peritonitis can be achieved under standing sedation, using a laparoscopic technique. In appropriately selected cases, this allows for adequate visualization of the dorsal abdomen and efficacious abdominal lavage.

Résumé — Lavage abdominal laparoscopique debout à l’aide d’un dispositif d’irrigation par aspiration chez deux chevaux atteints de péritonite suppurée primaire. L’utilisation d’un dispositif laparoscopique d’irrigation par aspiration pour le lavage de l’abdomen pour le traitement d’une péritonite suppurée primaire chez deux chevaux debout est rapportée. Deux chevaux ont été présentés avec une histoire de 1 à 2 semaines de perte de poids. L’abdominocentèse a révélé un nombre total de cellules nucléées très élevé. Des systèmes de lavage périnéal ont été placés chez les deux chevaux, mais des complications ont empêché un lavage adéquat. Les deux chevaux ont subi une laparoscopie debout; l’abdomen dorsal a été exploré, et l’abdomen a été abondamment lavé à l’aide d’un dispositif d’irrigation par aspiration. La procédure était efficace et permettait une visualisation adéquate de l’abdomen dorsal et un lavage. Une résolution positive a été obtenue dans les deux cas.

Message clinique clé :
Le lavage de l’abdomen de chevaux atteints de péritonite peut être réalisé sous sédation debout, en utilisant une technique laparoscopique. Dans des cas bien choisis, cela permet une visualisation adéquate de l’abdomen dorsal et un lavage abdominal efficace.

Peritonitis is an inflammation of the peritoneum that results in exudation of fibrin, serum, and inflammatory cells, leading to the formation of pus (1). Peritonitis can be primary or secondary. Primary peritonitis occurs spontaneously and usually lacks an obvious cause. Secondary peritonitis can occur from many causes including gastrointestinal and non-gastrointestinal sources (1). Several studies have reported a survival rate for peritonitis in horses that ranges from 40 to 87% (2–5).

Treatment for peritonitis, regardless of the cause includes: intravenous fluid and electrolytes, correction of protein concentration, antimicrobial, anti-inflammatory and anti-endotoxic therapy, and removal of bacteria, toxins, and foreign debris (1). One author recommends that abdominal drainage and lavage be performed in non-surgical peritonitis cases when the total nucleated blood cell count (TNCC) is greater than 100 000 cells/μL (1).

Abdominal lavage and drainage may be achieved by surgical lavage, and/or placement of a ventral lavage/drainage catheter, with or without a paralumbar lavage catheter (1,4,6,7). The option of lavage under laparoscopic guidance has been
Table 1. Abnormal variables for the horse in case 1.

<table>
<thead>
<tr>
<th>Day</th>
<th>WBC</th>
<th>Neuts</th>
<th>HC</th>
<th>Hb</th>
<th>Alb</th>
<th>Glob</th>
<th>Fib</th>
<th>Peritoneal fluid TNCC</th>
<th>Peritoneal fluid TP (g/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>18.8</td>
<td>13.91</td>
<td>0.23</td>
<td>94</td>
<td>11</td>
<td>—</td>
<td>6.0</td>
<td>335.9</td>
<td>23</td>
</tr>
<tr>
<td>19</td>
<td>16.6</td>
<td>11.29</td>
<td>0.19</td>
<td>75</td>
<td>15</td>
<td>35</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>23</td>
<td>8.8</td>
<td>5.63</td>
<td>0.18</td>
<td>69</td>
<td>15</td>
<td>45</td>
<td>—</td>
<td>135.0</td>
<td>45</td>
</tr>
<tr>
<td>30</td>
<td>16.7</td>
<td>9.02</td>
<td>0.16</td>
<td>62</td>
<td>17</td>
<td>50</td>
<td>5.0</td>
<td>40.3</td>
<td>28</td>
</tr>
<tr>
<td>38</td>
<td>14.2</td>
<td>9.09</td>
<td>0.19</td>
<td>71</td>
<td>18</td>
<td>47</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Reference range
5.1–1.0 × 10^9/L  2.8–7.7 × 10^9/L  0.28–0.44 L/L  112–169 g/L  30–37 g/L  26–41 g/L  0.9–2.8 g/L × 10^9 cells/L

Day 1 was the first day of clinical signs on the farm. Surgery was on day 14.
WBC — white blood cell count × 10^9/L; Neuts — neutrophils; HC — hematocrit; Hb — hemoglobin; Alb — albumin; Glob — globulin; Fib — fibrinogen; TNCC — total nucleated cell count; TP — total protein.

mentioned (1,8). The suction-irrigation device (Strykeflow 2 Disposable Suction/Irrigation; Stryker, Hamilton, Ontario) is simple to use, and allows the surgeon to control and direct the flow of fluid. Using a separate button, suction can be achieved. To our knowledge, clinical reports of laparoscopic lavage for the treatment of primary septic peritonitis in the horse have not been published; although this technique is widely used in human surgery (9).

The objective of this paper is to report on the use of a laparoscopic suction-irrigation device in 2 standing horses for lavage of the abdomen for the treatment of primary suppurative peritonitis of undetermined origin.

Case descriptions

Case 1
A 1-year-old Hanoverian gelding was presented with an 11-day history of inappetence, weight loss, diarrhea, and pyrexia. Prior to presentation, a complete blood (cell) count (CBC) revealed a mildly increased white blood cell (WBC) count. The horse was treated with activated charcoal and bismuth subsalicylate, water and electrolytes by nasogastric tube Intravenous flunixin meglumine, dipyrdyl and tetracycline were administered for 5 d. Marked improvement in attitude and appetite was reported and fecal consistency returned to normal.

On day 11, the gelding was presented for further evaluation and treatment as he was dull, had a fever (40.5°C), and was passing pasty feces. Flunixin meglumine (10 mL) was administered before transportation.

On admission, the horse was in poor body condition (1/5), weighed 350 kg, and was dull in attitude but responsive to stimuli. The heart rate and respiratory rate [62 beats/min (bpm) and 26 breaths/min, respectively] were elevated, but the rectal temperature was normal (37.3°C). Mucous membranes were pale pink and tacky with a prolonged capillary refill time, and the horse was clinically dehydrated (7%). Gastrointestinal sounds were bilaterally decreased in all quadrants. Normal manure was passed.

A CBC revealed a markedly increased WBC count due to neutrophilia, and the serum biochemistry profile revealed severe hypoproteinemia due to hypoalbuminemia (Table 1, day 11), and mildly increased creatine kinase [CK = 1212 U/L; reference range (RR): 120 to 470 U/L].

An ultrasonographic examination of the abdomen revealed moderate to severe accumulation of mildly echoic peritoneal fluid. An abdominocentesis revealed pale yellow, cloudy peritoneal fluid with a highly elevated nucleated cell count (Table 1, day 11). Intracellular structures were observed on microscopic examination that appeared to be recently phagocytosed microorganisms; but aerobic and anaerobic bacterial culture yielded no growth.

Treatment with sodium penicillin (Sodium Penicillin; Novapharm, Toronto, Ontario), 40 000 IU/kg body weight (BW), IV, q6h, gentamicin (Gentocin; Merck Animal Health, Kirkland, Quebec), 6.6 mg/kg BW, IV, q24h, and flunixin meglumine (Flunixin; Zoetis Canada, Kirkland, Quebec), 1.1 mg/kg BW, IV, q12h, was initiated and continued for 6 d.

A peritoneal lavage system was placed under standing sedation using a 22 F chest drain tube (Argyle Trocar catheter; Coviden, Dublin, Ireland), and placed through a stab incision in the ventral most portion of the linea alba. Ten liters of warmed (37°C) sterile lactated Ringers’ solution (LRS; Baxter, Mississauga, Ontario) were pumped into the abdomen, and left to drain passively. The following day, the abdomen was again lavaged with 5 L LRS, which was left to drain passively. Little fluid was retrieved; therefore, an additional drainage catheter was placed 5 cm caudal to the first one.

After 36 h of lavage, both drains were blocked by inflammatory debris. The horse was sedated and a standing laparoscopic exploration of the dorsal abdominal cavity with abdominal lavage using a suction-irrigation device was completed. Feed was not withheld prior to the procedure due to the already inappetent and cachectic state of the horse.

Case 2
A 10-year-old Thoroughbred gelding was presented for weight loss of 2-weeks duration. Prior to the onset of weight loss, the horse had been vaccinated against tetanus, strangles (intranasal), eastern and western encephalitis and subsequently developed muscle soreness, which was treated with intravenous fluid therapy and flunixin meglumine. The muscle soreness improved...
but extreme weight loss (estimate 100 kg) ensued. A CBC by the referring veterinarian on the day of presentation was reported as unremarkable.

On presentation (day 14), the gelding was quiet but alert and responsive. Body weight was 535 kg; body condition score was 1.5/5. All vital parameters were within normal limits. Gastrointestinal sounds were increased on ventral quadrants, but normal manure was passed.

Serum biochemistry profile revealed hypoalbuminemia, hyperglobulinemia, and elevated serum amyloid A (SAA) (Table 2, day 14). Serum protein electrophoresis revealed a polyclonal gammaglobulinopathy. A CBC was not repeated.

Thoracic radiographs revealed the presence of fluid ventrally but demonstrated no further abnormalities. Ultrasound examination confirmed a small amount of fluid (1 cm depth) in the right pleural cavity. Abdominal ultrasound examination revealed no further abnormalities. Ultrasound examination revealed a small amount of free fluid, which was observed mainly in dorsal locations.

Fluid samples from the thoracic and abdominal cavities indicated an elevated nucleated cell count and elevated total protein from the abdomen (Table 2, day 14), and thorax (nucleated cell count: $164.8 \times 10^9$ cells/L, total protein: 56 g/L) with 90% non-degenerate neutrophils and 10% macrophages. These findings were consistent with a marked suppurrative inflammation of unknown origin. Bacterial culture of fluid from both cavities yielded no growth.

The differential diagnoses were neoplasia or abscess within the abdominal or thoracic cavity or both. The horse was hospitalized to await results of testing and was allowed free access to hay. Vital parameters remained within normal limits, and the horse had good appetite and attitude.

On day 4 of hospitalization, once cytology and culture and susceptibility results were obtained, peritoneal fluid was obtained from a different location to further investigate the differential diagnoses (Table 2, day 18). A few small clusters of dense-staining, atypical cells which appeared to be of epithelial origin were observed; however, the tissue of origin could not be determined. The following day (day 19), 3 L LRS were instilled into the abdomen in attempt to remove cells and obtain a greater volume for cytological analysis. Under sedation, fluid instillation was achieved by placing a 28F chest drain (Argyle Trocar catheter; Covidien) through a left paralumbar fossa stab incision. This drain was removed due to improper placement evidenced by subcutaneous fluid leakage, and the incision was closed routinely. Fluid collected from the ventral abdomen with a spinal needle (18 G × 3 in) revealed that the nucleated cell count and total protein were markedly increased compared to days 14 and 18. Neutrophils were noted to have frequent intracellular bacilli. No atypical cells were noted. A CBC was subsequently determined and was within normal limits. The abdominal fluid was cultured and yielded no bacterial growth. Polymerase chain reaction (PCR) on the abdominal fluid for Streptococcus equi subsp. equi was negative. Treatment with trimethoprim-sulfa (Borgal; Merck Animal Health), 24 mg/kg BW, IV, q12h, and flunixin meglumine, 1.1 mg/kg BW, IV, q12h, via indwelling jugular catheter was then initiated on day 18.

On day 19, standing laparoscopic exploration of the dorsal abdomen, lavage of the abdomen with the suction irrigation device, and placement of lavage catheters through the paralumbar fossae were performed under laparoscopic guidance. Feed was withheld for 24 h before surgery.

**Surgical technique**

Both the left and right paralumbar fossae were prepared for aseptic surgery. The horses were restrained in stocks and operated in a standing position using neuroleptanalgesia and local anesthesia, as previously described (10).

Two portals were used for each side: 1 for the laparoscope and 1 for the suction-irrigation device. Portal 1 was located midway between the tuber coxae and the 18th rib, through the dorsal aspect of the crus of the internal abdominal oblique muscle. Portal 2 was located at the caudal part of the 17th intercostal space at the level of the ventral aspect of the tuber coxae. The first trocar-cannula unit (512X Endopath disposable surgical trocar; Endo-Surgery, Cincinnati, Ohio, USA) was inserted at portal 1 and the laparoscope was introduced to confirm its intra-abdominal position. Insertion of the accessory trocar-cannula units at portal 2 was assisted by laparoscopic guidance to avoid visceral injury. Insufflation was not used.

**Laparoscopy via the left portals**

In case 1, initial laparoscopic visualization of the left abdominal viscera revealed enlarged mesenteric lymph nodes of the small intestine and a massive accumulation of fluid. The suction irrigation device (Strykeflow 2 Disposable Suction/Irrigation;
Stryker, Hamilton, Ontario; Figure 1) was inserted through portal 2 and approximately 8 L of fluid were retrieved. The abdomen was lavaged with 10 L of LRS, which was retrieved using the device. Lavage was discontinued once the retrieved fluid was clear. The 2 ventral drains were removed during surgery.

In case 2, aspiration from the right side was more challenging and abnormal findings included an enlarged and irregular surface of the spleen, fibrous deposits on the peritoneum, and fibrous adhesions between the liver and diaphragm on the left side. The serosa of the small intestine that could be visualized appeared reddened and irritated. A location in the caudal aspect of the 16th intercostal space, at the level of the ventral tuber coxae, was determined using a spinal needle under laparoscopic guidance and a stab incision was made, following instillation of local anesthetic. A laparoscopic grasping forcep was inserted directly into the incision to obtain a sample of the fibrous adhesions on the liver, and a TruCut biopsy device (Products Group International, Lyons, Colorado, USA) was used to obtain a sample of the spleen using a percutaneous technique. The abdomen was lavaged with 35 L LRS through the right and left sides, which were aspirated using the suction irrigation device, until the retrieved fluid was clear.

**Laparoscopy via the right portals**

Two trocar-cannula units were placed as described for the left side. However, in case 1, the cannula for portal 1 was inadvertently placed into the cecum. As a result of this complication, prolonging surgery time and the risk of the weak and cachectic horse falling, a decision was made not to lavage the abdomen from the right side. The portal incision was enlarged while the scope was maintained in the cecum, then the wall of the cecum was exteriorized, and the puncture was closed and lavaged. The flank incision was closed routinely.

In case 2, aspiration from the right side was more challenging as a result of the propensity of mobile intestine to be sucked onto the end of the device. A 28F chest tube was placed through the laparoscopic portal on the left and right sides and sutured in place. An additional 28F chest tube was placed in the ventral most aspect of the abdomen through the linea alba. All incisions were closed routinely.

**Post-operative care**

The horse in case 1 remained hospitalized for a further 22 d. He was stall-rested, allowed free access to hay and water, supplemented with a high energy/high protein pelleted feed (Equine Senior; Purina, Mississauga, Ontario), and allowed to graze 3 times a day.

The horse in case 2 remained hospitalized for a further 7 d. He was stall-rested and given free access to hay and water. Cytological and histopathological analysis of the biopsies of the spleen and liver were unremarkable. The abdomen was successfully lavaged via the paralumbar fossa drains with a total of 10 L of LRS once a day for 2 d. Flunixin meglumine was continued until 2 d after surgery and then decreased to 1.1 mg/kg BW, IV once daily for 5 d then discontinued. Trimethoprim-sulfa was continued for 10 d after surgery, for a total administration period of 12 days.

**Follow-up**

**Case 1**

The horse was bright with good appetite, and moderate tachycardia (52 to 60 bpm) for 3 d after surgery. On day 19 (5 d after surgery), the horse developed a fever (40.5°C). A CBC and serum biochemistry profile revealed a continued leukocytosis with mature neutrophilia, and a moderate to marked microcytic non-regenerative anemia (Table 1, day 19). The albumin and globulin remained low and high, respectively, (Table 1, day 19). The fever was attributed to a jugular vein thrombophlebitis based on clinical findings of an enlarged painful mass around the indwelling catheter and ultrasonographic findings consistent with thrombus formation. The fever resolved within 48 h after removal of the catheter and change in medication: trimethoprim-sulfa, 24 mg/kg BW, PO, q12h and rifampicin (Rofact; Valleeant Canada, Saint Laurent, Quebec), 5 mg/kg BW, PO, q12h, which were continued for a further 35 d, and phenylbutazone (Phenylbutazone; Vétoquinol, Lavaltrie, Quebec), 4.4 mg/kg BW, PO, q24h for 5 d.

A CBC was repeated on day 23 and revealed a normal WBC count, but a mild anemia was detected. Abdominocectomy was repeated (9 d after surgery), which revealed a significantly lower cellularity than on admission and continued elevated total protein. The cell population was composed mainly of non-degenerate neutrophils. There was no evidence of infectious agents.

On day 24, the horse was too weak to stand and was placed in an Anderson sling (CDA products, Potter Valley, California, USA) for 4 d. A CBC on day 30 revealed an elevated WBC count, ongoing anemia, and a moderately high WBC count. Fibrinogen was still high indicating ongoing inflammation. Cytological analysis of the peritoneal fluid revealed a lower nucleated cell count and decreased total protein than on day 11 (Table 1, day 30). The horse remained in the hospital to gain strength before returning home.

On the day of discharge from the hospital (day 38), the WBC count was reduced with a mature neutrophilia, and moderate anemia. The serum total protein concentration was increased considerably compared to presentation (Table 1, day 38), although still marginally below normal limits. The horse's...
appetite was very good, and there was gradual weight gain. At the time of discharge, he weighed 311 kg.

Seven months later, the horse was examined at our institution for an unrelated reason and weighed 403 kg. Eight years after suppurative peritonitis, the horse was in good health and was sold by his owners.

**Case 2**
The day after laparoscopy, the horse was quiet and had diarrhea. Fecal culture yielded no growth of known enteropathogens (i.e., *Salmonella* spp., *Clostridioides difficile*). Two days after laparoscopy the diarrhea had resolved, and the horse was bright with good appetite and normal manure. Repeat abdominocentesis revealed a markedly improved, but still elevated nucleated cell count (Table 2). Repeat thoracic ultrasound examination showed no detectable fluid. All vital parameters remained within normal limits during the postoperative period of hospitalization.

Five days after surgery (day 25), a CBC, biochemistry profile, and an abdominocentesis revealed no significant abnormalities, other than a moderate decrease of globulins and mild further decrease of albumin. The abdominocentesis revealed a significant decrease of the total cell count consisting of mainly non-degenerate neutrophils. The horse weighed 530 kg when he was discharged from the hospital, with the remainder of the medications to be administered by the owner. Five years after discharge from the hospital, the owner reported the horse to be in good health.

**Discussion**
A successful outcome was achieved in both horses described in this report.

There were 2 main advantages of laparoscopic lavage compared with non-laparoscopic placement of lavage/drainage systems. The first was an improved system for lavage, allowing removal of abnormal peritoneal fluid and lavage fluid, compared with the lavage systems used initially. Non-laparoscopic ventrally placed and flank lavage systems both have complications reported with their use (1). The ventrally placed lavage system used in case 1 likely did not allow drainage because it was plugged with omentum. Minor complications were reported in 49% of horses in which ventral drains were placed for active intra-abdominal drainage, including blockage caused by omentum (6). Retrieval of fluid may have been more successful if a multi-fenestrated catheter was used (7). The paralumbar flank system that was attempted in case 2 has been previously reported (2,7). One author suggests that lavage using the paralumbar flank system is not sufficient because a tract forms between the dorsal and ventral drains which does not allow the fluid to sufficiently bathe the peritoneal surfaces (11). Laparoscopic visualization of the lavage and suction in the cases reported here addressed this concern by allowing control over direction of fluid and confirmation that the procedure was successful. Use of the suction-irrigation device was simple and effective.

The amount of fluid used in the horses for intra-abdominal lavage was based on the recommended minimum of 10 L (12). This amount is considered sufficient to bathe the serosal surfaces. In case 2, more was required than in case 1, partly because both sides were lavaged, but also because it took a greater volume of lavage fluid to obtain a return of clear fluid. One author suggests that the frequency of lavage is also important: case 2 had continued lavage for 2 more days with no complications associated with the drains (1). In case 1 drainage was discontinued due to the problems already encountered with drain placement.

The second advantage of laparoscopic lavage was a minimally invasive exploration of the abdomen under standing sedation, with the avoidance of general anesthesia in already catabolic horses. Standing laparoscopy is a recognized technique in the diagnostic process for horses with abnormal peritoneal fluid results. In the cases described here, although not diagnostic, abnormal findings were made in both cases. In addition to aiding in assessing the dorsal abdomen in a standing horse, laparoscopy can facilitate accurate sampling for histopathology and culture, offer opportunity for adhesiolysis, and small intestinal biopsy if needed (13,14). However in some horses with peritonitis, a ventral approach might be necessary to identify and correct the primary problem.

Lavage is not always a part of treatment protocols, including 1 recently reported (2,5). Current recommendations are that peritoneal lavage be combined with abdominal drainage for the removal of excess fluid and bacterial products to ensure all aspects of the large surface area within the abdomen of the horse are reached (15). There are no prospective controlled studies evaluating survival rates in horses with peritonitis receiving peritoneal lavage, and no statistical association has been made between treatment and survival rates in published retrospective studies. However, 1 author reports a statistical trend toward improved survival following peritoneal lavage, compared to not doing it (4). In addition, peritoneal lavage has been shown to decrease the frequency of adhesion formation after abdominal surgery (12).

In case 2, the measured WBC of the peritoneal fluid increased significantly between days 14 and 19. Serial abdominocenteses is recommended in suspected cases of peritonitis as it may improve the chance of reaching an etiological diagnosis (13). The sample collected on day 19 was taken following peritoneal lavage, which is reported to greatly increase the diagnostic accuracy of peritoneal fluid analysis (16). In case 2, it is possible that the peritonitis was localized initially and the lavage of the affected area with fluids washed the WBC to a location accessible for sampling. It is also possible, however, that the peritonitis simply worsened during this time.

No growth from bacterial culture occurs in 9.5 to 32.5% of cases, as occurred in cases 1 and 2. Culture of peritoneal fluid is not always productive but should nevertheless always be attempted for appropriate use of antimicrobials (1). However in this case, presence of bacteria was identified on cytology. Abdominal abscess is a differential diagnosis that would be consistent with this finding and cannot be ruled out as the cause of the peritonitis in the 2 cases reported here, because the dorsal laparoscopic approach does not explore the entire abdomen. The inciting cause of the peritonitis was not found in either case, consistent with reports of primary peritonitis (2).
The complication in case 1 of entering the cecum when placing the right-sided laparoscopic portal may have occurred because feed was not withheld before surgery. This complication has been described previously (8). Difficulties, related to aspirating fluid, were also encountered on the right side, which raises the question of whether it is necessary to lavage from both sides. It is possible to pass instruments from the left side to the right side, as evidenced by removal of right ovaries from the left side only (17); therefore, the suction irrigation device would reach the target area on the right side. However, an exploration of the right dorsal abdomen would not be as comprehensive with the laparoscope placed in the left paralumbar fossa. The laparoscopy was carried out without the use of insufflation; however, this may assist in some aspects of the procedure, including improved visualization, and possibly prevention of suction of the small intestine, as occurred in case 2.

Standing laparoscopy would not be the approach of choice for many presentations of peritonitis, including most causes of secondary peritonitis. However, decision-making should be done on a case-by-case basis. For example, in case 1, it was advantageous to avoid general anesthesia due to the already weakened state of the horse. Nevertheless, laparoscopy can provide valuable diagnostic information, as well as offering the opportunity for lavage, and does not preclude a ventral celiotomy. In our opinion, this should be considered in horses if financial means allow.

In conclusion, laparoscopic lavage of the abdomen, using a suction-irrigation device offers an alternative and advantageous treatment option for equine suppurative peritonitis, allowing visualization and confirmation of the lavage procedure and partial examination of the gastrointestinal tract. 

References
Case Report  Rapport de cas

Bacterial meningitis after dental extraction in a 17-year-old horse

Stefanie Arndt, Isabelle Kilcoyne, Colleen M. Heney, Talia S. Wong, K. Gary Magdesian

Abstract — Dental extractions in horses may result in bacteremia, which can lead to systemic complications. Bacterial meningitis following oral cheek tooth extractions in a 17-year-old Thoroughbred gelding is described in this report. The bacterial meningitis was confirmed by histopathology. The gelding was presented for evaluation of intermittent fever, loose feces, and mild colic signs which started 5 days after cheek tooth extraction. This case illustrates a rare complication associated with oral tooth extraction in a horse and highlights the unusual presenting features of meningitis.

Key clinical message: Bacterial meningitis secondary to oral cheek tooth extraction should be considered as differential diagnosis; particularly in cases with the development of pyrexia a few days after the procedure.

Résumé — Meningite bactérienne après extraction dentaire chez un cheval de 17 ans. Les extractions dentaires chez les chevaux peuvent entraîner une bactériémie, ce qui peut amener des complications systémiques. Un cas de méningite bactérienne à la suite d’extractions buccales de dents jugales chez un hongre pur-sang de 17 ans est décrite dans ce rapport. La méningite bactérienne a été confirmée par histopathologie. Le hongre a été présenté pour évaluation d’une fièvre intermittente, de selles molles et de signes de coliques légers qui ont commencé 5 jours après l’extraction de la dent jugale. Ce cas illustre une complication rare associée à l’extraction dentaire orale chez un cheval et met en évidence des caractéristiques inhabituelles de la méningite.

Message clinique clé: La méningite bactérienne secondaire à l’extraction buccale des dents jugales doit être considérée comme un diagnostic différentiel, en particulier dans les cas de développement d’une pyrexie quelques jours après l’intervention.


Extraction of equine cheek teeth can result in complications, although recent improvements in minimally invasive oral extraction techniques have led to a lower incidence of complications (1–3). Recognized post-operative complications secondary to dental extractions in horses include nonhealing alveoli due to dental fragments or alveolar bone sequestrum formation; which can result in oroantral or oronasal fistula formation, orofacial sinus tract formation, or regional osteomyelitis (4). Dental extractions and periodontal procedures can result in bacteremia in horses, humans, and dogs (5–10). Case reports of systemic complications as a result of dental extractions in horses have documented abscessation of masseter muscle as well as extensive thrombophlebitis of the jugular, facial, and rostral cervical veins (11), facial cellulitis progressing to an orbital abscess (12), and bacterial endocarditis (13,14).

The findings of a horse, which developed bacterial meningitis without sinusitis following oral cheek tooth extraction, and later confirmed by histopathology are described in this report.

Case description

A 17-year-old Thoroughbred gelding in good body condition [492 kg body weight (BW), body condition score 5/9] was presented to the William R. Pritchard Veterinary Medical Teaching Hospital (VMTH), University of California Davis, for evaluation of intermittent pyrexia of unknown origin and mild colic signs of 5-days duration. The gelding had a prior history of endodontic disease. The 109 and 110, and 210 teeth (Modified Triadan numbering system) had all been extracted between 2 to 6 y before presentation for the treatment of complicated crown-root fractures.

Ten days before presentation to the VMTH, the 111 and 211 teeth were extracted for treatment of severe periodontitis diagnosed by identification of increased periodontal probing.
depths of 10 to 15 mm and mobility index of 3 (15). The extraction of the 111 tooth was complicated by excessive hemorrhage and external replacement resorption (ankylosis) of part of the mesial tooth root. The extraction of the 211 tooth had no apparent complications. The gelding received 1 dose of gentamicin sulphate (Gentamicin; Vetone, Boise, Idaho, USA), 6.6 mg/kg BW, IV, once, prior to extraction, and was prescribed trimethoprim-sulphamethoxazole [Bactrim DS (sulfatrim); Aurobindo, East Windsor, New Jersey, USA], 30 mg/kg BW, PO, q12h for 10 d, after surgery. Five days after the extractions, the gelding was reported to have intermittent fevers. On the day of referral to the VMTH, the gelding had started to show mild colic signs, his rectal temperature was 38.9°C and he passed soft feces. Administration of flunixin-meglumine (Banamine Inj; Merck, Madison, New Jersey, USA), 1.1 mg/kg BW, IV, once, did not improve his condition and he was referred to the VMTH for further diagnostic procedures and treatment.

On presentation the horse was bright, alert, and responsive. No cranial nerve deficits were noticed on presentation. Heart rate and respiratory rate were elevated [68 beats/min (bpm) and 20 breaths/min (brpm), respectively] with no cardiac murmurs, arrhythmias, or increased bronchovesicular sounds noted on auscultation. There was no nasal discharge. Borborygmi were mildly decreased in all quadrants. Rectal temperature was 37.7°C. A complete blood (cell) count (CBC) revealed a mild leukocytosis [11 600 cells/µL; reference range (RR): 5000 to 11 600 cells/µL], a neutrophilia (9752 cells/µL; RR: 2600 to 6800 cells/µL), and a hyperfibrinogenemia (5 g/L; RR: 1 to 4 g/L). No other significant clinical pathology abnormalities were identified. Abdominal ultrasound revealed hypo- motile small intestine. A nasogastric tube was passed, and no reflux was obtained. No abnormalities were palpated on rectal examination. Abdominocentesis yielded grossly normal peritoneal fluid. Abdominal radiographs showed no clinically significant abnormalities.

A possible colonic impaction was suspected, and medical treatment was instituted. An intravenous catheter was placed in the left jugular vein (Mila Extended Use MILACATH; MILA International, Florence, Kentucky, USA), 14 Ga × 13 cm. The horse received intravenous polyionic fluids (Vetivex 5L; Dechra, Overland Park, Kansas, USA), 10 L, IV fluid bolus, followed by a constant rate infusion, 3 mL/kg BW per hour. He also received enteral fluids which consisted of 5 L of water and MgSO4 (Swan Epsom Salt; Smyrna, Tennessee, USA), 1 g/kg BW via nasogastric tube once. Feed was withheld for the first 24 h of hospitalization. The oral antimicrobial treatments were changed due to concerns for antimicrobial associated colitis. Gentamicin sulphate (Vetone), 6.6 mg/kg BW, IV, q24h was administered. He was also started on omeprazole (GastroGard; Merial, Duluth, Georgia, USA), 4 mg/kg BW, PO, q24 h.

Initially the horse responded to medical management. He remained bright and alert and was passing normal manure with no pyrexia recorded in the initial 12 h of hospitalization. Refeeding was initiated and was well-tolerated. Twenty-four hours after admission, the horse became dull and pyrexic (38.8°C), and was treated with flunixin-meglumine (Banamine Inj; Merck), 0.55 mg/kg BW, IV, once. Forty-eight hours after presentation the horse was noted to be straining and was observed to be dribbling urine intermittently. Interspersed with these episodes the horse was noted to urinate in a normal manner. Urinalysis did not reveal significant abnormalities. The horse continued to be pyrexic each day 38.8 to 39.7°C but responded to flunixin-meglumine (Banamine Inj; Merck), 0.55 mg/kg BW, IV, q12h. The horse maintained a good appetite and was passing normal manure. A nasal swab for equine herpesvirus-1 was negative on polymerase chain reaction (PCR). The intravenous catheter site was examined every 6 h and there were no significant abnormalities.

Given the history of previous oral dental extractions, a dental examination was performed under standing sedation with detomidine (Dormosedan Inj; Zoetis, Kalamazoo, Michigan, USA), 5 mg via IV catheter 4 d after presentation (14 d after the initial extraction). The sedation level was adequate for performance of an oral examination and dental radiographs, and no ataxia was noticed. There were no significant extraoral findings. Teeth with a known history of previous extraction were noted to be missing (109 and 110, 210 and 211). A small retained fragment of the 111 palatal root was identified within the previous extraction site, with the remainder of the tooth missing. The alveoli of the previously extracted 111 and 211 teeth otherwise had healthy granulation beds which had filled in approximately 80% of the alveolus. The retained fragment of the palatal root of 111 was removed with gingival elevators and determined to be 1.6 cm in length and 1 cm at its widest diameter. No local anesthesia was used for the fragment removal. Sinus and dental radiographs were taken following removal of the retained tooth fragment, and other than the previously identified missing teeth, no clinically significant findings were identified.

Two hours after the dental examination, the horse was sedated with detomidine (Dormosedan Inj; Zoetis), 2 mg via IV catheter, to facilitate a full abdominal ultrasonographic examination. Approximately 10 min later he became moderately atactic. He was returned to his stall to recover from the sedation. Approximately 2 h later he was observed to be persistently circling to the right in his stall and he was ataxic (grade IV/V). Cranial nerve examination revealed an absent menace in the left eye and a delayed menace in the right eye and the horse was behaviorally blind. There was no evidence of other cranial nerve involvement. The ataxia of both thoracic and pelvic limbs, declining mentation, circling, and apparent blindness were most consistent with cortical or diffuse central neuroanatomical localization. In addition, the intermittent urine dribbling may have been associated with central neurological disease, has been reported in humans with eastern equine encephalitis (16). Because of safety concerns for personnel with the persistent walking, apparent blindness, and ataxia (grade IV/V), further neurological evaluation was not carried out. Treatment with intravenous fluids was continued and additionally dimethyl-sulfoxide (DMSO) (RIMSO 50; Valhoma, Oklahoma, USA), 1 g/kg BW, IV, once and flunixin-meglumine (Banamine Inj; Merck), 1.1 mg/kg BW, IV, once and minocycline (Minocycline hydrochloride capsules USP; Aurobindo Pharma, Hyderabad, India), 4 mg/kg BW, PO, q12h, were administered. The horse deteriorated and progressed to seizure. During an initial seizure...
episode, a venous blood gas analysis demonstrated a lactate of 7.3 mmol/L, PCV 47%, and total protein 80 g/L. The seizure activity responded to midazolam (Midazolam Inj; Hospira, Lake Forest, Illinois, USA), 0.05 mg/kg BW, IV, once. Two and a half hours later the gelding experienced a second seizure, which again responded to intravenous midazolam (Midazolam Inj; Hospira), 0.05 mg/kg BW, IV, once. Additional treatment with phenobarbital (Luminal 60 mg tablets; Hikma, Eatontown, New Jersey, USA), 10 mg/kg BW, PO once, was started; however, the horse experienced a third seizure, which was more violent than the first two. Clinical signs did not resolve after intravenous administration of midazolam (Midazolam Inj; Hospira), 0.1 mg/kg BW, IV once. Euthanasia was recommended and elected. The horse was anesthetized with ketamine (Ketalar Inj; Vetone, Boise, Idaho, USA), 2.2 mg/kg BW, IV and midazolam (Midazolam Inj; Hospira), 0.05 mg/kg BW, IV, once, and then pentobarbital (Euthasol inj; Virbac, Fort Worth, Texas, USA), 100 mg/kg BW, IV was administered.

Cerebrospinal fluid (CSF) was collected immediately after death from the atlanto-occipital space using aseptic technique. The cerebrospinal fluid appeared grossly abnormal (turbid and xanthochromic). Abnormal findings on cytology included a total protein concentration of 9.13 g/L (RR: 0.45 to 0.61 g/L) and an elevated total nucleated cell count of 7910 cells/mL (RR: 0 to 7 cells/mL) consisting of 93% neutrophils, 3% small mononuclear cells, and 4% large mononuclear cells. No organisms were seen on cytology, but the findings were consistent with marked neutrophilic inflammation (meningitis). Postmortem, but prior to histopathology results, the cerebrospinal fluid tested negative for West Nile virus with capture enzyme-linked immunosorbent assay (ELISA), *Listeria monocytogenes* with PCR, and *Neospora hughesi* on immunofluorescence assay (IFA). The CSF was positive for *Sarcocystis neurona* at 1:80 on IFA, and for Lyme disease on multiplex analysis (OSPF CSF: Serum ratio > 4). The fluid was submitted for bacterial culture, but no growth was obtained.

The brain was collected separately and submitted for rabies screening using fluorescent antibody testing before complete necropsy. Test results were negative. No significant oral lesions associated with the site of extraction were identified grossly. A 1-mm thick, soft, dark red to black plaque coated the spinal cord and filled the subdural space, extending from the C7 to C8 spinal nerves to the cauda equina. Epaxial muscles surrounding the T1 through T5 vertebrae were streaked with 1- to 2-mm thick, soft, dark red to black plaque coated the spinal cord and filled the subdural space, extending from the C7 to the cauda equina correlated with the gross findings, and was unassociated with significant inflammation; consequently, the hemorrhage was independently attributed to iatrogenic trauma.

**Discussion**

Complications following oral cheek tooth extraction in horses are reported to occur in 8 to 20% of cases and typically involve the alveolus and directly associated structures; such as, the maxillary or mandibular bone and the nasal cavity (1–3,17). Systemic infection following oral cheek tooth extraction has been reported rarely in horses (11–13,18). In humans, dental extractions are associated with a high risk for inducing transient bacteremia (19). Bacteria originating from the oral cavity can circulate in the bloodstream and cause infections such as endocarditis, meningitis, and brain or liver abscesses and can progress to sepsis in humans (20–22). A recent study reported transient bacteremia following cheek tooth extractions in horses (10). Bacteria can circulate in the bloodstream immediately after gingival disruption, but the bacteremia is usually cleared prior to the end of the dental extraction or periodontal procedure without resulting in sepsis, in both horses and humans (9,10).

The most commonly isolated bacteria from blood cultures obtained during cheek tooth extraction in horses were reported to be alpha-hemolytic streptococci and anaerobes such as *Fusobacterium spp.*, and *Prevotella spp.* and facultative anaerobes such as *Actinomyces spp.* (10). In this case, Gram-negative rods and coccii were identified within a meningeal vessel. It would have been ideal to further characterize the bacterial genera,
as this would have potentially supported that the meningitis was a direct complication of the tooth extraction; but unfortunately, no bacteria were cultured. Oral bacterial flora shifts towards predominantly anaerobic and Gram-negative bacteria with periodontal disease. Specific bacteria associated with periodontal disease arePrevotella spp., Porphyromonas spp., andPeptostreptococcus spp. (23). Kern et al (10) showed that bacteria isolated from the swabs of samples of extracted teeth largely corresponded with those identified in blood cultures. Culturing the tooth root remnant perhaps was a missed opportunity in this case; however, it would have been difficult to justify before receiving the histopathology results, given the ambiguity of the clinical signs.

Primary sinus, nasal, submandibular, and periocular infections have been reported as causes of bacterial meningitis and brain abscessation (18,24,25). To the authors’ knowledge this is the first report of bacterial meningitis after cheek tooth extraction without evidence of secondary sinusitis observable on radiographs. On initial presentation, meningitis was not a differential diagnosis for this case given the lack of neurological signs. Based on the chronicity identified in the histopathologic findings, the authors assume that the pyrexia was attributable to subclinical meningitis. Neurological signs did not progress until 4 d after initial presentation to the hospital (14 d after dental extraction). This is somewhat longer than reported in a case series of 5 horses that were presented with bacterial meningitis after sinus surgery. In these cases, clinical signs associated with the meningitis occurred 5 to 11 d after surgery (25). In retrospect, the intermittent urinary dribbling may have reflected neurological disease, which was noted 48 h after presentation. The reason for the delayed onset of clinical signs in this case is unknown but may have been due to the systemic antimicrobial (trimethoprim-sulfonamide combination) administration after tooth extraction.

Bacteria from paranasal sinus and odontogenic infections can gain access to the neurologic system by different routes including lymphatic vessels, blood vessels, or cranial nerves, as well as with osteitis and bony erosion or direct head trauma (24–27). In this case, healthy granulation tissue was present in the alveolus on oral examination and no bony abnormalities were noted on radiographic examination. In addition, no gross evidence on necropsy of local ascending spread of bacteria through the alveolar bone to the brain was apparent. However, the presence of a bacterial thrombus in a meningeal vessel suggests hematogenous spread of the infection.

The gelding was initially administered oral phenobarbital due to the cost of the intravenous formulation of the drug. It is possible that intravenous phenobarbital would have reached a steady state more quickly resulting in a better response (28). However, the mortality rate of horses with meningitis or meningoencephalomyelitis is 60 to 96% (29,30) and can reach 100% in horses with a history of bacterial meningitis secondary to an infectious disease of the head (18,24–26). In this case, the horse did not respond to initial therapy and continued to seizure, necessitating euthanasia.

No bacteria were seen on cytologic examination of the cerebrospinal fluid and bacterial culture did not reveal any significant growth of bacteria. This is not surprising, as a case series including horses with meningitis and meningoencephalitis only had a positive bacterial culture in 9% of antemortem cerebrospinal fluid samples (30). In addition, the horse was treated with antibiotics, which might have decreased the chance of identification of bacteria on cytology and culture. Findings on histopathology showed a population of mixed bacteria, which is a similar population to the bacterial growth of the cerebrospinal fluid in published case studies (24,30). Good penetration of the central nervous system can be achieved using macrolides, trimethoprim and sulfonamide, fluorinated quinolones, metronidazole, chloramphenicol, rifampin, and tetracyclines. The initial choice of an aminoglycoside was not appropriate (31,32); however, meningitis was not considered as a differential diagnosis at that time. The horse was switched to minocycline once neurologic signs were noticed, although the gelding was already in an advanced stage of the disease.

The positive CSF results for Sarcocystis neurona and Borrelia burgdorferi OSPF antibodies were likely due to altered blood brain barrier permeability and leakage of serum proteins considering the degree of inflammation within the CNS. Although it is impossible to completely rule these agents out, the histopathology was not consistent with either equine protozoal myeloencephalitis or Lyme disease.

This case illustrates an unusual complication associated with oral tooth extractions in a horse and highlights the unusual presenting features of meningitis. Although rare, clinicians should be aware of the potential risk of bacterial meningitis and brain abscessation (18,24,25). To the authors’ knowledge this is the first report of bacterial meningitis after cheek tooth extraction, particularly with the development of pyrexia a few days after the procedure. Early diagnostic tests, such as a complete neurological examination and potentially CSF fluid collection, might be indicated if pyrexia persists and other potential causes of pyrexia are excluded.

References
Case Report  
Rapport de cas

Suspected primary pure red cell aplasia in a 4-month-old intact male mixed breed Bernese mountain dog

Iris To, Patrick R. Boelsterli, Julie J. Walter, Bronwyn E. Rutland

Abstract — A 4-month-old, 31-kg intact male mixed-breed Bernese mountain dog was presented for evaluation of severe non-regenerative anemia after several days of lethargy, inappetence and pale mucous membranes. Bone marrow evaluation and complete response to immunosuppressive therapy were suggestive of primary pure red cell aplasia (PRCA). Primary PRCA is a rare immune-mediated non-regenerative anemia that is overrepresented in middle-aged to older spayed female dogs and has not previously been described in an intact male puppy.

Résumé — Aplasie primaire pure des globules rouges suspectée chez un bouvier bernois mixte mâle intact âgé de 4 mois. Un bouvier bernois mixte mâle intact âgé de 4 mois et pesant 31 kg a été présenté pour l’évaluation d’une anémie grave non régénérative après plusieurs jours de léthargie, d’inappétence et de muqueuses pâles. L’évaluation de la moelle osseuse et la réponse complète au traitement immunosuppresseur suggéraient une aplasie primaire pure des globules rouges (PRCA). L’érythroblastopénie primaire est une anémie non régénérative à médiation immunitaire rare qui est surreprésentée chez les chiennes stérilisées d’âge moyen à plus âgées et qui n’a pas été précédemment décrite chez un chiot mâle intact.

Can Vet J 2021;62:408–412

A
nemia is defined as a reduction in erythrocyte mass, and non-regenerative anemia results from decreased erythrocyte production (1). Pure red cell aplasia (PRCA) represents 5% of non-regenerative anemia cases and is more prevalent in middle-aged to older spayed female dogs (2,3). Pure red cell aplasia is typically characterized by normocytic normochromic anemia with reticulocytopenia and a lack of erythroid precursors from the bone marrow (4). The aplasia may be primary (immune-mediated) or secondary to neoplasia, infections, toxins, or systemic diseases, such as systemic lupus erythematosus or diabetes mellitus (4,5). This disorder is limited to the erythrocytic line of blood cells; other cell lines appear unaffected (1).

This paper reports on the diagnostic approach and management of suspected primary PRCA in a 4-month-old intact male mixed-breed Bernese mountain dog which was presented for non-regenerative anemia. To the authors’ knowledge, primary pure red cell aplasia has not previously been reported in a young intact male puppy.

Case description

A 4-month-old, 31-kg intact male Bernese mountain dog mixed breed dog was presented to his family veterinarian because of a 5-day history of lethargy, a 3-day history of inappetence, exercise intolerance, and pale mucous membranes. No melena or bleeding events were noted. There was no significant exposure to potentially noxious substances and no other pertinent medical history.

Initial diagnostic procedures were performed: an abdominal focused assessment using sonography for trauma (AFAST) scan was negative for free fluid, an in-clinic serum biochemical profile (Catalyst Dx Chemistry Analyzer; IDEXX, Westbrook, Maine, USA) was within normal limits, and a saline slide agglutination test, consisting of 1 drop of ethylenediaminetetraacetic acid (EDTA) blood mixed with 1 drop of 0.9% sterile saline, was negative for macroscopic and microscopic autoagglutination. An in-clinic complete blood (cell) count (CBC) (ProCyte Dx; IDEXX) revealed a severely decreased hematocrit of 0.118 L/L [reference interval (RI): 0.38 to 0.57 L/L], erythrocyte count of $2.02 \times 10^{12}/L$ (RI: 5.65 to $8.87 \times 10^{12}/L$), and hemoglobin of 39 g/L (RI: 131 to 205 g/L), with a total protein of 54 g/L (RI: 48 to 72 g/L). The mean corpuscular volume (MCV) was decreased at 58.4 fl (RI: 61.1 to 73.5 fl), mean corpuscular hemoglobin (MCH) was decreased at 19.3 pg (RI: 21.2 to 25.9 pg), and mean corpuscular hemoglobin concentration (MCHC) was within normal limits at 331 g/L (RI: 320 to 379 g/L). The reticulocyte count was below normal limits at 0.0067 $\times 10^{12}/L$ (RI: 0.01 to 0.11 $\times 10^{12}/L$). Mild elevations in lymphocyte count (6.19 $\times 10^{9}/L$; RI: 1.1 to $5.0 \times 10^{9}/L$) and basophil count (0.16 $\times 10^{9}/L$; RI: 0.0 to

VCA Canada 404 Veterinary Emergency and Referral Hospital, 510 Harry Walker Parkway South, Newmarket, Ontario L3Y 0B3.

Address all correspondence to Dr. Iris To; e-mail: iris.to@amcny.org

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.
A 109/L) were reported. It was determined that the dog had a marked microcytic normochromic non-regenerative anemia and was discharged with a 5-day course of oral fenbendazole (Panacur; Merck Animal Health, Madison, New Jersey, USA) and sucralfate (Sulcrate Suspension Plus; Apotex Pharma Canada, Mont-Saint-Hilaire, Quebec). A blood transfusion was recommended. The dog was presented to an emergency hospital the same evening with a packed cell volume (PCV) of 0.09 L/L and total solids of 60 g/L measured in-clinic with standard capillary tubes, centrifugation, and a refractometer. A repeated saline slide agglutination test, performed as described before, was negative. Prothrombin time (PT) and activated partial thromboplastin times (aPTT) were within normal limits. A SNAP 4Dx test (IDEXX) for infectious disease was negative for Dirofilaria antigen, Ehrlichia canis and E. ewingii, Borrelia burgdorferi, Anaplasma phagocytophilum and A. platys. The dog was blood typed as DEA 1.1 positive and cross-matched to a DEA 1.1 negative donor. One unit of a packed red blood cell transfusion was administered without complication and the post-transfusion negative donor. One unit of a packed red blood cell transfusion was performed; the minimally concentrated specific gravity of 1.014 was considered clinically insignificant, as the dog was euhydrated on examination and had no evidence of renal abnormalities. Three-view thoracic radiographs were interpreted to be normal. An abdominal ultrasound revealed modest lymphadenopathy and scant free fluid consistent with the dog’s age; testicular assessment found no abnormalities, such as Sertoli cell tumors which may cause anemia (1). An IDEXX Fecal Dx Test was negative for fecal ova, parasites, Giardia spp. antigen, hookworm antigen (including Anclylostoma spp. and Uncinaria stenocephala), whipworm antigen (including Trichuris spp.) and roundworm antigen (including Toxocara cati, Toxocara canis, Toxascaris leonine, and Balcyascaris procyonis). The dog’s cobalamin (Vitamin B12) level was found to be markedly decreased, below the level of detection at < 111 pmol/L (RI: 150 to 700 pmol/L). As cobalamin is a component of erythropoiesis, the dog was treated with 2 doses of subcutaneous cobalamin within the first 10 d of initial presentation at 1100 µg each and was prescribed oral cobalamin at 1 mg once daily and oral folate at 2 to 5 mg once daily on an ongoing basis. Fenbendazole was discontinued at this time. The dog was rechecked 5 d after cobalamin supplementation was initiated. His clinical condition was stable. A repeat CBC conducted by IDEXX Reference Laboratories revealed a persistent moderate normocytic hypochromic non-regenerative anemia with a hematocrit of 0.19 L/L (RI: 0.38 to 0.57 L/L), erythrocyte count of 2.8 × 1012/L (RI: 5.4 to 8.7 × 1012/L) and hemoglobin of 60 g/L (RI: 134 to 207 g/L). The reticulocyte count was inadequate at 0.0168 × 1012/L (< 0.110 × 1012/L is inadequate if anemic). The MCH was 21.1 pg (RI: 21.9 to 26.1 pg) and MCHC was 320 g/L (RI: 326 to 392 g/L). The MCV was within normal limits and total protein was 66 g/L (RI: 55 to 75 g/L). Improvement of anemia or evidence of regeneration would have been expected during this period if the dog were to respond to supplementation (6). A bone marrow biopsy was recommended due to an unexplained lack of regenerative response despite persistent anemia. Bone marrow aspirates and core biopsies were acquired from the iliac crest without complication. A pathologist’s review of the aspirates described a moderately hemodiluted sample with 50 to 60% fat and 40 to 50% hematopoietic cells (Figure 1). Megakaryocytes and coarse iron were present. Polychromasia and erythrocytic cells were rare to absent. A 400-cell differential cell count showed 14.8% segmented neutrophils, 14.5% band neutrophils, 6.3% metamyelocytes, 2.5% myelocytes, 2% myeloblasts and promyelocytes, 4.3% eosinophils and eosinophilic precursors, 4.5% plasma cells, 3.8% monocytes and monoblasts, and 47.3% small lymphocytes. Less than 1% macrophages were seen. The myeloid cell line was morphologically unremarkable. The aspirate findings were suggestive of a severe lack of production of the erythroid cell line, such as in pure red cell aplasia. The bone marrow biopsy revealed 50% cellularity in the sample, which was lower than expected given the dog’s age. Megakaryocytes and granulocytic precursors were present in adequate numbers with normal cell matura- tion. Review by several pathologists concluded that there was absence of the erythroid cell line in the biopsy and there was no apparent cause. The dog’s sample was inconsistent with the most commonly reported bone marrow changes associated with hypocobalaminemia in canine patients, which include megaloblastic anemia and mitotic figures (7). Hypercellularity of all cell lines, most pronounced in the erythroid line and an increase in MCV despite anemia, has been reported in human patients with...
hypocobalaminemia, but was not seen in this dog (8). Despite the dog's unusual signalment compared to typically reported PRCA cases, it was proposed that congenital forms of the disorder, such as Diamond-Blackfan syndrome, be considered.

Based on the diagnostic workup thus far, an immune-mediated process was suspected, and immunosuppressive treatment was started at 1.5 mg/kg body weight (BW) per day of oral prednisone (Apo-Prednisone; Apotex, North York, Ontario). Determination of the dog's serum erythropoietin level was measured in-clinic. After 8 d of treatment, the dog became lethargic with a PCV of 0.13 L/L and total solids of 54 g/L, and a second blood transfusion was administered. The dog was cross-matched to a DEA 1.1 positive donor and received 1 unit of packed red blood cells. The transfusion raised the PCV to 0.19 L/L with total solids of 60 g/L measured in-clinic. After 8 d of treatment, the dog became lethargic with a PCV of 0.13 L/L and total solids of 54 g/L, and a second blood transfusion was administered. The dog was cross-matched to a DEA 1.1 positive donor and received 1 unit of packed red blood cells. The transfusion raised the PCV to 0.19 L/L with total solids of 60 g/L measured in-clinic.

Twenty-two days after initiating prednisone treatment, the dog continued to be anemic on a repeat CBC and a serum biochemical profile determined by IDEXX Reference Laboratories, showed a hematocrit of 0.16 L/L, erythrocyte count of 2.3 × 10¹²/L (RI: 5.4 to 8.7 × 10¹²/L) and hemoglobin of 49 g/L (RI: 134 to 207 g/L). The dog had an inadequate (< 0.110 × 10¹²/L) but improved reticulocyte count of 0.0874 × 10¹²/L and total protein of 66 g/L (RI: 55 to 75 g/L). Concurrent serum biochemical profile and urinalysis were unremarkable. Fourteen days later, the dog had a hematocrit of 0.37 L/L, marginally below the reference interval of 0.38 to 0.57 L/L, with an erythrocyte count of 4.7 × 10¹²/L, hemoglobin of 112 g/L, and total protein of 65 g/L. The dog was subsequently determined to be in remission, and his response to treatment was consistent with an immune-mediated disorder. The dog remained on oral cobalamin and folate supplementation for 4 mo after initial presentation for anemia, at which time his hypocobalaminemia had resolved, and prednisone was continued. Four months following the start of immunosuppressive treatment, the dog's hematocrit remained stable within normal limits, thus prednisone therapy was tapered and then discontinued over 8 wk, and the dog experienced no relapse of anemia upon repeated CBC tests. Long-term follow-up is not available as this dog died from an unrelated cause, 4 mo after the discontinuation of immunosuppressive therapy.

**Discussion**

Non-regenerative anemia is indicative of decreased production of erythrocytes, which may be primary or secondary to another ongoing process (1). Blood smear evaluation in this dog did not indicate a specific cause of the anemia; however, interpretation was complicated by the blood transfusion prior to evaluation of the smear. It was unknown whether the spherocytes in this dog's smear were present before the transfusion or were attributable to the recent transfusion. Ideally, evaluation of the smear would have been performed in advance of any blood transfusions.

In the absence of a diagnosis from examination of the smear, further investigation into other causes of non-regenerative anemia was indicated. In puppies, in addition to gastrointestinal parasitism and hypocobalaminemia which were investigated, these possible causes may include infectious disease, toxicities, portosystemic shunts, renal disease, and endocrine diseases (hypothyroidism, hypoadrenocorticism, and diabetes mellitus) (1). These were less likely, based on the results of the 4DX and IDEXX Canine Anemia Panel, serum resting cortisol, serum total T4, and patient history and clinical signs. Potential causes that remained considerations after initial diagnostic tests included immune-mediated disease, gastrointestinal disease and bone marrow disease.

Severe hypocobalaminemia was the only significant abnormality other than anemia present in the dog's database. Cobalamin is obtained through dietary intake and is a component of erythropoiesis (7). Gastrointestinal disease is one of the most common causes of cobalamin deficiency, including chronic enteropathies and exocrine pancreatic insufficiency in dogs (9). Hypocobalaminemia can be associated with symptoms of the primary disease, including anorexia, vomiting, diarrhea, intestinal changes such as villous atrophy and malabsorption, and weight loss (9). Despite being a potential consequence of cobalamin deficiency, anemia was not significantly correlated with hypocobalaminemia in a recent retrospective study; although further research is indicated in this area (7). There was a lack of evidence to support gastrointestinal disease in this dog; thus, other causes of hypocobalaminemia were investigated.

Congenital disorders leading to hypocobalaminemia were considered in this young dog. Imerslund-Gräsbeck syndrome (IGS) has been described in humans to cause pale mucous membranes, fatigue, stunted growth, recurrent infections, and proteinuria (10). This syndrome is reported in border collies and beagles at 8 wk of age, and neutropenia is also seen in beagles (11,12). There is a well-established genetic basis for IGS in these breeds associated with frameshift mutations, for which genetic testing is available (11–13). This dog's breed and presentation were not typical for IGS, and the unremarkable granulocytic cell line in the bone marrow was inconsistent with this condition. However, he was severely hypocobalaminemic and cobalamin supplementation was initiated to treat the deficiency and monitor for any response to therapy. The dog's poorly

**Figure 1.** Photomicrograph of the bone marrow aspirate at 1000× magnification. Copyright IDEXX Laboratories. Used with permission.
regenerative anemia persisted after cobalamin supplementation commenced, prompting further investigation.

Drug-induced anemia secondary to fenbendazole administration was considered and the medication was discontinued. However, the dog was markedly anemic prior to prescription of fenbendazole and the level of suspicion for fenbendazole to target the erythroid line alone was low, making this differential less likely. Previous reports have documented bone marrow hypoplasia with reversible secondary pancytopenia, and bone marrow coagulation-type necrosis causing neutropenia and thrombocytopenia (14,15). Low erythropoietin levels were also considered as a cause for anemia, and human recombinant erythropoietin (rHuEpo) and erythropoiesis-stimulating agents such as darbepoietin have been used in small animals to treat anemia secondary to renal failure or blood loss (16–19). Erythropoietin testing was not pursued by the clients in this case.

The bone marrow aspirate sample was limited, likely due to the degree of aplasia. Pathologist consultations regarding both the bone marrow aspirate and biopsy were highly suggestive of pure red cell aplasia, although other congenital and genetic disorders could not be ruled out at the time and there was no obvious cause for the aplasia.

Immune-mediated disease was most highly suspected thus far in the workup, and high-dose glucocorticoids was started. Treatment of immune-mediated disorders such as PRCA can be unpredictable and the risk of an adverse response or a lack of response to therapy exists (2,3). This dog ultimately responded positively to corticosteroid therapy, supporting an immune-mediated origin of the condition.

Primary PRCA was therefore pursued as the leading differential diagnosis. Although several other primary non-dysplastic and non-neoplastic bone marrow disorders respond to immunosuppressive therapy similar to primary PRCA, there are features of these disorders that were not consistent with the bone marrow biopsy and blood smear results of this dog (20,21). This includes the involvement of other cell lines, as in immune-mediated thrombocytopenia, myelonecrosis, idiopathic aplastic pancytopenia, and hemophagocytic syndrome; or the presence of a regenerative response, as in immune-mediated hemolytic anemia with secondary erythroid hyperplasia (20,21). Pure red cell aplasia is also different from erythroid hypoplasia, a nonspecific condition of the bone marrow that can occur as part of a primary condition or secondary to other primary disorders (20). Erythroid hypoplasia is defined as a granulocyte to erythroid ratio greater than 2:1; whereas, PRCA is a more severe non-regenerative anemia with granulocyte to erythroid ratio greater than 75:1 and may have the presence of spherocytes (20). The bone marrow findings of this dog were more consistent with primary PRCA than with erythroid hypoplasia due to the apparently normal granulocyte production and nearly absent erythroid cell line production (20). The forms of immunosuppressive therapy used vary among these bone marrow disorders discussed. Prednisone was chosen in this case; however, reports have indicated that other disorders, such as idiopathic aplastic pancytopenia, may respond more successfully to cyclosporine and azathioprine (22). Remission, defined as the resolution of anemia and return to a hematocrit within the laboratory reference range, is possible in both human and canine PRCA patients (3).

In 1 study in dogs, the median time to remission following immunosuppressive therapy was 118 d and 77% of the dogs achieved complete remission (3). This is slightly lower than the reported 80% in human patients (23).

Consideration was given to congenital and genetic disorders affecting the erythroid line in the young dog. Two variant forms of primary PRCA are Diamond-Blackfan syndrome and transient erythroblastopenia of childhood (TEC) (24,25). These disorders manifest as non-regenerative anemia in juvenile patients, with no other blood cell lines affected (24,25).

Diamond-Blackfan syndrome (congenital hypoplastic anemia) is the most common congenital, inherited type of primary PRCA in humans and is associated with a gene deletion (24). Patients typically exhibit other congenital defects, characteristically craniofacial malformations and triphalangeal thumbs, and typically present at 2 to 3 mo of age (24). In humans, short-term prognosis is good, with 70% of patients entering remission with steroid therapy, but long-term prognosis is poor, with 40% of patients relapsing and requiring transfusions or a hemopoietic stem cell transplant (24). Diamond-Blackfan syndrome has been documented in 1 dog but was considered unlikely in this dog, due to the absence of congenital defects and lack of a reliable test for the condition (26).

Transient erythroblastopenia of childhood (TEC) is another human pediatric disease that was considered due to the young age of the dog. It is a self-limiting, benign variant of primary PRCA that manifests between 3 mo and 5 y of age (27). It has been associated with a history of recent infection, such as with the B19 strain of parvovirus, and is diagnosed based on bone marrow examination and patient history (25,28). This disease has not been documented in dogs, and this dog had no known history of infection; consequently, further evaluation was not pursued for this differential diagnosis.

To the authors’ knowledge, this is the first documented case of suspected primary PRCA in a intact male puppy. Considering the limited data on young PRCA patients, the authors aim to make clinicians aware of possible congenital and juvenile forms of the disorder. This will allow future improvements in definitive diagnosis of the condition and its possible causes, as well as testing for known human manifestations of PRCA, such as Diamond-Blackfan syndrome and TEC.

Acknowledgments

The authors acknowledge Dr. Emmeline Tan of VCA Canada Mississauga-Oakville Veterinary Emergency Hospital and Referral Group and IDEXX Laboratories, Dr. Melanie Ammersbach of Antech Diagnostics, and the clients, clinicians, and staff involved in the management of this case. The authors acknowledge IDEXX Laboratories for permission to reproduce the photomicrograph.

References


Answers to Quiz Corner
Les réponses du test éclair

1. A) Urine pH is acidic in carnivores, and alkaline in herbivores.
A) Le pH de l’urine est acide chez les carnivores et alcalin chez les herbivores.

2. E) West Nile virus is transmitted by mosquitoes.
E) Le virus du Nil occidental est transmis par les moustiques.

3. B) Answer A is hyphema, answer C is keratic precipitates, and answer D is flare.
B) La réponse A correspond à l’hypéméa, la réponse C décrit des précipités kératiques, et la réponse D est le phénomène de Tyndall.

4. A) The most common clinical sign observed in horses with CRF is weight loss. Also, a small plaque of ventral edema is frequently seen.
A) Le signe clinique le plus commun observé chez les chevaux souffrant d’insuffisance rénale chronique est la perte de poids.

5. A) 3-methyl indole is then absorbed into the bloodstream where it travels to the lungs resulting in pneumocyte damage.
A) Le 3-méthyl-indole est absorbé dans la circulation sanguine et se rend aux poumons, où il cause des dommages aux pneumocytes.

NEW!

Dermcare Malaseb® Medicated Shampoo for Dogs and Cats
2% Chlorhexidine Gluconate / 2% Miconazole Nitrate
For the treatment of bacterial and fungal skin infections, including those caused by MRSP.
Also indicated for the adjunct treatment of dermatophytosis.

Quiz Corner is generously sponsored by
Dechra

FOR PERSONAL USE ONLY

Rapport de cas

412
Cvi / Vol 62 / April 2021
Blame the pandemic: Why you need to raise your fees for 2021

Darren Osborne, Chris Doherty

Practicing socially distanced veterinary medicine has taken its toll on staff. It takes twice as long to do half as much, but fortunately, pet owners have been very appreciative of the continued level of service and continue to support their local veterinarian. Demand for veterinary medicine remains at an all-time high. Internally, the same factors are driving the cost of running a veterinary hospital to an all-time high as well. For 2021, veterinary practices could see their expenses rise more than 5%, requiring an even higher increase in professional fees.

To protect veterinarians and staff, most hospitals (87% nationally) pivoted to curbside medicine in March 2020 and have maintained this ever since. It was a struggle to explain to clients why they needed to stay outside of the building in the summer when COVID-19 cases were trending down, but given the latest figures, most now understand and appreciate the move.

Internally, curbside medicine is taking a toll on staff. Carting animals, bags of food, medications and payment terminals back and forth to clients waiting outside, along with increased cleaning and disinfecting, has made all appointments more time-consuming, and most days non-stop. To make matters worse, the schedule is jammed for a few weeks, and there seems to be no end in sight.

As if that weren’t enough, just when all hands are needed on deck, hospitals are facing the highest absentee rate ever. Many staff have young families, and childcare-related absences are increasingly common. “Sorry, my kid’s classmate just tested positive, so I need to take the next 2 weeks off to quarantine with my son.”

In the average hospital, it is estimated that the cost of hiring more staff to cope with curbside medicine, as well as the accelerating wage pressure for many non-DVM positions will increase staffing costs by 10%; this is the combination of higher pay and more bodies.

Although most big bank economists are forecasting 2021’s inflation figure to come in under 1%, the cost of running a veterinary hospital is likely to accelerate much faster. Nationally, the Consumer Price Index (CPI, a.k.a. inflation) figures are heavily influenced by lower mortgage rates, cheaper flights and entertainment, and lower fuel prices. However, for the average veterinary hospital, the main expenses are very different from the basket of goods measured by CPI.

In many hospitals, the amount spent on bank fees is climbing, particularly as they are conducting “card not present” transactions, by taking payment over the phone to remain physically distanced from clients. This can push bank fees up by 25%, costing an average 3-DVM practice an additional $10 000.

Drug and supply costs are likely to rise as well, not only to account for the increased expense of providing stacks of personal protective equipment (PPE) to veterinary staff, but because manufacturers are having to incur these costs and physically distance plant workers, thus driving up costs and prices charged. Similarly, maintenance costs are predicted to rise as suppliers pass on increased costs and equipment requirements, for the same reasons.

Perhaps the only expense that is expected to decline is continuing education. The savings from attending a virtual conference, in registration, travel, meals, and hotels will be noticeable. Overall, total hospital expenses are expected to increase by 5%, equating to 3.5% of gross revenue; in the average hospital, total non-DVM expenses are 70% of gross revenue, so a 5% increase takes these to 73.5% of revenue.

This, however, doesn’t account for yet another substantial rising expense that has either hit, or is just about to hit, more veterinary hospitals: veterinarian compensation. Even before COVID-19, the demand for veterinary labor was pushing to unprecedented levels. Although demand slowed temporarily at the height of lockdowns, it has since surged back upwards, with the number of help wanted advertisements reaching new records despite the pandemic. It seems that 2021 will feature more of the same, with demand continuing to climb. As a result of this, veterinarian compensation is expected to increase well above inflation.

If hospitals hope to cover these costs, their professional fees will need to increase quite steeply. In the average companion animal hospital, professional services account for approximately 60% of revenue. The remaining 40% is generated from dietary, pharmaceutical, and retail sales. Thus, increasing professional fees by 5% would only increase revenues by 3%, falling short of...
covering the higher expenses. To cover all of the increased costs, a robust fee increase closer to 8% is necessary. The good news is clients are positioned to accept the increase. From many clients’ perspective, a historic large pile of household savings, as well as a 30% surge in new puppies and kittens have combined to make veterinary medicine more attractive than ever. Many pet owners are working from home, spending all day with their pets, and thus have a heightened awareness of any pet health issues.

Clients are also going to the veterinarian more often and spending greater sums. Most hospitals have seen an increase in revenue in the second half of the year; 1/3 of this has been fueled by new pet owners, with the other 2/3 a result of increased spending from existing clients.

Pet owners have not been able to spend money on family trips, restaurants, and bars, and those working from home are saving a fortune on commuting, dry cleaning, and work clothes. This new money is burning a hole in their pockets. Economists call this phenomenon “consumption smoothing.” Consumers will strive to maintain a consistent spending level, so when they overspend in one area, they will save more than normal to get back on track. In the times of COVID-19, when spending is heavily restricted due to lockdowns and closures, consumers are forced to save, and many will overspend to get back on their personal consumption track.

If the looming surge in hospital expenses, combined with the readiness of clients to spend more on their pets isn’t enough to motivate an increase in fees, take solace in the notion that when fees are increased by 10%, the margin is boosted and a 25% loss in clients can be afforded while keeping the net income consistent.

Member authors benefit from discounted fees for CVJ and CVJR

Did you know? CVMA members who publish manuscripts in The Canadian Veterinary Journal or in the Canadian Journal of Veterinary Research are entitled to discounted publication fees and page charges.

Please check the Instructions for Authors on each Journal web page to confirm the current fees and to review submission guidelines (www.canadianveterinarians.net). For additional information, contact the CVMA Journals Department.

Membership in CVMA does have its privileges!
Corrosive client communicators

Myrna Milani

Every time Dr. Janelly thinks about her client, Ms. Westerly, she wonders what she did wrong when she met the client for the first time 2 years ago. As far as she could recall, she had greeted the client no differently than she greeted her other clients. Nor had she treated the client’s animals any differently or in any manner that the client found upsetting in any way. As far as the practitioner knew, her client was quite pleased with her work.

However, a pattern in Ms. Westerly’s communication with Dr. Janelly had emerged over time. Within a day or two of their appointment, the client’s phone calls would begin. At first the practitioner willingly accepted these calls because she believed it was part of her veterinary responsibility to answer any questions her clients might have regarding their animal’s condition and its treatment. But when it became obvious that Ms. Westerly was among those who had not followed the clinician’s directions regarding the animal’s treatment nor read the handouts she provided, Dr. Janelly found her desire to talk with the client waning considerably.

After one especially nonproductive and frustrating phone call with Ms. Westerly, Dr. Janelly softly swore after she had terminated the call and tossed her phone on her desk. How could someone who superficially appeared so nice and even referred other clients to the practice be so inconsiderate?

“It sounds like you were talking to one of our more corrosive client communicators,” Dr. Janelly’s more seasoned employer, Dr. Oesterhager, remarked with a sympathetic smile. “I call them ‘corrosive’ because they can really wear you down. I shudder to think how many good practitioners these clients have driven to the brink of burnout.”

However, these clients also would be among the first to admit — albeit it sometimes sheepishly — that sometimes they were so exhausted and had become so relaxed, they didn’t hear a thing the practitioner or technician told them when the animal was returned to them. Once these clients returned home and assumed their own remote work- and family-related responsibilities, what little they remembered about their animals’ condition or treatment, or any other recommendations the veterinarian had made soon faded. And while they promised themselves that they must read all the handouts, they often forget all about these if their animals continue to do well. If their animals do not, then genuine concern about their animals’ wellbeing may cause them to contact the veterinarian.

Other clients may not have escaped the various potential long-term side effects of coronavirus infection. Among these, “brain fog,” a collective term use to describe the difficulty thinking or concentrating some people experience long after more obvious signs of the disease have disappeared, may undermine...
quality client-clinician communication. For them, listening to
the veterinarian or staff member discuss their animals’ problem
as well as processing any information on written handouts could
be problematic. Other long-term side effects that undermine
clients’ physical health, e.g., coughs, joint or chest pain, fatigue,
headache, muscle pain, and depression among others — similar-
ly could interfere with clients’ ability to process information
no matter how much they care about their animals. These
symptoms and any anxiety these caused those clients regarding
their own health also could make it difficult for them to focus
on what the veterinarian or a staff member is telling them about
their animals’ health.

Those in a third group who normally would feel obligated to
bring their animals to the veterinary clinic or have practitioners
visit their property may be so fearful of contracting the virus
that even their practitioners’ assurance that they and their staffs
adhere to the most stringent protocols does not con-
vince them. Instead, they send whoever they can find willing to
interact with the practitioner for them. Although some of those
animal transporters may pay close attention to everything the
veterinarian or staff member tells them and faithfully repeat
this information to the animals’ owners, others may feel no
obligation to do so.

Corrosive communication also may have other causes
unrelated to the pandemic. Although Ms. Westerly’s post-
appointment calls to get information Dr. Janelly already had
communicated in multiple ways during their appointment
had increased during the pandemic, this pattern was not new.
It began exerting its corrosive effect on the quality of the
veterinary-client communication long before pandemic-related
changes exacerbated the effect.

Ms. Westerly owns a business that owes its success to her
24/7 commitment to it. Thus, it is not uncommon for her to be
thinking about business-related concerns during her veterinary
visits. Consequently, she may often leave the veterinary clinic
with a long business-related to-do-list and only a vague impres-
sion of what Dr. Janelly discussed in detail about her specific
animal’s condition. Because the handouts lack that specificity,
she contacts the veterinarian for more information.

A similar phenomenon may result from other distractions.
Lonely or bored clients may perceive in-person or remote
veterinary interactions as such novel events that they cannot
discriminate between what is important and what is not. While
the practitioner focuses on their animal’s history, physical exami-
nation, diagnosis, and treatment, these clients may scrutinize the
clinician and examination room for any novel (to them) features
and other details so familiar to practitioners and staff that they
do not even notice these.

Other conditions or orientations that may lead to decreased
client comprehension or memory of their interactions with
the veterinarian include side effects of prescription and non-
prescription drugs, anxiety unrelated to the veterinary event,
and early signs of Alzheimer’s disease or dementia.

Nor can practitioners deny any effects their client’s mental
state may have on their animals’ health and behavior, or the
ability of the client to function as a calming presence during
the veterinary examination if necessary. Although veterinary
medicine positions the person as keeper and protector of the
animal, some clients who feel vulnerable for some reason may
rely on their animals’ ability to physically and emotionally sta-
bilize them. Despite their sometimes seeming dissociation from
the veterinary process, some of these people may share profound
bonds with their animals.

Although practitioners may be unable to eliminate the causes
of many of these client distractions, they can limit their negative
effect on the veterinary process and the corrosive communica-
tion they may support. After repeated incidents with these
clients make it clear that they are not fully engaged during their
animal’s examination process, Dr. Janelly expresses her concern
to these clients about their and their animal’s wellbeing. She
suggests that they ask a friend or relative to be present dur-
ing the veterinary appointment to act as a second pair of ears.
Those with the necessary know-how are encouraged to record
their interactions if that would help them. She also does not
hesitate to ask these clients for their insights regarding how she
can help ensure a quality veterinary experience for them and
their animals. While she may not always like what she hears, the
more she learns about these clients’ perspective of the process,
the more she can address their special needs.

True, it may take time and effort to formulate solutions that
will satisfy the needs of veterinarians and their clients. But when
compared to the time and effort wasted merely tolerating these
clients and the negative effects this may have on the quality
of the clinician’s interactions with staff and other clients, the
benefits are worth the cost.
Avoid the pitfalls of a corporate offer

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

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

What does your practice use for doing paw prints?

Time is money! Save time with this one step, instant and easy to use pawprint memento kit.

orders@pawpalsorders.ca
www.pawpalsorders.ca
Available through AVP and WDBC

NO KNEADING • NO MIXING • NO BAKING • NO DRYING

The Evolution of the Cone is here. And it’s not what you think.

The Medical Snuggle
Worry Free • Freedom • Compost

DOGORA MEDICAL WEAR
dogora.ca/pages/clinic
PASSWORD: VET2021

PRACTICE ONE CONSULTING
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

• Practice Management Agreements
• Incorporations
• Employment Matters
• Discipline Proceedings and Malpractice Defence
• Buying and Selling a Practice

Borden Ladner Gervais
www.wardanduptigrove.com

Douglas C. Jack
Partner | VetLaw™

REACHING 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
100% response in Double Blind Trials. See the results on www.lebalab.com

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
LebaLab Inc.
LEAD THE WAY TO PREVENTION

RECOMBITEK® offers a complete line of canine vaccines with:

✓ Advanced science for proven protection
✓ Safety you can count on
✓ Protection you can be confident in
✓ Immunity that lasts
✓ Flexibility for your practice

Targeted, advanced science without the need for adjuvants*

*Duramune® Max 5/4L and Duramune® Maxil® 4L CvK contains adjuvants

Recombithek®, Duramune® & Bronchi-shield® are registered trademarks of Boehringer Ingelheim Vetmedica GmbH, used under licence.

©2021 Boehringer Ingelheim Animal Health Canada Inc. All rights reserved.