Suspected congenital urethral diverticulum in a dog

Catastrophic gastric rupture in a horse secondary to psyllium pharmacobezoars

Case-control study of mineral concentrations of hoof horn tissue derived from feedlot cattle with toe tip necrosis syndrome (toe necrosis)

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Short- and long-term outcomes after shoulder excision arthroplasty in 7 small breed dogs

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Letters to the Editor

Veterinary School Admission — A comment

Dear Editor,

I am writing in response to Dr. Francis’ comments about “Veterinary School Admission” published in the November 2017 issue of The Canadian Veterinary Journal (CVJ;58:1145–1146). While I appreciate the standpoint offered in Dr. Wichtel’s response, I would like to provide another perspective and some additional evidence in support of Ontario Veterinary College’s (OVC) practices.

As a previous OVC faculty member and participant in the admission process (including the Multiple Mini Interview format) for 3 years, I echo Dr. Wichtel’s sentiments and that of the evidence he provided, which states that the process is reliable and feasible in selecting candidates for the DVM program.

Additionally, as an advocate for wellness in the veterinary profession, I feel called to specifically respond to Dr. Francis’ question “Why are we admitting second career people as veterinarians?” As someone who grew up with both parents as veterinarians, I understand the feeling that “veterinary medicine is in one’s blood.” I knew from a young age that I wanted to follow my parents’ path into veterinary medicine and subsequently was accepted into the Western College Veterinary Medicine DVM program at the age of 19. However, it would be untrue for me to claim that this benefited me in any way, as I felt far less mature, prepared, or competent than my older classmates who had already completed bachelors and masters degrees or who had pursued other careers.

With the growing concerns about mental health and well-being in the veterinary profession, I think it behooves us to consider who we are selecting for the DVM program. Recent research investigating factors associated with resilience in medical students has shown that older age is associated with increased resilience scores (1). This might be due to anatomical maturation within the prefrontal cortex, the area of the brain responsible for complex cognitive behavior, decision-making, and personality expression that occurs during young adulthood (age 23 to 25 years old). So, while it might seem that children or even late adolescents (age 18 to 19 years old) know for certain the career path they wish to pursue, research suggests that incomplete brain maturation might prevent optimum cognition and decision-making at that age (2). Although this does not mean that admission of younger adults to the DVM program is detrimental, I believe there is more evidence in the literature to support the admission of older adults, especially into academic programs that are as demanding and stressful as veterinary medicine.

Ultimately, how old a person is when they decide to pursue a career in veterinary medicine should not be a determining factor in admitting them to veterinary school.

References


Transportation of horses to Japan for slaughter — A comment

Dear Editor,

This comment is in response to the ethical question of the month submitted by Dr. M. Harper in the December 2017 Canadian Veterinary Journal (CVJ 2017;58:1253). Dr. Harper has suggested that the Canadian Food Inspection Agency (CFIA) is not enforcing the Health of Animals Regulations in relation to horses transported by air to Japan and that the transport is not compliant with the International Air Transport Association (IATA) Live Animals Regulations (LAR). The CFIA would like to provide clarification.

The CFIA is responsible for the administration and enforcement of the Health of Animals Regulations, and in this capacity, it is committed to animal welfare during transportation. After due inspection and evaluation, the CFIA takes measures that are deemed appropriate according to the facts.

It has been observed that larger draft-type feeder horses have a strong instinct to remain in familiar social groups. Accordingly, the CFIA recognizes that it may be in the best interest of the horses to travel in small groups, subject to an assessment of all relevant facts, including incompatibility by reason of weight.

Constructive and professional comments made in the spirit of intellectual debate are welcomed by the Editor. Writers are expected to be respectful of others and to ensure that letters are considerate and courteous. The Editor reserves the right to remove comments deemed to be inflammatory or disrespectful.
nature, height, age, etc. This approach is consistent with the modernization of Part XII of the *Health of Animals Regulations* (Transportation of Animals), anticipated to be published in the *Canada Gazette* in 2018.

The question also states that “the International Air Transport Association (IATA) Live Animal Regulations do not allow horses to be shipped in wooden containers.” We would like to correct this misunderstanding. The IATA Live Animal Regulations (LAR) clearly indicate that wooden crates are permitted and mention wood as an acceptable material. In fact, the current (43rd edition) of LAR includes an illustration of an acceptable wooden crate.

Jaspinder Komal, DVM, Acting Chief Veterinary Officer for Canada, Canadian Food Inspection Agency/Agence canadienne d’inspection des aliments, Ottawa, Ontario K1A 0Y9.

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**Transportation of horses to Japan for slaughter — A reply**

The CFIA should legally be enforcing all sections of its current animal transport regulations. Thus, horses’ heads must not come into contact with the tops of shipping containers and horses over 14 hands must be segregated when being transported by air, as per Sections 142 (a) and 141 (8), respectively of the Health of Animals Animal Transport Regulations. I am aware, from access to information documents that many of these shipments are comprised of draft horses that are residing in feedlots and as such, they are considered to be wild due to minimal handling. As a result, they have the potential to do serious damage to one another if they aren’t segregated. Installing partitions, between the horses from the withers down, would still allow horses to see one another and socialize. Such partitions would prevent serious inflictions of leg injuries by other horses, while providing the animals with sufficient space to remain upright during flight.

There is currently no provision in the International Air Transport Association (IATA) Live Animals Regulations (LARs) to permit draft horses to be transported unsegregated in bulk wooden containers (personal communication with IATA). Exception 5 of the IATA LARs only allows for small polo ponies, Icelandic ponies, weaned pony foals, and pony yearlings to be shipped in unsegregated containers. There is no such provision for draft horses. It further states that it is essential that sufficient space be given to all animals so that they can move in order to balance and maintain good foothold. The IATA regulations require at least 8 inches head clearance for larger farm stock and minimally 3 inches between horses at their widest points. These requirements have not been respected with a number of these shipments (access to information documents).

In summary, both the federal animal transport regulations and IATA regulations are in place to help protect the welfare of animals. Horses have been both injured and killed in some of these shipments (access to information documents). The World Organization for Animal Health (OIE) recognizes the IATA LARs as the international standard for live animal transport by air. As an OIE member country, Canada is expected to implement those standards. After 40 years, the CFIA recently embarked on updating the Health of Animals Animal Transport Regulations. It is very disconcerting that within the proposed changes, the CFIA is removing the current requirement of segregation for horses over 14 hands and the requirement of horses heads not to come into contact with the tops of shipping containers. To do so would not be consistent with the international standards of IATA and the OIE.

Maureen Harper, DVM, MSc (Epidemiology), Brampton, Ontario.
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This year, 2018, marks the year that the Canadian Veterinary Medical Association (CVMA) turns 70 years old! Seventy years of service and leadership that started with an Act of Parliament on August 25, 1948. There have been a few crests and logos along the way but the current CVMA logo was adopted in 1993 and stands today. The first veterinary oath was adopted in 1951 with a newer oath adopted in 2004. I was happy to hear the recital of the veterinary oath by all of the Annual General Meeting attendees at the Prince Edward Island Veterinary Medical Association meeting last fall. I felt proud to be CVMA president and a veterinarian.

The CVMA council consisted of men in the beginning and over the course of time we have seen that change as the profession has changed. The first female president of the CVMA was Dr. Christiane Gagnon in 1989. The National Examining Board (NEB) of the CVMA was started in 1956 and at that time the candidates examined were graduates of foreign veterinary schools only. By 2000, candidates included foreign-trained veterinarians and all graduates of Canadian universities. In 1960, the first issue of The Canadian Veterinary Journal (The CVJ) was published. In 1968, the CVMA acquired the Canadian Journal of Comparative Medicine (later renamed the Canadian Journal of Veterinary Research [CJVR]). The CVJ and the CJVR are highly respected journals in Canada and the world over.

In 1983, the staff of the CVMA took up residence at 339 Booth Street in our Nation’s Capital, Ottawa. In 1985, the first Animal Health Week was celebrated across the country and is still observed and embraced by so many of you. Inaugural training for the Canadian Veterinary Reserve took place in 2007.

Through all these years, the CVMA has lobbied governments, participated in government and industry workshops, enjoyed great relationships with industry and government, and has been active on the world stage. The Association is involved with, and has representatives on, the World Veterinary Association, the World Small Animal Veterinary Association, Panvet, the World Organization for Animal Health (OIE), and the Canadian Veterinary Medical Association (CVMA). The CVMA is active on the world stage.


Pendant toutes ces années, l’ACMV a exercé des pressions auprès des gouvernements ainsi que participé à des ateliers du gouvernement et de l’industrie, entretenu d’excellentes relations...
International Veterinary Officers Council, and the Federation of Veterinarians of Europe, to name only a few.

The Students of the CVMA ensure that veterinary students have a voice on CVMA council as the president is a voting member. Each year the SCVMA organizes a Student Symposium, the location of which rotates among the 5 Canadian veterinary colleges. The Symposium brings students from across the country together for a weekend of meetings, interactive lectures, networking, and social events. Veterinary students are immensely important to the future of our profession, and I am proud that they are getting involved in their profession from the start of their careers. This involvement is essential to the future of the CVMA.

The times they are a changin’ as Bob Dylan said. The age of disruption is upon us. What are the qualities of an association at the forefront, such as the CVMA, in an age of disruption? I will mention a few:
1. Transparency — it builds strong relationships, creates authenticity, engenders trust, and drives higher levels of performance.
2. Communication — strong communication fosters alignment on activities, resources, and priorities. It also promotes the sharing of results, insights, and best practices across the profession.
3. Influence — being able to influence others without having direct authority is extremely important. Positive influence sparks motivation and engagement.
4. Engagement — membership in the CVMA results in staying grounded in the realities of veterinary medicine, and inspires members to unleash their passions and talents around a shared vision.

Together, members of the CVMA are the voice of Canadian veterinarians from coast to coast to coast. We are the voice for animal welfare advocacy, we are the leaders on national and international issues, and we are the voice for the successful practice of veterinary medicine.

Please join me in wishing the Canadian Veterinary Medical Association a Happy 70th Birthday, and may it have 70 more! See you all at the 2018 CVMA Convention in beautiful Vancouver, British Columbia!

Troye McPherson
Ethical question of the month — March 2018

Videos were sent to major media outlets documenting poor husbandry practices at 2 dairy farms. As a well-respected dairy veterinarian you are asked to visit the farms and review their husbandry practices by the organization that purchases the milk. You observe and document an above average standard of care on both farms. On questioning the managers of each farm, you are told that the abusive practices shown in the videos were perpetrated by new hires that admittedly were inadequately supervised. Those employees were immediately fired. Remaining employees have been told that the farms’ animal care standards are a priority and will be strictly enforced. Video surveillance cameras are being installed at both farms to monitor animal care around the clock. You are satisfied with the approach both farms have taken to remedy the problems seen on the videos and report your findings. The next day you receive a press release that says after a review by a well-respected dairy veterinarian, the milk purchaser has decided to drop them from their supply chain. You contact the purchaser and explain that dropping the dairies was not your recommendation. The purchaser replies that they understand this but that their reputation is their number one concern so the dairies had to go. You realize that the 2 farm managers must think you were disingenuous when you told them you would give them a good report. How should you respond?

Question de déontologie du mois — Mars 2018

Des vidéos ont été envoyées aux grands réseaux médiatiques pour documenter les mauvaises pratiques d’élevage observées dans deux fermes laitières. L’organisme qui achète le lait vous demande, à titre de vétérinaire laitier respecté, de visiter les fermes et d’évaluer les pratiques d’élevage. Vous observez et documentez une norme de soins supérieure à la moyenne dans les deux fermes. Vous interrogez les gestionnaires des deux fermes et on vous dit que les pratiques abusives présentées dans les vidéos ont été perpétrées par de nouveaux employés qui n’avaient pas été bien encadrés. Ces employés ont été immédiatement congédiés. Les autres employés ont ensuite été informés que les normes des soins aux animaux étaient une priorité de la ferme et que les règles seraient strictement appliquées. Des caméras de surveillance vidéo étaient en voie d’être installées dans les deux fermes afin que les soins aux animaux puissent être continuellement surveillés. Vous êtes entièrement satisfait de l’approche adoptée par les deux fermes afin d’aborder les problèmes observés dans les vidéos et vous présentez un rapport sur vos constatations. Le lendemain, vous recevez un communiqué de presse stipulant que, après une évaluation effectuée par un vétérinaire laitier respecté, le transformateur a décidé de ne plus faire affaire avec ces deux fermes pour son approvisionnement en lait. Vous contactez le transformateur pour lui expliquer que vous n’avez pas recommandé la cessation des activités avec ces fermes. Le transformateur explique qu’il comprend mais que sa réputation représente sa principale préoccupation et qu’il doit mettre fin à la relation. Vous réalisez que les deux gestionnaires de ferme doivent croire que vous n’étiez pas sincère lorsque vous leur aviez dit que vous déposeriez un bon rapport sur votre inspection. Comment devriez-vous répondre?

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

Suggested ethical questions of the month are also welcome! All ethical questions or scenarios in the ethics column are based on actual events, which are changed, including names, locations, species, etc., to protect the confidentiality of the parties involved.

Les réponses au cas présenté sont les bienvenues. Veuillez limiter votre réponse à environ 50 mots et nous la faire parvenir par la poste avec vos nom et adresse à l’adresse suivante : Choix déontologiques, a/s du D’ Tim Blackwell, 6486, E. Garafraxa, Townline, Belwood (Ontario) N0B 1J0; téléphone : (519) 846-3413; télécopieur : (519) 846-8178; courriel : tim.e.blackwell@gmail.com

Les propositions de questions déontologiques sont toujours bienvenues! Toutes les questions et situations présentées dans cette chronique s’inspirent d’événements réels dont nous modifions certains éléments, comme les noms, les endroits ou les espèces, pour protéger l’anonymat des personnes en cause.

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Ethical question of the month — December 2017

The Health of Animals Animal Transport Regulations ensures that animals are transported humanely. Transporters, producers, and abattoirs have been charged by the Canadian Food Inspection Agency (CFIA) with not adhering to these regulations. Infractions include overcrowding, insufficient protection from the elements, improper segregation of animals, and improper protection of animals from injury. The routine shipment of Canadian horses to Japan by air for slaughter falls under this regulatory jurisdiction. The CFIA oversees the loading of these large breed horses into wooden shipping containers prior to the horses being loaded onto the aircraft. Horses are commonly shipped with 3 to 4 horses per container, where the larger horses’ heads come into contact with the tops of the crates. These events are in contravention of the animal transport regulations that require horses over 14 hands to be individually segregated and further require that animals’ heads do not come into contact with the tops of the shipping containers. In addition, the International Air Transport Association (IATA) Live Animal Regulations do not allow horses to be shipped in wooden containers. Documentation shows that horses have been injured and killed in the course of these shipments. The federal regulatory body effectively enforces the transport regulations when infractions by producers or transporters are noted. How can infractions by the regulatory body itself be addressed?

Submitted by Maureen Harper, Brampton, Ontario

Question de déontologie du mois — Décembre 2017

Les dispositions relatives au transport du Règlement sur la santé des animaux veillent à ce que les animaux soient transportés de manière non cruelle. Des transporteurs, des producteurs et des abattoirs ont fait l’objet d’accusations de la part de l’Agence canadienne d’inspection des aliments (ACIA) pour avoir enfreint ces règles. Les infractions incluent la surpopulation, une protection insuffisante contre les intempéries, une ségrégation inadéquate des animaux et une protection inappropriée afin de prévenir les blessures chez les animaux. L’expédition routinière par avion de chevaux canadiens vers le Japon aux fins d’abattage est soumise à cette réglementation. L’ACIA supervise le chargement de ces chevaux de grande race dans des conteneurs d’expédition avant qu’ils ne soient placés dans l’avion. Les chevaux sont habituellement expédiés en plaçant 3 ou 4 chevaux dans un conteneur où la tête des chevaux plus grands touche le plafond des caisses à claire-voie. Ces instances contreviennent au Règlement sur le transport des animaux qui exigent que les chevaux de plus de 14 mains soient séparés individuellement et aussi que la tête des animaux n’entre pas en contact avec le plafond des conteneurs d’expédition. De plus, la Réglementation du transport des animaux vivants de l’Association du transport aérien international (IATA) n’autorise pas l’expédition dans des contenants en bois. La documentation montre que des chevaux ont été blessés et tués lors de ces expéditions. L’organisme fédéral de réglementation applique les règles sur le transport lorsqu’il observe des infractions par les producteurs ou les transporteurs. Comment peut-on aborder les infractions commises par l’organisme de réglementation lui-même?

Soumise par Maureen Harper, Brampton (Ontario)

Horses being transported to Japan for slaughter — A comment

I am in receipt of a response from the Minister of Agriculture, Honorable Lawrence MacAuley, regarding this particular issue of horses being transported to Japan for slaughter. The animals are being crammed into small wooden containers, unsegregated. In essence, the Minister of Agriculture’s response justified this breach of the animal transport regulations. He stated that the horses were being shipped unsegregated in order to keep them calm and to allow them to be transported “better” by permitting the horses to be shipped with familiar animals. The rationale for this is that many of the horses in these shipments are minimally socialized due to being raised in feedlots.

My response is the following: No veterinary inspector at the airport, overseeing the loading of these horses into wooden crates (not sanctioned for shipping horses by air by the International Air Transport Association), is able to assess, at the time of loading, the compatibility of any one particular horse with another. Secondly, there is documented evidence that shipment of horses in this way has led to injuries and even death as animals have gone down in the crates and were unable to get up because of inadequate room to do so. And being unsegregated, other horses have trampled the downed horses. And finally, no regulatory agency has the legal authority to disregard its own regulations. All that to say, the federal animal transport regulations have been put in place for a reason, and the Canadian Food Inspection Agency is legally obliged to enforce them. This is currently not happening with these shipments of large draft horses.

Judith Samson DVM, Bragg Creek, Alberta
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An ethicist’s commentary on horse transport

What is described in this case is as old as human civilization: who watches the watchers? It is for this reason that Plato, in describing the ideal state in his masterpiece, *The Republic*, insisted on the highest level of education for police and military, realizing full well that such people are subject to extraordinarily severe pressures and temptations to abuse their authority.

None of us have reached adulthood without becoming cognizant of such corruption. Whether it be police who are bought off by mobsters; building inspectors who look the other way when confronted with shoddy and often unsafe construction; or, as in this case, those who are entrusted with the lives and well-being of innocent animals.

What is described in this scenario is unconscionable. It is bad enough that animals, particularly large, social, skittish animals like horses, are transported great distances for profit under highly unnatural conditions. To the credit of the air transport of animals industry, they have been well aware of these issues for decades, and have expended great effort to improve the conditions under which animals are moved. I have been a speaker at their conventions on more than one occasion, and was struck by the level of concern of most members of the association. Under the firm but gentle influence of the late head of the Canadian Council on Animal Care, veterinarian Dr. Harry Rowsell, progress was made.

But what is to be done when those we count on to enforce the law protecting those creatures who cannot speak for themselves abrogate their responsibilities and allow the animals to suffer? In the United States, there exists a federal watchdog organization called the GAO — the Government Accountability Office. Designed to be independent and nonpartisan, the GAO website’s own words describe the agency as follows: “The US Government Accountability Office (GAO) is an independent, nonpartisan agency that works for Congress. Often called the ‘congressional watchdog’ GAO investigates how the federal government spends taxpayer dollars.”

Among other things, the GAO operates by “investigating allegations of illegal and improper activities [and] reporting on how well government programs and policies are meeting their objectives,” (www.gao.gov/about). In my experience, the GAO has done an excellent job when, on numerous occasions, it was asked by Congress to report on various aspects of animal research and its regulation. The equivalent agency in the Canadian federal government is the Office of the Auditor General, whose attention should be called to the deplorable state of affairs described in the above case, since among the jobs of the OAG is auditing performance by government officials.

In my view, however, the ultimate recourse to stopping the atrocities delineated in the case is invoking public opinion. As I have often remarked in this column, public opinion has ever increasingly turned towards issues of animal welfare, ranging from the treatment of agricultural animals in industrial agriculture, to the treatment of animals used in research and product testing. If the press were alerted to the current situation, one can virtually guarantee that these abuses would stop dead in their tracks. The management of the animals being atrociously transported borders on outright cruelty and gross negligence. I would hope that the mass media would engage this issue in Canada as soon as possible. We should recall that societal concern for these innocent creatures completely transcends partisan differences and crosses political lines.

*Bernard E. Rollin, PhD*
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1. A 6-year-old Pionus parrot is examined because of a recent change in the sound of its vocalizations. Which of the following is a reasonable diagnosis?
   A. Aspergillosis
   B. Upper tracheal foreign body
   C. Airsacculitis
   D. Pneumonia
   E. Hepatomegaly

2. A cataract that has begun to resorb portions of the lens protein would be characterized as which of the following?
   A. An incipient cataract
   B. An immature cataract
   C. A mature cataract
   D. A hypermature cataract

3. An apparently healthy 7-year-old Doberman pinscher has echocardiographic findings of left ventricular enlargement and reduced ventricular contractility consistent with pre-clinical dilated cardiomyopathy. Which of the following is the most appropriate therapy?
   A. Furosemide
   B. Enalapril
   C. Hydralazine
   D. Diltiazem
   E. Amlodipine

4. Head bobbing and vocalization in a neonatal foal occurs in which of the following cases?
   A. When the foal is showing aggression
   B. When the foal is in pain
   C. When the foal is learning to suckle
   D. When the foal is fearful

---

1. On fait l’examen d’un perroquet Pione âgé de 6 ans à cause d’un changement récent dans le son de sa voix. Lequel des diagnostics suivants est le plus raisonnable?
   A. aspergillose;
   B. corps étranger dans la partie supérieure de la trachée;
   C. aérosacculite;
   D. pneumonie;
   E. hépatomégalie.

2. Laquelle des cataractes suivantes caractérise une cataracte qui a commencé à résorber une partie des protéines du cristallin?
   A. cataracte incipiente;
   B. cataracte immature;
   C. cataracte mûre;
   D. cataracte hypermûre.

3. Un Doberman pinscher âgé de 7 ans, apparemment en santé, montre des signes échographiques d’un agrandissement ventriculaire gauche et de réduction de contractilité ventriculaire, compatibles avec une cardiomyopathie dilatée préclinique. Lequel des traitements suivants est le plus approprié?
   A. furosémide;
   B. énalapril;
   C. hydralazine;
   D. diltiazem;
   E. amlopidine.

4. Le branlement de la tête et le hennissement chez un poulain nouveau-né se produisent dans lequel des cas suivants?
   A. Lorsque le poulain manifeste de l’agression.
   B. Lorsque le poulain éprouve de la douleur.
   C. Lorsque le poulain apprend à téter.
   D. Lorsque le poulain est craintif.

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Quiz Corner
Test éclair

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5. Which of the following is an appropriate suture pattern for closure of the bovine uterus after caesarean section?
   A. Simple interrupted
   B. Simple continuous
   C. Horizontal mattress
   D. Cushing
   E. Connell

   (See p. 310 for answers./Voir les réponses à la page 310.)

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

The CVMA Council, comprised of representatives of CVMA members in all provinces, veterinary colleges, veterinary students, and the registered Veterinary Technologists and Technicians of Canada (RVTTC), met in December to make policy decisions and provide direction for the CVMA's 2018 program plans.

Council welcomed new members, Dr. Leighann Hartnett (Nova Scotia) and Ms Kira Moser (SCVMA president) and bid farewell to Dr. Kathleen MacMillan (Atlantic Veterinary College — AVC) whose term ended on December 31, 2017. Council would like to thank Dr. MacMillan for sharing her expertise and for her dedication as council member and as chair of the successful 2017 CVMA Convention in Charlottetown.

Dr. Marie-Claude Blais (Faculté de médecine vétérinaire — FMV de l’Université de Montréal) will commence her term on January 1, 2018 as the representative on Council of FMV/AVC.

As of January 1, 2018, CVMA Council is as follows:

- Dr. Troye McPherson, president
- Dr. Terri Chotowetz, president-elect (Saskatchewan)
- Dr. Melanie Hicks, vice-president (New Brunswick)
- Dr. Enid Stiles, executive member (Quebec)
- Dr. Troy Bourque, immediate past-president
- Dr. Barry Stemshorn, treasurer (ex-officio)
- Mr. Jost am Rhyn, CEO (ex-officio)
- Dr. Christiane Armstrong (British Columbia)
- Dr. Louis Kwantes (Alberta)
- Dr. Christopher Bell (Manitoba)
- Dr. Timothy Arthur (Ontario)
- Dr. Leighann Hartnett (Nova Scotia)
- Dr. Juanita Glencross-Winslow (Prince Edward Island)
- Dr. Margaret Brown-Bury (Newfoundland)
- Dr. Karen Machin (WCVM/UCVM/OVC)
- Dr. Marie-Claude Blais (FMV/AVC)
- Ms. Kira Moser (SCVMA president)
- Ms. Lois Ridgway (RVTTC Ex-officio)

Mise à jour du Conseil

Le Conseil de l’ACMV, qui se compose de représentants de l’ACMV pour toutes les provinces et les écoles de médecine vétérinaire ainsi que de représentants des étudiants en médecine vétérinaire et de Technologues et techniciens vétérinaires agréés du Canada (TTVAC), s’est réuni en décembre afin de prendre des décisions stratégiques et de fournir une orientation aux plans des programmes de l’ACMV pour 2018.

Le Conseil a accueilli de nouveaux membres, la Dre Leighann Hartnett (Nouvelle-Écosse) et la Mme Kira Moser (présidente des ÉACMV) et a fait ses adieux à la Dre Kathleen MacMillan (Atlantic Veterinary College — AVC) dont le mandat a pris fin le 31 décembre 2017. Le Conseil aimerait remercier la Dre MacMillan pour son dévouement et le partage de son expertise en tant que membre du Conseil et présidente du congrès 2017 de l’ACMV qui a connu un grand succès à Charlottetown. La Dre Marie-Claude Blais, de la Faculté de médecine vétérinaire (FMV) de l’Université de Montréal, a entamé son mandat le 1er janvier 2018 à titre de représentante de la FMV et de l’AVC au sein du Conseil.

Voici les membres du Conseil de l’ACMV au 1er janvier 2018 :

- Dte Troye McPherson, présidente
- Dte Terri Chotowetz, présidente désignée (Saskatchewan)
- Dte Melanie Hicks, vice-présidente (Nouveau-Brunswick)
- Dte Enid Stiles, membre de l’exécutif (Québec)

Dr. Troye McPherson, CVMA President, (left) says goodbye to Dr. Kathleen MacMillan.

La Dte Troye McPherson, présidente de l’ACMV, (à gauche) dit au revoir à la Dte Kathleen MacMillan.
The following guests provided updates and engaged with Council:

- **Dr. Mary-Jane Ireland**, director general, the Veterinary Drugs Directorate (VDD), and **Dr. Manisha Mehrotra**, director, Human Safety Division, VDD.
- **Dr. Howard Njoo**, deputy chief public health officer, Infectious Disease Prevention and Control Branch, Public Health Agency of Canada (PHAC).
- **Dr. Jaspinder Komal**, acting chief veterinary officer/World Organisation for Animal Health (OIE) delegate for Canada.

The following are some topics from the Council table:

**Antimicrobial resistance (AMR) regulatory and policy changes:** In conjunction with VDD and the Canadian Animal Health Institute (CAHI), the CVMA developed a diagram outlining the dates and intent of the various changes that may affect veterinary practices. This diagram can be found on the CVMA website (www.canadianveterinarians.net/documents/timelines-hc-regs-veterinary-antimicrobials). The CVMA has developed and will launch a communications campaign in collaboration with VDD to keep veterinarians, veterinary regulators, academia, and veterinary technicians informed on the implementation of the new regulatory and policy changes and their implications.

**Renewal of CVMA Prudent Use Guidelines:** This CVMA project will contribute to veterinary antimicrobial stewardship and is scheduled to wrap up on March 31, 2018. The final product will be a web-based database for 6 species groups: beef, companion animals, dairy, poultry, small ruminants, and swine. The CVMA may follow-up with a project to disseminate information and provide communication regarding AMR to increase awareness and foster change as appropriate.

**Antimicrobial use (AMU) surveillance:** Phase 1 of this CVMA project (January–March 2017) focused on the assessment of current Canadian AMU among veterinarians, government, industry and other stakeholders, and the development of recommendations for the initiation of veterinary-focused AMU surveillance. Phase 2 (December 2017–March 2018) focuses on the design of working prototype(s) in targeted regions and agricultural sectors to support veterinary based AMU surveillance in Canada. Phase 3 (April 2018–March 2020, pending funding approval) will focus on building a functional prototype for limited collection, collation and analysis of AMU data and identification of both best practices and challenges associated with broader implementation. The data collection will likely be conducted in whole or in part through an electronic prescription system(s). Phase 2 of the project will therefore include researching and evaluating such systems with the goal of employing them in the AMU surveillance prototype. The project will be carried out in close collaboration with stakeholders, in particular the veterinary regulatory bodies.

**House of Commons:** The CVMA, represented by **Dr. Duane Landals**, appeared before the House of Commons Standing Committee on Health in relation to its study of antimicrobial resistance. Such opportunities are important in demonstrating to legislators the importance of the proper use of antimicrobials for animal health and welfare, and a safe food supply.

**Antimicrobial use (AMU) surveillance:**

- **D’ Troy Bourque**, président sortant
- **D’ Barry Stemshorn**, trésorier (membre d’office)
- **M. Jost am Rhyn**, PDG (membre d’office)
- **D’ Christiane Armstrong** (Colombie-Britannique)
- **D’ Louis Kwantes** (Alberta)
- **D’ Christopher Bell** (Manitoba)
- **D’ Timothy Arthur** (Ontario)
- **D’ Leighann Hartnett** (Nouvelle-Écosse)
- **D’ Juanita Glencross-Winslow** (Île-du-Prince-Édouard)
- **D’ Margaret Brown-Bury** (Terre-Neuve)
- **D’ Karen Machin** (WCVM/UCVM/OVC)
- **D’ Marie-Claude Blais** (FMV/AVC)
- **M’ Kira Moser** (présidente des ÉACMV)
- **M’ Lois Ridgway** (TTVAC, membre d’office)

Les invités suivants ont présenté des mises à jour et ont échangé avec le Conseil :

- **D’ Mary-Jane Ireland**, directrice générale, Direction des médicaments vétérinaires (DMV), et **D’ Manisha Mehrotra**, directrice, Division de l’innocuité pour les humains, DMV.
- **D’ Howard Njoo**, sous-administrateur en chef de la santé publique, Direction générale de la prévention et du contrôle des maladies infectieuses, Agence de la santé publique du Canada (ASPC).
- **D’ Jaspinder Komal**, vétérinaire en chef par intérim et délégué pour le Canada auprès de l’Organisation mondiale de la santé animale (OIE).

Voici quelques-uns des sujets discutés à la table du Conseil :

**Renouvellement des Lignes directrices de l’ACMV sur l’administration judiciaire des antimicrobiens:** Ce projet de l’ACMV contribuera à l’antibiogouvernance vétérinaire et doit se terminer le 31 mars 2018. Le produit final sera une base de données sur Internet pour les six groupes d’espèces : bovins de boucherie, animaux de compagnie, bovins laitiers, volaille, petits ruminants et porcs. L’ACMV pourra effectuer un suivi à ce projet en diffusant des renseignements et en transmettant des communications à propos de l’antibiorésistance afin de rehausser la sensibilisation et de favoriser les changements au besoin.

**Surveillance de l’utilisation des antimicrobiens:** La phase 1 de ce projet de l’ACMV (de janvier à mars 2017) s’est concentrée sur l’évaluation de l’utilisation actuelle des antimicrobiens au Canada parmi les vétérinaires, au sein de l’industrie et du gouvernement ainsi que par les autres intervenants et sur l’élaboration de recommandations pour la mise en place de la surveillance de l’utilisation des antimicrobiens en médecine.
Fentanyl/opioids: Health Canada officials and the CVMA met to discuss opioid use in relation to veterinary practice. Two major points arose: a) the importance of safe management of opioids and b) “Doctor shopping,” the concern that some patients may shop around for opioids for their pets and may use the drugs themselves. The CVMA has developed a brief summary of current knowledge and best practices as a potential reference tool for the veterinary healthcare team and as a resource for further discussions on this matter. This tool is under the Practice & Economics tab, Practice Tool section of the CVMA website (www.canadianveterinarians.net). Most provincial licensing bodies have detailed guidelines for the purchase, safe storage, tracking, dispensing and disposal/destruction of scheduled drugs, and it is incumbent on each licensed practitioner to maintain competence in this area.

Veterinary dentistry: Council approved the following revised position statement:

“The Canadian Veterinary Medical Association (CVMA) considers that all procedures comprising veterinary dentistry must be performed or delegated and directly supervised by a duly licensed veterinarian. The CVMA acknowledges that supra-gingival scaling and polishing and some other procedures in some species may be delegated by a veterinarian, however, such procedures must always be performed under veterinary supervision in accordance with regulations of the relevant jurisdiction. The CVMA does not support anesthesia-free dentistry.”

Canadian Veterinary Reserve (CVR): Emergency Management BC approached the CVMA in August to ask that the CVR be ready for a call-up and deployment of reservists to provide emergency care for animals (mainly cattle) affected by the more than 1000 wildfires. Emergency Management BC and the CVR finalized the preparations for call-up and deployment. However, in the end, the situation on the ground changed, making the deployment of the Reserve unnecessary.

Animal abuse: Council approved the revised position statement on The Responsibility of Veterinary Professionals in Addressing Animal Abuse and Neglect as follows:

“The Canadian Veterinary Medical Association (CVMA) holds that veterinary professionals, including veterinarians and registered veterinary technologists/technicians, have a duty to protect the health and welfare of animals. This includes addressing any and all first-hand observations leading to suspicion of animal abuse and/or neglect. This includes, but is not limited to, reporting of suspected abuse to the appropriate law enforcement authorities. Depending on the jurisdiction in which he or she practices, a veterinarian may or may not have a legal obligation to report suspected abuse or neglect and may or may not be immune from liability resulting from reporting in good faith.”

Capture of Wild Animals for the Pet Trade: Council approved the following revised position statement:

“The Canadian Veterinary Medical Association (CVMA) is opposed to the capture of wild animals to be kept or sold as pets.”


CVMA Insurance Program: The CVMA Insurance Program was designed by veterinarians, for veterinarians. Over the veterinary. The phase 2 (de décembre 2017 à mars 2018) se concentre sur la conception de prototypes de travail dans les régions et les secteurs agricoles ciblés afin d’appuyer la surveillance de l’utilisation des antimicrobiens vétérinaires au Canada. La phase 3 (d’avril 2018 à mars 2020, sous réserve de l’approbation du financement) portera sur la mise au point d’un prototype fonctionnel pour la collecte limitée, la collation et l’analyse des données sur l’utilisation des antimicrobiens ainsi que l’identification des meilleures pratiques et des défis associés à une mise en œuvre à plus grande échelle. La collecte des données sera probablement réalisée en totalité ou en partie à l’aide d’un ou de plusieurs systèmes d’ordonnance électronique. La phase 2 du projet inclura donc des travaux de recherche et d’évaluation de tels systèmes dans le but de les utiliser pour le prototype de surveillance de l’utilisation des antimicrobiens. Le projet sera réalisé en étroite collaboration avec les intervenants, particulièrement les organismes de réglementation de la médecine vétérinaire.

Chambre des communes: L’ACVM, représentée par le Dr Duane Landals, a comparu devant le Comité permanent de la santé de la Chambre des communes en lien avec son étude sur la résistance aux antimicrobiens. De telles occasions sont importantes afin de démontrer aux législateurs l’importance d’une utilisation appropriée des antimicrobiens pour la santé et le bien-être des animaux ainsi que pour un approvisionnement alimentaire sécuritaire.

Fentanyl/opioids: Des représentants de Santé Canada et de l’ACVM se sont réunis afin de discuter de l’utilisation des opioïdes en lien avec la pratique vétérinaire. Deux sujets importants ont été soulevés: a) l’importance d’une gestion sécuritaire des opioïdes et b) le «magasinage de médecins», soit la préoccupation que certains patients pourraient magasiner afin de se procurer des opioïdes pour les animaux et les utiliser eux-mêmes. L’ACVM a rédigé un bref sommaire des connaissances et des meilleures pratiques actuelles en tant qu’outil de référence potentiel pour l’équipe de soins vétérinaires et comme ressource permettant des discussions plus approfondies sur le sujet. Cet outil se trouve sous l’onglet Pratique et finances, dans la section des Outils de la pratique du site Web de l’ACVM (www.veterinairesau canada.net). La plupart des organismes de réglementation provinciaux possèdent des lignes directrices détaillées pour l’achat, l’entreposage sécuritaire, le suivi, la distribution ainsi que l’élimination et la destruction des drogues à l’annexe et il incombe à chaque praticien autorisé de mettre ses compétences à jour dans ce domaine.

Dentisterie vétérinaire: Le Conseil a approuvé la révision de l’énoncé de position suivant:

«L’Association canadienne des médecins vétérinaires (ACVM) considère que toutes les interventions liées à la dentisterie vétérinaire doivent être réalisées ou déléguées et supervisées directement par un médecin vétérinaire autorisé. L’ACVM reconnaît que le nettoyage supra-gingival et le polissage, ainsi que d’autres interventions chez certaines espèces, peuvent être délégués par un médecin vétérinaire. Cependant, ces interventions doivent toujours être effectuées sous la supervision d’un médecin vétérinaire conformément aux règlements du territoire pertinent. L’ACVM n’appuie pas la dentisterie sans le recours à l’anesthésie.»

Réserve vétérinaire canadienne (RVC): L’organisme de gestion des urgences en Colombie-Britannique, Emergency Management BC, a passé une convention de mise à disposition avec les équipes de sauveteurs de la réserve vétérinaire canadienne (RVC) en vue de renforcer la gestion des urgences en Colombie-Britannique, Emergency Management BC, a passé une convention de mise à disposition avec les équipes de sauveteurs de la réserve vétérinaire canadienne (RVC) en vue de renforcer la gestion des urgences en Colombie-Britannique, Emergency Management BC, a passé une convention de mise à disposition avec les équipes de sauveteurs de la réserve vétérinaire canadienne (RVC) en vue de renforcer la gestion des urgences en Colombie-Britannique, Emergency Management BC, a passé une convention de mise à disposition avec les équipes de sauveteurs de la réserve vétérinaire canadienne (RVC) en vue de renforcer la gestion des urgences en Colombie-Britannique, Emergency Management BC, a passé une convention de mise à disposition avec les équipes de sauveteurs de la réserve vétérinaire canadienne (RVC) en vue de renforcer la gestion des urgences en Colombie-Britannique. La Réserve vétérinaire canadienne (RVC) a été créée en 1999 et est composée de bénévoles qui se portent volontairement pour aider les animaux de la région lors de catastrophes naturelles. La RVC a participé à plusieurs interventions en Colombie-Britannique, notamment lors de l’incendie de l’île de Vancouver en 2009 et de l’ouragan de 2013. La RVC fournit également un service d’urgence en temps normal pour les animaux blessés ou malades. La RVC a été reconnue par l’organisme de réglementation canadien et est membre de l’International Veterinary Emergency and Critical Care Society.”
in recent years, the commercial liability insurance program grew by over 7.3%, the Employee Benefits program by 7.5%.

**Small Business tax reform:** The CVMA has been part of a coalition of associations that grew from a few participants to 80 business associations. The objective of the coalition is to give voice to small business on the proposed federal small business tax changes. To assist in navigating through this complex issue, the coalition engaged a number of tax experts. Recent actions by the coalition include a presentation to the Commons Entrepreneur Caucus (consisting of members of all 3 major parties) and an appearance before a Senate Committee. The Federal Government took a welcomed step in announcing a reduction of the small business corporate tax rate from 10.5% to 9% by 2019. At the time of the CVMA December Council meeting, discussions with the government were pending regarding rules that were foreseen to penalize business owners for paying dividends and other forms of income to adult family members, suggested passive investment rules, and methods to make intergenerational transfers less costly for business owners. The coalition also felt that the government should undertake an economic impact assessment of the proposed tax reform package.

**2018 CVMA committee membership:** Council appointed over 90 members to the following committees: AHTVTPAC, Animal Welfare, Editorial, National Issues, Professional Development, National Examining Board, and Students of the CVMA, as well as the following Advisory Groups: Business Management, Communications, Environment, Student Liaison, Veterinary Wellness, and Veterinary Pharmaceutical Stewardship.

**2018 CVMA representations:** "If you are not at the table, you may be on the menu." In many instances, it is crucial for Canada’s veterinarians to be represented at the national level so that the expertise and voice of veterinarians can be heard and considered. Hardly a week passes by without the CVMA receiving enquiries from the public or government for veterinary policy input.

On a formal level, the CVMA maintains representation in a total of 28 national and international groups including: Aquatic Animal Health Consultative Committee of CFIA’s National Aquatic Animal Health Program (AAHC); Atlantic Veterinary College Advisory Council (AVC); Canada’s Accredited Zoos and Aquariums (CAZA); Canadian Animal Health Coalition (CAHC); Canadian Animal Health Products Regulatory Advisory Committee (CAHPRAC); Canadian Animal Health Surveillance System (CAHSS); Canadian Cattle Identification Agency (CCIA); Canadian Council on Animal Care (CCAC); Canadian General Standards Board: Committee on Service Dogs (CGSB); Canadian Veterinary Reserve Advisory Board; Canadian Pork Council’s Quality Assurance Program; Council on Education; Domestic Group on Emergency Management (DGEM); Educational Commission for Foreign Veterinary Graduates (ECFVG); Equestrian Canada; Federation of Veterinarians of Europe (FVE); National Board of Veterinary Medical Examiners (NBVME); National Companion Animal Coalition (NCAC); National Farm Animal Care Council (NFACC); National Farm Animal Health & Welfare Council (NFAHWC); PANVET; Pet Nutrition Alliance (PNA); Registered Veterinary Technologists and Technicians of Canada (RVTTC); University of Calgary Veterinary Management BC, has approached the ACMV in August in order to demand that the RVC be put in place for a mobilization and a deployment of the reservists in order to provide food for the animal and other 10,000 fires of bushfire. Emergency Management BC and the RVC has finalized the preparations for the mobilization and the deployment. Cependant, in fin de compte, la situation sur le terrain a changé et le déploiement de la Réserve n’a plus été requis.

**Violence envers les animaux:** Le Conseil a approuvé la révision de l’énoncé de position sur la responsabilité des professionnels vétérinaires à l’égard de la violence et de la négligence envers les animaux, comme suit:

«L’Association canadienne des médecins vétérinaires (ACVM) estime que les professionnels vétérinaires, y compris les médecins vétérinaires et les technologues et techniciens vétérinaires agréés, ont le devoir de protéger la santé et le bien-être des animaux. Cette obligation comprend la responsabilité d’aborder toutes les observations de première main qui suscitent des soupçons de violence et/ou de négligence envers les animaux, et, entre autres, la déclaration des abus soupçonnés aux autorités d’application de la loi appropriées. Selon le territoire dans lequel il exerce, un médecin vétérinaire peut avoir l’obligation légale de signaler la violence ou la négligence et peut être poursuivi contre les poursuites découlant d’une déclaration de bonne foi.»

**Capture des animaux sauvages pour le commerce d’animaux de compagnie:** Le Conseil a approuvé la révision de l’énoncé de position suivant:

«L’Association canadienne des médecins vétérinaires (ACVM) s’oppose à la capture d’animaux sauvages en vue d’en faire des animaux de compagnie ou de les vendre comme tels.»

**Agrément par le CAPTSATV :** Le Conseil a approuvé l’agrément du Programme de technologie vétérinaire de Douglas College, à New Westminster, en Colombie-Britannique, et du Programme de technologie vétérinaire de St. Lawrence College, à Kingston, en Ontario.

**Programme d’assurance de l’ACVM :** Le Programme d’assurance de l’ACVM a été conçu par les vétérinaires, pour les vétérinaires. Au cours des 12 mois précédents, le programme d’assurance responsabilité commerciale a connu une augmentation de 7.3% et le Programme des avantages sociaux des employés a affiché une hausse de 7.5%.

**Réforme fiscale pour les PME :** L’ACVM s’est jointe à une coalition de 80 associations qui n’était formée à l’origine que de quelques participants. La coalition avait pour objectif de faire entendre la voix des PME à l’égard du projet de réforme fiscale pour les petites et moyennes entreprises. Afin de faciliter la navigation de cet enjeu complexe, la coalition a retenu les services d’experts en fiscalité. Les actions récentes de la coalition incluent une présentation devant le Caucus des entrepreneurs de la Chambre des communes (qui se compose de membres des trois grands partis) et une composition devant un Comité du Sénat. Le gouvernement fédéral a signalé une mesure qui a été bien accueillie en annonçant une réduction de la taxe sur les entreprises qui passerait de 10.5 % à 9 % d’ici 2019. Au moment de la réunion de décembre du Conseil de l’ACVM, on attendait d’entamer des discussions avec le gouvernement concernant les règles qui pourraient pénaliser les propriétaires d’entreprise pour le paiement...
Medicine Stakeholder Advisory Council; Western College of Veterinary Medicine Advisory Council; World Small Animal Veterinary Association (WSAVA); World Veterinary Association (WVA); and WVA Advisory Group on Pharmaceutical Stewardship. Council appointed or re-appointed representatives for each of these organizations, for a one-year term.

**Canadian Animal Health Coalition:**
CVMA Council nominated Dr. Duane Landals as recipient of the CAHC’s Carl Block award and is very pleased that Dr. Landals has been chosen as the recipient.

**2018 CVMA Convention:**
The 2018 CVMA Convention will be held in Vancouver, British Columbia, July 5–8. This CVMA event will offer over 110 diverse sessions, 25 speakers, 2 wet labs, and one workshop and will feature over 75 exhibits. The CVMA Summit, chaired by Dr. Terri Chotowetz, CVMA president-elect, scheduled for July 5, will engage participants on the topic of Changing Dynamics of Private Practice. The National Issues Forum, also held on July 5, will be on the Use of Cannabinoids in Veterinary Medicine.

We hope to see many CVMA members in Vancouver in July! What a great place to reconnect and help propel the profession forward.

(by Jost am Rhyn, CEO, CVMA)
Mars a arrivé... et nous sommes prêts pour l'édition 2018 du Mois national de la sensibilisation aux tiques (MNST)!

Pour la troisième année consécutive, on encourage les vétérinaires à l'échelle du pays à unir leurs forces dans un effort concerté afin d’accroître la sensibilisation du public à propos des tiques, de l’endroit où elles se trouvent, de leur période d’activité et de ce que l’on peut faire pour protéger les animaux de compagnie contre ces bestioles.

Les populations grandissantes de tiques représentent une préoccupation croissante pour les propriétaires d’animaux qui semblent avoir plus de questions que jamais auparavant, malgré la vaste disponibilité de renseignements.

“On parle et on écrit beaucoup à propos des tiques, ce qui peut parfois semer la confusion au sein du public. Les vétérinaires se trouvent dans une position idéale pour aider les propriétaires d’animaux à comprendre ce qu’ils écoutent, ce qui se passe dans leur région ainsi qu’à apprendre comment ils peuvent mieux se protéger, eux-mêmes et leurs amis à quatre pattes”, dit la Dr. Troye McPherson, présidente de l’ACMV. “Notre campagne réussie de 2017 dans les médias sociaux nous a aidé à envisager les choses du point de vue des propriétaires d’animaux. Nous avons appris beaucoup en écoutant nos clients, ce qui nous a inspiré à concevoir la campagne de cette année pour répondre à leurs questions les plus pressantes!”

La campagne de cette année portera sur la réponse aux questions les plus fréquemment posées par les propriétaires d’animaux à propos des tiques.

Be prepared to respond to your clients’ most pressing questions with fun and engaging communication material

Les propriétaires d’animaux sont-ils bien renseignés à propos des tiques?

Soyez prêts à répondre aux questions les plus pressantes de vos clients avec du matériel de communication amusant et dynamique

How much do pet owners really know about ticks?

Be prepared to respond to your clients’ most pressing questions with fun and engaging communication material

Les propriétaires d’animaux sont-ils bien renseignés à propos des tiques?

Soyez prêts à répondre aux questions les plus pressantes de vos clients avec du matériel de communication amusant et dynamique

March has arrived... and all systems are go for National Tick Awareness Month (NTAM) 2018!

For the 3rd consecutive year, veterinarians across the country are encouraged to join forces in a concerted effort to increase public awareness about ticks, where they are found, when they are active, and what can be done to protect pets against them.

Expanding tick populations are a growing concern for pet owners who seem to have more questions than ever, despite the large amount of available information.

“A lot is being said and written about ticks, which can sometimes be confusing for people. Veterinarians are in an ideal position to help pet owners make sense out of what they’re hearing, understand what’s going on in their area, and learn how to best protect themselves and their 4-legged friends,” says Dr. Troye McPherson, CVMA president. “Our successful 2017 social media campaign has helped us see things from pet owners’ perspective. We’ve learned a lot by listening to your clients, which has inspired us to build this year’s campaign around what they most want to know!”

Providing answers to pet owners’ most frequently asked questions about ticks will be the main focus of this year’s NTAM campaign.

To help you further empower pet owners and build on the momentum of the previous NTAM campaigns, the Canadian Veterinary Medical Association (CVMA), in partnership with Merck Animal Health, has produced a number of unique communication tools.

Outils d’engagement des propriétaires d’animaux

Vos clients sont-ils bien renseignés à propos des tiques? Quelles sont leurs questions les plus pressantes à propos des tiques, des maladies transmises par les tiques et du contrôle des tiques? Découvrez ces articles amusants et interactifs qui sauront lancer la conversation!
• Series of 12 “What Do You Really Know About Ticks?” videos (shareable), in which Canadian veterinarian Dr. Scott Stevenson, BMSc, MSc, DVM, provides answers to questions frequently asked by pet owners.

NTAM launch webinar
The 2018 NTAM campaign was launched on March 1, 2018, with a webcast featuring Dr. Stevenson, who introduced this year’s theme, presented the tools and resources available, and provided suggestions on ways to use them to help make NTAM a success in your clinic.

This webinar is now available for on-demand streaming on the CVMA website.

How to access the NATM resources
For more information on National Tick Awareness Month, and to access all NTAM resources — including the NTAM launch webcast, video animation, Q&A videos, social media graphics and waiting-room poster — please visit the CVMA website (www.canadianveterinarians.net).

• Animation vidéo présentant quelques-unes des questions les plus intéressantes posées par les propriétaires d’animaux à propos des tiques. (Pouvez-vous deviner ces questions?)

• Des éléments graphiques, basés sur l’animation vidéo, pour partager dans vos réseaux des médias sociaux afin de susciter des débats et de rehausser la sensibilisation.

• Une affiche pour la salle d’attente, aussi basée sur l’animation vidéo.

• Une série de 12 vidéos intitulée « Que savez-vous vraiment au sujet des tiques? » (à partager), où le vétérinaire canadien D’ Scott Stevenson, B.M.Sc., M.Sc., D.V.M., répond aux questions fréquemment posées par les propriétaires d’animaux.

Webinaire de lancement du MNST
La campagne 2018 du MNST a été lancée le 1er mars 2018, par une émission Web mettant en vedette le D’ Stevenson, qui a présenté le thème de cette année, les outils et les ressources offerts et fourni des suggestions sur les façons de les utiliser pour assurer le succès du MNST dans votre clinique.

Cette émission Web est maintenant disponible pour visualisation sur demande sur le site Web de l’ACMV.

Comment accéder aux ressources du MNST
Pour en savoir davantage à propos du Mois national de sensibilisation aux tiques et accéder à toutes les ressources du MNST — y compris l’émission Web de lancement du MNST, de l’animation vidéo, des vidéos de questions et réponses des éléments graphiques pour les médias sociaux et une affiche pour la salle d’attente — veuillez visiter le site Web de l’ACMV (www.veterinaireascaucanada.net).

We’re on Instagram!
Nous sommes maintenant sur Instagram!

Follow us at @CVMA.ACMV and stay tuned for posts about current activities and general info on common animal health issues and conditions, from bringing home a new pet, to keeping your goldfish in good health.

Restez à l’écoute pour vous renseigner à propos des activités de l’ACMV (@CVMA.ACMV) et obtenir de l’information générale sur les affections et les situations fréquemment observées en santé animale, notamment l’adoption d’un nouvel animal de compagnie et comment garder votre poisson rouge en bonne santé.
2018 CVMA Convention
July 5 to 8, 2018
Ignite Your Passion!

With registration open as of February 21, if you haven’t already familiarized yourself with the CVMA Convention’s Preliminary Program included with this month’s CVJ, now is the time as some events are limited in seating and require pre-registration.

The CVMA Summit entitled “Changing Dynamics of Private Practice” will take place on the morning of Thursday, July 5 and will be chaired by Dr. Terri Chotowetz, CVMA president-elect. The National Issues Forum will be held in the afternoon for the 3rd consecutive year and will focus on the “Use of Cannabinoids in Veterinary Medicine.”

This year, hands-on labs and specialty workshops will be held on Thursday, July 5.

“Too Much Extraction Techniques and Nerve Blocks in Dogs and Cats” will be offered by Dr. Kevin Stepaniuk and Dr. Sue McTaggart and sponsored by Serona Animal Health. The morning session is a basic level with the afternoon session being rated moderate to advanced.

Dr. Ameet Singh will be offering a surgical lab “Common Surgical Procedures of the Canine Abdomen,” which will allow practitioners to gain valuable experience performing prophylactic gastropexy, splenectomy, small intestinal resection and anastomosis, and organ biopsy.

Ms. Tara Evans will host a workshop on Sunday, July 8 entitled “Dental Instrument Sharpening” providing participants with an opportunity to practice their sharpening techniques using stones. Additionally, there will be a demonstration of a RX Honing Machine as an alternative sharpening method.

Lastly, experience the splendor of Vancouver aboard the stunning Magic Spirit, where you will sail out of False Creek into Coal Harbour during sunset. This is an evening you won’t want to miss — buffet dinner, entertainment and an astonishing view that will leave you breathless.

With all these events being limited in availability and requiring pre-registration, you will want to peruse the Preliminary Program to review the available continuing education (CE) sessions and register early to ensure you don’t miss out. CE sessions are offered from Friday, July 6 through Sunday, July 8 and include the following tracks: companion animal, ruminant, equine, animal welfare, workplace wellness, and for the first time, an introduction to honey bees.

Stay up-to-date with the latest event details by downloading the Convention app or view online at (www.eventmobi.com/cvma18). Visit the CVMA website (www.canadianveterinarians.net) to register before the early bird deadline of May 31, 2018 to receive the discounted registration fees. See you in Vancouver!

(by Sarah Cunningham, Manager, Conventions, CVMA)

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

L’inscription ouvrira le 21 février et si vous n’avez pas encore consulté le programme préliminaire du congrès de l’ACMV qui est inclus dans le présent numéro de La RVC, il est maintenant temps de le faire car certaines activités offriront un nombre de places limité et exigent une inscription à l’avance.

Le Sommet de l’ACMV s’intitulera «La dynamique changeante de la pratique privée», se déroulera le matin du jeudi 5 juillet et sera présidé par la Dʳ Terri Chotowetz, présidente de l’ACMV. Le Forum sur les enjeux nationaux se tiendra en après-midi pour la troisième année consécutive et portera sur «L’utilisation des cannabinoïdes en médecine vétérinaire».

Cette année, des laboratoires de travaux pratiques et des ateliers spécialisés se tiendront le jeudi 5 juillet.

«Techniques d’extraction des dents et blocs nerveux chez les chiens et les chats» sera présenté par le D’ Kevin Stepaniuk et la Dʳ Sue McTaggart et commandité par Serona Animal Health. La séance du matin s’adressera aux débutants tandis que la séance d’après-midi sera de niveau modéré à avancé.

Le D’ Ameet Singh présentera un laboratoire en chirurgie intitulé «Interventions chirurgicales communes de l’abdomen canin» et permettra aux praticiens d’acquérir de l’expérience utile pour la réalisation d’une gastropexie prophylactique, d’une splénectomie, d’une résection du petit intestin et de l’anastomose ainsi que d’une biopsie des organes.

Mme Tara Evans tiendra un atelier le dimanche 8 juillet qui s’intitulera «Aiguisage des instruments dentaires» et fournira aux participants l’occasion d’exercer leurs techniques d’aiguisage à l’aide de pierres. De plus, il y aura une démonstration d’une machine d’afileage RX comme autre méthode d’aiguisage.

Enfin, vous pourrez faire l’expérience de la splendeur de Vancouver à bord du magnifique Magic Spirit, lorsque vous naviguerez de False Creek jusqu’à Coal Harbour au coucher du soleil. Ce sera une soirée à ne pas manquer — dîner buffet, spectacles et un panorama époustouflant qui vous laisseront bouche bée.

Vu que toutes ces activités comportent un nombre de places limité et exigent une inscription à l’avance, vous voudrez parcourir le programme préliminaire afin de consulter les ateliers de formation continue offerts et vous inscrire tôt afin de vous assurer de ne rien manquer. Les ateliers de formation continue sont offerts du vendredi 6 juillet jusqu’au dimanche 8 juillet et comprennent les volets suivants : animaux de compagnie, ruminants, équidés, bien-être animal, bien-être au travail et, pour la première fois, une introduction aux abeilles domestiques.


(par Sarah Cunningham, gestionnaire, Congrès, ACMV)
Veterinarians Without Borders Youth Volunteer Program in Kenya 2017

Every summer, Veterinarians Without Borders (VWB) sends a group of youth volunteers on a 3-month summer placement to Kenya, one of 6 countries involved in their Young Volunteer’s Cooperation Program. In 2017, the youth team included 3 students, Alina Gardiner, Kelly Hammond, and Megan White, plus Dr. Shauna Richards (the primary in-country supervisor), Dr. John VanLeeuwen (providing overall program coordination, and initial in-country orientation/supervision), and local support people. The team worked with smallholder dairy farmers in the Mukurwe-ini area in central Kenya. Along with another charity — Farmers Helping Farmers — and the Atlantic Veterinary College at the University of Prince Edward Island, VWB has worked in cooperation with the Mukurwe-ini Wakulima Dairy Ltd. (MWDL). This Dairy Group provides a vital marketing system and source of income for residents of the area selling their milk.

The focus of this year’s Kenyan Youth Volunteer Project was calf care. Drs. Richards and VanLeeuwen chose this topic of focus as they observed a need for further education on calves while Dr. Richards completed her PhD research on cow comfort and welfare in Kenya, under Dr. VanLeeuwen’s supervision. Though calves are the future of each producer’s milking herd, in both Kenya and Canada, inputs provided to calves are often minimized; in Kenya because of farmers’ preferences to direct scarce resources into the milking cows that are currently earning income. Therefore, we had to make sure that the messaging was focused on practical low-cost suggestions, for example, growing and feeding high-protein forages (at a low cost) to meet calves’ protein requirements, as an alternative to some of the expensive high-protein commercial feeds.

With the help of our Kenyan team members (who helped us with phoning farmers, finding farms and translating), we worked directly with over 500 farmers and delivered about 40 seminars. A total of 54% of the farmers we worked with were women. We discussed calf management, beginning at birth, including nutrition, housing, disease prevention, and the importance of water. The farmers were always eager to learn about better management practices and ways to improve their production. Although the seminars were focused on calves, we were always asked additional questions on topics such as deworming, heat detection, and mineral feeding for cows.

Another goal in 2017 was to provide more on-farm one-on-one training than in past years. Therefore, after each seminar, we offered to visit the attendees’ farms, and to provide specific advice on how to best improve their housing, feeding, and management practices for both their calves and cows. At some farms, we were able to assist with minor reconstruction of housing to improve cow and calf comfort. By working one-on-one with farmers, we ensured that their individual needs were addressed to set them up to succeed.

Of the 90 farms we visited, we hosted 24 seminars at farms owned by youth, who were the focus of last year’s project, and an additional 14 seminars were held at farms from previous years of Dr. Richards’ PhD research. Most local farmers own

Programme 2017 des jeunes bénévoles au Kenya de Vétérinaires sans frontières

Tous les étés, Vétérinaires sans frontières (VSF) envoie un groupe de jeunes bénévoles pour un stage d'été de trois mois au Kenya, l’un des six pays participant à leur Programme de coopération pour les jeunes bénévoles. En 2017, l’équipe de jeunes comprenait trois étudiantes, Alina Gardiner, Kelly Hammond et Megan White, ainsi que la Dr. Shauna Richards (la principale superviseure au pays), le Dr. John VanLeeuwen (qui assurait la coordination du programme, l’orientation et la supervision initiale au pays) ainsi que des personnes de soutien locales. L’équipe a travaillé avec de petits producteurs laitiers dans la région de Mukurwe-ini au centre du Kenya. De concert avec un autre organisme de bienfaisance — Farmers Helping Farmers — ainsi que l’Atlantic Veterinary College de l’Université de l’Île-du-Prince-Édouard, VSF a travaillé en coopération avec Mukurwe-ini Wakulima Dairy Ltd. (MWDL). Ce groupe laitier fournit un système de commercialisation essentiel et une source de revenu pour les résidents de la région qui vendent leur lait.

Le Projet des jeunes bénévoles au Kenya de cette année portait sur les soins des veaux. Les Drs. Richards et VanLeeuwen ont choisi ce domaine car ils ont observé un besoin d’éducation sur les veaux tandis que la Dr. Richards a réalisé sa recherche de doctorat sur le confort et le bien-être des vaches au Kenya, sous la supervision du Dr. VanLeeuwen. Même si les veaux sont l’avenir du troupeau laitier de chaque producteur, tant au Kenya qu’au Canada, les soins fournis aux veaux sont souvent minimisés parce que, au Kenya, les fermiers préfèrent orienter les rares ressources vers les vaches laitières qui créent des revenus. Par conséquent, nous devions nous assurer que les messages portaient sur des suggestions pratiques à faible coût, notamment la culture et l'alimentation en fourrages riches en protéines (à faible coût) afin de satisfaire aux besoins en protéines des veaux et de remplacer certains des aliments commerciaux à forte teneur en protéines qui sont disponibles.

Avec l’aide des membres de notre équipe au Kenya (qui nous ont aidé à appeler les fermiers, à trouver les fermes et ont servi d’interprètes), nous avons travaillé directement avec plus de 500 fermiers et présenté environ 40 ateliers. Cinquante-quatre pour cent des fermiers avec qui nous avons travaillé étaient des femmes. Nous avons parlé de la gestion des veaux, en commençant dès la naissance, et nous avons examiné les sujets de la nutrition, du logement, de la prévention des maladies tout en soulignant l’importance de l’eau. Les fermiers étaient toujours motivés de se renseigner sur les meilleures pratiques de gestion et les façons d’améliorer leur production. Même si les ateliers portaient sur les veaux, on nous posait toujours des questions additionnelles sur des sujets comme la vermifugation, la détection des chaleurs et l'alimentation en minéraux pour les vaches.

Un autre objectif pour 2017 consistait à offrir plus de formation individuelle à la ferme par rapport aux années précédentes. Par conséquent, après chaque atelier, nous offrions de visiter les fermes des participants et de fournir des conseils spécifiques sur la façon d’améliorer leurs pratiques de logement, d'alimentation et de gestion pour les veaux et les vaches. Dans certaines fermes, nous pouvions porter assistance avec des projets de reconstruction.
1 to 3 milking cows, so the production and conception rates, as well as the individual health and welfare of each cow, contributes significantly to their family’s income.

Due to limited acreage and mountainous landscapes, most of the farms in this region use a zero-grazing system. Cow sheds are often basic in design, consisting of resting and milking stalls, a manger, and a small walkway in between them. Most of Kenya experienced a severe drought in 2017 which, combined with the individual difficulties each farmer faced, made dairy farming a much more challenging endeavor. However, we were continually impressed with the dedication and ingenuity of the farmers we spoke with, and their resilience through this difficult time.

A final goal of 2017 was to address One Health issues, which is a guiding principle of VWB, through training of school age kids. We visited 5 primary schools and taught 360 students about rabies prevention, how to avoid dog bites, staying safe around farm animals, and zoonotic disease prevention. We instructed these students to share this information with their siblings and parents, to create an even larger impact on the surrounding community.

We want to acknowledge the hard work and dedication of our Kenyan team members, without whom this project would not have been possible. Each member of our team has been essential in helping us reach our goals. We are also grateful to the MWDL as well as the local community for welcoming us with open arms. We would like to thank our wonderful supervisors Drs. Richards and VanLeeuwen for their knowledge and guidance throughout our placement, Veterinarians Without Borders Canada for their sponsorship of this project, Farmers Helping Farmers for their continued logistical support, and the Sir James Dunn Animal Welfare Centre and Global Affairs Canada for their generous financial contributions. Last but not least, we want to extend a special thank you to everyone who donated their time, services, money and encouragement for us to participate in this amazing summer experience. None of this work would be possible without you!

(by Alina Gardiner, Kelly Hammond, and Megan White)

Dr. Shauna Richards (red coat, center) teaching a group of female farmers with the help of a translator, Priscilla Muthoni (white blouse).

La Dr Shauna Richards (sarrau rouge, au centre) enseignant à un groupe de fermières avec l’aide d’une interprète, Priscilla Muthoni (sarrau blanc).

From left to right, volunteers Megan White, Kelly Hammond, and Alina Gardiner with the team’s driver, Ephraim Mutahi.

De gauche à droite, les bénévoles Megan White, Kelly Hammond et Alina Gardiner avec le chauffeur de l’équipe, Ephraim Mutahi.
Case report

Suspected congenital urethral diverticulum in a dog

Aylin Atilla

Abstract — A 2-year-old neutered male dog with a history of urinary incontinence, recurrent urinary tract infections, and unilateral cryptorchidism was presented with an acute onset of perineal swelling. Urinary contrast studies revealed a urothelial lined structure in the perineum. Surgical resection of 80% to 90% of this structure, suspected to be a congenital urethral diverticulum, was successful.

Résumé — Diverticule urétral congénital soupçonné chez un chien. Un chien mâle stérilisé âgé de 2 ans ayant une anamnèse d’incontinence urinaire, d’infections des voies urinaires récurrentes et de cryptorchidie unilatérale a été présenté suite à l’apparition aiguë d’enflure périnéale. Des épreuves de contraste urinaire ont révélé une structure urothéliale recouverte dans le périnée. Une résection chirurgicale de 80 % à 90 % de cette structure, soupçonnée d’être un diverticule urétral congénital, a été réalisée avec succès.


Case description

A 2-year-old neutered male red merle Australian cattle dog was presented to the emergency service for evaluation of an acute onset of perineal swelling. The dog had been adopted from a rescue society a few months earlier with a history of urinary problems and abnormalities but the swelling in the perineum was only noted by the owners a few days before presentation. The dog had been turned over to the rescue society at 8 mo of age because of constant dribbling of urine. Blood analysis [complete blood (cell) count (CBC) and biochemistry panel; IDEXX Laboratories Canada, Markham, Ontario] performed at that time showed a normal blood urea nitrogen [BUN; 6.4 mmol/L; reference range (RR): 3 to 10 mmol/L] and creatinine (86 µmol/L; RR: 30 to 140 µmol/L). Urinalysis (catheter specimen) at the time showed a urine specific gravity (USG) of 1.016, pH of 8, and no other abnormalities. The dog was noted to be cryptorchid with a retained right testicle and was neutered. The left testicle was removed through a routine prescrotal approach. The right testicle was found on the right side of the abdomen halfway between the kidney and the inguinal ring and was removed. The dog was then referred for an excretory urogram as ectopic ureters were suspected based on his constant dribbling of urine.

At 1 year of age an excretory urogram was conducted and the dog was diagnosed with right renal aplasia. The left kidney had evidence of mild renal pelvic and ureteral dilation suggestive of pyelonephritis. Two contrast-filled structures were noted in the caudal abdomen, pelvis, and perineal area with the differential diagnoses being an anomalous formation of the bladder or a ureterocele (Figures 1 to 6). Surgical consultation and exploration were recommended at that time but were not pursued by the rescue society.

The dog was adopted from the rescue society months later and was doing well other than his constant dribbling of urine. A few months after adoption he was presented to his veterinarian with an acute swelling on the right side of his perineum. He was referred to the emergency service for a possible perineal hernia with retroflexion of the urinary bladder.

On presentation to the emergency service the dog’s physical examination findings were normal except for the following. There was a large swelling on the right side of the perineum. Upon rectal palpation there was laxity in the pelvic diaphragm and a fluid-filled swelling could easily be palpated on the right. The dog was sedated with butorphanol (Torbugesic; Zoetis, Kirkland, Quebec), 0.2 mg/kg body weight (BW), IV and midazolam (Midazolam; Pfizer, Kirkland, Quebec), 0.2 mg/kg BW, IV, a urinary catheter was placed, and urine was removed. This alleviated the swelling in the perineum so a retroflexed urinary bladder was suspected. The urinary catheter was left in place until surgical consultation occurred. A sample of the urine was sent for urinalysis and culture and susceptibility testing. The USG was 1.021 and there were 21 to 50 white blood cells per high power field (hpf) (RR: 0 to 3), and 21 to 50 red blood cells per hpf (RR: 0 to 3), as well as struvite crystals and > 100 rod-shaped bacteria per hpf. Culture revealed an Escherichia coli that was resistant to amoxicillin/amoxicillin and susceptible to amikacin, clavamox, ceftazolin, cefpodoxime, cephalaxin/cefadroxil, enrofloxacin,
marbofloxacin, nitrofurantoin, tetracycline, and trimethoprim/sulfa. The dog was initially treated with cefazolin (Cefazolin for injection; Sandoz, Boucherville, Quebec), 22 mg/kg BW, IV, q8h, pending culture and susceptibility results. In-house blood analysis revealed an increased BUN at 13.0 mmol/L (RR: 2.5 to 8.9 mmol/L) and an increased creatinine at 131 μmol/L (RR: 27 to 124 μmol/L). Total calcium and potassium were within the normal range. A perineal hernia was suspected so a surgical consultation was recommended. The radiographs and results of the previous contrast study were not available and the clinicians were not informed about the radiographs by the owners or through the records received from the referring veterinarian. The radiographs were later forwarded by the owner to the author after the owner was asked for permission to write up the case as a case study.

The dog was presented to the surgical service for evaluation 2 d later. A CBC, chemistry panel, and urinalysis were repeated and submitted to Antech Laboratories (Gloucester, Ontario) to evaluate the previously noted abnormalities. The BUN, creatinine, potassium, phosphorous, and calcium were within normal limits at this time. A contrast computerized tomography (CT) scan was recommended to the owner to try to determine whether the dog had ectopic ureters since he was consistently dribbling and this did not fit the clinical picture of a perineal hernia. The owner declined all further diagnostics due to financial constraints and asked that we address the urgent situation (presumed retroflexed urinary bladder). Surgical abdominal exploratory to perform a vasopexy and colopexy was offered as well as perineal herniorrhaphy and the owner elected to proceed with these procedures.

The patient was placed under general anesthesia and after endotracheal intubation, anesthesia was maintained with isoflurane in oxygen. The patient was placed in dorsal recumbency and the ventral abdomen (from xyphoid to pubis) was clipped and aseptically prepared. A standard ventral midline and parapreputial approach to the abdomen was made. The abdomen

**Figure 1.** Pre-contrast lateral radiograph showing some of the swelling in the perineal area (white arrow).

**Figure 2.** Ventro-dorsal view 5 min after IV administration of contrast. Note that only the left kidney is visible (white arrow).

**Figure 3.** Ventro-dorsal view 30 min post-contrast. Note the 2 large swellings in the caudal abdomen/perineal area. The cranial one is believed to be the bladder (long arrow) and the caudal one is likely to be the urethral diverticulum (short arrow). Note the intrapelvic bladder – this persists through the entire study.
was explored. The bladder was located in a normal anatomic position in the abdomen and was normal in size with no bruising or discoloration. There was no kidney nor ureter on the right side. The left kidney had a small indentation indicative of an old infarct on the outer cortex. The left ureter appeared to enter the bladder in the correct anatomic location and appeared normal in diameter. A red rubber urinary catheter was passed into the penile urethra but it could not be palpated in the bladder or in the pelvic urethra. Vasopexies were performed on both sides. The cut end of the vas deferens on the right side was significantly thickened so the end was removed and submitted for histopathology. A colopexy was performed to the left body wall and the abdomen was closed routinely. With the red rubber catheter still in place, the patient was then flipped into sternal recumbency. Gauze was placed in the rectum and a purse string suture was placed to close the rectal opening for the procedure. A right-sided paramedian approach was made in the right perineal area over the swelling. The rectum was identified and palpable. Lateral and ventral to the rectum on the right side was a large sac-like structure. No identifiable pelvic musculature was noted. The sac-like structure was opened and the previously placed urinary catheter was visualized within it (Figure 7). The distal urethral and proximal urethral openings were identified. The urinary catheter was threaded into the proximal urethral opening and into the bladder. The proximal and distal urethral openings were 4 to 5 cm apart. The proximal urethral opening was approximately 1 cm caudal to the pelvic brim (Figure 8). The presumed urethral diverticulum was dissected out most of the way (Figure 9). There were sections of the presumed urethral diverticulum that were adherent to adjacent structures medially and ventrally. Approximately 80% to 90% of the diverticulum was resected. This tissue was submitted for histopathology. The remaining tissue was closed over the urinary catheter using 3-0 polydioxanone (PDS; Ethicon, Sommerville, New Jersey, USA) in simple continuous fashion. The site was lavaged and closed routinely.

Histopathology of the thickening of the vas deferens revealed vas deferens and a portion of the tail of the epididymis. Histopathology on the tissue removed from the perineum showed epithelium lined with transitional type epithelium with smooth muscle deep to it, consistent with a urethral diverticulum. Severe lymphoplasmacytic inflammation was also associated with this tissue.
The patient was monitored in the intensive care unit after surgery. A red rubber urinary catheter was maintained in place for 5 d to allow the resection site to heal. The catheter was expected to allow urine to bypass this area and allow the urothelium to heal. An Elizabethan collar was placed and remained on at all times. The dog was given hydromorphone (Hydromorphone hydrochloride for injection; Sandoz), 0.1 mg/kg BW, IV, q4h for pain control overnight and then started on oral medications the next day — Tramadol (Ultram; Jansen Pharmaceuticals, Toronto, Ontario), 4 mg/kg BW, PO, q8h for 12 d and Gabapentin (Neurontin; Pfizer, Saint-Laurent, Quebec), 5.5 mg/kg BW, PO, q12h for 7 d. Non-steroidal anti-inflammatory drugs were not used due to the mild renal azotemia present on initial presentation. The dog was maintained on Cefazolin (Cefazolin for injection; Sandoz), 22 mg/kg BW, IV, q6h overnight and then started on amoxicillin/clavulanic acid (Clavamox; Zoetis), 13.5 mg/kg BW, PO, q8h for 21 d the following day based on the original culture and susceptibility testing. Lactulose (Lactulose; Abbott Laboratories, Victoriaville, Quebec), 5 mL PO, q8h for 5 d was started after 4 d of hospitalization because no bowel movements had been noted.

The urinary catheter was removed 5 d after surgery and the catheter tip was submitted for culture and susceptibility testing. The dog was started on phenylpropanolamine (PPA) (Propalin; Vétoquinol, Lavaltrie, Quebec), 1.35 mg/kg BW, PO, q12h, 2 days after the urinary catheter was removed as he continued to occasionally dribble urine after surgery. The culture and susceptibility identified an Enterococcus faecium resistant to numerous antibiotics. As the dog was clinically doing well at his recheck examination 2 wk after surgery and the Enterococcus was suspected to be a contaminant, this was not treated and a re-check was recommended 4 to 6 wk later. At his re-check, the owners noted that the dog was continuing to dribble a little urine at night so the dose of PPA was increased to 1.35 mg/kg BW, q8h. This was discontinued by the owner a few months later as there seemed to be no change in the extent of dribbling. No veterinary recheck examination was pursued by the owner concerning this decision.

E-mail follow-up with the owners 2 y after surgery revealed that the dog still dribbled urine occasionally but remained greatly improved from before surgery. The dog was able to have a normal urine stream and urinated a large amount (this was never noted pre-surgery) and then dribbled a little after that. The dog has not had any clinical signs (polakiuria, stranguria, hematuria) associated with urinary tract infection since the surgery.

The urinary catheter was placed into the proximal urethral opening leading to the bladder. The previously placed (during the abdominal surgery) urinary catheter was identified coming out of the distal urethral opening (large arrow). The tip was then placed into the proximal opening (small arrow) and it was passed into the bladder within the abdomen and urine was retrieved, confirming its location.
Urethral diverticula have not been reported in the veterinary literature. A urethral diverticulum is a saccular dilation that extends from the urethral lumen (1). It is lined with epithelium and is either a distention of a segment of the urethra or the attachment of a structure to the urethra by a narrow neck (2). Ureteral diverticula (ureteroceles) have been reported in dogs and cats (3–7).

In humans, urethral diverticula are most common in women aged 30 to 50 y of age and there is debate about whether they are congenital or acquired (8,9). Clinical signs include dysuria, dribbling urine and never had a normal urine stream until the repair of strictures (1,10). Congenital urethral diverticula tend to be asymptomatic in human males unless a secondary process such as an infection or a urethral stone occurs (10). In the case described here, the patient exhibited constant dribbling. This could be due to undiagnosed recurrent urinary tract infections or to a difference in the anatomy of urethral diverticuli between species. The congenital diverticuli that are symptomatic tend to be anterior urethral diverticuli which become filled then closed off by a lip of tissue distally which acts as a valve. In this case no lip of tissue was noted at surgery.

In humans, numerous surgical approaches have been described such as transurethral excision or endoscopic incision but 86% of female patients are relieved of their presenting complaints following a transvaginal approach to excise the diverticulum (8). In males, the diverticulum and surrounding urethral tissue are completely excised when the defect is short enough; primary anastomosis of the urethral ends is performed (1). If the defect is too long, then the urethra can be reconstructed using either a urethral flap created from the wall of the urethral diverticulum or substitution urethroplasty using penile skin or a buccal mucosal graft (1). Some patients with concomitant medical issues such as paraplegia and neurogenic bladders are treated by urinary diversion (1). Patients with reconstructive surgeries are managed after surgery with an indwelling urinary catheter and prophylactic oral antibiotics for several weeks (1,10).

The embryologic origin of congenital urethral diverticula in human males is not known but it is suspected to be due to a ruptured Cowper’s duct cyst (12). The bulbourethral glands are known as Cowper’s glands and the ducts leading secretions to the penile urethra can sometimes form a syringocele. If this syringocele ruptures, then the distal portion can act as an obstructing valve leaflet when the diverticulum fills with urine. In the case described here, the anatomic location does not fit with the location of the bulbourethral glands which, in dogs, are located at the base of the penis. The condition in this dog is suspected to be a congenital defect because the dog had been dribbling urine and never had a normal urine stream until the procedure. Also, congenital urethral diverticula are lined by epithelium and full thickness involvement of the urethral wall, while acquired ones are lined by epithelium and granulation tissue (1). In this patient, the urethral diverticulum wall was composed of transitional type epithelium with smooth muscle beneath it.

This report suggests that surgical management of suspected congenital urethral diverticula in canines is feasible and can help to resolve or ameliorate clinical signs. The clinical signs that the patient was showing before surgery are suspected to be due to the diverticulum. The diverticulum likely filled with urine when the dog was voiding its urinary bladder which also caused perineal swelling. The diverticulum would slowly empty with movement and gravity. A voiding contrast urethrogram would have helped to identify the anomaly in this dog, but these are not performed in veterinary medicine due to the difficulty in getting patients to urinate on command.

On the contrast radiographs, the left ureter was never seen to definitively enter the trigone area of the bladder. Although it was seen at surgery to enter the trigone, this does not rule out an intramural ectopic ureter and could have been a contributing

Discussion

Urethral diverticula have not been reported in the veterinary literature. A urethral diverticulum is a saccular dilation that extends from the urethral lumen (1). It is lined with epithelium and is either a distention of a segment of the urethra or the attachment of a structure to the urethra by a narrow neck (2). Ureteral diverticula (ureteroceles) have been reported in dogs and cats (3–7).

In humans, urethral diverticula are most common in women aged 30 to 50 y of age and there is debate about whether they are congenital or acquired (8,9). Clinical signs include dysuria, dribbling after voiding, and dyspareunia (painful sexual intercourse) (8,9). Urinary tract infections are common in patients (8,9). The most helpful imaging study in humans is a voiding cystourethrogram which is a contrast study that is performed under fluoroscopy with the patient standing (8,9). Other imaging modalities that can be employed are ultrasound, cystourethroscopy, video urodynamics, CT, or magnetic resonance imaging (MRI) (8–10).

Urethral diverticula are rare in human males (1,10). Acquired urethral diverticuli are more common in human males than congenital ones (10,11). Risk factors listed for the acquired urethral diverticuli include periurethral abscess, trauma, stones, hypospadias repair, long-term indwelling urinary catheter, strictures or

Figure 9. A photograph of the diverticulum that had been dissected out before resection of the area. The dissection plane between the diverticulum and surrounding perineal tissues was maintained in close proximity to the diverticulum wall. The stay sutures are pulling the anomalous structure to the right. The purse string suture placed around the anus is visible to the left.
factor to this dog’s persistent dribbling. Another contributing factor is that the diverticulum was not resected completely so some dilation of the area may remain, allowing urine to pool during urination then dribble out slowly afterwards.

During the abdominal surgery, the vasopexy and colopexy were performed despite the lack of evidence of a retroflexed bladder because the exact nature of what was going on in the perineal area was not yet known and the bladder was positioned caudally in the abdomen. The goal of vasopexy is to help return the bladder and prostate to a more normal location within the abdomen and the goal of colopexy is to help the colon and rectum become more tubular by stretching them in order to decrease the accumulation of stool within.

The pelvic diaphragm was not reconstructed because no muscles were clearly identified. Since colopexy and vasopexy had been performed there was less concern for a bladder or rectal prolapse. At that time, there was also concern about the possibility of the resection site not healing and that the patient had been under anesthesia for a while. It was considered to be in the patient’s best interest to allow recovery from anesthesia and these procedures, assess function, and reassess in the future if needed. Further procedures were to be considered in the future depending on the patient’s recovery.

Acknowledgment
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References
Case Report  Rapport de cas

Catastrophic gastric rupture in a horse secondary to psyllium pharmacobezoars

Thomas C. Bergstrom, R. Russell Sakai, Jorge E. Nieto

Abstract — A mare was euthanized because of gastric rupture secondary to complete duodenal obstruction by 2 bezoars located in the pylorus and proximal duodenum. Infrared spectroscopy showed that the bezoars were composed of psyllium. The mare had been receiving treatment with a pelleted psyllium product at 4 times the recommended dosage. Veterinarians should be aware that treatment of colic in horses with pelleted psyllium products could be associated with gastric impaction.

Résumé — Rupture gastrique catastrophique secondaire à des pharmacobézoards de psyllium en boulettes chez un cheval. Une jument a été euthanasiée en raison d’une rupture gastrique secondaire à une obstruction duodénale complète par deux bézoards situés dans le pylore et le duodénum proximal. La spectroscopie infrarouge a montré que les bézoards se composaient de psyllium. La jument avait reçu un traitement composé d’un produit de psyllium en boulettes à quatre fois la dose recommandée. Les vétérinaires devraient être au courant que le traitement des coliques chez les chevaux avec des produits de psyllium en boulettes pourrait être associé à une impaction gastrique.

Case description

A 15-year-old, 401 kg Arabian mare with a body condition score of 5/9 was presented with an approximately 5-hour history of abdominal pain. She had no history of major health issues except for 1 colic episode at 8 y of age that responded to medical management. The patient was part of a herd that was accommodated in a sandy paddock and had a history of sand colic. The patient and herd mates had been inconsistently treated with psyllium pellets in the past due to exposure to sand in their environment and the presence of sand in fecal sediments. The patient was in the 3rd day of a week-long course of psyllium administered by the owner. The mare was being fed 453 g [1.13 g/kg body weight (BW), PO, q24h; recommended dose 0.31 to 0.46 g/kg body weight, q24h] of psyllium pellets (Sand Clear, Fanram Companies, Phoenix, Arizona, USA) in a mixture with commercial grain. The mare's forage was a grass alfalfa mix and she had free access to water. The mare had been receiving routine health care by the referral veterinarian for more than 10 y. On the day of examination, the mare was found to be rolling, pawing, and demonstrating signs of abdominal pain at the evening feeding after appearing clinically normal in the morning. The patient remained uncomfortable in the field with no obvious abnormalities on physical examination by the referring veterinarian and no new feces were noted during the examination. The lack of abnormalities and failure to respond to analgesics flunixin meglumine (Banamine; Merck Animal Health/Intervet, Madison, New Jersey, USA), 1.1 mg/kg BW, IV, once, and butorphanol tartrate (Torbugesic; Zoetis, Parsippany, New Jersey, USA), 0.025 mg/kg BW, IV, once, prompted referral to the UC-Davis William R. Pritchard Veterinary Medical Teaching Hospital (VMTH).

On presentation, the patient was not exhibiting signs of abdominal pain, had a normal heart rate [40 beats/min (bpm); reference interval (RI): 28 to 44 beats/min], mild tachypnea [24 breaths/min (br/min); RI: 8 to 15 br/min], and normal body temperature (37.5°C; RI: 37.2°C to 38.3°C). The remainder of the physical examination revealed reduced borborygmi in the left quadrants and adequate borborygmi in the right quadrants. No feces were passed during the examination or the 40-minute trailer ride before presentation. Results of a rectal examination were unremarkable at the time of presentation. Additionally, the patient had small amounts of mud and bedding material on the dorsum, indicating recent rolling or recumbency. Due to concerns of enterolithiasis, abdominal radiographs were taken and revealed a moderate amount of sand in the ventral colon, but no evidence of an enterolith. An abdominal ultrasonographic examination revealed no significant findings except a slightly enlarged stomach, filled with gas, which extended to the 14th intercostal space. A complete blood cell count revealed a slight leukopenia.
(4170 cells/µL; RI: 5400 to 14 300 cells/µL) characterized by a neutrophil count of 2990 cells/µL (RI: 2300 to 8600 cells/µL), and lymphopenia of 1010 cells/µL (RI: 1500 to 7700 cells/µL). Blood lactate (1.9 mmol/L), glucose (7.22 mmol/L), electrolytes (potassium 2.9 mmol/L, sodium 136 mmol/L, ionized calcium 1.39 mmol/L, chloride 96 mmol/L), packed cell volume (30%), and total protein (76 g/L) were also measured at the time of admission. A nasogastric (NG) tube was placed and 3 L of net reflux that was not foul smelling and was mixed with approximately 200 to 300 g of well-masticated feed were recovered. The NG tube was left indwelling. Abdominocentesis was not performed due to the risk of enterocentesis, given the presence of sand in the ventral colon.

The mare was hospitalized and administered a 10 L IV bolus of isotonic crystalloids followed by a maintenance rate of 1 to 2 L/h. The patient was quiet when admitted to the intensive care unit with a heart rate of 36 bpm and respiratory rate of 12 br/min. The mare was checked for reflux 2 h after admission and no net reflux was obtained. Approximately 2 h after the administration of enteral fluids, signs of abdominal pain (rolling) were observed and the mare was noted to have full body muscle fasciculations, and a heart rate of 100 bpm. Analgesia/sedation was provided with xylazine hydrochloride (XylaMed; VetOne, Boise Idaho, USA), 0.49 mg/kg BW, IV, and the patient was immediately evaluated for gastric reflux. Repeat abdominal ultrasonography was unremarkable with the exception of a segment of thickened nonmotile small intestine (7 mm wall thickness) along the left flank at the level of the costochondral junction. At the onset of abdominal pain, blood lactate, packed cell volume, and total protein were measured and found to be 14.5 mmol/L, 63%, and 90 g/L, respectively. Abdominocentesis under ultrasound guidance was performed and brown, sour smelling fluid was obtained with suspected feed material. A second ultrasound-guided abdominocentesis was performed in a different location to ensure enterocentesis had not occurred and similar fluid was obtained. Abdominal fluid was evaluated by a blood gas analyzer (ABL 705 blood gas analyzer; Radiometer America, Westlake, Ohio, USA); pH < 6.3 (below range of analyzer), lactate of 16 mmol/L (RI: < 1 mmol/L), glucose of 0.8 mmol/L (RI: 5.3 to 6.9 mmol/L), and a total protein of 17 g/L (reference value: < 20 g/L). Gastric rupture with septic peritonitis was confirmed and euthanasia was elected.

Necropsy was performed the following day during which a severe, acute, focal full thickness rupture of the greater curvature of the stomach was identified. A 7.5 × 6 × 3 cm black-green bolus of impacted material was removed from the pylorus (Figure 1) and a similar 5 × 4 × 4 cm bolus was removed from the duodenum 15 cm aborad to the pylorus. On cut section both objects appeared to be composed of hay, psyllium, and husk-like structures. Further abnormalities included severe, acute septic peritonitis with serosanguinous fluid mixed with ingesta. The remainder of the gastrointestinal tract was examined grossly and other abnormalities (such as increased mural thickness, other rupture, strangulation) were not identified. Microscopic examination of tissue was not undertaken.

Infrared spectroscopy of wet and dried portions of the bezoar was performed and the resulting spectra compared with that of a sample of the same brand of psyllium pellets fed by the owner. Infrared spectroscopy is a method used in analytical chemistry in which an unknown sample is exposed to infrared radiation. The bonds in the sample will absorb the infrared radiation at specific wavelengths unique to that chemical structure. The absorbance of these specific wavelengths is measured and results in an absorbance spectrum. This spectrum can then be compared to known samples and used to identify the chemical composition. This technique has been used in human medicine to identify bezoars composed of psyllium (1). In this case, the infrared spectroscopy absorbance spectrum of wet and dried portions of the bezoars matched a sample of psyllium pellets fed by the owner (Figure 2).

**Discussion**

We report a case of an equine patient suffering a gastric rupture secondary to pyloric and proximal duodenal obstructions by psyllium pharmacobezoars. The hygroscopic properties of the psyllium caused the pellets to swell and congeal together in the stomach and form 2 bezoars. These bezoars moved aborad and caused obstruction of gastric outflow that initiated a gastric impaction and secondary gastric rupture. Equine gastric ruptures can be caused by problems within the stomach (severe gastric ulceration, excessive feed intake, fermentation of
ingesta, or obstructions of the pylorus), or due to physical or functional obstruction aboral to the stomach (2,3). A bezoar is an aggregate of inedible or undigested material formed in the alimentary tract of mammals (4). The materials that compose bezoars can include plant matter (phytobezoar), hair (trichobezoar), a combination of plant material and hair (trichophytobezoar), or milk proteins (lactobezoar) (4). Reports of bezoars composed of medications, pharmacobezoars, were published in the human literature as early as the 1930s (5). Various medications have been reported to form pharmacobezoars in humans including aluminum hydroxide, sucralfate, enteral feeding formulas, enteric-coated aspirin, and psyllium (1,5–11).

Pellet and powdered formulations of psyllium are commercially available and are used in horses to treat sand impactions (12). In 2007 the Food and Drug Administration (FDA) ruled that granular formulations of psyllium were no longer recognized as safe and effective for human use due to their propensity to cause esophageal obstruction and bezoars (13). This ruling documented 98 choking-related and esophageal obstruction events due to a psyllium product and 78 of these events were related to psyllium in granular formulation (13). These instances of esophageal obstruction occurred when ingested psyllium granules swelled after contact with water and became lodged in a hollow viscus (9,13,14). In the veterinary literature there are no reported instances of alimentary tract obstruction associated with either formulation of psyllium. Additionally, there is disagreement on the efficacy of psyllium in horses as 1 study demonstrated a lack of efficacy (15) and others demonstrated that psyllium is useful in resolving sand impactions (16–18). Most studies administer psyllium in the powdered formulation at a dose of 1 g/kg BW without reported incidences of morbidity or mortality (17,18). In the present case, a dose of 1.13 g/kg BW, PO, q24h of the psyllium pellets formulation resulted in an obstructing pharmacobezoar that initiated a gastric outflow obstruction followed by gastrorrhesis. This pelleted dosage (by weight) is approximately 4 times the manufacturer’s recommended dosage (0.31 g/kg BW to 0.46 g/kg BW, PO, q24h), indicating that off-label use of psyllium pellets should be discouraged. The concentration of psyllium husk in the commercial psyllium pellets formulation is 72%.

Vague clinical signs on presentation made diagnosing this mare’s gastric impaction particularly difficult. Due to the small amount of reflux, low heart rate, and comfort of the mare at presentation we did not assume she was in imminent danger of stomach rupture. Since abdominocentesis was not performed at admission, it is unknown if changes in the peritoneal fluid were present indicating ongoing gastric wall damage. Other initial clinical findings suggestive of a gastric impaction and gastrorrhesis were the mild leukopenia and slightly enlarged stomach on ultrasonography. A retrospective study found that 33% of horses diagnosed with gastric impactions had leukopenia which, in conjunction with the other findings in this case, was suggestive of gastric impaction (19). However, the clinical findings in this mare were nonspecific and the initial blood analysis was unremarkable. Without the complete history of treatment with psyllium pellets at the time of clinical examination, an obstructing psyllium pharmacobezoar was not considered. Given the nonspecific nature of clinical findings associated with gastric impactions, gathering a complete history of any treatment with psyllium pellets is of the utmost importance in diagnosing an obstructing psyllium pharmacobezoar (19,20).

Despite suspecting a gastrointestinal rupture based on clinical examination, other than a focal region of thickened small intestine, ultrasonography abnormalities were limited. The thickened small intestine was likely due to vascular congestion and edema secondary to intraluminal obstruction. Additionally, serosal exposure to gastric contents likely contributed to the increased bowel wall thickness. The lack of additional abnormalities...
could be explained by the acute nature of the rupture and lack of time for more diffuse abnormalities to develop. Infiltrative small intestinal disease has been reported to predispose to gastric impaction and rupture (19); however, histology was not performed and the exact cause for the bowel thickening cannot be confirmed.

Gastroscopy may have been helpful in diagnosing the gastric impaction. A gastroscopy/duodenoscopy, after complete gastric lavage, could have identified the bezoars at the pyloric antrum or proximal duodenum. Gastroscopy in human patients has been used to identify psyllium pharmacobezoars (1). Surgical exploration may have been recommended had an abdonimocentesis been performed at presentation, which indicated the presence of bowel damage or ischemia. The gastric impaction would have been apparent at surgery but whether a proximal duodenal obstruction would have been identified or treatable is unknown. In general, gastric impactions are treated medically when possible at our institution.

In horses, persimmon phytobezoars are known to cause gastric impactions and ruptures in a similar mechanism to the psyllium pharmacobezoar described in this case (21–23). Persimmons have a high concentration of tannin monomers that polymerize and form a phytobezoar in the presence of hydrochloric acid in the stomach (24). A retrospective study found that horses suffering from gastric or enteric persimmon phytobezoars present with variable clinical signs including chronic weight loss, anorexia, diarrhea, and colic (21). In that study, 4 of 11 treated patients required surgery to relieve obstructions; all patients required intensive medical treatment, and survival was greater for gastric (7/8) than enteric phytobezoars (1/5) (21). Two patients with enteric phytobezoars were euthanized due to gastric rupture (21), indicating that alimentary tract obstruction by a bezoar is a medical emergency associated with mortality, especially in cases of enteric obstructions. Similarly, the mare in this report was at increased risk for mortality due to the duodenal bezoar. Additionally, this case illustrates that horses with psyllium pharmacobezoars may initially show only mild clinical signs of discomfort, making diagnosis challenging.

In humans, treatment of psyllium bezoar is mainly endoscopic division and removal with forceps or snare (1). In horses the treatment of obstructing psyllium pharmacobezoars must consist of resolving the obstructing bezoar and addressing the gastric impaction. Enteral fluid therapy is a commonly used treatment for gastric impactions and has been associated with good success, as 90% (18 of 20) of horses treated with enteral fluids survived to discharge in 1 study (19). However, in cases of obstructive psyllium pharmacobezoars enteral fluid therapy must be administered cautiously in the event the gastric outflow is completely occluded. Fasting is another important aspect of treatment as feeding increases stress on the gastric wall. In cases in which extended fasting is required, patients should receive supportive fluids and if necessary, partial or total parenteral nutrition. Dissolution therapy with carbonated cola and serial monitoring with gastroduodenoscopy should be considered, as cases of persimmon phytobezoars have been successfully treated in this manner (23). Other potential medical treatments include nasogastric intubation with mineral oil, cellulase, diocetyl sodium succinate, or intrabezoar injection with water or N-acetylcysteine. Surgical correction has resulted in successful removal of gastric and duodenal persimmon phytobezoars (22). However, surgery to resolve gastric impactions has been shown to have a poor outcome as 1 study found 5 of 6 horses with gastric impactions treated surgically were euthanized (20). If a diagnosis of a bezoar is made in a horse, it may be beneficial to remove as much gastric contents as possible before surgery using an NG tube, to reduce the risk of abdominal contamination during gastrostomy. Surgery should be considered if no improvement is observed after medical treatment.

No case of equine gastric rupture secondary to a psyllium pharmacobezoar has been reported. A cursory search of the UC-Davis VMTH records revealed 2 additional cases, which potentially suffered gastric ruptures secondary to pyloric obstructing psyllium bezoars. The first case occurred in the year 2000 after a 25-year-old Appaloosa gelding collapsed with tachycardia and signs of endotoxemia. Necropsy revealed a severe acute gastric rupture with 2 bezoars identified 10 cm aboral to the pylorus that resembled concealed psyllium and feed. However, no further testing was conducted to identify the composition of the bezoars and no history of psyllium use was provided. A second case occurred in 2013 when a miniature horse was suspected to have a gastric rupture and was euthanized. The owner believed the animal had free access to psyllium pellets. On necropsy, a rupture along the greater curvature was described in addition to 1 large bezoar composed of granular, rubbery material admixed with grain at the pylorus weighting 1.3 kg. No attempt to identify the composition of this bezoar was made. Our confirmed case and these suspected cases warrant further investigation into the potential for psyllium pharmacobezoars to result in secondary gastric ruptures. It is possible that horses resolve these obstructions with medical therapy and this phenomenon has so far gone unrecognized.

Underlying alimentary tract disease has been identified in horses affected by gastric impaction. Postmortem examinations on horses euthanized for gastric impaction found that 6 of 7 horses had thickening of muscular layers in the stomach wall (20). Lymphoplasmacytic inflammatory bowel disease has also been identified in horses suffering from recurrent gastric impacions (19). These pathologies could indicate chronic abnormal gastric motility and a predisposition to gastric impaction. No muscular hypertrophy or other gross pathology was identified in the present case but histological examination was not performed. Regardless, any pathology reducing gastric motility due to mechanical, neural, or hormonal alterations could predispose horses to formation of a psyllium pharmacobezoar. Dental disease also has been identified in as many as 50% of horses with primary gastric impactions (19). A brief dental examination on this horse revealed sharp enamel points in premolars and molars. The mare had received regular preventive medicine including dental floating by the same veterinarian for over 10 y. In addition, no asymmetries in the muscles of mastication were identified and the feed retrieved from nasogastric intubation was appropriately masticated. It is the opinion of the authors that horses with poor dental care are more likely to inadequately masticate psyllium pellets thus predisposing them to the formation
of a psyllium pharmacobezoar. In addition, reduced water intake may also facilitate the formation of bezoar. Finally, the mare in the present case report was diagnosed with a moderate amount of sand in the ventral colon. The clinical significance of this finding to the gastric rupture is unknown but could have predisposed this mare to gastric rupture. Any underlying gastrointestinal conditions that reduce gastric motility could predispose horses to formation of a psyllium pharmacobezoar. Therefore, in horses with diagnosis of such diseases psyllium pellets should be administered with caution.

The present case, morbidity and mortality associated with impactions by equine phytobezoars (21), difficulties in diagnosing equine gastric impactions, and the FDA ruling (13) on granular psyllium underscore that care must be taken when using psyllium pellets. Veterinarians and horse owners should be aware of the potential risks of psyllium pellets, especially when administered at a higher dose than the manufacturer’s recommendation. This case suggests that in horses with recent treatment of psyllium pellets and signs of colic a psyllium pharmacobezoar must be considered. Additionally, off-label use of psyllium pellets should be discouraged as the horse herein was fed 4 times the manufacturer’s recommended dosage of pellets. Further studies are warranted on both pelleted and powdered psyllium to attain a better understanding of the risk factors for the development of pharmacobezoars in horses.

In summary, this is the first reported case of gastrorrhesis secondary to an obstructing psyllium pharmacobezoar. The fatality and the immediate prior treatment with psyllium pellets, at higher than the recommended dose by the manufacturer, demonstrate the need for further investigation to determine the safety of this product in equine medicine.

Acknowledgments

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References

Case-control study of mineral concentrations of hoof horn tissue derived from feedlot cattle with toe tip necrosis syndrome (toe necrosis)

Murray Jelinski, Cheryl Waldner, Gregory Penner

Abstract — This study determined whether mineral concentrations in the hooves of cattle with toe tip necrosis syndrome (cases) differed from those of cattle dying of all other causes (controls). Samples were collected over a 2-year period from 16 different feedlots and analyzed for 8 minerals [cobalt (Co), copper (Cu), iron (Fe), magnesium (Mg), manganese (Mn), molybdenum (Mo), selenium (Se), and zinc (Zn)]. Mineral concentrations in the hoof wall and solar horn of the same hoof were poorly correlated; Se was the most correlated ($r = 0.865; P < 0.001$), while Mg ($r = 0.465; P < 0.001$) and Zn ($r = 0.157; P = 0.053$) were the least correlated. The cases had significantly lower Mg concentrations in both the hoof wall and solar horn tissue compared to the control subjects. For every 10 ppm decrease in Mg, the odds of a diagnosis of toe tip necrosis syndrome (TTNS) increased by 1.13 times for the hoof wall ($P = 0.002$) and 1.21 times for solar horn ($P < 0.001$).

Résumé — Étude cas-témoin des concentrations de minéraux dans les tissus de la corne des sabots provenant de bovins en parc d’engraissement atteints du syndrome de nécrose du bout de l’onglon (nécrose de l’onglon).

Cette étude a déterminé si les concentrations de minéraux dans les sabots des bovins atteints du syndrome de la nécrose du bout de l’onglon (cas) différaient de celles des bovins qui mouraient de toutes les autres causes (témoins). Des échantillons ont été prélevés pendant une période de 2 ans dans 16 parcs d’engraissement différents et analysés pour déceler la présence de 8 minéraux (cobalt [Co], cuivre [Cu], fer [Fe], magnésium [Mg], manganèse [Mn], molybdène [Mo], sélénium [Se] et zinc [Zn]). Il y avait une faible corrélation entre les concentrations des minéraux dans la paroi du sabot et la corne du même sabot. Le Se était le minéral avec la plus grande corrélation ($r = 0.865; P < 0.001$), tandis que le Mg ($r = 0.465; P < 0.001$) et le Zn ($r = 0.157; P = 0.053$) avaient la plus faible corrélation. Les cas présentaient des concentrations de Mg significativement inférieures dans la paroi du sabot et les tissus de la corne comparativement aux sujets témoins. Pour chaque diminution de 10 ppm en Mg, la probabilité d’un diagnostic du syndrome de nécrose du bout de l’onglon augmentait de 1,13 fois pour la paroi du sabot ($P = 0.002$) et de 1,21 fois pour la corne ($P < 0.001$).

Introduction

Lameness is a significant disease of North American feedlot cattle resulting not only in economic loss due to treatment costs and decreased production performance, but the pain associated with the lameness is an animal welfare concern. A retrospective study of Canadian feedlot cattle, spanning the years 2008 to 2013, found that lameness comprised 40% of all treatments (1). Within this study, foot rot (5.44%) accounted for the highest incidence of lameness (1st treatments), followed by joint infections (0.80%), and injuries (0.47%). These findings are similar to those of an American survey of consulting nutritionists, veterinarians, and feedlot managers who identified footrot, injury, and toe abscesses as the 3 most common causes of lameness in feedlot cattle (2).

Although toe abscesses are a common cause of lameness of feedlot cattle, there is a lack of consensus when it comes to terminology. Synonyms for toe abscesses include toe ulcers, toe tip necrosis, P3 necrosis, apicus necrotica, and apical white line disease. The International Committee for Animal Recording (ICAR) uses the technical term “necrosis of distal phalanx,” but also uses a number of other synonyms/explanations: toe necrosis, osteomyelitis of distal phalanx, and degradation of the pedal bone (3,4). While the terminology may be confusing, each refers to a bacterial infection of the tip of the toe and involves the 3rd phalangeal bone (P3). More recently, Paetsch and Jelinski (5) proposed the term toe tip necrosis syndrome (TTNS) because toe tip necrosis describes the primary pathological finding, while syndrome encompasses the sequelae commonly associated with the disease.
The current theory of pathogenesis for the disease posits that the lesion is initiated by excessive wear along the apex of the toe, which compromises the white line juncture. A breach in the white line allows for microbial colonization, leading to a retrograde infection that leads to necrosis of the horn tissue at the tip of the toe and/or abscess formation. The infection may progress to necrosis of the P3 bone and a host of other sequelae such as P2 osteomyelitis, septic arthritis, tenosynovitis, cellulitis, and a bacteremia that affects more distant organs such as the lungs, liver, and kidneys (6,7). Thus, uncomplicated toe necrosis is perhaps best considered as an early manifestation of TTNS.

While toe necrosis has been described in both beef (6,7) and dairy cattle (8,9), the lameness associated with the disease is probably observed and treated sooner and more aggressively in dairy cattle. As a result, dairy producers, veterinarians, and researchers may tend to equate the disease with early stage necrosis of the tip of the toe, with more severe cases involving P3. In feedlot cattle, however, the animals are less confined and because of this, disease surveillance is less intense. Therefore, subtle signs of lameness in feedlot cattle may be overlooked in the early stages. As a result, the untreated infection is more likely to progress to P3 necrosis and its sequelae.

While confusion may exist regarding the most appropriate terminology for TTNS, the clinical presentation and epidemiology are less equivocal. There are numerous well-documented outbreaks of TTNS occurring in both beef (6,7,10) and dairy cattle (8,9). More recently, the epidemiology of TTNS was described in a large-scale study of North American feedlot cattle (11), while a subsequent case-control study identified factors associated with the disease (12). Based on the historical and contemporary reports, TTNS develops within days to weeks of transport to a feedlot, or other cattle handling facility, and invariably involves the hind feet, with a predilection for the mid-metatarsal or metatarsophalangeal joint. The hooves were placed in plastic palpation sleeves and stored under refrigeration (−4°C to −20°C) until shipping by overnight courier to the Western College of Veterinary Medicine (Saskatoon, Saskatchewan). It was not uncommon to receive both sets of hind claws. If both were clinically normal, then 1 foot was designated as the control sample. If the toes on 1 or more feet had lesions consistent with TTNS, then 1 foot was designated as the case sample. Researchers used a band saw to make multiple sagittal sections of the frozen hooves until a definitive diagnosis was confirmed. Claws that did not fulfill the case definition were eliminated from the study. The feet were then frozen until they could be batch processed for mineral analyses.

Individual animal health records accompanied the hoof samples and included data relating to gender, DOF, arrival body weight, actual/estimated body weight at time of death, treatment history, pen identification, lot identification, feedlot identification, and the Canadian Cattle Identification Agency tag number.

Sample preparation and testing
Inductively coupled plasma mass spectrometry (“ICP-MS”) (ICP-MS II Series; Thermo-Fisher, Waltham, Massachusetts, USA) was used to determine the concentrations of the following minerals in both the hoof wall and solar horn material: cobalt (Co), Cu, iron (Fe), Mg, Mn, molybdenum (Mo), selenium (Se), and Zn. The internal standards (VWR International, Edmonton, Alberta) were indium (In) and yttrium (Y); 10 ppb were added to each working standard and all samples. Biological plausibility, cost, and convenience were the main reasons for choosing the 8 minerals for testing. Specifically, the testing laboratory offers a number of standard mineral panels and the one chosen represented the broadest coverage of minerals.

Sample preparation began with the thawing and washing of the claws to remove all foreign material. An electric drill, fit with a 9.5-mm drill bit, was used to harvest the horn samples (Figure 1). The aim was to collect ≥ 1.0 g of solar horn and a similar amount of hoof wall horn from each submission; sole and hoof wall samples from both claws of the same hoof.
Statistical analyses

Laboratory results were provided in spreadsheet format (Microsoft Excel v. 12; Microsoft Corporation, Redmond, Washington, USA) and analyzed in a statistical software program (Stata/SE 14.0 for Windows; StataCorp, College Station, Texas, USA). To evaluate the balance of risk factors other than minerals in the dataset, a Student’s t-test was used to compare DOF as well as the initial and final body weights among the cases and controls.

Mineral concentrations for hoof wall and sole were assessed to determine if they followed a normal distribution using Kolmogorov-Smirnov tests, histograms fitted with a normal curve, and Q-Q plots. All possible pairwise correlations between the mineral results for hoof wall and sole were examined separately using Spearman’s correlation coefficient as mineral concentrations did not fit a normal distribution. Spearman’s rank order test was used to determine whether the concentrations of the minerals in the sole were correlated with those in the hoof wall and the Mann-Whitney U-test was used to determine if concentrations in the hoof wall and sole were significantly different from each other. The level of significance for all statistical analyses was \( P < 0.05 \) (two-tailed).

Logistic regression was used to identify the differences in mineral concentrations between cases and controls for the hoof and sole samples. Unconditional or bivariate analysis of all 8 minerals was performed to determine which should be offered to the logistic regression models, with the initial inclusion criterion being \( P < 0.20 \). No 2 minerals were considered for simultaneous inclusion in a final multivariable model if their pairwise correlation was \( > 0.9 \). Final body weight at time of death, DOF, and year of sample collection were forced into the final multivariable models. All continuous variables retained in the final model were checked for linear association with the log odds of being a case by introducing both the covariate and the square of the covariate into the full model. Significant squared terms were considered evidence of violation of the linearity assumption. The feedlot from which the samples originated and the submitting veterinary practice were included in the models as hierarchical random intercepts to account for the potential for unmeasured confounders and resulting clustering of outcomes by source.

Since there were 8 minerals being analyzed, a Bonferroni correction was used to mitigate against a Type I error. Therefore, only variables for which \( P < 0.00625 \) were considered statistically significant.

Factor analysis was used to determine if higher concentrations of specific types of minerals were more likely to cluster together in groups within the hoof wall or sole. Concentrations were \( \log_{10} \) transformed and examined using the Shapiro-Wilk test to determine if the resulting distribution more closely matched a normal distribution before generating principal-component factors. The Bartlett test of sphericity and Kaiser-Mayer-Olking measure of sampling adequacy were assessed before analysis. The number of retained factors was based on the Kaiser-Guttman criterion and only factors with an eigenvalue \( > 1 \) were selected. Scree plots were also examined. Orthogonal rotations, including varimax, equimax, and quartimax were compared to determine the best fit.

Results

Over a 2-year period, 3 veterinary practices provided hoof samples from 183 beef cattle that came from 16 different feedlots. In 7 instances, it was equivocal whether the foot came from a case or control and hence these feet were eliminated from the study, leaving 176 feet for analyses. Most samples \( (n = 126; 71.6\%) \) were collected in year 1 (2012) and the median number of samples/feedlot was 7 (range: 1 to 49). Forty of the paired cases and controls died on the same day and came from the same feedlot, accounting for 45.5% (80/176) of all submissions. In another 47 instances, the cases and controls came from the same feedlot, but died 1 to 7 d apart, representing 53.4% (94/176) of the hoof submissions.

After sectioning of the claws with a band saw to confirm a definitive diagnosis (case versus control), a total of 174 sole
(85 cases and 89 controls) and 156 hoof wall samples (75 cases and 81 controls) were submitted for analyses (Table 1). There were fewer hoof wall samples because in some instances the prerequisite 1.0 g of material could not be obtained. In addition, some of the hoof wall material was used to develop the sample preparation procedure and to check for repeatability of the ICP-MS test results.

There was no difference in the mean number of DOF \((P = 0.064)\) between the cases (32.0 d) and controls (27.6 d). However, the mean final weight of the cattle with TTNS (259.5 kg) was less than that of the control cattle (280.3 kg) \((P = 0.039)\).

Overall, the mineral concentrations in the sole and hoof wall of the same hoof were poorly correlated. Zinc was the least correlated \((P = 0.157; P = 0.053)\), while Se \((P = 0.865; P < 0.001)\) and Mg \((P = 0.465; P < 0.001)\) were the most correlated. The following minerals were found in greater concentrations in the hoof wall than the sole of the same hoof: Mg \((P < 0.001)\), Mn \((P < 0.001)\), Cu \((P < 0.001)\), Zn \((P < 0.001)\), and Co \((P = 0.04)\); there were no differences in Fe \((P = 0.07)\), Se \((P = 0.10)\), and Mo \((P = 0.57)\) concentrations between the hoof wall and sole. Because of the differences in hoof wall and sole concentrations, separate models were developed to determine how the mineral concentrations of each were associated with case and control status.

Unconditional analysis of the hoof wall data identified 5 factors for consideration in the building of the final logistic regression model \((P < 0.20)\) for the hoof wall samples: final body weight \((P = 0.042)\), DOF \((P = 0.068)\), Mg \((P = 0.002)\), Cu \((P = 0.097)\), and Se \((P = 0.18)\). After controlling for final body weight, DOF, and collection year as a study design variable, the hoof wall samples derived from the case animals had lower Mg concentrations \((P = 0.002)\) than the control samples (Table 2). There was also a trend for Cu concentrations to be greater in the cases than the controls \((P = 0.067)\).

Unconditional analyses identified 4 factors for consideration when building the final logistic regression model for the sole samples: final body weight \((P = 0.070)\), DOF \((P = 0.028)\), Mg \((P < 0.001)\), and Se \((P = 0.19)\). After controlling for final body weight, DOF, and collection year as a study design variable, the sole horn tissue from the cases had lower Mg \((P < 0.001)\) but higher Fe \((P = 0.001)\) concentrations than the controls (Table 3).

Factor analysis was used to identify patterns in the mineral concentrations for hoof wall data. Log\(_{10}\) transformation did not improve fit with the normal distribution; therefore, the raw data were used in the analysis. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.602 and Bartlett’s Test of Sphericity was < 0.001. The initial analysis generated eigenvalues and a scree plot, both of which indicated that the 8 minerals could be grouped into 3 factors. Orthogonal quartimax rotation was chosen to optimize the distribution of the variance among the 3 factors and the factor loadings towards +1. Table 4 shows how the 8 minerals loaded onto the 3 factors, which explained 70.2% of the total variation in the hoof wall mineral data. In general, the hoof wall concentrations of Mn, Cu, and Se were more closely related to each other than to the other 5 minerals. The same could be said for Fe and Co in the 2nd factor. Finally, Mg and Zn were associated with each other in the 3rd factor. Molybdenum was not strongly associated with any of the 3 factor groupings for hoof wall mineral concentrations.

### Table 1. Summary of observed selected mineral concentrations (ppm dry weight) for hoof wall and sole samples from toe tip necrosis syndrome cases and control samples.

<table>
<thead>
<tr>
<th>Hoof wall samples</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Co</th>
<th>Cu</th>
<th>Zn</th>
<th>Se</th>
<th>Mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases ((n = 75))</td>
<td>Median</td>
<td>212</td>
<td>0.70</td>
<td>10.8</td>
<td>14.1</td>
<td>5.1</td>
<td>166</td>
<td>1.40</td>
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<tr>
<td>5th percentile</td>
<td>130</td>
<td>0.35</td>
<td>5.6</td>
<td>6.1</td>
<td>3.3</td>
<td>96.0</td>
<td>0.57</td>
<td>34.8</td>
</tr>
<tr>
<td>25th percentile</td>
<td>179</td>
<td>0.59</td>
<td>7.3</td>
<td>9.6</td>
<td>4.6</td>
<td>151</td>
<td>0.93</td>
<td>51.9</td>
</tr>
<tr>
<td>75th percentile</td>
<td>237</td>
<td>1.08</td>
<td>14.4</td>
<td>19.3</td>
<td>6.0</td>
<td>181</td>
<td>2.26</td>
<td>134</td>
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<tr>
<td>95th percentile</td>
<td>309</td>
<td>1.87</td>
<td>37.5</td>
<td>36.0</td>
<td>7.3</td>
<td>214</td>
<td>3.93</td>
<td>300</td>
</tr>
<tr>
<td>Controls ((n = 81))</td>
<td>Median</td>
<td>235</td>
<td>0.73</td>
<td>8.9</td>
<td>12.8</td>
<td>5.4</td>
<td>165</td>
<td>1.25</td>
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<tr>
<td>5th percentile</td>
<td>152</td>
<td>0.43</td>
<td>5.2</td>
<td>6.1</td>
<td>2.3</td>
<td>112</td>
<td>0.47</td>
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<tr>
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<td>217</td>
<td>0.57</td>
<td>7.0</td>
<td>8.9</td>
<td>4.2</td>
<td>145</td>
<td>0.86</td>
<td>56.6</td>
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<tr>
<td>75th percentile</td>
<td>263</td>
<td>0.97</td>
<td>13.0</td>
<td>19.8</td>
<td>6.0</td>
<td>180</td>
<td>1.99</td>
<td>126</td>
</tr>
<tr>
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<td>27.1</td>
<td>36.2</td>
<td>6.8</td>
<td>199</td>
<td>3.50</td>
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<table>
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<tr>
<th>Sole samples</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Co</th>
<th>Cu</th>
<th>Zn</th>
<th>Se</th>
<th>Mo</th>
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<tbody>
<tr>
<td>Cases ((n = 85))</td>
<td>Median</td>
<td>186</td>
<td>0.55</td>
<td>11.2</td>
<td>11.9</td>
<td>2.3</td>
<td>71.7</td>
<td>1.22</td>
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<tr>
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<td>124</td>
<td>0.22</td>
<td>5.0</td>
<td>4.0</td>
<td>1.5</td>
<td>50.6</td>
<td>0.64</td>
<td>44.0</td>
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<tr>
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<td>145</td>
<td>0.36</td>
<td>8.0</td>
<td>7.8</td>
<td>2.0</td>
<td>63.7</td>
<td>0.88</td>
<td>59.8</td>
</tr>
<tr>
<td>75th percentile</td>
<td>216</td>
<td>0.87</td>
<td>18.6</td>
<td>22.6</td>
<td>2.5</td>
<td>78.5</td>
<td>1.87</td>
<td>111</td>
</tr>
<tr>
<td>95th percentile</td>
<td>284</td>
<td>1.61</td>
<td>38.7</td>
<td>46.0</td>
<td>3.0</td>
<td>85.7</td>
<td>3.22</td>
<td>181</td>
</tr>
<tr>
<td>Controls ((n = 89))</td>
<td>Median</td>
<td>210</td>
<td>0.66</td>
<td>9.5</td>
<td>11.3</td>
<td>2.2</td>
<td>69.1</td>
<td>1.11</td>
</tr>
<tr>
<td>5th percentile</td>
<td>142</td>
<td>0.30</td>
<td>5.0</td>
<td>4.7</td>
<td>1.0</td>
<td>51.7</td>
<td>0.50</td>
<td>46.3</td>
</tr>
<tr>
<td>25th percentile</td>
<td>187</td>
<td>0.44</td>
<td>7.2</td>
<td>7.5</td>
<td>1.8</td>
<td>63.5</td>
<td>0.82</td>
<td>64.2</td>
</tr>
<tr>
<td>75th percentile</td>
<td>259</td>
<td>0.90</td>
<td>14.1</td>
<td>17.2</td>
<td>2.5</td>
<td>77.9</td>
<td>1.60</td>
<td>119</td>
</tr>
<tr>
<td>95th percentile</td>
<td>346</td>
<td>2.03</td>
<td>35.0</td>
<td>37.4</td>
<td>3.3</td>
<td>95.4</td>
<td>2.82</td>
<td>178</td>
</tr>
</tbody>
</table>

Mg — magnesium; Mn — manganese; Fe — iron; Co — cobalt; Cu — copper; Zn — zinc; Se — selenium; Mo — molybdenum.
Table 2. Association between mineral concentrations (dry weight) in the hoof wall and the odds that the sample came from a case of toe tip necrosis compared with a control case in the final multivariable model adjusted for potential confounders and accounting for clustering by submitting clinic and the feedlot of origin.

<table>
<thead>
<tr>
<th></th>
<th>Odds ratio</th>
<th>Lower 95% CI</th>
<th>Upper 95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoof wall Mg concentration (per 10 ppm decrease)</td>
<td>1.13</td>
<td>1.05</td>
<td>1.21</td>
<td>0.002a</td>
</tr>
<tr>
<td>Hoof wall Cu concentration (per 1 ppm increase)</td>
<td>1.25</td>
<td>0.984</td>
<td>1.60</td>
<td>0.067</td>
</tr>
<tr>
<td>Final body weight (per kg)</td>
<td>0.998</td>
<td>0.995</td>
<td>1.001</td>
<td>0.22</td>
</tr>
<tr>
<td>Days on feed (per day)</td>
<td>0.977</td>
<td>0.952</td>
<td>1.003</td>
<td>0.09</td>
</tr>
<tr>
<td>Year of collection (2013 versus 2012)</td>
<td>1.11</td>
<td>0.53</td>
<td>2.30</td>
<td>0.79</td>
</tr>
<tr>
<td>Intercept</td>
<td>23.8</td>
<td>1.66</td>
<td>341</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Random intercept: Variance: $1.21 \times 10^{-34}$; Standard error: $3.12 \times 10^{-35}$

$^a P < 0.00625$ considered statistically significant after Bonferroni correction. Mg — magnesium; Cu — copper; 95% CI — 95% confidence interval.

Table 3. Association between mineral concentrations (dry weight) in the hoof sole and the odds that the sample came from a confirmed case of toe tip necrosis compared with a control in the final multivariable model adjusted for potential confounders and accounting for clustering by submitting clinic and the feedlot of origin.

<table>
<thead>
<tr>
<th></th>
<th>Odds ratio</th>
<th>Lower 95% CI</th>
<th>Upper 95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sole Mg concentration (per 10 ppm decrease)</td>
<td>1.21</td>
<td>1.12</td>
<td>1.30</td>
<td>&lt;0.001a</td>
</tr>
<tr>
<td>Sole Fe concentration (per 1 ppm increase)</td>
<td>1.08</td>
<td>1.03</td>
<td>1.14</td>
<td>0.001a</td>
</tr>
<tr>
<td>Final body weight (per kg)</td>
<td>0.998</td>
<td>0.995</td>
<td>1.001</td>
<td>0.21</td>
</tr>
<tr>
<td>Days on feed (per day)</td>
<td>0.974</td>
<td>0.947</td>
<td>1.002</td>
<td>0.07</td>
</tr>
<tr>
<td>Year of collection (2013 versus 2012)</td>
<td>1.78</td>
<td>0.75</td>
<td>4.25</td>
<td>0.19</td>
</tr>
<tr>
<td>Intercept</td>
<td>97.6</td>
<td>8.83</td>
<td>1079</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Random intercept: Variance: $0.002$; Standard error: $5.67 \times 10^{-34}$

$^a P < 0.00625$ considered statistically significant after Bonferroni correction. Mg — magnesium; Fe — iron; 95% CI — 95% confidence interval.

For the sole samples, the 8 minerals were again grouped into 3 factors. For this analysis, the 8 minerals were log_{10} transformed before analysis. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.709 and Bartlett’s Test of sphericity was < 0.001. Table 5 shows how the 8 minerals loaded onto the 3 components after orthogonal quartimax rotation. Cobalt and Fe were most closely related, but were also associated with Mn, Mg, and Mo. Selenium and Zn loaded most strongly onto the 3rd factor, while Cu, and to a much smaller extent Zn, contributed to the 3rd factor. The 3 factors retained in this analysis explained 67.6% of the total variation in the sole mineral data.

**Discussion**

Magnesium concentrations were significantly lower in both the hoof wall and solar horn tissue of the animals with TTNS compared to the control animals. It is unlikely that these findings were a result of a systematic bias relating to how the cattle were recruited into the study. The study was conducted over a 2-year period and involved 16 feedlots spread across a broad geographical region of southern Alberta. In addition, the median number of submissions per feedlot was only 7. One feedlot did account for 49 submissions; however, these submissions were made over a 2-year period and from a feedlot having a one-time capacity of > 25 000 head. Furthermore, although TTNS cases may cluster by lot load, feedlot, and in time (11), there was nothing to suggest that certain pens of cattle were experiencing outbreaks of TTNS. It was unlikely, therefore, that many of the cases or controls were pastured or managed together, which could have biased the results.

A case-control study design was chosen because it was the most efficient method of recruiting cases, while controlling for extraneous factors that may have confounded the results. Specifically, control subjects were to have died on the same day, originated from the same feedlot, and have been of the same class of cattle (calf or yearling) as the cases. Approximately 45% of submissions fulfilled these criteria, whereas another 53.4% of controls died at the same feedlot within 7 d of the paired case. Thus, 98.9% of the cases and controls died at the same feedlot within 7 d of each other. This is important because in most instances the cases and controls would have been subjected to the same or similar processing and handling procedures, flooring and pen conditions, weather conditions, and fed the same ration.

The finding of an association between low Mg concentrations and TTNS does not equate to causation. Perhaps the association...
is spurious; however, this seems unlikely since even after applying a Bonferroni correction, the Mg levels were significantly lower in both the hoof wall and solar horn of the TTNS cases. The only other significant finding was increased Fe concentrations in the solar horn; however, this was not replicated in the hoof wall. Perhaps the increased Fe concentrations were due to soil contamination or from blood associated with solar hemorrhage in the cattle with TTNS. Although Mg is not considered to be directly involved in keratinization or in determining hoof hardness, it is the second most abundant intracellular cation after K (18,19). Furthermore, it is frequently reported to be a co-factor in >300 enzymatic reactions and is critical for a wide variety of physiological functions including, but not limited to, the synthesis of nucleic acids and proteins; cellular replication and energy metabolism; hormone receptor binding and the regulation of transmembrane ion flux (20–21). Magnesium has also been shown to regulate the keratin-based intermediate filament networks of human epithelial cells, which protect the cells by strengthening the cytoskeleton (22,23). Given the ubiquity of Mg involvement in physiological functions, it is plausible that a chronic subclinical deficiency may have directly or indirectly affected horn production, the supporting dermis, and even the immune system.

Another potential explanation for the association between low Mg concentrations and TTNS is that Mg may serve as a surrogate indicator for other mineral imbalances, either excesses or deficiencies. Sugg et al (24) reported that P concentrations in hoof material of bulls in a feedlot performance test were inversely correlated to the hoof horn concentrations of Mg, Ca, Na, Mn, and positively correlated to Cu, while Baggott et al (17) found lame cattle to have lower concentrations of Zn in the hoof horn, but elevated Mg and Cu concentrations. Hidiroglou and Williams (25) reported strong correlations between hoof Ca and Mg concentrations, with both decreasing over the summer grazing period. These reports coupled with the factor analyses conducted in the current study underscore the interdependencies between various pairs and sets of minerals. Hence, it is reasonable to assume that Mg may be related to minerals that were not analyzed in the current study, but are known to be important in the development and maintenance of keratin (i.e., Ca, S) (14–16), and to increase hoof hardness (i.e., Ca, P) (17).

The rationale for sampling the entire hoof wall and solar surfaces versus restricting the sampling to the white line was, in part, based on the knowledge of how keratin is formed. Briefly, the hoof is best thought of as specialized skin, comprised of a dermis and epidermis. The dermis or corium is highly vascularized and envelopes the 3rd phalangeal bone and provides nutritional support to the avascular epidermis. The horn of hoof is epidermal tissue, comprised of 4 different cell layers, each in varying stages of cell differentiation (keratinization). It is well-known that hormonal and nutritional factors affecting the production or quality of epidermal cells in the stratum basale will ultimately be manifested in the quality of the horn tissue (14,15,26–27). Furthermore, the production of keratinized horn is a slow process, with the dorsal hoof wall of calves and yearlings growing at a rate of ∼5 to 6 mm a month (27).

Since the current study was the first to investigate the relationship between mineral concentrations of the horn and TTNS, sampling the entire hoof was considered the most logical option for obtaining a representation of the animal’s nutritional status over the summer grazing season. It could be reasoned that only horn tissue bordering the white line should have been sampled, since this is the location of the inciting lesion. This assumes, however, that the pathogenesis of the disease is fully understood, which is not the case. While the disease may be initiated by physical trauma, leading to a breakdown in the integrity of the white line juncture, there are other factors involved. For example, animals with TTNS are more likely to have an acute bovine viral diarrhea virus (BVDV) infection than control animals (12), a finding that suggests that immunocompromised animals may be more likely to die or be euthanized because of TTNS. Given that Mg is critical in such a broad range of physiological functions and that animals with TTNS appear to have been chronically deficient in Mg during the summer grazing period, it seems plausible that the role of Mg in the development of TTNS is more nuanced than simply being a reduction in horn quality or hardness at the apex of the toe.

Conceivably, TTNS may have lead to a reduction in Mg concentrations versus low Mg leading to the disease. Briefly, cattle have large stores of Mg within the skeletal bone; however, these stores are indirectly controlled by Ca homeostasis and hence
cattle are reliant upon a steady daily dietary intake of Mg (28). Inappetence associated with shipping and lameness could have resulted in subclinical hypomagnesemia. However, most TTNS cases develop immediately prior to, or shortly after, arrival at the feedlot and 50% of the animals die before reaching 27 DOF (11). Not only was the period of morbidity insufficient to have influenced mineralization of the horn tissue, but it bears mention that the control cattle were not healthy animals and hence they too would have been subject to the same factors, such as inappetence, which could have theoretically decreased Mg concentrations in new horn material. It is also worth noting that large commercial feedlot operations in western Canada routinely employ nutritionists to formulate the rations to meet or exceed NRC’s nutritional requirements for feedlot cattle.

The sole and hoof wall mineral concentrations were poorly correlated within the same animal, which seems counter-intuitive because it is assumed that the nutritional status of the animal should be reflected uniformly in the composition of all horn tissue. This, however, was not the case, nor were these findings unique. Baggott et al (17) reported that the mineral composition of the horn tissue of the heel, sole, and hoof wall varied widely. The poor association between mineral concentrations of the sole and hoof wall may explain the inconsistent results of the factor analyses, wherein there was no clear pattern of mineral relationships/interdependencies across the hoof wall and solar horn. These findings underscore the need to consider both the time it takes to produce keratin as well as differences in mineral concentrations within regions of the hoof when it comes to developing a sampling strategy.

The study had a number of limitations, the main one being that Ca, sulfur (S), P, potassium (K), and sodium (Na) were not included in the analysis. However, the 8 minerals that were analyzed formed the broadest cross-section of minerals that the diagnostic laboratory offered as a standard panel. Additional individual elements could have been analyzed separately, but cost and logistics precluded these analyses. The current study did fulfill its objectives in that it found a very strong and consistent relationship between low Mg concentrations in both the hoof wall and sole of animals dying of TTNS. Additional research involving a broader range of minerals appears warranted.

Acknowledgments

We thank the 3 participating veterinary practices for their cooperation in providing samples: Alberta Beef Health Solutions, Feedlot Health Management Services, and Veterinary AgriHealth Services. This project was supported by the Alberta Livestock Meat Agency. We thank our team of summer students and research assistants for all their efforts in sample collection and preparation: Katrina Barth, Mike Smela, Laura Campbell, and Tim Campbell.

References

Evaluation of post-operative pain after active desufflation at completion of laparoscopy in mares undergoing ovariectomy

Ian F. Devick, Britta S. Leise, Sangeeta Rao, Dean A. Hendrickson

Abstract — The cause of transient post-operative pain in a subset of horses undergoing laparoscopy is unclear. The objective of this study was to evaluate if residual pneumoperitoneum is associated with transient post-operative pain in mares undergoing ovariectomy. Thirty-eight mares undergoing routine standing laparoscopic ovariectomy were randomly allocated into 2 groups. At the completion of laparoscopy, either the abdominal cavity was actively desufflated or the cannulas were opened to achieve ambient pressure before incisional closure. Assessments were performed for 18 hours after surgery using a validated visceral/somatic pain scale for horses. Overall, pain was minimal in both groups (median score 2/39) post-surgery. Active desufflation of the pneumoperitoneum at the completion of laparoscopy approached statistical significance ($P = 0.07$) in decreasing pain at 12 hours after laparoscopy. However, effects of active desufflation were not significant throughout the monitored 18-hour post-surgery period. We conclude that the decision to actively desufflate at the completion of laparoscopy should be based on surgeon’s preference.

Introduction

Standing laparoscopic ovariectomy is performed in mares for behavior modification, removal of ovarian tumors, preparation of “jump” mares for breeding operations, prevention of pregnancy, and for elimination of estrus-related abdominal discomfort (1–4). Laparoscopic ovariectomy has several advantages compared with other surgical approaches and includes superior visual observation, tension-free hemostasis, observation of the ovarian pedicle for hemorrhage during the procedure, reduced surgical morbidity due to the minimally invasive nature of the procedure, and shortened hospitalization (3–8). Additionally, when laparoscopy is performed in a standing sedated mare, the complications associated with general anesthesia are eliminated (9).

Peritoneal insufflation during laparoscopic surgery improves visual observation and creates working space (10). Carbon...
dioxide is commonly used for insufflation because it can be used safely with electrosurgery, has a high diffusion coefficient which may reduce the risk of gas embolism, and is inexpensive (11–14). Pneumoperitoneum appears to be well-tolerated in healthy standing horses undergoing laparoscopy with few adverse cardiopulmonary, plasma chemistry variables, and hematology effects (15). However, it has been reported that horses can display signs of mild discomfort during a laparoscopic procedure at insufflation pressure of 15 mmHg or greater (15,16). Peritoneal insufflation and laparoscopic surgery result in a mild inflammatory response within the peritoneal cavity and a significant acute increase in peritoneal fluid total protein and nucleated cell count (3,15). The cause of the inflammatory response and post-operative discomfort has been suggested to be a result of carbonic acid formation from the carbon dioxide in contact with the peritoneal fluid (13,16).

Potential complications associated with laparoscopic surgery can be grouped as complications related to laparoscopy and those related to the specific procedure being conducted (12). In equine laparoscopic surgery, complications have been well-documented and include intestinal, splenic, or vascular puncture, retroperitoneal insufflation, and inadequate procedural hemostasis (17,18). Septic peritonitis, adhesions, ileus, and incisional complications can also occur (3). Subcutaneous emphysema can develop after surgery and is a result of the carbon dioxide escaping from the pneumoperitoneum through the incision and emanating subcutaneously (18). After peritoneal insufflation, the presence of the pneumoperitoneum remains for 24 h (19) or even a few days after surgery in humans (20). When the pneumoperitoneum is actively aspirated at the completion of laparoscopic surgery in humans, there is a decrease in post-operative pain (19). However, there are no reports on active peritoneal desufflation at the completion of equine laparoscopy and its effect on post-operative pain. Allowing carbon dioxide to escape at the completion of laparoscopic surgery has been reported as advantageous in reduction of development of subcutaneous emphysema in the horse (16). It has been suggested that actively desufflating the pneumoperitoneum at the end of the laparoscopic procedure would further reduce the incidence of post-operative subcutaneous emphysema (18). It has been reported that 18% to 20% of horses undergoing standing laparoscopic ovariectomy show signs of abdominal discomfort after surgery (17,21).

The objective of this study was to compare post-operative pain following active desufflation of carbon dioxide or no active desufflation at the completion of laparoscopic ovariectomies in mares.

Materials and methods

Cases and presurgical management

Mares admitted to Colorado State University Veterinary Teaching Hospital for a unilateral or bilateral ovariectomy between March 2015 and September 2016 and hospitalized for at least 18 h after surgery were included in this study. The study was approved by the Colorado State University Institutional Animal Care and Use Committee. Written client consent was obtained before participation in the study and clients received a financial incentive for enrollment in the study. Prior to initiation of the study, an online random list generator was used to create an order of group assignment for each mare to either the active desufflation or non-active desufflation (control) group. The author responsible for post-operative pain score assessment was blinded to the group assignment and the active or non-active desufflation procedure. Pre-operative vital parameters were recorded, and blood was collected for determination of packed cell volume and total protein in all mares. Feed was withheld for 12 h prior to surgery and mares were given access to water until the time of surgery.

Surgical procedure

An IV catheter was placed in the left or right jugular vein and the mare positioned in standing stocks. Presurgical antibiotic (penicillin G potassium; Pfizerpen, Pfizer, New York, New York, USA), 22 000 IU/kg body weight (BW), IV, and a nonsteroidal anti-inflammatory drug (flunixin meglumine; Prevail, VetOne, Boise, Idaho, USA), 1.1 mg/kg BW, IV, were administered approximately 30 min before the start of surgery. Sedation was initially achieved with detomidine hydrochloride (Dormosedan; Zoetis, Kalamazo, Michigan, USA), 0.01 mg/kg BW, IV, and butorphanol tartrate (Torbugesic; Zoetis), 0.01 mg/kg BW, IV. A level plane of sedation was maintained throughout the procedure by a continuous infusion of detomidine hydrochloride (20 mg) and butorphanol tartrate (10 mg) in 1 L 0.9% sodium chloride (Hospira, Lake Forest, Illinois, USA) at a rate adjusted to the desired effect depending on the individual mare's behavior and stimulation at any given time throughout the procedure.

Depending on previous determination (from history and clinical examination of the patient) and whether a unilateral or bilateral ovariectomy was to be performed, either one or both paralumbar fossae were clipped with wide margins, then aseptically prepared, and draped in a routine manner. Mepivacaine hydrochloride (Carbocaine-V; Zoetis), 0.01 to 0.05 mL/kg BW per site was injected subcutaneously and intramuscularly at 3 portal sites in one or both paralumbar fossae for local anesthesia. The middle portal site was at the level of the ventral aspect of the tuber coxae and halfway between the cranial aspect of the tuber coxae and the last rib. The dorsal portal was 4 to 5 cm dorsal and 4 to 5 cm cranial to the middle portal. The ventral portal was 5 to 6 cm ventral to the middle portal. A 1-cm incision was made through skin, subcutaneous tissue, and external abdominal oblique fascia at the middle portal site in the left paralumbar fossa (or right paralumbar fossa in the case of a right-sided unilateral ovariectomy). A laparoscopic cannula and blunt obturator (10 mm diameter, 20 cm long; Surgical Direct, DeLand, Florida, USA) were inserted into the abdomen at an angle perpendicular to the skin. A 30° forward viewing laparoscope (10 mm diameter, 56 cm long; Karl Storz Veterinary Endoscopy, Goleta, California, USA) was inserted into the cannula, confirming proper location in the peritoneal space. The peritoneal space was insufflated (Stryker 40L High-Performance Insufflator; Kalamazo, Michigan, USA) with carbon dioxide at a rate of 12 L/min and maintained at 10 to 12 mmHg throughout the procedure. Incisions were made in a similar fashion for the
remaining 2 instrument portals at the previously determined sites. Two additional cannulas were inserted into the abdominal cavity under direct visual observation and the laparoscope was transferred into the dorsal cannula for the remainder of the procedure. The left ovary in the case of bilateral ovariec- tomies or the ipsilateral ovary for unilateral ovariec- tomies was observed and mepivacaine hydrochloride (0.01 to 0.05 mL/kg BW) was injected into the mesovarium, mesosalpinx, and proper ligament of the ovary using a laparoscopic injection needle (5 mm diameter, 45 cm long, 19 gauge; Surgical Direct). The ovary was observed and grasped with acute claw laparoscopic grasping forceps (10 mm diameter, 45 cm long; Surgical Direct) through the ventral portal. A vessel-scaling device (LigaSure Atlas; Medtronic, Minneapolis, Minnesota, USA) was inserted through the middle portal and the jaws were applied to the cranial aspect of the mesovarium and proper ligament of the ovary. The device was then activated (setting 3 bars or 190 to 275 V) and once the tissue was sealed, it was transected using the integrated blade. This process was repeated across the mesovarium, proper ligament of the ovary, and the mesosalpinx, until the ovary was separated from the ovarian pedicle. For bilateral ovariec- tomies, once the ovary was transected, it was held by grasping forceps and remained in the left abdomen while a similar approach was carried out to the right ovary by approaching through the right paralumbar fossa. After transection of the ovary, the remaining ovarian pedicle(s) was assessed for hemorrhage and the ovaries were removed from their respective side of the abdomen in the case of unilateral ovariec- tomies. In cases of bilateral ovariec- tomy, the right ovary was passed to the left side of the abdomen using the acute claw graspers and sweeping the ovary over the bladder and under the uterus and small colon. The right ovary was then visualized and grasped with acute claw graspers from the left side of the abdomen. The 2 most ventral portal sites on the ipsilateral side for unilateral ovariec- tomies and the left side in cases of bilateral ovariec- tomies were connected by incising through the skin, subcutaneous tissue, and external abdominal oblique fascia. The muscle layers and peritoneum were separated bluntly with digital manipulation and the ovaries were then extracted through the incision with traction and manipulation. For the non-active desufflation group the external abdominal oblique muscle of the extended incision was closed with 0 polyglyconate (Maxon; Covidien, Mansfield, Massachusetts, USA) in a simple continuous pattern (10). The skin was sutured with 0 polypropylene (Surgipro; Covidien) with a simple continuous pattern for the extended incision and a cruciate pattern for the remaining portal incisions (10). For mares in the active desufflation group, the cannulas remained in the dorsal portal on each side and all other incisions were closed in the same fashion as described. The insufflation tubing was connected to suction and each side of the abdominal cavity was desufflated separately under laparoscopic visual observation until full peritoneal cavity collapse was achieved and no free gas was observed within the peritoneal cavity. The scope and cannula were then removed and the remaining portal incision(s) was/ were routinely closed as described (10). The total surgery time and time of active desufflation, if performed, were recorded for each mare.

**Post-operative management**

After surgery the mares were monitored hourly while in the hospital. Complete physical examinations including evaluation of the incision sites for subcutaneous emphysema, swelling, heat, discharge, or pain on palpation were conducted every 6 h. Pain was assessed and scored every 6 h for the first 18 h after surgery using the composite pain scale described by Bussi`eres et al (22).

The pain scale is a multifactorial rating scale with 13 assess- ment categories incorporating behavior, response to observer, and physiologic data. Pain is assessed with the patient in a box stall and each of the 13 categories is scored from 0 to 3 for a total pain scale range between 0 (no pain) and 39 (maximal pain) (22).

Patients received flunixin meglumine (1.1 mg/kg BW, IV) 12 h after surgery and then transitioned to a course of phenyl- butazone (VetriBute; VetOne), 2.2 mg/kg BW, PO, q12h for 4 d. No post-operative antibiotics were administered.

**Statistical analysis**

Before initiation of the study, 30 mares were determined as the minimum number of mares to be included in the study for a power of 0.9. The association between active desufflation at the completion of standing laparoscopic ovariec- tomy and post- laparoscopic pain was evaluated using the Fisher’s exact test separately for each time point (6, 12, and 18 h after surgery). The likelihood of post-laparoscopic pain was evaluated using logistic regression analysis to calculate odds ratios (OR) and 95% confidence limits (CI). Age, weight, and surgical time were evaluated for statistical difference between the 2 groups using a non-parametric Wilcoxon test and data were reported as the medians. A $P$-value of 0.05 was used to determine statistical significance and SAS v9.4 (SAS Institute, Cary, North Carolina, USA) was used for all data analysis.

**Results**

**Cases**

Thirty-nine mares were admitted to Colorado State University Teaching Hospital for a unilateral or bilateral ovariec- tomy between March 2015 and September 2016. One mare was excluded from the study group due to being discharged from the hospital shortly after surgery resulting in the inability for 18 h post-operative monitoring and pain score assessment. The remaining 38 mares fit the inclusion criteria and were included in the study for analysis. Breed was evenly distributed between the groups and was predominantly American Quarter Horse ($n = 19$), American Paint ($n = 5$), and Warmblood ($n = 3$) breeds with the remainder ($n = 11$) belonging to 8 different breed types. The median (range) in ages of the mares in the active and non-active desufflation groups were 11 y (range: 3 to 17 y) and 10 y (range: 3 to 24 y), respectively. The median (range) weights of the mares were 470 kg (range: 327 to 550 kg) and 490 kg (range: 390 to 650 kg), for the active desufflation and non-active desufflation groups, respectively. The median ages and weights were not significantly different between active desufflation and non-active desufflation groups. In 32/38 (84%) mares, a bilateral ovariec- tomy was performed and in the remaining 6/38 (16%) mares, a unilateral ovariec- tomy was performed (3 left-sided and 3 right-sided). Through randomization, 17/38 (45%)
of the mares were allocated to the active desufflation group and 21/38 (55%) to the non-active desufflation group. Of the unilateral ovariectomies performed, 2/6 (33%) were randomly allocated to the active desufflation group and 4/6 (67%) to the non-active desufflation group. Of the bilateral ovariectomies performed, 15/32 (47%) were randomly allocated to the active desufflation group and 4/6 (67%) to the non-active desufflation group. The bilateral ovariectomy group (n = 32) showed a pattern similar to the overall study population. When the likelihood of pain (score of 1 to 39) compared to no pain (score of 0) was evaluated, there were no statistically significant differences between the active desufflation and non-active desufflation groups at any of the post-operative time points (Table 2).

Within the first 18 h after surgery, 7/17 (41%) and 11/21 (52%) mares had developed subcutaneous emphysema around the incisions for the active desufflation and non-active desufflation groups, respectively. There was 1 mare in the active desufflation group that experienced moderate discomfort and the period of 18 h.

Table 1. Distribution of no pain versus pain for the different post-operative time points of all mares.

<table>
<thead>
<tr>
<th>Time after surgery</th>
<th>No pain (score ≤ 39)</th>
<th>Pain Score (score &gt; 39)</th>
<th>Odds ratio (95% Confidence interval)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 h</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active desufflation</td>
<td>4 (24%)</td>
<td>13 (76%)</td>
<td>1.30 (0.30 to 5.46)</td>
<td>0.73</td>
</tr>
<tr>
<td>Non-active desufflation</td>
<td>6 (29%)</td>
<td>15 (71%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 h</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active desufflation</td>
<td>7 (41%)</td>
<td>10 (59%)</td>
<td>0.24 (0.05 to 1.13)</td>
<td>0.07</td>
</tr>
<tr>
<td>Non-active desufflation</td>
<td>3 (14%)</td>
<td>18 (86%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 h</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active desufflation</td>
<td>3 (18%)</td>
<td>14 (82%)</td>
<td>0.49 (0.07 to 3.34)</td>
<td>0.47</td>
</tr>
<tr>
<td>Non-active desufflation</td>
<td>2 (10%)</td>
<td>19 (90%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Distribution of no pain versus pain for bilateral ovariectomies.

<table>
<thead>
<tr>
<th>Time after surgery</th>
<th>No pain (score ≤ 39)</th>
<th>Pain Score (score &gt; 39)</th>
<th>Odds ratio (95% Confidence interval)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 h</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active desufflation</td>
<td>4 (27%)</td>
<td>11 (73%)</td>
<td>0.85 (0.71 to 4.20)</td>
<td>0.84</td>
</tr>
<tr>
<td>Non-active desufflation</td>
<td>4 (24%)</td>
<td>13 (76%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 h</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active desufflation</td>
<td>7 (47%)</td>
<td>8 (53%)</td>
<td>0.24 (0.05 to 1.22)</td>
<td>0.09</td>
</tr>
<tr>
<td>Non-active desufflation</td>
<td>3 (18%)</td>
<td>14 (82%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 h</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active desufflation</td>
<td>3 (20%)</td>
<td>12 (80%)</td>
<td>0.25 (0.02 to 2.71)</td>
<td>0.25</td>
</tr>
<tr>
<td>Non-active desufflation</td>
<td>1 (6%)</td>
<td>16 (94%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Unilateral and bilateral ovariectomies were then analyzed separately. The unilateral ovariectomy group (n = 6) was too small for meaningful statistics. The bilateral ovariectomy group (n = 32) showed a pattern similar to the overall study population. When the likelihood of pain (score of 1 to 39) compared to no pain (score of 0) was evaluated, there were no statistically significant differences between the active desufflation and non-active desufflation groups at any of the post-operative time points (Table 2).

Within the first 18 h after surgery, 7/17 (41%) and 11/21 (52%) mares had developed subcutaneous emphysema around the incisions for the active desufflation and non-active desufflation groups, respectively. There was 1 mare in the active desufflation group that experienced moderate discomfort and displayed signs of colic in the immediate post-operative period. The clinical signs resolved with medical therapy alone and the mare had no other complications after surgery. No other post-operative complications were observed within the defined study period of 18 h.

**Discussion**

Post-laparoscopic pain originates from 3 broad sources: the skin incisions and trocar sites in the abdominal wall, the pneumoperitoneum that is created, and the procedure itself (23,24). The stretching of the peritoneum that is caused by insufflation is thought to be one of the components of post-laparoscopic pain and may be exacerbated through secondary factors, such as peritoneal irritation and visceral hypoxia (23). Peritoneal irritation...
may develop from carbonic acid formation as a result of the carbon dioxide in contact with the peritoneum which could result in post-operative discomfort (23,25). Visceral hypoxia can result from compression of the intra-abdominal pressure on the abdominal microvasculature (23). In human studies, the pneumoperitoneum can remain for 24 h (19) or even a few days after laparoscopy (20). There is an association between the volume of remaining post-laparoscopic pneumoperitoneum and the level of post-operative pain (26). Techniques previously used in humans to reduce the volume of the pneumoperitoneum include manual decompression of the abdominal wall to expel carbon dioxide through the trocar (25) or active aspiration at the completion of laparoscopic surgery to decrease post-operative pain (19).

More recently, low pressure pneumoperitoneum and intra-peritoneal washout with saline at the end of the laparoscopic procedure have shown a reduction in post-operative pain and a superior outcome to low pressure alone in humans (23). In the standing equine patient, a complete saline washout at the end of a laparoscopic procedure could prove challenging to achieve due to the non-dependent nature of a gas and the mid-abdominal portal locations which would presumably result in gas remaining within the abdomen dorsal to the portal locations. If residual pneumoperitoneum is a component of post-laparoscopic pain and methods such as manual compression of the abdominal wall, active aspiration, or a saline washout improve post-operative pain in humans, then one would suspect that laparoscopic-guided active desufflation of the pneumoperitoneum would improve post-laparoscopic pain in horses.

Post-laparoscopic discomfort in horses has been reported (17,27), but is usually transient and resolves within 4 to 6 h after surgery (6,27). In this study the assessment of mare comfort was carried out over the first 18 h after surgery using a 39-point pain scale (22). The pain scale has been further validated for somatic and visceral pain in horses in a study by van Loon et al (28). Analysis of pain scores obtained in this subset of mares did not reveal a significant difference in post-operative pain between horses undergoing active abdominal desufflation or not. Throughout this study post-laparoscopic pain in mares was mild (Table 3). Due to the mild level of post-laparoscopic pain observed, the probability of pain (score of 1 to 39) compared to no pain (score of 0) was modeled (Table 1). The likelihood of pain did not reveal a statistically significant difference between the active desufflation and non-active desufflation groups at any of the post-operative time points. However, for the 12-hour post-operative time point, pain scores approached statistical significance ($P = 0.07$) with lower pain scores for the active desufflation compared to the non-active desulfated mares.

Other factors that may have contributed to post-operative pain that were not evaluated in this study include level and duration of anesthetic desensitization of the ovarian pedicle, length of the body wall incision created to extract the ovaries, and level of manipulation of the incision required to obtain successful ovarian extraction. Other limitations of this study include that multiple surgeons with different levels of laparoscopic experience were involved in the ovariectomies. As well, potentially a different pain scale assessment, such as a visual analogue scale, may have given different results. Although a power calculation was performed before the initiation of the study, the post-laparoscopic pain scores of the 38 mares were lower than anticipated and as a result a larger study population may have been necessary to show a significant difference between the 2 groups.

Lower pain in the active desulfated mares approached statistical significance, however, since a statistically significant difference was not achieved in this study, the cause of discomfort post-standing laparoscopic ovariectomy in a subset of mares still remains a question to be further investigated.

Subcutaneous emphysema surrounding the incision was observed after surgery and although fewer mares had emphysema (7/17; 41%) in the active desufflation group compared with the non-active desufflation group (11/21; 52%) there was no significant difference between groups. Pain was observed during peri-incisional palpation and was incorporated into the pain assessments. It is worth noting that in most cases in which pain was detected on palpation, it was located near the unilateral elongated incision used for ovary extraction. There was also 1 mare in the active desufflation group that experienced moderate discomfort and displayed signs of colic in the immediate post-operative period. The clinical signs resolved with medical therapy alone and the mare had no other complications post-surgery.

Results from this study demonstrate that pain assessed by a validated pain scoring system was very mild after laparoscopic ovariectomy. Active carbon dioxide desufflation of the pneumoperitoneum at the completion of standing laparoscopic ovariec-
tomies in this group of mares approached statistical significance.

<table>
<thead>
<tr>
<th>Time after surgery</th>
<th>Pain score median (/39) All mares ($n = 38$)</th>
<th>Pain score median (/39) Bilateral ovariectomy ($n = 32$)</th>
<th>Pain score range (/39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 h</td>
<td>Active desufflation: 2</td>
<td>Active desufflation: 2</td>
<td>0–8</td>
</tr>
<tr>
<td></td>
<td>Non-active desufflation: 2</td>
<td>Non-active desufflation: 2</td>
<td>0–4</td>
</tr>
<tr>
<td>12 h</td>
<td>Active desufflation: 2</td>
<td>Active desufflation: 1</td>
<td>0–5</td>
</tr>
<tr>
<td></td>
<td>Non-active desufflation: 2</td>
<td>Non-active desufflation: 1</td>
<td>0–6</td>
</tr>
<tr>
<td>18 h Post-surgery</td>
<td>Active desufflation: 3</td>
<td>Active desufflation: 2</td>
<td>0–6</td>
</tr>
<tr>
<td></td>
<td>Non-active desufflation: 2</td>
<td>Non-active desufflation: 3</td>
<td>0–6</td>
</tr>
</tbody>
</table>
surgeon preference and experience. Therefore, the decision to severe pain observed in these patients. It is also possible that cant differences between the active desufflation and non-active desufflation groups at any post-operative time point. The lack of difference between the 2 groups could have resulted from the difficulty in detecting pain or from absence of moderate to severe pain observed in these patients. It is also possible that residual pneumoperitoneum is not a cause for post-operative pain in the horse as it is in humans. Therefore, the decision to actively desufflate or not at the end of laparoscopic surgery in horses to improve comfort should continue to be based on surgeon preference and experience.

Acknowledgment

The authors gratefully acknowledge the Marion and Hadley Stuart Foundation for funding this project.

References

The distribution of animal antimicrobials in British Columbia for over-the-counter and veterinary sales, 2012 to 2014

Brian R. Radke

Abstract — Canadian Animal Health Institute (CAHI) data are used for provincial, national, and international comparisons of Canadian animal antimicrobial use. The objectives of this paper were to: i) use CAHI and British Columbia (BC) antimicrobial distribution data to group BC antimicrobial sales into the following BC retail distribution channels: over-the-counter retail outlets, livestock and poultry feed mills, aquaculture feed mills, livestock and poultry veterinarians, and companion animal veterinarians; and ii) to validate the CAHI BC distribution data and BC’s antimicrobial distribution data from 2012 to 2014. Annual total antimicrobial distribution and distribution by antimicrobial class were presented for each distribution channel. The distribution of medically important antimicrobials for production animals was validated, the distribution of ionophores was not. A lack of data precluded any attempt to validate the distribution of antimicrobials for companion animals. Each distribution channel typically experienced substantial fluctuations in total antimicrobial use and use by antibiotic class at least once over the 3-year period. The validated data are useful for evidence-based analysis of a proposed Canadian policy requiring a veterinary prescription for all medically important antimicrobials.


(Traduit par Isabelle Vallières)
Introduction

Antimicrobial use (AMU) in animals is of considerable interest due to the global concern with antimicrobial resistance in human pathogens. The interest includes use in the various animal species and sales by distribution channel (i.e., sales by veterinarians versus over-the-counter sales). Canadian federal legislation requires a prescription for the sale of some antimicrobials and not others. The latter are known as over-the-counter (OTC) products. The Canadian government has proposed requiring a prescription (1) for all medically important antimicrobials (2) used in animals. However, there is a lack of information on Canadian antimicrobial sales by distribution channel. Filling this information gap could be useful in evidence-based analysis of an expanded veterinary prescription requirement and other AMU policies.

In Canada, the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) is the primary source of animal AMU surveillance data. Antimicrobial use for broilers and grower-finisher hogs (3) is included in CIPARS, as are data from the Canadian Animal Health Institute (CAHI) on quantities of antimicrobials distributed for sale for use in animals. The CAHI data have been used in Canada's international comparisons of AMU. The CAHI is the trade association representing companies that manufacture and distribute pharmaceuticals for administration to animals. As of 2012, CAHI's total annual distributions have been broken down by province, and by use in companion animals versus production animals (4). The World Health Organization (WHO) states that the accuracy of such sales data must be assessed (5). Weese et al (6) caution that the accuracy of voluntarily disclosed antimicrobial sales data provided by pharmaceutical companies, feed mills, and others may be poor. While Grave et al (7) note national and or regional sales data can be used to validate data obtained from other sources.

The government of British Columbia generates antimicrobial distribution data (8) from its licensing of over-the-counter (OTC) retailers and feed mills. The objectives of this paper were to: i) use the CAHI and BC licensing data sources to group BC antimicrobial data into the following 5 retail distribution channels: OTC retail outlets, livestock and poultry feed mills, aquaculture feed mills, livestock and poultry veterinarians, and companion animal veterinarians; and ii) to validate the CAHI BC production animal distribution data and the BC licensing data (BC LD).

Materials and methods

Grouping the BC retail distribution of antimicrobials into 5 distribution channels was accomplished using the CAHI and BC LD as illustrated in Figure 1. In this section, each data source is described, followed by the methods used to group the data. Then the methods to validate the CAHI data and BC LD are presented.

CAHI has estimated its members' annual provincial distribution of antimicrobials for 2012 to 2014, measured in kg of active ingredients per antimicrobial class, for production and companion animals (3,4,9). The CAHI data include information from its member companies that manufacture, wholesale, and distribute antimicrobial products in Canada for use in animals. The CAHI data include sales to feed manufacturers, veterinary clinics, and OTC retail outlets. Estimates on CAHI members’ sales represent over 90% of all sales of licensed animal pharmaceuticals in Canada (3), but an estimate of CAHI’s members’ shares of total licensed animal antimicrobials is not available. Antimicrobial use was assigned to either production animals (inclusive of horses) or companion animals by the CAHI members according to label claim. In situations in which mixed species were indicated on the label, the manufacturer assigned (estimated) the species as either companion animal or production animal based on the veterinary clinic practice profile. The attribution of antimicrobials sold in each province to type of animal (companion animals versus production animals) (Figure 1) was based on multiplying a national average percentage of the antimicrobial sold for companion animals/production animals by the total reported in that province (3).

Briefly, the BC Ministry of Agriculture issues licences under the BC Veterinary Drugs Act and associated regulation for the sale of OTC veterinary drugs by livestock and poultry feed mills, aquaculture feed mills, and OTC retail outlets (Figure 1). Pharmacies and veterinarians can also sell OTC veterinary drugs and are exempt from the BC veterinary drugs legislation licensing requirements. As a condition of licensing, BC licensees annually submit licensing data (BC LD) to the Ministry. The BC LD varies with the distribution channel.

The BC LD from the livestock and poultry feed mills and the OTC retail outlets record the business’ veterinary drug purchases from wholesalers or distributors. The purchase records include the date of purchase, name of supplier, quantity purchased, the generic name, trade name, and name of the manufacturer of the drug. Aquaculture feeds medicated with antimicrobials require a veterinary prescription (10). The BC LD submitted to the Ministry by the aquaculture feed mills is the information on the aquaculture prescriptions, including the date of feed manufacture, production class of fish to be fed, proprietary and generic drug name, and concentration of active ingredient. Antimicrobial products from the BC LD are annually entered into an Excel spreadsheet (Microsoft Corporation, Redmond, Washington) for compilation and analysis (8). The spreadsheet was used to generate the annual retail antimicrobial distribution for BC LD OTC Retail Outlets, BC LD Livestock and Poultry Feed Mills, and BC LD Aquaculture Feed Mills (Figure 1), measured in kg of active ingredient.

The BC LD spreadsheet was analyzed to annually determine the antimicrobials that were not distributed by CAHI members, measured in kg of active ingredient. The CAHI membership was determined by reviewing the CAHI on-line membership list (11) and in consultation with Ms. Jean Szotnicki, CAHI President (personal communication). The non-CAHI products were distributed only by BC LD OTC Retail Outlets (Figure 1). Most non-CAHI distributed OTC products were labelled for production animal use. A few products included label indications for production animals and companion animals, but such products annually accounted for less than 6% of the kg of active ingredients annually distributed by non-CAHI members. As
BC’s licensed OTC retailers are essentially farm supply stores, all non-CAHI distributed products were assigned to production animal use.

The total wholesale distribution of antimicrobials into BC for production animals in a given year was calculated as (Figure 1):

\[
\text{Total BC Production Animal Wholesale Distribution} = \text{CAHI BC Production Animal Distribution} + \text{Non-CAHI BC Distribution} \tag{1}
\]

The BC wholesale distribution of production animal antimicrobials was grouped into the following retail distribution channels: BC LD OTC Retail Outlets, BC LD Livestock and Poultry Feed Mills, BC LD Aquaculture Feed Mills, and BC Livestock and Poultry Veterinarians (Figure 1). The distribution by BC Livestock and Poultry Veterinarians was estimated by using the CAHI BC Production Animal Distribution data and the BC LD. Specifically, the annual distribution of antimicrobials by BC Livestock and Poultry Veterinarians was calculated as:

\[
\text{Distribution by BC Livestock and Poultry Veterinarians} = \text{Total BC Production Animal Wholesale Distribution} - \text{BC LD OTC Retail Outlets} - \text{BC LD Livestock and Poultry Feed Mills} - \text{BC LD Aquaculture Feed Mills} \tag{2}
\]

Review of the Compendium of Veterinary Products (12) did not identify any prescription antimicrobials distributed by non-CAHI members. Therefore, CAHI BC Companion Animal Distribution was deemed to represent BC companion animal veterinarians’ retail distribution of prescription antimicrobials (Figure 1).

Using Equations 1 and 2, BC’s annual wholesale production animal distribution and retail distribution of antimicrobials were calculated for 2012, 2013, and 2014. All antimicrobial classes reported by CAHI, with the exception of chemical coccidiostats which were not included in the BC data compilation, were analyzed using the CAHI identified active ingredients in each class. Nicarbazin was included in the CAHI ionophores antimicrobial class for 2012 and 2013 (4,9). For these years, BC feed mill purchases of nicarbazin, which is typically considered a chemical coccidiostat, was calculated using the feed mill purchase records.

Two approaches were used to validate the CAHI production animal distribution data and the BC LD (data from the BC OTC retail outlets, livestock and poultry feed mills, and aquaculture feed mills) and relied on the distribution by BC Livestock and Poultry Veterinarians being the difference in Equation 2. First, the data sources were validated if sales of each antimicrobial class by BC Livestock and Poultry Veterinarians was non-negative. A negative sale technically indicates product returns were greater than sales and this suggests an inconsistency between the CAHI and BC data. Second, although ionophores were primarily administered in feed, an oral bolus product was available for cattle. As British Columbia’s OTC retailers did not report sales of the bolus product, then sales were likely occurring through veterinarians. As a result, distribution of ionophores by BC Livestock and Poultry Veterinarians was expected to be greater than zero, and a non-positive value would invalidate the

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**Figure 1.** The British Columbia licensing data (BC LD) and the Canadian Animal Health Institute (CAHI) data sources, and their relationships, used to group BC’s antimicrobial distribution into the following 5 retail distribution channels: BC LD over-the-counter (OTC) Retail Outlets, BC LD Livestock and Poultry Feed Mills, BC LD Aquaculture Feed Mills, BC Livestock and Poultry Veterinarians, and CAHI BC Companion Animal Distribution.
Table 1. 2012 wholesale distribution of animal antimicrobials in BC parsed into retail distribution channels (kg).

<table>
<thead>
<tr>
<th>Antimicrobial class</th>
<th>Active ingredients</th>
<th>Retail distribution</th>
<th>Wholesale distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aminoglycosides</td>
<td>Amikacin, apramycin, dihydrostreptomycin, gentamicin, neomycin, spectinomycin, streptomycin</td>
<td>-</td>
<td>9719</td>
</tr>
<tr>
<td>Lincosamides</td>
<td>Clindamycin, lincomycin</td>
<td>81</td>
<td>251</td>
</tr>
<tr>
<td>Macrolides</td>
<td>Erythromycin, tilmicosin</td>
<td>4</td>
<td>251</td>
</tr>
<tr>
<td>Other antimicrobials</td>
<td>Bacitracin, bambermycin, florfenicol, nitrofurantoin, tiamulin, virginiamycin</td>
<td>702</td>
<td>32579</td>
</tr>
<tr>
<td>Tetracyclines</td>
<td>Chlorotetracycline, oxytetracycline, tetracycline</td>
<td>14</td>
<td>1580</td>
</tr>
<tr>
<td>Sulfonamides</td>
<td>Sulfadimethoxine, sulfadoxine, sulfaguanidine, sulfamerazine, sulfamethazine, sulfanilamide, sulfadiazine, sulfaquinoxaline, sulfathiazole, trimethoprim</td>
<td>5939</td>
<td>800</td>
</tr>
</tbody>
</table>

*Underlines denote sold in BC LD OTC Retail Outlets or BC LD Livestock and Poultry Feed Mills.

†Distribution by BC Livestock and Poultry Veterinarians = CAHI BC Production Animal

CAHI BC Non-CAHI BC Distribution — BC LD OTC Retail Outlets — BC LD Livestock and Poultry Feed Mills.

††Includes succinylsulfathiazole.

‡‡Includes minocycline.
Table 2. 2013 wholesale distribution of animal antimicrobials in BC parsed into retail distribution channels (kg).

<table>
<thead>
<tr>
<th>Antimicrobial class</th>
<th>Active ingredients</th>
<th>CAHI BC Production Animal</th>
<th>Non-CAHI BC Distribution</th>
<th>BC LD OTC Feed Mills</th>
<th>BC LD Livestock and Poultry (OTC)</th>
<th>BC LD Aquaculture (Rs)</th>
<th>BC Livestock and Poultry</th>
<th>CAHI BC Companion Animal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aminoglycosides</td>
<td>Amikacin, apramycin, dihydrostreptomycin, gentamicin, neomycin, spectinomycin, streptomycin</td>
<td>628</td>
<td>7</td>
<td>382</td>
<td>11</td>
<td>242</td>
<td></td>
<td></td>
</tr>
<tr>
<td>β-Lactams and penicillin</td>
<td>Amoxicillin, ampicillin, cloxacillin, penicillin G, sulbactam</td>
<td>10 539</td>
<td></td>
<td>717</td>
<td>2941</td>
<td>6881</td>
<td>129</td>
<td></td>
</tr>
<tr>
<td>Cephalosporins</td>
<td>Cefaclor, cefadroxil, cefovecin, ceftriaxone, cephalotin</td>
<td>168</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluoroquinolones</td>
<td>Enrofloxacin, danofloxacin, difloxacin, marbofloxacin, orbifloxacin</td>
<td>34</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ionophores</td>
<td>Lasalocid, maduramicin, monensin, narasin, narathrin, salinomycin</td>
<td>17 890</td>
<td></td>
<td>32 832</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lincosamides</td>
<td>Clindamycin, lincomycin, pirlimycin</td>
<td>89</td>
<td></td>
<td>35</td>
<td></td>
<td>54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macrolides</td>
<td>Erythromycin, gamithromycin, tildipirosin, tilmicosin, tulathromycin, tylosin, tylospirin</td>
<td>928</td>
<td></td>
<td>378</td>
<td></td>
<td>550</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other antimicrobials</td>
<td>Bacitracin, bambermycin, chloramphenicol, clavulanic acid, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, ormethoprim, polymyxin, tiamulin, virginiamycin</td>
<td>11 259</td>
<td></td>
<td>10 647e</td>
<td>349e</td>
<td>263</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Tetracyclines</td>
<td>Chlortetracycline, oxytetracycline, tetracycline</td>
<td>12 474</td>
<td>13</td>
<td>397</td>
<td>4250</td>
<td>4625</td>
<td>3215</td>
<td></td>
</tr>
<tr>
<td>Trimethoprim and sulfonamides</td>
<td>Sulfabenzamide, sulfacetamide, sulfadiazine, sulfadimethoxine, sulfadoxine, sulfaguanidine, sulfamerazine, sulfamethazine, sulfanilamide, sulfasquinoxaline, sulfathiazole, trimethoprim</td>
<td>2341</td>
<td>129f</td>
<td>132f</td>
<td>1007</td>
<td>125</td>
<td>1206</td>
<td>54</td>
</tr>
<tr>
<td>Total</td>
<td>56 350</td>
<td>149</td>
<td>1628</td>
<td>52 101</td>
<td>5099</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a The antimicrobial classes and the active ingredients in each class are those reported by CIPARS (9).
b Underlines denote sold in BC LD OTC Retail Outlets or BC LD Livestock and Poultry Feed Mills.
d Consists of: bacitracin 9287 kg; tiamulin 45 kg; virginiamycin 1316 kg.
e Florfenicol.
f Includes succinylsulfathiazole.
Table 3. 2014 wholesale distribution of animal antimicrobials in BC parsed into retail distribution channels (kg).

<table>
<thead>
<tr>
<th>Antimicrobial class</th>
<th>Active ingredients(^a)</th>
<th>(\text{CAHI BC Production Animal}^a)</th>
<th>(\text{Non-CAHI BC Distribution}^b)</th>
<th>(\text{BC LD OTC Retail Outlets}^c)</th>
<th>(\text{BC LD Livestock and Poultry (OTC)}^d)</th>
<th>(\text{BC LD Aquaculture (Rs)}^e)</th>
<th>(\text{BC Livestock and Poultry}^f)</th>
<th>(\text{CAHI BC Companion Animal}^g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aminoglycosides</td>
<td>Amikacin, apramycin, dihydrostreptomycin, gentamicin, neomycin, spectinomycin, streptomycin</td>
<td>614</td>
<td>4</td>
<td>502</td>
<td>7</td>
<td>109</td>
<td></td>
<td></td>
</tr>
<tr>
<td>β-Lactams and penicillin</td>
<td>Amoxicillin, ampicillin, cloxacillin, penicillin G, sulfactam, clavulanic acid</td>
<td>11 267</td>
<td>1</td>
<td>982</td>
<td>2970</td>
<td>7316</td>
<td>138</td>
<td></td>
</tr>
<tr>
<td>Cephalosporins</td>
<td>Cefotiofur, cepahaprin, cefovecin, cefaclor, cefadroxil</td>
<td>201</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>201</td>
<td>15</td>
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<tr>
<td>Fluoroquinolones</td>
<td>Enrofloxacin, difloxacin, marbofloxacin, orbifloxacin</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>38</td>
<td>17</td>
</tr>
<tr>
<td>Ionophores</td>
<td>Lasalocid, maduramicin, monensin, salinomycin</td>
<td>11 008</td>
<td></td>
<td>13 688</td>
<td></td>
<td>−2680</td>
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<td></td>
</tr>
<tr>
<td>Lincosamides</td>
<td>Clindamycin, lincomycin, pirlimycin</td>
<td>92</td>
<td></td>
<td></td>
<td></td>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macrolides</td>
<td>Erythromycin, gamithromycin, tilmicosin, tilmicosin, tilmicosin</td>
<td>582</td>
<td>1</td>
<td>267</td>
<td></td>
<td>314</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other antimicrobials</td>
<td>Avilamycin, bacitracin, bambermycin, chloramphenicol, florfenicol, nitrofurantoin, nitrofurazone, novobiocin, polymyxin, tiamulin, virginiamycin</td>
<td>11 940</td>
<td></td>
<td></td>
<td>10 536(^f)</td>
<td>1211(^e)</td>
<td>193</td>
<td>9</td>
</tr>
<tr>
<td>Tetracyclines</td>
<td>Chlorotetracycline, oxytetracycline, tetracycline</td>
<td>19 384</td>
<td>11</td>
<td>233</td>
<td>4882</td>
<td>4302</td>
<td>9978</td>
<td></td>
</tr>
<tr>
<td>Trimethoprim and sulphonamides</td>
<td>Trimethoprim, trimethoprim, sulbenzamidine, sulfadoxime, sulfadiazine, sulfadimethoxine, sulfadoxine, sulfamethazine, sulfamerazine, sulfamethazine, sulfanilamide, sulfquinocine, sulfathiazole</td>
<td>2387</td>
<td>129(^g)</td>
<td>120(^f)</td>
<td>937</td>
<td>77</td>
<td>1382</td>
<td>55</td>
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<tr>
<td>Total</td>
<td></td>
<td>57 513</td>
<td>145</td>
<td>1838</td>
<td>33 314</td>
<td>5590</td>
<td>16 916</td>
<td>234</td>
</tr>
</tbody>
</table>

\(^a\) The antimicrobial classes and the active ingredients in each class are those reported by CIPARS (3).
\(^b\) Underlines denote sold in BC LD OTC Retail Outlets or BC LD Livestock and Poultry Feed Mills.
\(^d\) Consists of: bacitracin 9350 kg; tiamulin 57 kg; virginiamycin 1129 kg.
\(^e\) Florfenicol.
\(^f\) Includes succinylsulfathiazole.
CAHI Production Animal Distribution data and the BC LD used to calculate the ionophore distribution.

**Results**

The BC animal antimicrobial distribution results for 2012, 2013, and 2014 are presented in Tables 1, 2, and 3, respectively. The antimicrobial classes and the active ingredients in each class are those reported by CIPARS (3,4,9). The active ingredients distributed OTC (i.e., by BC LD OTC Retail Outlets or BC LD Livestock and Poultry Feed Mills) are underlined.

For each year, the calculated sales of each antimicrobial class by BC Livestock and Poultry Veterinarians were positive and validated the CAHI BC Production Animal Distribution data and the BC LD, with the exception of aminoglycoside distribution in 2012 and ionophore distribution in all 3 years. Distribution of aminoglycosides in 2012 was calculated as −29 kg, suggesting an inconsistency between the CAHI BC Production Animal Distribution data and the BC LD. This amount is less than 5% of the CAHI estimate of aminoglycoside use in production animals. The BC LD consistently reported distribution of a larger amount of ionophores than the CAHI data, and resulted in a negative calculated distribution by BC Livestock and Poultry Veterinarians. In the extreme, the 2013 purchases of ionophores by BC LD Livestock and Poultry Feed Mills was 184% of that reported by CAHI.

In each year, the non-CAHI BC Distribution of antimicrobials was small in absolute size (< 150 kg) and relative size (< 0.5% of CAHI distribution for production and companion animals). In each year, the majority of the non-CAHI BC distribution was sulfonamides and accounted for < 6% of the CAHI BC distribution (production animal and companion animal) of the trimethoprim and sulfonamides antimicrobial class.

On average, approximately 3/4 of the annual BC retail antimicrobial distribution was attributed to BC LD Livestock and Poultry Feed Mills from 2012 to 2014. Ionophores, which annually accounted for approximately half of this channel’s distribution, was the antimicrobial class with the greatest use, followed by other antimicrobials (i.e., bacitracin), tetracyclines, and β-lactams and penicillin (i.e., penicillin G).

British Columbia Livestock and Poultry Veterinarians annually distributed approximately 12% of the total antimicrobial mass, and this channel’s share doubled if the negative calculated ionophore distribution was ignored. β-lactams and penicillin, and tetracyclines were the most commonly distributed antimicrobial classes in this channel, and represented over half of the active antimicrobial ingredients distributed by these veterinarians.

British Columbia LD Aquaculture Feed Mills accounted for small < 10% of the antimicrobials annually distributed in BC. Over 3/4 of this use was tetracyclines, followed by florfenicol.

Distribution by BC LD OTC Retail Outlets annually accounted for < 4% of the total distribution and most was penicillin G, followed by aminoglycosides, tetracyclines, and sulfonamides.

Approximately 1% of the BC distribution was by CAHI BC Companion Animal Veterinarians, and primarily consisted of β-lactams and penicillins, cephalosporins and other antimicrobials.

Over the 3-year period substantial fluctuations in total antimicrobial weight for each distribution channel were noted, with the exception of Non-CAHI BC Distribution and BC LD Aquaculture Feed Mills. In addition, over the 3-year period, each channel experienced a substantial fluctuation in the distribution of at least 1 antimicrobial class from one year to the next, with the exception of Non-CAHI BC Distribution. For example, CAHI BC Production Animal Distribution of macrolides more than doubled from 2012 to 2013. Penicillin G distributed by BC LD OTC Retail Outlets decreased approximately 50% from 2012 to 2013, while BC LD Livestock and Poultry Feed Mill distribution increased 71% over the same period. Annual aquaculture distribution of florfenicol decreased 50% then increased over 200% from 2012 to 2014. Distribution of tetracyclines by BC Livestock and Poultry Veterinarians more than tripled from 2013 to 2014. Cephalosporin and other antimicrobial distribution by CAHI BC Companion Animal Veterinarians decreased over 90% from 2012 to 2013.

The distribution channel with the greatest annual distribution of the individual antimicrobial classes varied. British Columbia LD OTC Retail Outlets and BC Livestock and Poultry Veterinarians had the greatest annual distribution of aminoglycosides, and β-lactams and penicillins, respectively. British Columbia Livestock and Poultry Veterinarians annually distributed the most cephalosporins and fluoroquinolones except for 2012 when companion animal veterinarians distributed more of each class. The primary distribution channel for ionophores was the BC LD Livestock and Poultry Feed Mills. British Columbia Livestock and Poultry Veterinarians annually distributed the greatest amount of lincosamides. The greatest distributer of macrolides was BC LD Livestock and Poultry Feed Mills in 2012, and BC Livestock and Poultry Veterinarians in 2013 and 2014. British Columbia LD Livestock and Poultry Feed Mills accounted for the greatest annual distribution of other antimicrobials. British Columbia Livestock and Poultry Veterinarians had the greatest distribution of tetracyclines in 2012 and 2014, while aquaculture mills distributed the most in 2013. The largest distributor of the trimethoprim and sulfonamides antimicrobial class was BC LD Livestock and Poultry Feed Mills in 2012 and BC Livestock and Poultry Veterinarians in 2013 and 2014.

**Discussion**

With the exception of the ionophores, the annual CAHI BC Production Animal Distribution data and the BC LD from 2012 to 2014 were validated. Consistency between the CAHI data and the BC LD was not unexpected as the data should largely represent opposite sides of the same transactions. That is, the CAHI Production Animal Distribution data were its members’ sales to BC retailers of production animal antimicrobials, and the BC LD for OTC retailers and livestock and poultry feed mills are those businesses’ purchases of antimicrobials from wholesalers or distributors. Furthermore, these 2 retail channels represented approximately 80% of the total provincial antimicrobial distribution. In contrast, the BC LD for aquaculture feed mills, which accounts for < 10% of the antimicrobials annually distributed in BC, represents prescription information which is expected to closely approximate retail sales of the antimicrobials.
antimicrobial sales may not equal wholesale sales due to changes in inventory. Validation of the CAHI BC Companion Animal Distribution of antimicrobials was precluded due to a lack of an alternative data source on BC companion animal veterinarians’ purchases or sales of antimicrobials.

There was a small discrepancy in the 2012 distribution of aminoglycosides. Explanations for this inconsistency include data recording errors, or discrepancies in how CAHI versus the BC LD allocate distribution to a given calendar year. Due to these reasons and others, CIPARS cautions that annual data may be less reliable than data spanning multiple years. Although the validation of the annual production animal distribution data by antimicrobial class suggests they are reliable, each retail distribution channel had a large year-to-year fluctuation in at least one class, suggesting caution should be exercised when assessing annual changes in AMU. Specifically, caution should be exercised in extrapolating a single year-to-year change to a trend.

In addition to the fluctuations in distribution by antimicrobial classes, annual fluctuations in total antimicrobial sales for most of the retail distribution channels were noted. These fluctuations raise the issue of whether they were artifacts of data recording errors or true yearly variations in AMU. The fluctuations occurred in all data sources: the CAHI data (CAHI BC Companion Animal Distribution), the BC LD (BC LD OTC Retail Outlets, BC LD Livestock and Poultry Feed Mills, and the BC LD Aquaculture Feed Mills) and the distribution data that were a function of both the CAHI data and the BC LD (BC Livestock and Poultry Veterinarians).

The 2012 total national CAHI Companion Animal Distribution of the antimicrobial classes cephalosporins, other antimicrobials, and β-lactams and penicillin respectively decreased to approximately 3%, 7%, and 52% in 2013, with those lower levels continuing into 2014. Moreover, as exemplified by the CAHI BC Companion Animal Distribution data (Tables 1–3), each province experienced very similar respective patterns in the reported CAHI distribution of these 3 antimicrobial classes. The magnitude of declines and consistency across provinces is suggestive of a data recording error in the CAHI Companion Animal Distribution data. The minor annual changes in active ingredients associated with each antimicrobial class (Tables 1–3) were not expected to explain these patterns in distribution.

The retail distribution channels tend to be aggregates of the actions of many individuals, which made assessing the aggregate results difficult. In contrast, prescribing BC aquaculture veterinarians numbered less than 10. Informal discussions with some of these veterinarians suggested the fluctuations in florfenicol use in the BC LD Aquaculture Feed Mills were not unexpected with potential explanations including: changes in total production or production class of fish; changes in use of a given antimicrobial for a number of reasons including availability or changes in fish health status; and changes in prescribing practices such as altering the dose to ensure achievement of therapeutic levels. Differences in potency among antimicrobials could also have contributed to the fluctuations in kilograms of antimicrobials distributed by antimicrobial class or in total.

Fluctuations in AMU are not without precedent at the animal species level. Significant annual fluctuations in total AMU and use of some antimicrobial classes (measured in kg of active ingredient) have been noted in Canadian broilers (3) using farm level data. Fluctuations in total AMU and use of some antimicrobial classes (measured in kg of active ingredient) have been reported for Danish poultry and companion animals but not pigs or cattle using AMU data from a national prescription database (13,14). For example, a 58% increase in total AMU in Danish poultry (including broilers, layers, and turkeys) occurred in 2015 (15). Fluctuations in use (measured as defined daily doses animal at the farm level) of some antimicrobial classes have occurred in Dutch cattle, broilers, turkey, veal calves, and pigs with the latter also having fluctuations in total use (16). With the exception of the BC LD Aquaculture Feed Mills, the BC distribution channels were aggregations of data over multiple species and this is expected to dampen the AMU fluctuations of individual animal species, but the magnitude of the dampening is unknown.

The BC LD consistently reported significantly greater ionophore distribution than the CAHI data as reflected by the calculated negative ionophore sales by BC Livestock and Poultry Veterinarians (Tables 1 to 3). Furthermore, sustained release ionophore capsules were available for cattle and, although an OTC product, no licensed BC OTC retailers reported selling the product. Therefore, it was expected veterinarians were selling the product in which case the Livestock and Poultry Veterinarians’ sales of ionophores should have been positive. Due to the negative sales, the BC Production Animal Distribution data and BC LD on ionophore distribution could not be validated. The reason for the substantial discrepancy between the 2 AMU reporting systems is unclear. The BC LD and CAHI BC Production Animal Distribution data each exhibited moderate to substantial annual fluctuations in ionophore distribution, yet similar magnitudes of fluctuation in CAHI ionophore distribution were evident in approximately half of the other provinces over the same time period (3,4,9). CIPARS states there could be further interprovincial distribution of antimicrobials (3), but that seems unlikely to account for the 2 data sources’ large discrepancies in ionophore distribution.

Irregularities were noted in the CAHI assignment of antimicrobials to the chemical coccidiostats and ionophores, both of which are classes of coccidiostats. For example, nicarbazin, which is typically classified as a chemical coccidiostat, was included with the ionophores for 2012 and 2013 (4,9). In 2014, nicarbazin was classified as a chemical coccidiostat along with narasin (3), the latter is typically considered an ionophore. Excluding nicarbazin (data not shown) from the 2012 and 2013 BC LD Livestock and Poultry Feed Mill and including narasin (data not shown) in that distribution channel’s 2014 data resulted in BC Livestock and Poultry Veterinarians’ calculated retail distribution of ionophores being 4765 kg, and −3472 kg and −4310 kg in 2012, 2013, and 2014, respectively. These adjustments reduced the overall discrepancy in ionophore distribution between the CAHI BC Production Animal Distribution data and the BC LD, but the discrepancies remained sizable. The validation tests employed in this study were relatively weak so further validation of the CAHI BC Production Animal Distribution data and BC LD should be considered.
Perhaps the inability to validate the ionophore distribution data is unimportant because these antimicrobials are not considered to be medically important. Agunos et al (17), however, note the public health implications of ionophore use. The Government of Canada has proposed mandatory annual reporting (18) only of medically important antimicrobials for veterinary use. For each drug, the total quantity of antimicrobial sold or compounded with an estimate of the approximate quantity intended for each animal species must be reported by manufacturers and importers. The antimicrobial classes used in this study all contain medically important antimicrobials (2) except for the ionophores, and bambermycin which was included in the other antimicrobials class. This study validated the current voluntary reporting of medically important antimicrobials by antimicrobial class, but not by drug or animal species. The federal proposal does not mention reporting by province. Without provincial level data, future validation of the mandatory reported data would not be possible using the BC LD.

Due to a lack of data, this study did not include the distribution channels of antimicrobial importation by producers for their own use or the use, including importation, of active pharmaceutical ingredients. The latter would be captured by the proposed mandatory reporting requirement. The former would be eliminated for medically important antimicrobials under a new proposed federal regulation (18). However, the future oversight of antimicrobial purchases from internet pharmacies, including those not located in Canada, is unclear.

In BC, the CAHI distribution of antimicrobials represented over 99.5% of all antimicrobial sales, which is greater than CAHI’s estimated 90% market share of licensed animal pharmaceutical products (3). In BC, non-CAHI distribution of antimicrobials by OTC retailers is minor in terms of relative and absolute amount of active antimicrobial ingredients distributed. Non-CAHI distributed antimicrobials could also have been distributed by BC Livestock and Poultry Veterinarians or CAHI BC Companion Animal Veterinarians and this would have resulted in the underestimation of antimicrobial distribution by these channels. Due to a lack of data on antimicrobial distribution by BC veterinarians, the sizes of any underestimations are unknown.

Caution should be exercised in extrapolating the BC data on wholesale and retail antimicrobial distribution by channel to other provinces for a number of reasons including the inter-provincial variability in animal demographics. For example, in 2014, BC ranked 1st among the provinces in farmed salmon receipts, 3rd in dairy, chicken, and turkey receipts, and 6th in hog and beef receipts (19). Yet, differences in national versus BC’s animal demographics apparently didn’t negatively impact the validation of the CAHI and BC antimicrobial distribution data. The CAHI provincial allocation of antimicrobial classes between companion and production animals relied on national averages of the percent sold to each of the 2 groups (3). Caution should be exercised in comparing the distribution among channels as the potency of antimicrobials is not considered, nor is the biomass of the underlying animal populations. For example, similar to the BC distribution data (Tables 1 to 3), the 2014 national kilograms of cephaplorins and fluoroquinolones distributed for production animals was greater than that for companion animals, yet companion animals had the greatest distribution when the biomass of the underlying animal populations was considered (20).

Validated AMU data can be useful for policy analysis. The current data, although lacking detail in use by antimicrobial or species of administration, can inform evidence-based analyses, including the proposed veterinary oversight requirement of veterinary prescription (1) for all medically important antimicrobials (2). For example, BC’s retail distribution data clarify that fluoroquinolones and cephalosporins, antimicrobials of greatest importance to human medicine (2), are distributed only by veterinarians and not OTC. Although this limited distribution might be obvious to some veterinarians, it might not be to others, including the general public or public health officials. Given fluoroquinolones and cephalosporins are not available OTC, a prescription use only policy for veterinary antimicrobials cannot be expected to reduce their use. However, if the policy results in producers newly employing a veterinarian to access antimicrobials, which are a cornerstone of animal welfare, it will result in potential new access to all veterinary prescription antimicrobials, including the fluoroquinolones and cephalosporins. This is not to suggest an increased use of such important antimicrobials under veterinary oversight is imprudent. Nonetheless, this potential increased use of antimicrobials, which are of greatest importance to human medicine, is a non-intuitive outcome of a veterinary prescription use only policy with aims of improving stewardship.

The number of producers operating without veterinary oversight is unknown and the BC data should not be co-opted to address this knowledge gap. That is, OTC distribution is not equivalent to use without veterinary oversight. Producers operating under veterinary oversight could elect to purchase some OTC antimicrobials for a number of reasons including cost and accessibility.

Veterinary AMU surveillance goals tend to target highly detailed data which come at an increased cost. As evidenced by the current data, less costly and more aggregated data can also be useful in policy analysis and stewardship oversight.

Ironically, the planned AMU policy and regulatory changes will decrease the available AMU data in BC. For example, a prescription use only policy will eliminate antimicrobial distribution by the OTC retail outlet distribution channel and the associated AMU data source. Instead such products will likely be distributed through BC veterinarians, for whom there is currently no AMU distribution data. However, the federal regulatory and policy changes could present the opportunity to capture more detailed AMU data as currently occurs in BC with the collection of aquaculture prescription data. For example, the BC legislation on OTC veterinary drug retailers will likely require revision to be consistent with the proposed federal changes. This presents an opportunity to require more detailed AMU information from BC’s livestock and poultry feed mills, which is the retail distribution channel that accounts for approximately 75% of the province’s veterinary antimicrobials. These data would be nicely complemented by data on AMU prescribed by veterinarians and not administered in feed.
Acknowledgments
The thoughtful comments of 3 anonymous reviewers are gratefully acknowledged.

References
Short- and long-term outcomes after shoulder excision arthroplasty in 7 small breed dogs

Xavier Montasell, Jacques Dupuis, Louis Huneault, Guillaume R. Ragetly

Abstract — This study reports short- and long-term clinical outcomes following excision arthroplasty in 7 small breed dogs with shoulder pathology. Lameness and pain were scored before surgery, and reassessed at short- and long-term follow-ups with measurements of range of motion (ROM), scapulo-humeral angles of extension (EA) and flexion (FA), and muscle girth (MG) of the operated and contralateral limbs. All dogs improved clinically for lameness and pain. Range of motion, EA, and FA of the operated limb were not significantly different compared with the contralateral limb at short-term follow-up, but ROM and EA were significantly decreased at long-term examination. Muscle girth was not significantly different than the contralateral limb. Radiographic re-evaluations showed bony proliferation around osteotomies without interosseous union in most dogs and all owners were satisfied with the surgery outcome. Excision arthroplasty seems to be an effective treatment for chronic shoulder pathologies in small dogs. Range of motion and EA were decreased and a mild lameness remained present at long-term follow-up.

Introduction

Shoulder pathologies are important causes of thoracic limb lameness in dogs (1–6). These pathologies include joint fractures, tenosynovitis/avulsion tear of the biceps brachii tendon, incomplete ossification of the caudal glenoid accessory center, traumatic or congenital luxations, and chronic instability, all possibly leading to various degrees of degenerative joint disease (DJD). In small breed dogs, medial shoulder instability and DJD are the pathologies most frequently diagnosed (7,8).

Medical management, physical rehabilitation protocols, and several surgical procedures have been described for various pathologies of the shoulder (9–17). However, in case of failure of these treatments and in presence of pain, loss of function, and severe DJD, salvage techniques such as arthrodesis or excision arthroplasty may be indicated (18–24).

Arthrodesis is the most commonly described salvage procedure for the shoulder, and is often performed using a bone plate and screws (18–20). This procedure is technically demanding...
Selection criteria included dogs that underwent shoulder excision arthroplasty between October 2013 and April 2015 at Centre Vétérinaire Rive-Sud or at Centre Hospitalier Vétérinaire Frégis. For all dogs, the decision to perform an excision arthroplasty of the shoulder was based on the presence of severe lameness with severe degenerative changes that did not respond to previous medical or surgical management. In all dogs, the contralateral shoulder was carefully assessed during the orthopedic examination and under sedation for pain, crepitus, or instability/subluxation, and radiographs or ultrasound evaluations of that shoulder were taken depending on surgeon’s preference.

Materials and methods

Selection criteria included dogs that underwent shoulder excision arthroplasty between October 2013 and April 2015 at Centre Vétérinaire Rive-Sud or at Centre Hospitalier Vétérinaire Frégis. For all dogs, the decision to perform an excision arthroplasty of the shoulder was based on the presence of severe lameness with severe degenerative changes that did not respond to previous medical or surgical management. In all dogs, the contralateral shoulder was carefully assessed during the orthopedic examination and under sedation for pain, crepitus, or instability/subluxation, and radiographs or ultrasound evaluations of that shoulder were taken depending on surgeon’s preference.

Table 1. Population data and perioperative findings for 7 small breed dogs after shoulder excision arthroplasty.

<table>
<thead>
<tr>
<th>Dog</th>
<th>Breed</th>
<th>Gender</th>
<th>Age (y)</th>
<th>Weight (kg)</th>
<th>Side</th>
<th>Diagnosis</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Toy poodle</td>
<td>Male</td>
<td>14</td>
<td>2.8</td>
<td>Right</td>
<td>Chronic instability, DJD</td>
<td>Glenoid/humeral excision</td>
</tr>
<tr>
<td>2</td>
<td>Pug</td>
<td>Male</td>
<td>5</td>
<td>12.9</td>
<td>Right</td>
<td>Chronic glenoid fracture, DJD</td>
<td>Glenoid/humeral excision</td>
</tr>
<tr>
<td>3</td>
<td>Chihuahua</td>
<td>Female</td>
<td>7</td>
<td>2.9</td>
<td>Left</td>
<td>Unknown origin DJD</td>
<td>Glenoid/humeral excision</td>
</tr>
<tr>
<td>4</td>
<td>Daschund</td>
<td>Male</td>
<td>3</td>
<td>11.5</td>
<td>Right</td>
<td>Septic arthritis, DJD</td>
<td>Glenoid/humeral excision</td>
</tr>
<tr>
<td>5</td>
<td>Cocker spaniel</td>
<td>Female</td>
<td>3</td>
<td>10.1</td>
<td>Right</td>
<td>Chronic instability, DJD</td>
<td>Glenoid excision</td>
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<tr>
<td>6</td>
<td>Shiba inu</td>
<td>Male</td>
<td>0.6</td>
<td>9.5</td>
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<td>Chronic instability, DJD</td>
<td>Glenoid/humeral excision</td>
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<tr>
<td>7</td>
<td>Miniature pinscher</td>
<td>Male</td>
<td>7</td>
<td>9.3</td>
<td>Right</td>
<td>Traumatic luxation</td>
<td>Glenoid/humeral excision</td>
</tr>
</tbody>
</table>

Anesthesia and analgesia

All dogs were premedicated with hydromorphone (Summit Veterinary Pharmacy, Aurora, Ontario), 0.1 mg/kg body weight (BW), IV, and midazolam (Sandoz Canada, Boucherville, Quebec), 0.2 mg/kg BW, IV, or acepromazine (Boehringer Ingelheim Canada, Burlington, Ontario), 0.03 mg/kg BW, IV. General anesthesia was induced with propofol (Fresenius Kabi Canada, Richmond Hill, Ontario) and maintained with isoflurane (Baxter Healthcare, Mississauga, Ontario) in oxygen. A constant rate infusion of fentanyl (Summit Veterinary Pharmacy), 2 to 5 μg/kg BW, IV, was administered during surgery and for 12 to 24 h after surgery. Cefazolin (Teva Canada, Toronto, Ontario), 0.2 mg/kg BW, IV, was administered during the perioperative period.

After surgery, all dogs received a non-steroidal anti-inflammatory drug (Meloxicam; Boehringer Ingelheim Canada, Burlington), 0.1 mg/kg BW, PO, q24h or (Deracoxib; Novartis Animal Health Canada, Dorval, Quebec), 1 mg/kg BW, PO, q24h, for 14 to 42 d after the surgery and another analgesic (Tramadol; Summit Veterinary Pharmacy), 3 mg/kg BW, PO, q8h or (Buprenorphine; Summit Veterinary Pharmacy), 0.02 mg/kg BW, PO, q8h for 5 to 7 d.

Surgical procedures

Excision arthroplasty was performed as previously described (8,22,24). A lateral approach to the shoulder was taken, the acromion process was osteotomized, and a tenotomy of the

Figure 1. Immediate post-operative radiograph of dog 1. Note parallel ostectomy lines after the surgical procedure.
infraspinatus and teres minor muscles was performed to expose the joint. In most cases, ostectomies of the glenoid and humeral head were made to an estimated standing angle with a sagittal saw taking care to protect the suprascapular nerve, branches of the axillary nerve, and caudal circumflex humeral artery. Before closure, the teres minor muscle was pulled and sutured to the biceps brachii tendon between the osteotomized surfaces. The acromial process was re-attached with a cerclage wire through pre-drilled holes. Variations in technique included the use of a single ostectomy of the glenoid in 1 dog, and avoiding osteotomy of the acromion during the approach in 2 dogs.

**Evaluation**

All dogs were clinically evaluated before surgery, and at short-term (6 to 16 wk) and long-term (12 to 15 mo) follow-ups. All evaluations were carried out by 1 of 3 ACVS Board-certified surgeons or an ACVS resident.

Lameness was graded on a scale from 0 to 5 for both thoracic limbs (0 = no lameness, 1 = mild intermittent weight-bearing lameness, 2 = persistent mild weight-bearing lameness, 3 = persistent moderate weight-bearing lameness, 4 = persistent severe weight-bearing lameness, and 5 = persistent non-weight-bearing lameness) as previously described (25).

Pain was subjectively evaluated and graded on a scale from 0 to 2 for both shoulders (0 = no reaction nor vocalization during extension, flexion, or abduction of the shoulder, 1 = apparent mild reaction and/or vocalization during extension, flexion, or abduction of the shoulder, 2 = obvious and severe reaction and/or vocalization during extension, flexion, or abduction of the shoulder) (25).

Goniometrical measurements for the extension angle (EA) and flexion angle (FA) of the shoulder were evaluated in the operated and contralateral limbs. Measurements were performed without sedation using a plastic goniometer (Baseline, Fabrication Enterprises, Elmsford, New York, USA) as previously described (26,27). The difference between the EA and FA was used to determine the range-of-motion (ROM).

Muscle girth (MG) measurements were taken on the operated and contralateral limbs using a measuring tape with the acromion as a landmark as previously described (27).

Diagnostic radiographs were taken before surgery, immediately after surgery and at short- and/or long-term follow-ups. Lateral and caudo-cranial views of the shoulder were taken before and immediately after the surgery. Lateral views with or without caudo-cranial views were taken during the post-operative period depending on surgeon’s preference.

**Miscellaneous clinical procedures**

Ultrasoundography was performed on the shoulders of 2 dogs and arthroscopy was carried out on the shoulder of 1 dog before surgery. A biopsy sample of the shoulder was cultured and analyzed in 1 dog after surgery.

**Complications**

Post-operative complications were classified as minor or major. Minor complications were defined as any adverse event that was self-limiting or resolved with medical treatment. Major complications were defined as any complication resulting in the need for another surgery.

**Long-term follow-up questionnaire**

Owners were asked to answer a questionnaire at ≥12 mo after surgery. The questionnaire was based on a model used previously (28), focusing on the owner’s impression about the clinical status and comfort of their dog, and their satisfaction with the surgical procedure.

**Statistical analysis**

Continuous data were summarized as medians and interquartile range (25th–75th). Data distributions of angles and girth were assessed for normality using the Shapiro-Wilk test. Because of small sample size, non-parametric statistics were used. Wilcoxon signed-rank test for paired observations was conducted using statistical software (GraphPad Prism Version 5.02; GraphPad Software, La Jolla, California, USA). Data distributions from EA, FA, and MG were assessed separately for short- and long-term follow-ups and compared between operated and contralateral limbs. Data for lameness and pain scores were organized in a contingency table and analyzed with an X² test using the same statistical software. Results were considered significant if P < 0.05.

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**Table 2. Lameness and pain scores for 7 small breed dogs before and after shoulder excision arthroplasty.**

<table>
<thead>
<tr>
<th>Dog</th>
<th>Lameness score (0 to 5)</th>
<th>Pain score (0 to 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-operative</td>
<td>Short-term</td>
</tr>
<tr>
<td>1</td>
<td>3/5</td>
<td>3/5</td>
</tr>
<tr>
<td>2</td>
<td>3/5</td>
<td>2/5</td>
</tr>
<tr>
<td>3</td>
<td>5/5</td>
<td>3/5</td>
</tr>
<tr>
<td>4</td>
<td>5/5</td>
<td>4/5</td>
</tr>
<tr>
<td>5</td>
<td>3/5</td>
<td>3/5</td>
</tr>
<tr>
<td>6</td>
<td>4/5</td>
<td>2/5</td>
</tr>
<tr>
<td>7</td>
<td>4/5</td>
<td>2/5</td>
</tr>
</tbody>
</table>

Median (range):

- Lameness: 4/5 (3 to 5)
- Pain: 2/2 (1 to 2)

* Results statistically different compared with pre-operative period.
Table 3. Flexion angle, extension angle, and range-of-motion for 7 small breed dogs at short-term and long-term follow-up examinations.

<table>
<thead>
<tr>
<th>Dog</th>
<th>Flexion (°)</th>
<th>Extension (°)</th>
<th>ROM (°)</th>
<th>Flexion (°)</th>
<th>Extension (°)</th>
<th>ROM (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>150</td>
<td>170</td>
<td>110</td>
<td>150</td>
<td>170</td>
<td>110</td>
</tr>
<tr>
<td>L</td>
<td>160</td>
<td>145</td>
<td>135</td>
<td>160</td>
<td>145</td>
<td>135</td>
</tr>
<tr>
<td>C</td>
<td>160</td>
<td>145</td>
<td>135</td>
<td>160</td>
<td>145</td>
<td>135</td>
</tr>
<tr>
<td>L</td>
<td>160</td>
<td>145</td>
<td>135</td>
<td>160</td>
<td>145</td>
<td>135</td>
</tr>
<tr>
<td>O</td>
<td>150</td>
<td>170</td>
<td>110</td>
<td>150</td>
<td>170</td>
<td>110</td>
</tr>
<tr>
<td>L</td>
<td>160</td>
<td>145</td>
<td>135</td>
<td>160</td>
<td>145</td>
<td>135</td>
</tr>
<tr>
<td>C</td>
<td>160</td>
<td>145</td>
<td>135</td>
<td>160</td>
<td>145</td>
<td>135</td>
</tr>
<tr>
<td>L</td>
<td>160</td>
<td>145</td>
<td>135</td>
<td>160</td>
<td>145</td>
<td>135</td>
</tr>
</tbody>
</table>

Median (range):
- Flexion: 152.5° (range: 127.5° to 155.0°)
- Extension: 160° (range: 145.0° to 175.0°)

*Results statistically different compared with contralateral joint.*

OL — operated limb; CL — contralateral limb.

Results

Population data and pre-operative clinical findings

Five neutered male and 2 neutered female dogs (N = 7) were included in this study (Table 1). Median age at surgery was 5 y (range: 7 mo to 14 y). Median body weight was 9.5 kg (range: 2.8 to 12.9 kg). Six dogs were affected on the right shoulder and 1 dog was affected on the left shoulder.

Median lameness score before the surgery was 4/5 (range: 3/5 to 5/5). Except for 1 dog which was 1/2, all dogs were presented with a pain score of 2/2 before the surgery. Contralateral limbs did not show any anomaly upon clinical examination: no lameness, no pain or impression of atrophy. Population data and pre-operative clinical findings are summarized in Tables 1 and 2.

Diagnosis and surgical procedures

Diagnoses included traumatic medial shoulder luxation (n = 1), chronic medial instability with DJD (n = 3), DJD of unknown etiology (n = 1), chronic glenoid fracture with DJD (n = 1), and septic arthritis with severe DJD (n = 1). In all cases, an examination under sedation with radiographs was performed. Findings from ultrasonography on 2 dogs (dogs 3 and 4) were consistent with severe synovitis and degenerative bone proliferation along the joint surface in both cases. In dog 5, arthroscopic evaluation confirmed Outerbridge grade 4 cartilage lesions of the humeral head and glenoid cavity. Final diagnosis in dog 4 with septic arthritis was established by biopsy and culture during the surgical procedure, since a joint aspiration to obtain a synovial fluid sample before surgery was tried but failed. The dog with a traumatic luxation had previous surgical reconstruction with prosthetic medial gleno-humeral ligaments 2 y before excision arthroplasty.

Six of 7 dogs were treated surgically with a glenoid and humeral head excision (Figure 1), and 1 dog (#5) was treated with a glenoid excision alone. Diagnoses and procedures performed are summarized in Table 1.

Complications

No minor or major complication requiring additional surgery was reported in this study. An intermittent/transient lameness and discomfort was observed in dog 3 at 6 mo post-surgery. He was not examined then, but the lameness resolved according to the owner with rest and the administration of Meloxicam (Boehringer Ingelheim Canada), 0.1 mg/kg BW as needed for 2 wk.

Short-term outcome

Clinical evaluation for lameness and pain assessment was done between 6 to 16 wk after surgery (Table 2). All dogs were no longer on pain medication for at least 2 wk at that time. Median lameness score was 3/5 (2 to 3), which was not statistically different compared with pre-operative scores (P = 0.13). Median pain score was 1/2 (0 to 1), which was statistically different from pre-operative scores (P < 0.01).

Measurements of the FA and EA were taken in 4 of 7 dogs (Table 3). Median EA on the operated and contralateral limbs were 152.5° (range: 127.5° to 155.0°) and 160° (range: 145.0° to
163.7°), respectively. Median FA on the operated and contralateral limbs were 65° (56.2° to 85.0°) and 60° (range: 55.0° to 65.0°), respectively. Median ROM on the operated and contralateral limbs were 87.5° (range: 42.5° to 98.7°) and 100° (80.0° to 108.7°). No significant difference was present in EA (P = 0.09), in FA (P = 0.17), or in ROM (P = 0.12) between operated and contralateral limbs.

Muscle girth (MG) measurements were also taken in 4 of 7 dogs (Table 4). Median MG was 18.5 cm (range: 10.2 to 24.8 cm) for operated limbs and 19 cm (range: 11.6 to 26.3 cm) for contralateral limbs. There was no significant difference in MG between the operated and contralateral limbs (P = 0.25).

Long-term outcome
All dogs were re-evaluated between 12 and 15 mo after surgery (Table 2). Median lameness score was 1/5 (range: 1 to 2), which was statistically different versus pre-operative (P = 0.01), but not versus short-term scores (P = 0.13). Pain scores were 0/2 for all dogs, which was statistically different versus pre-operative (P < 0.01), but not versus short-term scores (P = 0.07).

Measurements of the EA and FA were taken for all dogs (Table 3). Median EA on the operated and contralateral limb was 150° (range: 140.0° to 160.0°) and 170° (range: 160.0° to 175.0°), respectively. Median FA on the operated and contralateral limbs was 55° (range: 45.0° to 65.0°) and 55° (range: 40.0° to 60.0°), respectively. Median ROM on the operated and contralateral limbs was 100° (range: 75.0° to 105.0°) and 110° (range: 105.0° to 135.0°), respectively. The difference between operated and contralateral joints was considered significant in EA (P = 0.02) and in ROM (P = 0.02). However, no significant difference was observed in FA (P = 0.26).

Muscle girth measurements were taken for all dogs (Table 4). Median MG was 24 cm (range: 15.0 cm to 27.0 cm) for the operated limb and 25 cm (range: 15.0 cm to 27.0 cm) for the contralateral limb. There was no significant difference in MG between the operated and contralateral limbs (P = 0.23).

Radiographic re-evaluation
Six of 7 dogs were evaluated radiographically 2 to 12 mo after surgery. Three dogs had lateral and caudo-cranial views and 3 dogs had only lateral views. Five dogs had similar changes on the surgery site with bone proliferation along and around ostectomy sites and a radiolucent line present between the humerus and scapula (Figure 2). Mineralized fragments were present around the ostectomy sites on 3 of these 5 dogs. Another dog (dog 1) had a cranial subluxation of the humerus on the lateral view. A cranio-caudal view was not taken in this dog to evaluate if medio-lateral subluxation was also present. In dog 4 (dog with septic arthritis), radiographic signs of bone fusion/arthrodesis of the shoulder joint were observed 6 mo after surgery (Figure 3). Radiographic healing of the acromion was complete in all 5 cases in which acromial ostectomy was performed.

Long-term owner questionnaires
All owners completed the questionnaire at ≥ 12 mo after surgery (Table 5). All owners were satisfied with the outcome of surgery and all of them would agree to do surgery again in the case of a similar problem. Most owners reported a mild lameness with no problems running, jumping, climbing stairs or going down stairs. Many owners also subjectively commented on how their dog became playful again after surgery.

Table 4. Muscle girth for 7 small breed dogs at short-term and long-term follow-up examinations.

<table>
<thead>
<tr>
<th>Dog</th>
<th>Short-term follow-up</th>
<th>Long-term follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OL</td>
<td>CL</td>
</tr>
<tr>
<td>1</td>
<td>15.5</td>
<td>16.5</td>
</tr>
<tr>
<td>2</td>
<td>21.5</td>
<td>21.5</td>
</tr>
<tr>
<td>3</td>
<td>8.5</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>26</td>
<td>28</td>
</tr>
<tr>
<td>5</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>6</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>7</td>
<td>16</td>
<td>17</td>
</tr>
</tbody>
</table>

Median (range) OL — operated limb; CL — contralateral limb.
Table 5. Long-term questionnaire for owners. The score was graded from 1 to 10, where 10 means no lameness/pain or complete satisfaction with the outcome.

<table>
<thead>
<tr>
<th>Question</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is your dog’s exercise tolerance?</td>
<td>6</td>
</tr>
<tr>
<td>How well can your dog walk without pain?</td>
<td>8</td>
</tr>
<tr>
<td>How well can your dog climb up stairs?</td>
<td>8</td>
</tr>
<tr>
<td>How well can your dog climb down stairs?</td>
<td>8</td>
</tr>
<tr>
<td>How well can your dog jump up/down (e.g., in/out of car)?</td>
<td>8</td>
</tr>
<tr>
<td>How well can your dog lie down/get up without pain or hesitation?</td>
<td>8</td>
</tr>
<tr>
<td>Does your dog nod his/her head at a walk?</td>
<td>8</td>
</tr>
<tr>
<td>How stiff is your dog in the morning?</td>
<td>8</td>
</tr>
<tr>
<td>How would you grade the success of the operation?</td>
<td>8</td>
</tr>
<tr>
<td>Would you have the surgery done again in the same circumstances?</td>
<td>8</td>
</tr>
</tbody>
</table>

N/A — Not available.

Discussion

Excision arthroplasty is a salvage technique theoretically indicated for severe shoulder diseases, when the gleno-humeral joint cannot be reconstructed adequately, in cases of non-successful previous surgical attempts, or when medical management of pain is not effective (22,23). In our small population, there was clinical improvement in lameness and pain scores after surgery, confirming part of our hypothesis and corroborating data from the limited number of cases previously reported (22–24).

Improvements on lameness scores were not significant at the short-term follow-up compared to the pre-operative period. However, significant improvement was observed at the long-term follow-up, suggesting that a long time is needed for improvement in lameness after this procedure. Furthermore, 6 of 7 patients kept a mild lameness more than 12 mo after surgery. This may be explained by modifications of the shoulder biomechanics after surgery, producing a mild chronic instability leading to a residual mechanical lameness, or persistence of some discomfort that had not been observed on pre-operative clinical examination.

Pain scores were significantly decreased at short-term, which suggests the efficacy of this technique to alleviate pain in a short time period, although the lameness can take many months to improve.

Extension angles and ROM were significantly decreased at long-term, also confirming part of our hypothesis, although these changes were not observed at short-term follow-up. The reduction of the EA of the operated joint at long-term follow-up may partly explain the remaining lameness observed in those dogs at that time. This difference in extension was not observed at short-term follow-up, possibly because proliferation of fibrous tissue was not sufficient at this time to limit the ROM. Another potential explanation may be the lack of data for 3 dogs at short-term follow-up. The difference in ROM between operated and contralateral joints was similar to that reported in the limited number of cases in previous reports (22–24). Despite this, we believe that the motion between the scapula and the thoracic wall should compensate for the decreased extension of the shoulder, as it does following shoulder arthrodesis. This may also explain better lameness scores at long-term follow-up despite the decreased EA and ROM.

Radiographic findings in 5 of 6 dogs at short- and long-term follow-up were similar to those described in previous reports with a mild bone proliferation at the osteotomy sites without a bone union (22–24). One of these dogs had a cranial subluxation without clinical signs of instability observed at re-evaluation. One dog had a complete fusion of the joint, which could be explained by the septic origin of the disease that may have caused greater tissue damage and increased bone activity. Complete intervertebral body fusions have been reported in cases of discospondylitis treated with external fixation (29).

Despite the positive clinical outcomes of shoulder arthrodesis, there is a high rate of post-operative complications reported in the literature (42% to 50%) after this salvage procedure (18,20). Reported complications include mal-unions, breakage/migration of implants, infection, dehiscence, screw loosening, and delayed unions. Complications reported with excision arthroplasty include recurrence of lameness after exercise and recurrence of medial luxation. In the present study only 1 of the 7 small dogs had an episode of temporary increase in lameness during recovery. In a previous report it was suggested that the stress and fatigue of muscles and tendons may result in acute inflammatory reactions following excision arthroplasty (23). Until the fibrous pseudo-joint becomes more stable, muscular and tendinous injuries are possible following such a procedure. The low rate of complications after excision arthroplasty compared with arthrodesis may be explained by the absence of orthopedic implants, no attempt to solidly fix the bones with a standing angle, the more limited surgical approach, and the shorter anesthesia/surgery time. The low rate and severity of complications after excision arthroplasty compared with arthrodesis may be considered when weighing treatment options for severe shoulder disease in small dogs.

Two types of techniques for shoulder arthroplasty have been described. In one the glenoid cavity is excised (22), and in the other the glenoid cavity and the humeral head are osteotomized (23). It has been suggested that the second technique may allow faster proliferative fibroplasia by providing a greater vascular surface with osteotomy of both joint surfaces and preventing bone on bone friction by the interposition of the teres minor muscle (8,24). However, the use of muscular interposition in femoral head and neck excision remains controversial, and adverse effects such as muscle atrophy and decreased ROM
have been reported (30). Additional studies in shoulder excision arthroplasty are necessary to analyze the advantages and disadvantages of muscular interposition. In our study, 6 dogs had an excision arthroplasty (osteotomy of both surfaces) and 1 had only a glenoid excision. No clinical difference can be detected between the techniques with such small numbers.

This clinical study had several limitations, the first being a small cohort of dogs weighing no more than 13 kg. Clinical evaluations such as lameness, pain, and owner questionnaires had scores that were subjective. Although measures for musculature, EA, FA, and ROM were based on the same instructions for all dogs, measures were not taken in all cases by the same clinician, generating potential bias for measurements between different patients or at different times. However, this was attenuated by always using the contralateral limb as a control. Although the contralateral limbs did not show any anomaly on clinical examination, procedures such as radiographs or ultrasound were not performed to confirm the complete health of those limbs. The surgical technique and the duration of the post-operative medication varied depending on the patient and on the surgeon’s preference. Physical therapy was recommended in all cases, but was not always performed by a physical therapist. Radiographic follow-up was not performed equally in all cases with some dogs having only a lateral view, producing a potential loss of additional information, particularly for medial luxation. Some patients were operated on before the beginning of the study, with a potential loss of information during the earlier periods in those dogs. Flexion-extension angles data from a few cases were missing at first follow-up. However, only data from lameness and pain evaluations were compared statistically short-term versus long-term. Moreover, MG was not measured before surgery, and the short-term follow-up period was so long because of difficulties for some owners to come precisely between 6 and 8 wk after surgery. Despite these limitations, we note that excision arthroplasty is a rarely performed procedure, in part due to the lack of information on this technique in the literature. Prospective studies with a larger number and variety of animals and additional objective measurements such as force plate analysis may provide additional information about the results and potential complications of this salvage procedure.

In conclusion, excision arthroplasty seems to be an effective treatment for chronic and severe shoulder pathologies in small breed dogs, decreasing lameness and pain upon palpation in affected dogs. The ROM of the shoulder can be expected to decrease with a lower EA, and a mild lameness is likely to remain in the long-term. This technique could be considered an alternative to shoulder arthrodesis in small breed dogs with a seemingly low rate of complications and reasonable long-term function.

Acknowledgments
The authors thank Dr. J. Benito for statistical support and Dr. M. Freire for assistance with language.

References
Characteristics of parasitic egg shedding over a 1-year period in foals and their dams in 2 farms in central Saskatchewan

Elzbieta Misuno, Chris R. Clark, Stacy L. Anderson, Emily Jenkins, Brent Wagner, Katarzyna Dembek, Lyall Petrie

Abstract — The goals of this study were to report the seasonal shedding patterns of strongyle and Parascaris spp. eggs in repeated fecal samples for mares (n = 38) and foals (n = 39), and to evaluate the efficacy of ivermectin treatment in mares from 2 selected horse breeding farms in central Saskatchewan. Median strongyle fecal egg counts (FEC) peaked in July and August in adult horses. The farms differed significantly (P = 0.0005) in regard to strongyle shedding categories (< 200; 200 to 500; and > 500 eggs/g) over time, but for each individual horse (both farms combined) these categories did not differ over time (P = 0.13) on samples collected in grazing season. When evaluating 3 samples collected fall, summer and fall in 2 consecutive grazing seasons, 94% of horses that shed < 200 eggs/g on 2 initial samples, remained in the same category on the third sample. Mares on each farm didn’t differ statistically in shedding categories when comparing September samples from 2 consecutive years (Farm A: P = 0.56, Farm B: P = 0.06). Peak strongyle shedding occurred late fall in the first year of life for foals on Farm A, and in July in the second year of life for foals on Farm B. Parascaris spp. FEC were greatest in foals ≤ 6 months of age, with peak observed when foals were 5 to 6 months old. Ivermectin was 100% effective at reducing strongyle FEC 2 weeks after treatment in adult horses. Horses in Saskatchewan had relatively high strongyle shedding levels, which were significantly different between the farms, and high prevalence of Oxyuris equi. Strongyle shedding consistency was observed for FECs collected from mares in grazing season (July to September).

Résumé — Caractéristiques de l’excrétion des œufs de parasites pendant une période de 1 an chez les poulains et leurs mères dans deux fermes du centre de la Saskatchewan. Cette étude avait pour but de dresser un rapport sur les tendances d’excrétion saisonnière des œufs des strongyles et de Parascaris spp. dans des prélèvements fécaux répétés pour les juments (n = 38) et les poulains (n = 39) et d’évaluer l’efficacité du traitement à l’ivermectine chez deux juments provenant de deux fermes d’élevage de chevaux dans le centre de la Saskatchewan. Les comptes médians d’œufs fécaux des strongyles ont culminé en juillet et en août chez les chevaux adultes. Les fermes présentaient des différences significatives (P = 0.0005) à l’égard des catégories d’excrétion des strongyles (< 200; de 200 à 500; et > 500 œufs/g) dans le temps, mais, pour chaque cheval individuel (les deux fermes combinées), ces catégories ne présentaient pas de différences à la longue (P = 0.13) pour les échantillons prélevés durant la saison de pâturage. Lors de l’évaluation des reois échantillons prélevés à l’automne, à l’été et à l’automne pendant deux saisons de pâturage consécutives, 94% des chevaux qui avaient excrété < 200 œufs/g pour deux prélèvements initiaux, sont demeurés dans la même catégorie pour le troisième échantillon. Les juments de chaque ferme ne présentaient pas de différences statistiques pour les catégories d’excrétion lorsque l’on comparait les échantillons de septembre provenant de deux années consécutives (Ferme A : P = 0,56, Ferme B : P = 0,06). L’excrétion des strongyles a culminé à la fin de l’automne pendant la première année de vie pour les poulains de la Ferme A et en juillet de la deuxième année de vie pour les poulains de la Ferme B. Les comptes d’œufs fécaux de Parascaris spp. étaient les plus importants chez les poulains âgés de ≤ 6 mois et le point culminant était observé lorsque les poulains étaient âgés de 5 ou 6 mois. L’ivermectine était efficace à 100 % pour réduire les comptes d’œufs fécaux 2 semaines après le traitement chez les chevaux adultes. Les chevaux de la Saskatchewan ont présenté des taux d’excrétion relativement élevés de strongyles, qui étaient significativement différents entre les fermes, et une forte prévalence d’Oxyuris equi. La constance de l’excrétion des strongyles a été observée pour les comptes d’œufs fécaux obtenus auprès des juments pendant la saison de pâturage (de juillet à septembre).

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Department of Large Animal Clinical Sciences (Misuno, Clark, Petrie), Department of Veterinary Microbiology (Jenkins, Wagner), University of Saskatchewan, Western College of Veterinary Medicine, 52 Campus Drive, Saskatoon, Saskatchewan S7N 5B4; Lincoln Memorial University, College of Veterinary Medicine, 6965 Cumberland Gap Parkway, Harrogate, Tennessee 37752, USA (Anderson); Iowa State University, College of Veterinary Medicine, 2503 Vet Med, 1600 S 16th Street, Ames, Iowa 50011, USA (Dembek).

Address all correspondence to Dr. Elzbieta Misuno; e-mail: e_misuno@yahoo.com

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Introduction

Intestinal parasitism is a common health concern in horses worldwide. Intensive anthelmintic treatment schedules that have utilized frequent dosing and rotation among drug classes have accelerated the development of anthelmintic resistance (1–12). For over 20 y, some European and, more recently, North American countries, have been implementing selective treatment protocols for strongyles based on testing for fecal egg count (FEC) (1,11,13,14). The threshold for anthelmintic treatment in such protocols is usually set at 150 to 200 eggs/g, and recommended frequency of individual horse repeated FECs vary, depending on country or veterinary practice (14–17). Furthermore, prophylactic treatments are administered to low shedders, with the frequency (once to twice a year) and timing dependent on climate and management of the herd and pasture (1,13,14). It is recommended to assess treatment efficacy with an FEC reduction test (FECRT), every 3 y (adult horses) or yearly (foals and weanlings) on at least 6 horses/farm, and to avoid treatments at times when parasite burdens on pasture are low (1). FEC-based parasite control programs aim to reduce total number of treatments, preserve parasitic refugia, allow for identification and targeted treatment of horses at high risk, and to slow the development of anthelmintic resistance (1,16–20).

In order to categorize horses’ shedding level (low < 200, 200 to 500, or > 500 eggs/g), FEC should be performed during a time when previous anthelmintic treatments are no longer effective and climatic conditions are optimal for parasite transmission (1). For example, an FEC should be performed 16 wk after moxidectin treatment (4 wk beyond egg reappearance period for this drug) during grazing season. The general recommendation is to perform more than one FEC at more than one time point (1).

The cost associated with repeated fecal sampling could be reduced by reducing the frequency of testing. From a limited number of studies (21–24) it is believed that adult horses (> 3 y old) remain consistent in their shedding levels unless their immune system is compromised, or they are moved to a new environment (with different environmental parasitic contamination). In a study analyzing sequential FECs as part of a selective anthelmintic program in Danish horses, Nielsen et al (14) evaluated FECs collected twice yearly (spring and fall) over a 3-year period, and estimated an 84% probability of a FEC result < 200 eggs/g for horses with the 2 previous FEC results < 200 eggs/g. When FEC exceeded 200 eggs/g on the previous 2 samples, the probability for a horse exceeding 200 eggs/g on the third sample was 59% (22). In another study from the Netherlands, 55.2% of horses had consistently low FECs (< 100 eggs/g) in 2 consecutive samples taken 6 wk apart (21), and for 303 horses in Germany the egg shedding remained fairly consistent on 9 samples collected over 1 y (24).

Environmental conditions such as temperature and humidity play an important role in egg and larval survival, as well as larval development time on a pasture. Extremely cold winters in western Canada greatly prolong or completely halt the development of strongyle eggs to infective L3 larval stage and decrease viability of eggs (25,26). A study by Polley (25) on the ecology of free-living stages of strongyles on the Canadian prairie showed a total inhibition of strongyle free living larval development for October, December, and January (25). Taken together, the climatic characteristics of different regions should be considered when optimizing a targeted parasite control program.

To our knowledge, strongyle and *Parascaris* spp. infections have not been investigated in seasonally pastured horses in Saskatchewan. Therefore, the goal of our study was to investigate parasite egg shedding over a 12-month period in 2 mare and foal herds under different management conditions, and estimate the strongyle egg shedding consistency in adult horses. Additionally, we report the efficacy of ivermectin on strongyle egg reduction for adult horses.

Materials and methods

Animals and farm management

All procedures and experimental protocols using animals were approved by the University of Saskatchewan’s Committee on Animal Care and Supply, and the University of Saskatchewan Animal Research Ethics Board. Horse owners consented to samples being obtained from their animals and to abide by the requirements of the study, including ceasing anthelmintic treatment of all horses during the study except for 1 treatment administered by investigators.

Fecal samples were collected from all mares and their foals on 2 equine breeding farms (Farms A and B) located within a 120 km radius from Saskatoon, Saskatchewan. Twenty-three mare-foal pairs were included from Farm A, in which mares represented numerous breeds (Standardbreds, Thoroughbreds, and Arabians) and foals were sired by a Friesian stallion. On Farm B, there were 15 Quarter Horse (QH) mares with 16 QH foals, as 1 mare had an additional foster foal. All foals included were born between May and July 2010. Horses on Farm A were housed in a 30 m × 60 m corral pen and fed round bale hay *ad libitum* throughout fall to summer and pastured on 48 hectares during summer months. The history of parasite control on this farm included no anthelmintic treatments for 5 y before starting the study, with the exception of male weanlings, which had been treated with ivermectin paste at the time of castration every year by a local veterinarian. Horses on Farm B were housed in a 4-hectare pen and fed round bale hay *ad libitum* between November and late July, and pastured on 13 hectares in August through October. The history of parasite control on this farm included twice yearly anthelmintic treatments: mares and foals were administered ivermectin (injectable bovine formulation administered orally) and oral pyrantel pamoate, respectively, before pasture turnout (usually in July), followed by administration of ivermectin (same formulation as described) to all horses upon moving to winter pens in November. On both farms, pastures and pens had not been maintained in the past 5 y in terms of manure removal or rotation of pastures.

Sample collection and analysis

The study was performed between July 2010 and September 2011. Fecal samples were collected in July, August, September, November, and December of 2010, and March, May, July, and September of 2011 (mares only). Foals born in 2010 were
sampled in July, August, September, November, and December 2010, and in March, June, and July 2011.

At each sampling, approximately 10 g of feces were obtained directly from the rectum of mares and foals. Samples were transported to the laboratory in a cooler with an ice pack. Samples were stored at 4°C and examined within 48 h of collection. A modified Wisconsin double centrifugal sugar flotation technique was used for all fecal egg counts (FEC) as previously described (27), with a minimum detection limit of 1 egg/g. Briefly, the sample was diluted with water, filtered through cheesecloth, and centrifuged at 300 × g for 10 min. Supernatant was then discarded and the sample was mixed with Sheather’s solution (Jorgensen Laboratories, Loveland, Colorado, USA; specific gravity 1.27) using a vortex mixer. The sample was then again centrifuged at 300 × g for 10 min. Slides were examined at 10× magnification under a standard light microscope. Eggs were counted and classified according to their morphology. All samples were processed and interpreted by the first author.

**Determination of strongyle susceptibility to ivermectin in mares**

In November 2010, following a collection of fecal samples for FEC, 0.2 µg/kg of ivermectin (Eqvalan; Mérial Limited, Baie d’Urfé, Quebec) was administered orally by the first author to all horses. The weight of the horses was estimated by the first and second authors and the breeder, and mean weight was used to calculate dose of ivermectin per horse. Ten to 14 d after anthelmintic treatment, the FEC was repeated and a fecal egg count reduction test (FECRT) was calculated as 100(1-egg count after treatment/egg count pre-treatment) (1).

**Statistical analysis**

All data, including horse number, date, FEC, and FECRT were entered into an Excel spreadsheet (Microsoft; Redmond, Washington, USA). Analyses were performed using R version 3.3.2, “nlme” package Version 3.1-129 for linear mixed effects model analysis, “ordinal” package Version 2015.6-28 was used for ordinal mixed effects model analysis, and “lsmeans” package Version 2.25-5 was used for pairwise comparison analysis. Statistical significance was set at $P < 0.05$ for all tests.

Fecal egg count data are highly skewed (visual justification was made through histograms), therefore median and range (minimum, maximum) are reported in summary statistics. Log-transformation on the FEC egg count was used for further data analysis. Specifically, 1 egg is added to all egg counts before log-transformation to avoid undefined values from logarithmic transforms. The transformed data were then analyzed using linear mixed effects models for each farm and month, with farm and month as fixed effects and horse as a random effect.
transformation. Additionally, FECs collected 10 to 14 d after deworming (December 2010) were removed from further analysis. Three FEC categories (<200, 200 to 500, >500 eggs/g) were used to categorize the egg shedding level.

Linear mixed effects models were used to examine the effects of farm and time (as fixed effects) on the log-transformed egg count data (as outcomes), after accounting for the dependence structure due to repeated measures in horses (as random effect). The assumptions of normality and equal variance were assessed using the specific models.

An ordinal logistic mixed effects model was used to examine the effects of farm and time (as fixed effects) on the 3 FEC shedding categories (as outcomes), after accounting for the repeated measures in horses (as random effect). In addition, post-hoc analysis using Tukey method for P-value adjustment was done for pairwise comparisons between groups.

Shedding consistency was approached with the following 3 methods. Friedman test was used to test for consistency in shedding categories in mares over time, and Wilcoxon signed rank test with continuity correction was used when only 2 time points were compared (September 2010 and September 2011). Lastly, we looked for consistency on 3 samples taken in consecutive grazing seasons (September 2010, July 2011, and September 2011), as described by Nielsen et al (22). Namely, the cutoff of 200 eggs/g was used, and results were presented as percent-age of horses remaining in the same category (<200 eggs/g or ≥200 eggs/g) on third sample, as on 2 previous ones.

Results

Mares

Ninety-seven percent (201/207) of fecal samples were recovered from mares on Farm A and 96% (130/135) from Farm B. On occasion, rectal feces were unavailable at the time of collection. Strongyle eggs were recovered at least once from 89.5% of all mares’ (Farm A and Farm B) fecal samples. *Parascaris* spp. and *Oxyuris equi* eggs were found in 3% and 2% of mares’ fecal samples, respectively. No cestode eggs were detected. Median strongyle FEC was 212, range 0 to 2490 eggs/g. Peak median strongyle FEC in mares was recorded in August 2010 for Farm A and July 2011 for Farm B.

Results from linear mixed effects models showed that both farm (P = 0.0027) and time (P = 0.0009) had statistically significant effects on the log of strongyle FECs in mares, and the farms were significantly different at every collection time. The results from the post-hoc pairwise comparison are shown in Figure 1.

The months of September 2010 and 2011 were used to compare egg shedding distribution and magnitude for Farm A and Farm B (Figure 2). Most horses on Farm A (60% in both years) had high FEC, and most on Farm B (66% and 53%, respectively) had low FEC (Table 1).
Results from the ordinal mixed effects model on shedding categories (low, moderate, and high) showed that both farm \((P = 0.0006)\) and time \((P = 0.0001)\) had statistically significant effects on the strongyle FEC egg shedding categories. For an animal in Farm A, the estimated odds of being in higher shedding category \((> 500 \text{ eggs/g})\) were 16.7 [95% confidence interval (CI): 3.33 to 100, \(P = 0.0006\)] times higher, compared to an animal in Farm B.

When comparing the actual strongyle FEC egg counts in the September months between 2010 and 2011 using Wilcoxon signed rank test with continuity correction, no statistical significant difference was found in Farm A or Farm B \((P = 0.56\) and \(P = 0.06\), respectively) (Figure 3).

Shedding categories for each of the mares did not statistically differ over time for samples collected in grazing season (all samples, excluding December 2010, March and June 2011) in both farms; \(P\)-values from the Friedman test were 0.13, 0.22, and 0.09 for both farms, Farm A and Farm B, respectively. When only post deworming (December 2010) sample was excluded, we found no statistical difference \((P = 0.12)\) in shedding categories over time in mares in Farm B, but there was a significant difference \((P = 0.0036)\) in mares in Farm A.

Lastly, consistency of strongyle FECs was assessed for 3 samples collected in consecutive grazing seasons in September 2010, July 2011, and September 2011. Of horses excreting low FEC (< 200 eggs/g) on 2 former samples (17/38), 94% (16/17) remained in the same category for the third fecal examination. Among horses with FEC results ≥ 200 eggs/g on the first 2 samples (10/38), 8/10 remained in the same category on the third fecal examination. Altogether 27/38 (71%) horses were consistent on all 3 samples either under low or moderate/high shedding categories.

### Foals

Ninety-four percent (173/183) of fecal samples were recovered from foals on Farm A and 96% (124/128) from Farm B. On occasion, rectal feces were unavailable at the time of collection. Strongyle eggs were recovered from 71.9%, *Parascaris* spp. eggs from 48.7%, and *Oxyuris equi* eggs from 7.8% of all foals’ samples.

Median strongyle FEC for foals was 108 eggs/g, range 0 to 1987 eggs/g. Peak median strongyle FEC occurred in July 2011.
on Farm A, and November 2010 on Farm B. Results from linear mixed effects models showed that both farm ($P < 0.0001$) and time ($P < 0.001$) had statistically significant effects on the log of strongyle FEC egg counts in foals, and the results from the post-hoc pairwise comparison are shown in Figure 4.

Median *Parascaris* spp. FEC for foals was 0 eggs/g, range 0 to 1554. Peak shedding occurred in 2010, in the months of August on Farm A, and November on Farm B. Only time had a statistically significant effect ($P < 0.001$) on the log of ascarid FEC egg counts in foals (Figure 5).

**Fecal egg count reduction test**
Ivermectin treatment was 100% effective in reducing strongyle shedding in all adult horses.

**Discussion**
The present study provides information on repeated FECs for adult horses and foals in 2 farms in Saskatchewan with the focus on magnitude and consistency of strongyle egg shedding over time.

The management practices of both breeding farms in our study included a period of time from fall to early summer when horses were crowded in smaller pens, from which manure and organic matter had not been removed for years. Additionally, lack of FEC-based parasite control programs and specific treatments against encysted cyathostomes could have contributed to our herds having both high percentage of strongyle positive samples in adult horses (89.5%) and relatively high median strongyle FECs (212, range: 0 to 2490 eggs/g), in particular in Farm A (416, range: 0 to 2490 eggs/g). The percentage of positive strongyle FECs was higher than reported for some European countries (48.1% in Germany, 61.1% Italy and 60.9% in the UK), but similar to that previously reported in Kentucky (99%) and Nicaragua (94%) (15,16,28).

Hesitance of some horse owners to perform fecal egg examinations likely originates from perceived cost. The frequency of FECs could be diminished based on assumption of shedding consistency among adult horses (> 3 y old) (1). Growing, yet limited knowledge is available on repeatability of FEC results (1,21–24). We looked into patterns of shedding among adult horses, including peak times and consistency, accounting for climate characteristics of our region. The Canadian prairies are unique in regards to their long-lasting, cold winters. With winter air temperatures often below $-20^\circ C$ for extended
periods, such an environment is seemingly less favorable for parasite survival. However, snow cover can keep the temperature to which the parasites are actually exposed more constant and closer to the freezing point, which can greatly prolong egg and larva survival. In a study performed 25 y previously, Polley (25) observed complete inhibition of development of strongyle larvae during the months of October, December, and January in the Saskatoon area. However, a small proportion of eggs placed in experimental plots throughout winter were viable the following spring and these contributed to the peak in number of infective larvae recorded in August and September. Peak strongyle FEC in our study occurred just before (July) and overlapped (August) with the times when environmental larval loads are expected to be high.

Studies evaluating repeated strongyle FEC determined that adult horses (> 3 y of age) tend to fall under the “70/30” rule, whereby the majority of the population sheds a low to moderate amounts of eggs, and a minority of the population (15% to 30%) sheds as much as 83% of all eggs in the grazing season (1,20). Kaplan and Nielsen (20) estimated that “treating all adult horses exceeding a strongyle FEC of 200 EPG, only leads to treating about 50% of the horse population, but still provides about 95% reduction of the overall egg shedding.” Based on our data, Farm B seemed to fit these criteria in the month of September 2010, and to a lesser extent in 2011, in which 93.37% and 60% of horses shed < 500 eggs/g, respectively (Table 1 and Figure 2). In contrast, as many as 60% of horses on Farm A were in the high shedding category for both years. Both farms were also significantly different in regard to shedding categories of individual horses over all FEC collection times. Animals from Farm A had 16.7 times higher odds to be in a shedding category over 500 eggs/g than did animals from Farm B. This particular difference could potentially originate from the historical differences in anthelmintic use in these farms. Other risk factors for gastrointestinal parasites such as use of pasture, high population density, failure to remove manure, housing younger and aged horses together, and lack of advice on parasite control (21–23,29–32) were similar for both farms. It is also possible that there were higher levels of contamination of pens and pastures on Farm A, and/or that environmental parasite stages had higher survival rates due to variability in microhabitat that was beyond the scope of our study.

At the level of the individual horse, we examined the consistency of shedding over time on repeated samples using

![Figure 5](image_url)

**Figure 5.** Means and 95% confidence intervals of lsmeans from linear mixed effects model on log of ascidian FEC in foals. Differences within the farm ($P < 0.05$) are marked with letters, with significance set as $P < 0.05$. Upper- and lowercase letter A represents Farm A, and upper- and lowercase letter B represents Farm B. No significant difference was observed between the farms at any time point.
3 different approaches. Analysis of shedding categories (< 200, 200 to 500, and > 500 eggs/g) over time for both farms combined showed no statistical difference for all samples excluding the post-deworming one (December 10), March and June 2011. The exclusion was based on the assumption that adult horses’ FECs are most reliable in the grazing season (1) when exposure is high enough to distinguish the natural ability of horses’ immune systems to decrease the shedding level versus low shedding due to low environmental exposure (cold months in the Northern hemisphere). Interestingly, Farm B was no different when March and June samples were included in analysis, and this is likely due to fact that animals in Farm B had overall higher odds to be in lower shedding categories; early spring and summer samples would be expected to be overall lower than in the grazing season. We also compared 2 years’ September samples for individual horses separately from each farm. Although statistically there was no difference in shedding levels from one season to another, Farm B was borderline significant at \( P < 0.06 \). This means that some animals switched categories from 1 year to another based on FECs performed in the peak of environmental exposure to parasites, and months after ERP of anthelmintic treatment. Although studies including larger number of animals are warranted, repeating FECs from one grazing season to another should be considered.

Nielsen et al. (22) examined strongyle shedding consistency in 3 consecutive samples from Danish horses that were under strategic parasite control. Fecal exams were performed twice yearly (spring and fall) and anthelmintic treatments administered to all horses with FEC > 200 eggs/g. These authors found that horses with FEC < 200 eggs/g on 2 consecutive samples had 84% probability for the same result on the third sampling. Moderate and high shedders (> 200 eggs/g) had a 59% chance to be within the same category on a third sample. To perform a similar analysis, we used fall, summer and fall samples available, and the likelihood of samples remaining in the same category was even more pronounced, with 94% of low shedders and 80% of moderate and high shedders combined remaining in their respective categories on the third FEC. Repeated fecal samples have inherently high variability for reasons such as uneven egg distribution in feces, seasonal changes in egg production by internal parasites, use of different flotation techniques, changes in environmental contamination (density of horses or other management interventions), or a horse’s health, immune status, and age (13, 16, 31). Our data set was also limited by small number of animals (39 adult horses on 2 farms) while Nielsen (22) used 424 horses on 10 farms, so it is difficult to extrapolate the results to the general horse population of Saskatchewan, and more studies are warranted.

Ivermectin dosed at 0.2 mg/kg body weight reduced strongyle shedding by 100% in adult horses in our study. Considering the historical sparse use of dewormers on Farm A for the past 5 y, this is an expected outcome. Farm B had a history of using the injectable bovine formulation of ivermectin orally. The bioavailability of this product is unknown. Potential under-dosing related to such practice could have selected resistant parasites over time. This does not seem to be the case based on FECRT, yet we did not examine the egg recurrence times, which would provide a more accurate picture of early signs of anthelmintic resistance (1). We did not measure but estimated the weight of the horses due to safety concerns such as working with previously unhandled horses in squeeze chutes. The weights were estimated by 2 veterinarians working with actual horses’ weights on a daily basis in an equine hospital, and by an experienced breeder on each farm. Although not ideal, the alternative method of using weight tape (most commonly used in the field) could have resulted in a similar margin of error as a visual estimate. Reavell (33) looked into visual versus weight tape weight estimates in adult horses, and found similar 8% to 12% error for both methods. Another study found that weight tape estimate was significantly different from horses’ actual weight, with a mean error of 65.81 kg (34).

Strongyle shedding levels in foals differed significantly between the farms. For all collection times that difference was pronounced at \( P < 0.001 \), with foals from Farm A shedding significantly more eggs than foals from Farm B. This correlates well with the high shedding levels observed in adult horses on Farm A, consistent with a potential high degree of pasture contamination. One cannot exclude other factors, such as differences in immune status or genetics of horses on the 2 farms, but this was beyond the scope of the present study.

**Parascaris** spp. is a ubiquitous ascarid parasite of foals and weanlings. Occasionally, *Parascaris* spp. eggs are recovered from adult horses’ feces, generally in immune-compromised animals kept in close association with foals (1, 35). First appearance of *Parascaris* spp. eggs in foal manure begins at approximately 3 mo of age (the prepatent period following ingestion of larvated eggs is approximately 10 wk) and subsides at about 18 mo of age (1). In our study, the peak of *Parascaris* spp. shedding occurred in November for both farms, when foals were approximately 5 (Farm B) to 6 (Farm A) mo of age. Opposite to strongyle shedding in both mares and foals, the farm had no effect on ascarid shedding levels, and the only significant difference was time. This finding is striking considering the historical differences in parasite control in foals between the 2 farms — none on Farm A, and 2 treatments in the first year of life for Farm B. However, as there is no direct correlation between FECs for *Parascaris* spp. and real worm counts in equids (15); FECs may not represent real ascarid infection levels for these foals. Therefore the FECs reported here provide qualitative (decrease in shedding in second year of life) rather than quantitative information.

**Oxyuris equi** eggs were found more often than expected in 7.8% of samples from foals and 2% of samples from adult horses. Historically, *Oxyuris equi* was more commonly found in weanlings and yearlings; however, in recent years it seems to be increasing in adult horse populations (1, 36). All samples in this study were collected directly from the rectum and rectal sleeves had contact with the perianal area. This likely contributed to a number of positive results, together with poor parasite control practices especially on Farm A, and macrocyclic lactone use in adults on Farm B, which may not be as effective in clearing the parasite from the host (36).

We did not find cestode eggs in any of the fecal samples. Cestode eggs pose a diagnostic challenge as they are contained...
within proglottids and are shed intermittently upon disintegration of the proglottid. The recommended diagnostic protocol is to examine FECs 24 h after cestocidal treatment (37), or potential inclusion of a salivary enzyme-linked immunosorbent assay (ELISA) test, which was not done in this study.

In conclusion, the parasite egg shedding in this study was generally high in prevalence and magnitude, and there were significant differences between the 2 farms with different management practices. There was a consistency of strongyle egg shedding in adult horses over time for samples collected in the grazing season. Further studies incorporating larger groups of horses and facilities are warranted to offer more guidance for parasite control strategies under Saskatchewan-specific environmental conditions and equine management practices.

Acknowledgments
Funding was provided by Equine Health Research Fund from the Western College of Veterinary Medicine’s Equine. We acknowledge Drs. Katharina Lohman and Steve Manning, Western College of Veterinary Medicine, University of Saskatchewan for their contribution to the idea for this study, and recruitment of animals. We also thank the owners of Farms A and B for their cooperation in this study. Ivermectin paste was supplied at no charge by Merial.

References
Review Article Compte rendu

Toward a harmonized approach to animal welfare law in Canada

David Fraser, Katherine E. Koralesky, Geoff Urton

Abstract — Animal protection law in Canada varies across the country. Federal animal protection law exists in the Criminal Code, in regulations for the transport of animals, and in regulations for humane handling and slaughter at abattoirs that are inspected by the Canadian Food Inspection Agency. Provincial animal protection laws often include provisions that i) describe a duty of care toward animals; ii) prohibit causing or permitting animal “distress;” iii) specify exemptions from prosecution; and iv) reference various national and other standards. Inconsistencies lead to duplication of effort, create difficulty in working across jurisdictions, and may erode public trust. A more consistent approach might be achieved by i) referencing a common suite of standards in provincial statutes; ii) citing the federal transport and humane slaughter regulations in provincial regulations; iii) establishing agreements so provincial authorities may enforce federal regulations; iv) wider and more uniform adoption of enforcement tools that require people to take immediate action to protect animal welfare; v) developing new standards; and vi) national consultation to define frequently used terms.

Résumé — Vers une harmonisation législative du bien-être animal au Canada. La réglementation applicable en matière de protection animale est variable au Canada. Au niveau fédéral, on retrouve des règles de protection au sein du Code criminel, de la réglementation sur le transport et de celle sur la manipulation et l’abattage lorsque ce dernier a lieu dans les abattoirs inspectés par l’Agence Canadienne d’Inspection des Aliments. Les règles de protection animale applicables au niveau provincial prévoient généralement i) la définition d’un devoir de diligence envers les animaux, ii) l’interdiction de causer ou de permettre une ‘détresse’ chez l’animal, iii) des dispenses à l’exercice de poursuites, et iv) la description de standards, notamment nationaux. L’absence d’uniformisation des textes nuit à l’efficacité des efforts réalisés, complique la compréhension et l’application des textes existants et peut alimenter la méfiance du public. Une approche plus rationnelle pourrait être appliquée en, i) adoptant une liste commune de standards au sein des lois provinciales, ii) citant les normes fédérales régulant le transport et l’abatage des animaux dans les lois provinciales, iii) établissant des accords visant à faire appliquer les lois fédérales par les provinces, iv) élargissant et uniformisant l’adoption d’outils juridiques permettant de prendre des actions immédiates afin de protéger le bien-être des animaux, v) en développant de nouveaux standards et vi) à travers une consultation nationale visant à définir les termes fréquemment utilisés.

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Introduction

Most animal protection law in Canada is made at the sub-national level, especially by provincial and territorial governments which have taken different approaches to the issue (1,2). The result is a patchwork of laws that can be confusing to the public and that prevent Canada from demonstrating a consistent approach to animal protection. In this paper we summarize key differences among the various jurisdictions, illustrate where and how national and other standards are cited in provincial legislation, and suggest ways to move toward a more harmonized national system.

Current animal protection law in Canada

In Canada, national animal protection law is limited in scope. The Constitution Act of 1867 gives the provinces power to make laws with respect to “property” and “all matters of a merely local or private nature in the province.” Animals are considered property under the law, and therefore the provinces have jurisdiction over laws concerning animals kept within the province. However, federal law applies to animal protection in several ways. First, the Criminal Code prohibits acts that wilfully (including recklessly) cause unnecessary pain, suffering, or injury to animals, and it bans certain activities such as the fighting or baiting of animals. Second, the transportation of animals...
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<tr>
<th>Province or territory and Act</th>
<th>Duties of person responsible</th>
<th>Offences and prohibitions</th>
<th>Exemptions to offences</th>
<th>Power to set standards by regulation</th>
<th>Standards referenced</th>
<th>Other requirements</th>
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<tr>
<td>Alberta Animal Protection Act</td>
<td>• to provide adequate food, water, care, protection, shelter, ventilation, and space</td>
<td>• causing distress</td>
<td>• if following regulations</td>
<td>• to develop regulations for animal care</td>
<td>• CCAC guides</td>
<td>• regulations for transport, markets, and assembly stations</td>
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<td>British Columbia Prevention of Cruelty to Animals Act</td>
<td>• to care for the animal, including protecting the animal from circumstances that are likely to cause distress</td>
<td>• causing distress</td>
<td>• if generally accepted practices</td>
<td>• to adopt or incorporate published standards, codes, etc.</td>
<td>• NFACC dairy cattle code</td>
<td>• Sled Dog Standards of Care Regulation</td>
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<td>Manitoba Animal Care Act</td>
<td>• to provide adequate food, water, medical care, protection from injurious heat or cold, space, sanitation, ventilation, and opportunity for exercise</td>
<td>• inflicting acute suffering, injury, harm, anxiety, or distress that significantly impairs health or well-being</td>
<td>• if following standards, codes, etc., specified as acceptable, or generally accepted practices, or if treatment is deemed reasonable</td>
<td>• to designate accepted activities</td>
<td>• PMU code</td>
<td>• standards for circuses and non-domestic species</td>
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<td>New Brunswick Society for the Prevention of Cruelty to Animals Act</td>
<td>• to provide food, water, shelter, and care in accordance with the regulations</td>
<td>• failure to comply with regulations</td>
<td>• if following standards, codes etc., in Schedule A (NFACC codes)</td>
<td>• to specify standards, codes, etc. as acceptable</td>
<td>• NFACC farm animal codes</td>
<td>• licensing for kennels and companion animal breeding premises and retail stores</td>
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<td>Newfoundland and Labrador Animal Health and Protection Act</td>
<td>• none defined</td>
<td>• causing distress</td>
<td>• if the class of animals is exempted from the regulation</td>
<td>• to prescribe standards for facilities, care, and activities involving animals</td>
<td>• NFACC farm animal codes</td>
<td>• Animal Care Regulations</td>
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Table 1. Features of the major provincial/territorial animal protection laws in Canada. Additional Acts with implications for animal care are included in the “Other requirements” column. Current as of September 2017.
### Table 1. Features of the major provincial/territorial animal protection laws in Canada. Additional Acts with implications for animal care are included in the “Other requirements” column. Current as of September 2017 (continued).

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<td>• to prescribe standards for facilities and care</td>
<td>• none</td>
<td>• Standards of Care for Cats and Dogs Regulations</td>
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<td>• Person responsible:</td>
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<td>• if person responsible takes immediate appropriate steps to relieve the distress</td>
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<td>• additional regulations under other Acts&lt;sup&gt;76&lt;/sup&gt;</td>
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<table>
<thead>
<tr>
<th>Province or territory and Act</th>
<th>Duties of person responsible*</th>
<th>Offences and prohibitions</th>
<th>Exemptions to offences</th>
<th>Power to set standards by regulation</th>
<th>Standards referenced</th>
<th>Other requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ontario Society for the Prevention of Cruelty to Animals Act</strong></td>
<td>• to comply with prescribed standards of care</td>
<td>• causing distress</td>
<td>• if following reasonable and generally accepted practices</td>
<td>• to prescribe standards of care</td>
<td>• none</td>
<td>• standards for food, water, medical care</td>
</tr>
<tr>
<td></td>
<td>• Person responsible:</td>
<td>• permitting distress</td>
<td>• in cases of prescribed classes of animals, prescribed circumstances, or prescribed activities&lt;sup&gt;6&lt;/sup&gt;</td>
<td>• to prescribe activities that constitute reasonable and generally accepted practices</td>
<td></td>
<td>• standards for dogs kept outdoors, captive wildlife and primates, marine mammals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• if activity is otherwise reasonable and does not cause unnecessary suffering</td>
<td></td>
<td>• to exempt research done under aegis of CCAC</td>
<td></td>
<td>• additional regulations under other Act&lt;sup&gt;7&lt;/sup&gt;</td>
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<td></td>
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<td></td>
<td>• to provide adequate food, water, veterinary care, shelter, opportunity for exercise, safe transport</td>
<td></td>
<td>• standards for housing, care, and transport of animals used in research facilities</td>
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<td></td>
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<td></td>
<td>• causing or prolonging distress</td>
<td></td>
<td>• standards for dog and cat shelters</td>
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<td>• torturing an animal</td>
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<td></td>
<td></td>
<td>• animal fighting</td>
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<td></td>
<td>• cosmetic surgery&lt;sup&gt;8&lt;/sup&gt;</td>
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<td>• tethering a horse or dog in a way that causes distress</td>
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<td></td>
<td>• loading or unloading an unfit commercial animal</td>
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<td></td>
<td>• if following reasonable and generally accepted practices</td>
<td></td>
<td>• NFACC farm animal codes</td>
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<td></td>
<td>• if activity is consistent with a standard specified as acceptable in regulations</td>
<td></td>
<td>• PMU code</td>
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<td></td>
<td>• if activity is otherwise reasonable and does not cause unnecessary suffering</td>
<td></td>
<td>• CCAC guides</td>
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<td></td>
<td></td>
<td></td>
<td>• to prohibit or restrict activities</td>
<td></td>
<td>• Sled Dog Code of Practice&lt;sup&gt;7&lt;/sup&gt;</td>
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<td>• to adopt standards, manuals, etc.</td>
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<td>• PIJACC recommended space requirements</td>
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<td>• to designate other animals to be included</td>
<td></td>
<td>• specified euthanasia standards&lt;sup&gt;1&lt;/sup&gt;</td>
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<td></td>
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<td>• to make compliance with standards and codes mandatory</td>
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<tbody>
<tr>
<td><strong>Prince Edward Island Animal Welfare Act</strong></td>
<td>• to provide adequate food, water, veterinary care, shelter, opportunity for exercise, safe transport</td>
<td>• causing distress</td>
<td>• if following reasonable and generally accepted practices</td>
<td>• to prescribe standards for facilities and care</td>
<td>• none</td>
<td>• regulation respecting the safety and welfare of cats and dogs</td>
</tr>
<tr>
<td></td>
<td>• Person responsible:</td>
<td>• animal fighting</td>
<td>• if activity is consistent with a standard specified as acceptable in regulations</td>
<td>• to define unacceptable methods of euthanasia</td>
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<td></td>
<td>• transporting or shipping an unfit animal to auction</td>
<td>• if activity is otherwise reasonable and does not cause unnecessary suffering</td>
<td>• to prescribe or adopt codes</td>
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<td></td>
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<td>• to designate other animals to be included</td>
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<td>• to provide adequate food, water, medical attention, protection, space, sanitation, ventilation, and opportunity for exercise</td>
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<td>• if following reasonable and generally accepted practices</td>
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<td>• if person responsible takes immediate appropriate steps to relieve the distress</td>
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<td>• to define unacceptable methods of euthanasia</td>
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</thead>
<tbody>
<tr>
<td><strong>Quebec Animal Welfare and Safety Act</strong></td>
<td>• to provide adequate food, water, suitable living conditions, exercise, protection from excessive heat or cold, proper transport, care when injured, ill, or suffering</td>
<td>• causing distress</td>
<td>• if following reasonable and generally accepted practices</td>
<td>• to prescribe standards for facilities and care</td>
<td>• none</td>
<td>• regulation respecting the safety and welfare of cats and dogs</td>
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<td></td>
<td>• Person responsible:</td>
<td>• animal fighting</td>
<td>• if activity is consistent with a standard specified as acceptable in regulations</td>
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<td></td>
<td>• transporting or shipping an unfit animal to auction</td>
<td>• if activity is otherwise reasonable and does not cause unnecessary suffering</td>
<td>• to prescribe or adopt codes</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>• agricultural, veterinary, teaching, and research activities carried out in accordance with generally recognized rules&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td>• to exempt research done under aegis of CCAC</td>
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<td>• to prescribe or adopt codes</td>
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<td></td>
<td>• to exempt research done under aegis of CCAC</td>
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Table 1. Features of the major provincial/territorial animal protection laws in Canada. Additional Acts with implications for animal care are included in the “Other requirements” column. Current as of September 2017 (continued).

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<tr>
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<th>Standards referenced</th>
<th>Other requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quebec Animal Health Protection Act</td>
<td>non-defined</td>
<td>if following reasonable practices not cause needless suffering</td>
<td>no</td>
<td>additional regulations under other Act</td>
<td>NEFACC farm animal codes</td>
<td>no</td>
</tr>
<tr>
<td>Yukon Animal Protection Act</td>
<td>none defined</td>
<td>if following practices prescribed as acceptable in the regulations</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Labrador Inuit Land Claims Agreement Act</td>
<td>none defined</td>
<td>if following reasonable practices not cause needless suffering</td>
<td>no</td>
<td>additional regulations under other Act</td>
<td>NEFACC farm animal codes</td>
<td>no</td>
</tr>
<tr>
<td>New Brunswick lists the following standards for euthanasia: AVMA Guidelines for the Euthanasia of Animals: 2013 Edition, Guidelines for Euthanasia of Domestic Animals by Firearms (CVMA).</td>
<td>none defined</td>
<td>if following practices prescribed as acceptable in the regulations</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Saskatchewan lists the following standards for euthanasia: AVMA Guidelines for the Euthanasia of Animals: 2013 Edition.</td>
<td>none defined</td>
<td>if following practices prescribed as acceptable in the regulations</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
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<td>Manitoba</td>
<td>non-defined</td>
<td>if following reasonable practices not cause needless suffering</td>
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<td>additional regulations under other Act</td>
<td>NEFACC farm animal codes</td>
<td>no</td>
</tr>
<tr>
<td>Newfoundland and Labrador Code of Practice</td>
<td>none defined</td>
<td>if following practices prescribed as acceptable in the regulations</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>none defined</td>
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<td>Ontario</td>
<td>non-defined</td>
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<td>no</td>
<td>additional regulations under other Act</td>
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<tr>
<td>Alberta</td>
<td>non-defined</td>
<td>if following reasonable practices not cause needless suffering</td>
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<tr>
<td>British Columbia</td>
<td>non-defined</td>
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<td>no</td>
<td>additional regulations under other Act</td>
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<tr>
<td>Alberta Livestock Inspection and Transportation Regulations, the Livestock Dealer Regulations, the Disposal of Deadstock Regulation</td>
<td>non-defined</td>
<td>if following reasonable practices not cause needless suffering</td>
<td>no</td>
<td>additional regulations under other Act</td>
<td>NEFACC farm animal codes</td>
<td>no</td>
</tr>
<tr>
<td>The Livestock Dealer Regulations require licensed dealers to comply with standards of care prescribed by the Livestock Industry Diversification Act; the Meat Inspection Regulations are made under the Meat Inspection Act.</td>
<td>none defined</td>
<td>if following reasonable practices not cause needless suffering</td>
<td>no</td>
<td>additional regulations under other Act</td>
<td>NEFACC farm animal codes</td>
<td>no</td>
</tr>
<tr>
<td>The Fur Farming Regulations, Domestic Game Farm Animal Regulations, Livestock Dealer Regulations, the Disposal of Deadstock Regulation, the Livestock Inspection and Transportation Regulations, and the Animal Safety and Security Manual;</td>
<td>none defined</td>
<td>if following reasonable practices not cause needless suffering</td>
<td>no</td>
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<tr>
<td>In Ontario, these exemptions apply to the Requirement to comply with prescribed standards of care (Section 11.1 of the Act), not to the prohibition on causing or permitting distress (Section 11.2).</td>
<td>none defined</td>
<td>if following reasonable practices not cause needless suffering</td>
<td>no</td>
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</tr>
<tr>
<td>In Ontario, Section 4(1) of the Act states that “accepted activities” include agricultural use of animals, slaughter, research, pest control and others, provided that these are done in a manner that is consistent with a standard, code, etc.</td>
<td>none defined</td>
<td>if following reasonable practices not cause needless suffering</td>
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</tr>
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is subject to regulations under the federal Health of Animals Act. Third, the handling and slaughter of animals at federally inspected abattoirs (abattoirs whose products are allowed to cross provincial and international borders) are regulated under the Meat Inspection Act (1).

On a sub-national level, all provinces plus Yukon have legislation pertaining to the protection, care, or welfare of animals. Provinces define “animal” in different ways, some simply stating that an animal is a non-human being with a developed nervous system, and others listing numerous species under the definition. Laws pertaining to animals differ in several key ways which are summarized as follows and in Table 1.

Duty of care
Seven provinces set out specific duties of people who own or are responsible for animals. In Alberta, for example, a person “who owns or is in charge of an animal” must ensure that the animal has adequate food and water, provide adequate care when the animal is wounded or ill, provide reasonable protection from injurious heat and cold, and provide adequate shelter, ventilation, and space. Manitoba and New Brunswick have similar requirements, and include that a person shall not confine an animal without providing an opportunity for exercise. Nova Scotia specifies roughly similar duties but applies them only to non-farm animals. British Columbia requires that anyone responsible for an animal must care for the animal and protect the animal “from circumstances that are likely to cause the animal to be in distress.” It also requires the operators of a “regulated activity” (keeping sled dogs, dairy farming, and operating a kennel or cattery) to ensure that their employees are “adequately trained and sufficiently equipped” to comply with the relevant regulations, and it creates a structure for the licensing or registration of operators and allows the government to set relevant standards. In Quebec the Animal Welfare and Safety Act specifies that the “owner or custodian” of an animal must ensure that the animal’s welfare and safety are not compromised.

Distress
Most jurisdictions specify some form of offence relating to animal “distress.” Nine provinces and Yukon prohibit any person from causing animals to be in distress, and additionally prohibit the owner (or person in charge) from permitting animals to be in distress. In British Columbia, for example, the Prevention of Cruelty to Animals Act states that “a person must not cause an animal to be in distress” (Section 23.2) and that the “person responsible for an animal must not cause or permit the animal to be, or continue to be, in distress” (Section 9.1).

Nine provinces and Yukon provide definitions of “distress.” For example, in Saskatchewan, an animal is deemed to be in distress if it is “deprived of adequate food, water, care or shelter; injured, sick, in pain or suffering; or abused or neglected.” Alberta’s definition also includes deprivation of adequate ventilation, space, and reasonable protection from injurious heat or cold.

Generally, the legal definitions of distress have broadened over time. For instance, amendments in 2008 to the British Columbia Prevention of Cruelty to Animals Act expanded the definition of distress beyond deprivation of adequate food, water, and shelter to include deprivation of “adequate ventilation, space, care, or veterinary treatment.” In 2012, the definition was broadened further to include deprivation of adequate exercise, failure to protect animals “from excessive heat or cold,” and keeping animals in unsanitary conditions. Manitoba’s law now also prohibits causing an animal “extreme anxiety…that significantly impairs its health or well-being.” Quebec’s definition of distress includes exposing an animal to conditions that cause “extreme anxiety or suffering;” Nova Scotia’s law includes animals that are “suffering undue hardship, anxiety, privation or neglect,” and in Prince Edward Island, distress is “any pain, suffering, harm, extreme anxiety, or other impairment of health or well-being.”

Exemptions
Most of the jurisdictions allow some form of exemption from prosecution under certain conditions. All provinces and Yukon include an exemption in cases in which a person has followed “reasonable and generally accepted practices” (or just “generally accepted practices”) of animal management (Table 1). Some provinces include other exemptions, for example, in Nova Scotia if the person “takes immediate appropriate steps to relieve the distress” or in New Brunswick if the treatment of an animal is “reasonable in the circumstances” or is “consistent with a standard or code of conduct, practice, or procedure specified in Schedule A” which lists the national farm animal codes. However, little or no specific guidance is generally given on the interpretation of terms such as “generally accepted” and “reasonable.” In addition, some provinces create an exemption in cases where a person has followed “regulations” (Alberta) or follows standards that have been “prescribed as acceptable” (Saskatchewan). In such cases, the Act typically gives the government the power to make regulations and/or to adopt existing standards.

Transport and slaughter
Federal regulations for the transportation of animals (Health of Animals Regulations, Part XII-Transportation of Animals) apply throughout the country, but additional provincial statutes, combined with different arrangements regarding enforcement, create a more complex picture. For the most part, only federal authorities or designated individuals are empowered to enforce the federal regulations. However, Ontario and Quebec have agreements with the Canadian Food Inspection Agency (CFIA) whereby provincial inspectors can monitor compliance with the federal transportation of animals regulations in order to achieve more efficient inspection and sharing of information with federal authorities.

Various other regulations for humane transport of animals exist in Alberta and Saskatchewan, and Ontario has regulations for the transport of animals (including livestock) used in research. Ontario also has the Disposal of Deadstock Regulation under the Food Safety and Quality Act which states that the person responsible for a fallen animal shall kill or arrange to have it killed humanely, and that “no person may move a fallen animal before it is killed.” In British Columbia’s Motor Vehicle Regulations, operators of regulated activities (such as keeping sled dogs, dairy farming, and operating a kennel or cattery) must ensure that their employees are “adequately trained and sufficiently equipped” to comply with the relevant regulations, and it creates a structure for the licensing or registration of operators and allows the government to set relevant standards. In Quebec the Animal Welfare and Safety Act specifies that the “owner or custodian” of an animal must ensure that the animal’s welfare and safety are not compromised.
Act Regulations, poultry and livestock must be transported with “adequate accommodation...to ensure that suffocation, injury or overcrowding does not occur.” Additionally, 8 provinces and Yukon contain provisions for the safe transport of animals. For example, Yukon’s Animal Protection Act states that “no person shall transport an animal outside the passenger compartment of any motor vehicle or trailer unless the animal is adequately confined.”

Several provinces (Alberta, Nova Scotia, Ontario, Quebec, and Saskatchewan) have provincial meat inspection regulations containing provisions for humane slaughter that apply to abattoirs that are not inspected by the CFIA and hence are not required to comply with federal regulations. In 4 provinces, however, the wording effectively requires provincially inspected abattoirs to conform to the same standards of humane slaughter as federally inspected abattoirs. Specifically, i) in British Columbia, the Meat Inspection Regulation under the Food Safety Act requires animals to be kept and slaughtered “in accordance with the provisions relating to the humane treatment of animals” contained in the federal Meat Inspection Regulations; ii) in Quebec, in addition to requirements for humane slaughter made under the Animal Welfare and Safety Act, the Regulations Respecting Food under the Food Products Act state that animals “must be restrained, rendered unconscious and bled” in accordance with the relevant sections (Sections 76–80) of the federal Meat Inspection Regulations; iii) Manitoba’s Animal Care Regulation, under the Animal Care Act, states that the slaughter of animals shall be done in accordance with the Meat Inspection Act (Canada) and the Meat Inspection Regulations made under that Act; and iv) Prince Edward Island’s Animal Welfare Regulations under the Animal Welfare Act state that “no person shall slaughter a food animal except in accordance with the provisions of Sections 77 to 80 of the Meat Inspection Regulations.”

Finally, provisions for religious slaughter also exist. Section 77 of the federal Meat Inspection Regulations states that “every food animal that is ritually slaughtered in accordance with Judaic or Islamic law shall be restrained and slaughtered…in a manner that causes the animal to lose consciousness immediately.” Alberta, Ontario, and Saskatchewan also include exemptions on religious grounds in their respective meat inspection regulations.
Compliance orders and other tools to safeguard animal welfare

As additional enforcement tools, some provinces have provisions that allow inspectors, agents, and/or directors to take immediate action, or to require others to take immediate action, regarding animal welfare.

Manitoba, Nova Scotia, Ontario, Prince Edward Island, and Quebec have legislation that authorizes a director, inspector, agent, or minister to issue an order that requires animal owners or custodians to take certain actions. For example, the “Director’s Order to Take Action” in Manitoba authorizes “the director” to order the individual responsible for an animal to take certain actions to relieve the animal of distress or seek veterinary care for the animal. Similarly, in Quebec the minister may order a person to relinquish custody of an animal, or impose other conditions, for a period of 60 days if an animal is in distress. In general, these options allow authorities to require immediate action without the potential delays involved in prosecution. Also in Manitoba, the “Justice’s Order to Restrict Number of Animals” allows a Justice of the Peace to prohibit “an owner from owning or having possession or control of more than a specified number or type of animals.” This type of provision can help deal with people who have a known propensity to hoard animals.

Ontario, Manitoba, and Prince Edward Island have additional options for safeguarding animal welfare at livestock auctions. In Ontario, the Livestock Community Sales Act requires that a provincially appointed inspector be present at auction markets when auction is being conducted. A compromised animal found at the auction can be tagged by a provincially appointed veterinarian so that it must proceed directly to a nearby slaughter plant (or be euthanized, treated, or sent for treatment) and not experience the handling and delays that may occur in the normal marketing process. In Manitoba, the transportation of unfit animals is prohibited by the Animal Care Act. The operator of a commercial animal market or assembly station, therefore, must notify the director of any unfit animals that arrive at the facility and must supply any additional information requested by the director. Under the Animal Welfare Regulations in Prince Edward Island, operators of commercial markets must provide shelter, food, water, and bedding for animals that remain at the market for more than 36 hours, and they must provide appropriate care and treatment if an animal becomes ill, injured, or fatigued.

Duplication of Criminal Code provisions

Seven provincial laws effectively duplicate provisions in the Criminal Code, most notably by banning the fighting of animals (see Table 1).

Standards referenced in animal protection law

In many provinces, animal protection regulations give formal recognition to the following national or other standards (Table 2).

1. Codes of practice for the care and handling of animals have been written for the major farm animal species, currently under the auspices of the National Farm Animal Care Council (NFACC) or, in the case of the code for pregnant mare urine operations, the government of Manitoba.

2. The Canadian Council on Animal Care (CCAC) has published numerous guides and guidelines on the care of animals used for research, teaching, and testing, plus a number of policy statements on matters such as the functioning of institutional animal care committees.

3. The Canadian Veterinary Medical Association (CVMA) has published codes for kennels and catteries, plus guidance on the use of firearms for euthanasia of animals.

4. The Pet Industry Joint Advisory Council of Canada (PIJACC) has published guidance on maximum stocking densities for animals in retail stores, plus other material.

5. The Canadian Association of Fairs and Exhibitions (CAFE) has published an Animal Safety and Security Manual, which is referenced by Manitoba.

6. Finally, Canada’s Accredited Zoos and Aquariums (CAZA, previously called the Canadian Association of Zoos and Aquariums) has an Animal Care and Housing Manual, which is referenced by Newfoundland and Labrador.

Some international standards are also referenced in provincial regulations. These include various guidance documents on euthanasia by the American Veterinary Medical Association (AVMA), Sled Dog Care Guidelines of the Alaska-based organization Mush with Providing Responsible Information on a Dog’s Environment (P.R.I.D.E.) and the Animal Care Guidelines for the Retail Pet Industry, published by the Pet Industry Joint Advisory Council (PIJAC) in the United States (Table 2).

Some provincial governments have created their own standards for specific activities. As examples, Alberta requires that licenced zoos comply with the Government of Alberta Standards for Zoos in Alberta, and British Columbia has regulations for sled dogs under the Prevention of Cruelty to Animals Act, as well as regulations for fur and game farms under the Animal Health Act. New Brunswick requires licenced shelters and pet retail stores to comply with provincial codes for amphibians, small animals, and birds, and the Horse and Pony Hauling Contests Regulation prohibits shouting at and whipping horses and ponies. Ontario has created its own regulation on standards of care for all animals, including captive wildlife and marine mammals, under its Society for the Prevention of Cruelty to Animals Act, and Manitoba and Prince Edward Island have specific requirements for circus animals and other non-domestic species.

Different approaches to referencing standards

The standards described are sometimes used in court cases, for example to establish whether a defendant was following “generally accepted” practices or rules. There is also a growing trend to reference standards explicitly in provincial regulations, but jurisdictions do this in different ways (Table 1).

In the case of farm animals, 6 provinces (British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, Prince Edward Island, and Saskatchewan) reference 1 or more of the national codes for farm animals in their animal protection regulations (Table 1), and Saskatchewan, Manitoba, and
Prince Edward Island reference the code for pregnant mare urine (PMU) operations.

In a different approach, some provinces reference national codes in their marketing or food regulations, sometimes through certification programs developed by producer organizations (3). For example, Nova Scotia’s Animal Care Program and On-Farm Food Safety Assurance Program Regulations under the Natural Products Act, state that chicken producers in Nova Scotia must meet the Requirements of the Animal Care Program and the On-Farm Food Safety Assurance Program that were developed by Chicken Farmers of Canada and is based on the NFACC Code of Practice for the Care and Handling of Hatching Eggs, Breeders, Chicken and Turkeys. Similarly, the Egg Farmers of Alberta Marketing Regulations, under Alberta’s Marketing of Agricultural Products Act, states that the Board may cancel, suspend, or refuse to renew a licence if a registered producer “fails to comply with the animal care policy,” which is based on the NFACC Code of Practice for the Care and Handling of Pullets and Laying Hens.

For laboratory animals, 5 provinces cite 1 or more CCAC guides or guidelines as appropriate standards. Nova Scotia’s Act, while not referencing CCAC documents, gives the government the power to exempt research from prosecution if it is done under the aegis of the CCAC. In contrast, Ontario created its own extensive regulations for laboratory animal care under its Animals for Research Act.

For kennels and other establishments dealing with companion animals, 6 provinces (British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, Prince Edward Island, and Saskatchewan) cite 1 or more national standards. In New Brunswick, for example, licenced kennels must comply with the kennel code of the CVMA, and licenced shelters and pet retail stores must comply with a range of requirements, some of which are taken from the CVMA kennel and cattery codes. In contrast, Nova Scotia and Quebec have regulations regarding the care of cats and dogs, but do not refer to the CVMA codes; Ontario has regulations for animal shelters under its Animals for Research Act; and both Nunavut and the Northwest Territories have a Dog Act that prohibits dog abuse.

Six provinces cite standards for the euthanasia of animals, although details vary from standard to standard, and NFACC codes also generally give guidance on euthanasia, Manitoba, New Brunswick, Prince Edward Island, and Saskatchewan reference the same Guidelines for Euthanasia of Domestic Animals by Firearms, attributed to the CVMA or Longair et al (4), depending on the province. British Columbia also cites these guidelines, but only in the Sled Dog Standards of Care Regulation. New Brunswick, Prince Edward Island, and Saskatchewan cite the AVMA Guidelines for the Euthanasia of Animals: 2013 Edition, while Manitoba cites the 1993 Report of the AVMA Panel on Euthanasia, and Newfoundland and Labrador references the “latest edition” of the Guidelines on Euthanasia published by the AVMA. New Brunswick and Prince Edward Island cite the CCAC Guidelines on: Euthanasia of Animals Used in Science, while Manitoba refers to CCAC’s Guide to the Care and Use of Experimental Animals.

The language used in referencing standards can either create a positive duty to comply or provide a defense by establishing “accepted practices,” giving standards varying degrees of strength in the law. British Columbia and Saskatchewan cite standards as a means of establishing generally accepted practices. Hence, failure to follow the standards is not by itself an offence; rather, the offence consists of causing or permitting distress, and conforming to the standards would allow the defence of following accepted practices. For example, British Columbia’s Dairy Cattle Regulation under the Prevention of Cruelty to Animals Act recognizes the NFACC Code of Practice for the Care and Handling of Dairy Cattle as “reasonable and generally accepted practices of dairy farming.” As another example, the Animal Protection Regulations under the Animal Protection Act in Saskatchewan cite prescribed standards or codes of conduct as “acceptable.”

In contrast, some provinces use language like “shall comply” or “must comply” when referencing certain standards. In Prince Edward Island, for example, license-holders for companion animal retail stores, owners of boarding facilities, and owners of commercial animals and/or sled dogs “shall comply” with the standards referenced, and animals used for research “shall be kept in accordance with” the CCAC guides listed. In Manitoba, the various animal activities listed “shall be done in accordance with” the standards referenced. New Brunswick states that “a person who has ownership, possession or care and control of more than 5 dogs … shall provide the animals with food, water, shelter and care in accordance with” the CVMA code for kennel operations, and that “failure to comply with the Regulations” (where the farm animal codes are listed) is an offence. Additionally, Alberta has the provision that “a person who owns or has custody, care or control of an animal for research activities must comply with” the CCAC documents listed.

Finally, the Animal Protection Regulations of Newfoundland and Labrador take a different approach by referencing a large number of codes and standards, and stating that the code or standard “may be considered a Requirement where the word ‘must,’ ‘shall,’ or ‘require’ is contained in the standard” (Table 1).

**Toward a coherent national system**

In a country as large and diverse as Canada, a persistent challenge is to balance the simplicity of a consistent, national approach against the desire to protect real differences among jurisdictions. Animal protection is an obvious case in point as some aspects (such as criminal law) are national, while many others vary by jurisdiction. The variation is obviously relevant where it meaningfully reflects the diversity of the country including different concerns or practices, for example between jurisdictions that do or do not have farming of wildlife. We suspect, however, that many of the differences in animal protection law in Canada arose more incidentally, for example if legislators or regulators were concerned about specific issues at a given time, or if options that were developed in one province were not widely known in others.

A more consistent, national approach could have several advantages, at least for jurisdictions with significant animal industries and a public that expresses concern over animal welfare. Many animal producer and user organizations support codes of practice (including the NFACC codes and CCAC guides) and see them as a way of maintaining good standards
and public confidence in their spheres of activity. However, because these codes and guidelines have different legal status in different jurisdictions, they provide limited assurance to the public of a consistent system of animal protection, and Canada cannot assure potential trading partners of a uniform approach. The use of national standards could also prevent duplication of effort in creating, enforcing, and complying with standards. In Ontario, for example, research establishments currently must comply with provincial regulations under the Animals for Research Act as inspected by provincial officials, and most must also comply with CCAC guides as assessed by the CCAC. In addition, some provinces duplicate each other's efforts, for example, by writing provincial standards, such as Nova Scotia's Standards of Care for Cats and Dogs Regulations rather than adopting national standards such as the CVMA kennel and cattery codes. The NFACC has established methods for using scientific evidence as a basis for setting standards for farm animals with broad input from across the country. This method seems likely to create public confidence (3,5), whereas the \textit{ad-hoc} development of provincial standards may not.

Greater harmonization of animal welfare law could be relevant to veterinarians in several ways. As captured in the Veterinarian's Oath, veterinarians aspire to be promoters of animal welfare, but in Canada, as a federated nation, they have little national policy to draw on (6,7). Creation of an effective national approach to animal welfare law could support veterinarians in this role and simplify their work in cases in which individuals practice in more than one province or territory. Veterinarians are also directly involved in animal welfare enforcement in some jurisdictions; this work could be facilitated if jurisdictions adopt effective regulations and compliance tools that have already proven valuable in other provinces. Moreover, many veterinarians play key roles in developing provincial/territorial policies and regulations; hence, communication and cooperation among veterinary services could play an important role in harmonization.

A concern is sometimes expressed that if codes are cited in regulations, there may be a temptation to include only minimal standards in future codes. Experience does not appear to support this view. For example, the NFACC \textit{Code of Practice for the Care and Handling of Dairy Cattle} was published in 2009 when codes were already referenced in several provinces, yet it contained major new Requirements, for instance that pain control must be used for disbudding, dehorning and castration, and that tail-docking be discontinued "unless medically necessary." Similarly, the NFACC \textit{Code of Practice for the Care and Handling of Pigs} (published in 2014) called for significant changes regarding pain control and limits on the use of gestation stalls.

In some provinces regulators may not wish to cite national standards because they do not want to be bound by standards set by an outside body, especially if these may be revised in the future. However, many provinces now have years of experience in citing national standards, and the trend over time has been for more provinces to adopt the approach and for none to abandon it. In addition, standards are normally cited in Regulations rather than the Act, so provincial regulators could make changes with relatively little difficulty if a standard is revised in a way that proves unacceptable to them.

Movement toward a consistent national program might be achieved in several ways.

1. One option is that provincial regulations could cite the same suite of codes and guidelines in a consistent way so that the same basic standards apply throughout the country. It may also be helpful to specify that it is the "Requirements" of the codes that should be followed, so that codes can continue to include recommendations for best practices without the risk that these will be interpreted as mandatory.

2. Marketing regulations and other programs that license or certify producers could incorporate codes in uniform ways, possibly following the examples of Alberta and Nova Scotia.

3. Provinces and territories could also cite the federal regulations for humane treatment and slaughter of animals, under the \textit{Meat Inspection Act}, so that these become the standard for provincially as well as federally inspected abattoirs.

4. Similarly, provinces and territories could cite the federal transportation of animals regulations, so that both provincial and federal officials are empowered to enforce what are effectively the same transportation standards.

5. Agreements between federal and provincial/territorial authorities, such as those that exist in Ontario and Quebec regarding the transportation of animals regulations, could allow provincial/territorial officials to enforce federal regulations and allow sharing of information on compliance perhaps via a shared database. This might require an agreement on cost-sharing as well.

6. Enforcement tools that authorize immediate action, such as compliance orders and options for handling compromised animals at auction markets, could be adopted more broadly and in a consistent manner.

7. When a jurisdiction needs a new standard, the process could be done at a national level according to the well-established procedures for code development of organizations such as NFACC.

8. As a more long-term goal, national consultation might help to achieve broad agreement on common approaches including duties of owners, the definition of distress, and other common terms such as "reasonable and generally accepted practices" so that more uniform approaches can be adopted as appropriate when Acts are revised.

9. Consultation and sharing of experience might help to clarify the effects of duplicating certain provisions, notably the ban on animal fighting that occurs in both criminal and certain provincial laws.

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References


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Veterinary Practice Management
Gestion d’une clinique vétérinaire

Veterinary care across Canada: Average provincial fees in 2017
Soins vétérinaires au Canada : tarifs provinciaux moyens en 2017

Chris Doherty

Venturing across Canada, one becomes acutely aware of how different the price can be for similar items, depending on where you find yourself. Filling up a gas tank in Vancouver is a much more expensive proposition than in St. John’s. Veterinary medicine is no different in this regard, with fees fluctuating extensively from coast to coast.

Using the 2017 CVMA Provincial Practice Owners Economic Surveys, the average fee for a number of companion and large animal procedures can be assessed from province to province. Nine bellwether treatments/items were selected across bovine, equine, and companion animal medicine. The average fee for these items in each province is presented in Table 1.

Alberta leads in bovine fees, with the exception of the mileage fee. Saskatchewan has some of the highest equine fees, while Nova Scotia has the priciest equine call fee. Ontario and Alberta were in a close race for the highest companion animal fees, with Ontario edging ahead on feline ovariohysterectomy fees.

However, as with most comparisons between provinces, it is insufficient to simply weigh average fees without including recognition of the variable cost of living across the nation. The cost-of-living index is a method of comparing how much a consistent standard of living costs in different places. This index measures various expenses, such as shelter, food, transportation, clothing, taxes, etc. By adjusting to take into consideration these Lorsque l’on voyage au Canada, on constate à quel point les prix peuvent varier pour des articles semblables selon l’endroit où l’on se trouve. Faire le plein d’essence à Vancouver est beaucoup plus dispendieux qu’à St. John’s. La médecine vétérinaire n’est pas différente à cet égard et les tarifs peuvent grandement varier d’un océan à l’autre.

On peut évaluer le tarif moyen de plusieurs interventions pour animaux de compagnie et grands animaux d’une province à l’autre en utilisant l’édition 2017 des Sondages économiques provinciaux auprès des propriétaires de pratique de l’ACMV. Neuf traitements ou services indicateurs de tendances ont été choisis en médecine bovine, équine ou des animaux de compagnie. Le tarif moyen de ces interventions dans chaque province est présenté au Tableau 1.

L’Alberta mène le classement pour les tarifs bovins, à l’exception du tarif facturé pour le kilométrage. La Saskatchewan affiche quelques-uns des tarifs équins les plus élevés, tandis que la Nouvelle-Écosse comporte les tarifs les plus dispendieux par appel pour les équidés. L’Ontario et l’Alberta se menaient une course serrée pour les tarifs les plus élevés pour les animaux de compagnie, tandis que l’Ontario prenait une longueur d’avance pour les tarifs de l’ovariohystérectomie féline.

Cependant, comme pour la plupart des comparaisons entre les provinces, il est insuffisant de simplement pondérer les tarifs...

Dr. Doherty is a graduate of the Ontario Veterinary College and he works as an economic analyst for the Ontario Veterinary Medical Association.

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Le Dr Doherty est diplômé de l’Ontario Veterinary College et travaille en tant qu’analyste économique pour l’Ontario Veterinary Medical Association.

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differential economic realities, a more accurate assessment of average veterinary fees is possible.

Utilizing the Statistics Canada Survey of Household Expenditure by Province, the average provincial fee for each of the bellwether treatments/items was adjusted to incorporate cost of living into the calculation. The results are presented in Table 2.

Once adjusting for cost of living, the highest fees may not be where one would expect to find them. Alberta's bovine fees slip below those of Saskatchewan. In equine medicine, Nova Scotia climbs to the top, with the highest call fee and physical examination fee; the most expensive hourly rate remains in Saskatchewan. New Brunswick and Newfoundland and Labrador companion animal fees increased significantly after including cost-of-living adjustments.

Theoretically, after adjusting for cost of living, similar items should have very similar, if not identical, prices across the provinces. After all, a tank of gas in Vancouver is not much different from one in St. John's. Those provinces that have cost-of-living adjusted average fees that significantly lag their neighbors may wish to look closer into the reasons behind the discrepancy. For example, Prince Edward Island’s cost-of-living adjusted average companion animal examination fee is $70.84, compared with $85.99 across the Confederation Bridge in New Brunswick. Assuming that an examination is not drastically different between these two provinces, it leads one to question why the gulf between the fees exists, and if this is an opportunity for Prince Edward Island veterinarians to raise their fees to closer match those found in New Brunswick.
Table 2. 2017 average cost-of-living adjusted provincial fee for bellwether bovine, equine, and companion animal medicine treatments/items.

<table>
<thead>
<tr>
<th>Treatment/Item</th>
<th>Cost-of-living adjusted provincial fee/ Tarif provincial ajusté au coût de la vie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bovine examination fee</td>
<td>$350.10</td>
</tr>
<tr>
<td>Bovine hourly rate</td>
<td>$227.83</td>
</tr>
<tr>
<td>Bovine mileage (per km)</td>
<td>$152.50</td>
</tr>
<tr>
<td>Equine call fee (&lt; 35 km)</td>
<td>$112.10</td>
</tr>
<tr>
<td>Equine hourly rate</td>
<td>$112.10</td>
</tr>
<tr>
<td>Equine physical examination</td>
<td>$112.10</td>
</tr>
<tr>
<td>Companion animal examination</td>
<td>$112.10</td>
</tr>
<tr>
<td>Canine examination and vaccines</td>
<td>$112.10</td>
</tr>
<tr>
<td>Feline ovariohysterectomy</td>
<td>$112.10</td>
</tr>
</tbody>
</table>

Notes: Average treatment/item fees were calculated using 2017 Provincial Practice Owners Economic Surveys. Cost-of-living adjusted average fee was calculated through use of the most recent Statistics Canada data on Average Household Expenditures, by Province. The Average Household Expenditure in each province was divided by the Average Household Expenditure of the nation as a whole, to determine the province-to-nation ratio. This ratio was then multiplied by the average fee in each province to determine the cost-of-living adjusted average fee in each province.

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Concomitant feline immunodeficiency virus (FIV) and Mycoplasma haemofelis in a barn cat

Alejandra Ceballos-Vasquez

Abstract — A 5-year-old male barn cat was presented with lethargy and excessive bleeding following castration. The patient developed hemolytic anemia and diagnostic tests revealed infection with feline immunodeficiency virus and Mycoplasma haemofelis. This case serves as a reminder of the importance of testing for infectious diseases and educating owners on feline infectious disease prevention and management.


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On June 6th, 2017, a 6.4 kg, 5-year-old intact domestic shorthair cat was presented at Troy Veterinary Services for elective castration as part of a barn cat sterilization program to provide surgical experience during the student externship. The patient had been vaccinated for rabies in April 2016 and had no history of previous medical illnesses. Physical examination completed before surgery revealed tachycardia, multiple old scars on the face/neck area, and 4 broken canine teeth with significant inflammation around the base of the teeth. Respiratory rate was not obtained due to excessive purring; all other vital signs and the rest of the physical examination were within normal limits. An open castration was performed and there were no complications associated with anesthesia or surgery. There were no signs of complications after surgery, the patient recovered well and was discharged in the afternoon later that day.

The following day the patient was presented by the owner for lethargy and excessive bleeding from the surgery site. On presentation the cat was bright, alert, and responsive and some minor bleeding was observed from the right scrotal incision; no inflammation was noted. The patient was tachycardic and tachypnic, but the rest of the physical examination did not identify any other abnormalities. Blood was collected from the medial saphenous vein for in-house determination of packed cell volume (PCV) and total solids (TS). A PCV of 26% was below the reference interval (RI) (30% to 45%) for cats, while TS of 68 g/L was within the RI (55 to 75 g/L). No plasma discoloration was observed in the capillary tube. The patient was kept overnight for monitoring. On June 8th, 2017 PCV and TS were measured again and both values (22% and 50 g/L, respectively) were below the reference intervals; moderate hemolysis was observed in the plasma. The patient was less active and a mild cough was noted; however, he continued to eat and drink well. Slight bleeding was observed from the right scrotal incision.

A complete blood (cell) count (CBC) revealed a regenerative anemia [hematocrit (HCT) was 30.1% (RI: 30.3% to 52.3%), hemoglobin (HGB) was 95 g/L (RI: 98 to 162 g/L), reticulocytes 105 × 10^9/L (RI: 30.0 to 50.0 × 10^9/L)] and monocytosis, 0.9 × 10^9/L (RI: 0.05 to 0.67 × 10^9/L). Red cell distribution width was 24.7%, the high end of normal, (RI: 15.0% to 27%) suggesting a shift to macrocytic anemia. Cytological examination of erythrocytes on a blood smear stained with Diff-Quik revealed moderate anisocytosis, 1 to 2 reticulocytes per high power field, and occasional hypochromic erythrocytes. Monocytosis and occasional band neutrophils were observed, while eosinophils and lymphocytes appeared normal. Small cellular inclusions consistent with Mycoplasma haemofelis were observed on erythrocytes (Figure 1). From the clinical presentation and blood analysis differential diagnoses included opportunistic infection with Mycoplasma spp. secondary to feline immunodeficiency virus (FIV) or feline leukemia virus (FeLV) immunosuppression or idiopathic hemolytic anemia plus possible chronic respiratory infection.

Blood from the jugular vein was collected and sent to the Animal Health Laboratory (AHL) (Guelph, Ontario) for
FIV/FeLV ELISA and Mycoplasma spp. polymerase chain reaction (PCR). Fecal flotation was negative for parasites. Lateral and dorso-ventral radiographs revealed a cranio-ventral and caudo-dorsal interstitial to alveolar pattern and pneumonia was suspected. Also, an irregularly marginated soft tissue structure in the right caudal lung lobe was observed (Figure 2). The patient was started on amoxicillin/clavulanic acid (Clavaseptin; Vétoquinol, Lavaltrie, Quebec), 62.5 mg, PO, q12h for 10 d. The cat remained in the hospital pending results of the tests. The patient was started on doxycycline (doxycycline hyclate capsules; Apotex, Toronto, Ontario), 100 mg, PO, q24h for 14 d. Although the patient continued to maintain a good demeanor, good appetite, and no other clinical signs while in the hospital, by the 7th day of hospitalization the PCV had dropped to 15% while TS remained within normal range. Also, the cat's weight dropped from the initial 6.4 kg to 5.9 kg. Due to owner's circumstances the cat was discharged on that day. The owner was informed about management of FIV and the importance of compliance with antibiotic treatment.

Telephone communication with the cat's caretaker the following week indicated that the cat had improved activity and was eating and drinking well; however, coughing persisted. At last communication with the owners, 22 d after discharge, the patient was doing well. There was no further follow-up.

Discussion

Feline immunodeficiency virus (FIV), a common infectious agent of cats, is a retrovirus that resembles human immunodeficiency virus (HIV) (1). Experimental infection of naïve cats with FIV has shown the disease has a similar progression as infection of humans with HIV: following initial acquisition there is an acute phase, then an asymptomatic phase, and lastly a terminal phase, which has been named “feline acquired immunodeficiency syndrome — FAIDS” (2). During the acute phase cats can present with transient fever, leukopenia, and lymphadenopathy; but often these clinical signs go unnoticed (3). It may be difficult for owners to recognize these clinical signs, particularly if the animal lives outdoors and is not under constant supervision, such as in this case of a barn cat. Cats may be asymptomatic for years following the initial response of the immune system; therefore, it is impossible to determine a timeline for infection. Cats infected with FIV have an impaired immune system due to reduced CD4+ helper T-cells, making them more susceptible to opportunistic infections (2,4). Life expectancy in FIV positive (FIV +ve) cats has been reported to be not significantly less than for FIV negative (FIV −ve) cats (2,4); but this could be due to lack of exposure to opportunistic agents or highly virulent pathogens (4). Infection with FIV persists for life (2–4) and death within 2 y of positive testing has been reported in 18% of positive cats (2).

Prevalence of FIV infection in cats in North America (4–11) ranges from 0.9% in healthy indoor cats (5) to 23% in stray cats (6); however, all studies found males are over-represented. For example, in a 2006 survey, 71.7% of all FIV positive cats were males (5); furthermore, intact males had a higher prevalence than castrated males (5,6). Transmission of the virus is commonly a result of bite wounds, although vertical transmission has also been described (4,12,13), so it is not surprising that intact males are overrepresented as they are more likely to be involved in fights with other males. The patient described here had multiple scars, so there is a high possibility that he had been involved in cat-to-cat aggression. In North America, it is not possible to differentiate positive FIV results because of natural infection from those due to vaccination (3,5).

*Mycoplasma haemofelis* is one of the 3 known species of hemotropic mycoplasmas or hemoplasmas, Gram-negative bacteria that attach to the outer surface of erythrocytes. *Mycoplasma haemofelis* is the most pathogenic of the 3; the other 2, Candidatus *Mycoplasma haemominutum* and Candidatus *Mycoplasma turicensis* are less pathogenic (14,15). Although *M. haemofelis* is one of the most common infectious causes of regenerative anemia in cats (16) and one of the causative agents of immune-mediated hemolytic anemia (IMHA) (16,17), it is also the least prevalent of the 3 (18). The frequency of cats presenting with anemia due to hemotropic *Mycoplasma* infection has been reported at 14% (19). Immune-mediated hemolytic anemia
in cats is not commonly a primary disorder, but rather a secondary disease. In cats infected with *M. haemofelis*, the damage to the red blood cells is not directly caused by the bacteria, but is a result of the immune response to the infection (16,17).

Clinical signs of hemoplasmosis can vary depending on factors such as stage of infection and concurrent diseases; however, acutely ill cats often present with anorexia, weight loss, depression, lethargy, pallor, and dehydration (14). Anemia and bacteremia are observed following the acute phase which can last 3 to 4 wk (18). On the day following castration, one of the owner’s presenting complaints was lethargy; anorexia, pyrexia, dehydration, and pallor were not observed. Weight loss was observed towards the end of the hospitalization period, and could have been due to an unidentified cause. It is impossible to determine the exact timeline for hemoplasma infection, and it is possible that the patient had been an asymptomatic carrier and that stress caused reactivation of the infection as has been reported (16,18). Removing a barn cat from his territory, taking him into a new and stressful environment such as a veterinary clinic, in addition to the stress associated with castration, may have been enough for the disease to recur.

Feline hemoplasma infection is more common in males (18), and while there is controversy as to whether or not there is an association with retroviral infection (18,20), 1 study reported that cats infected with *M. haemofilis* are 6 times more likely to be FIV positive (21). Despite the lack of direct relationship between retroviral and *M. haemofilis* infections, infections with intracellular organisms are common in FIV positive cats. In the present case we could not determine if this patient was infected by FIV first, which made him more susceptible to *M. haemofilis*.

Transmission of hemoplasmas has been attributed to arthropod vectors (i.e., fleas) (22,23), but transmission in the absence of vectors has also been observed (14), and may be due to cat aggression (23). The patient had a significant amount of old scars and scratches that could be an indication of previous fights, which could have resulted in acquiring FIV and/or *M. haemofilis*. The treatment of choice for cats infected with feline hemoplasma is doxycycline, but only partial clearance has been observed despite appropriate dosage and duration (14,16,18). Long-term clearance (6 mo) was demonstrated in 1 case with treatment for 6 wk (24). The patient in this report was treated with a higher dose than recommended, due to his clinical condition and our knowledge of poor response of hemoplasmas. Whether this treatment resulted in clearance is not known as the patient was lost to follow-up.

It is important to isolate and segregate cats known to be positive for retroviruses to avoid the spread of FIV and other infectious diseases among feral, stray, and owned free-roaming cats. Since 2013 there have been no studies on the seroprevalence of FIV in Canadian cat populations. Knowledge of seroprevalence of infectious diseases such as FIV and FeLV is important to monitor frequency and distribution of this and other diseases in cats. In 2008, the American Association of Feline Practitioners recommended a partnership between pet owners and veterinarians, with the intention of educating people, and increasing testing and vaccination to maximize prevention (3). We need to emphasize to owners that although FIV and FeLV on their own might not result in disease, predisposing cats to other infectious diseases can not only reduce cat life-expectancy and quality of life, but can also result in diseases with zoonotic potential. The potential for zoonosis with hemoplasma infection has been described (14,18). Furthermore, preventing transmission can help in preventing mutations that might facilitate crossing into new host species (6).

This case serves as a reminder of the importance of improving testing for infectious diseases and educating owners on feline infectious disease prevention and management.

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Answers to Quiz Corner
Les réponses du test éclair

1. A) A foreign body in the upper trachea, airsacculitis, pneumonia, and hepatomegaly may result in a decrease in the amount of vocalizing the bird does but not necessarily in the sound of the voice. To have this effect, the disease would have to be located at the syrinx, one of the most common locations for aspergillomas to develop. Pionus parrots are predisposed to this disease.

A) Un corps étranger dans la partie supérieure de la trachée, une aérosacculite, une pneumonie et une hépatomégalie, peuvent conduire à une diminution de la quantité des sons que l’oiseau émet, mais pas nécessairement dans le son de sa voix. Pour avoir cet effet, la maladie doit être localisée dans la syrinx, un des endroits les plus communs pour les aspergillomes à développer. Les Pionus parrots sont prédisposés à cette maladie.

2. D) Answer A is a very small cataract, answer B does not yet completely fill the lens, answer C completely fills the lens, and answer D is the stage of cataract resorption.

D) La réponse A est une très petite cataracte, la réponse B ne remplit pas complètement le cristallin, la réponse C remplit complètement le cristallin et la réponse D est le stade de résorption de la cataracte.

3. B) Angiotensin-converting enzyme inhibitors may delay the progression of dilated cardiomyopathy to development of clinical signs.

B) Les inhibiteurs de l’enzyme de conversion de l’angiotensine peuvent retarder la progression de la cardiomyopathie dilatée pour le développement des signes cliniques.

4. C) Head bobbing and vocalization is normal while a foal learns to suckle.

C) Le branlement de la tête et le hennissement sont normaux lorsque le poulain apprend à téter.

5. D) The Cushing or Utrecht patterns are preferred. Both are continuous, inverted, and are placed partial thickness through tissue. The first closure is usually oversewn with the same pattern.

D) On préfère la suture de Cushing ou la suture d’Utrecht. Les deux sont des sutures continues, inversées et placées à épaisseur partielle à travers les tissus. La première fermeture est habituellement en surjet avec le même motif.
Feline atopy (also called non-flea non-food allergic dermatitis or feline atopic dermatitis) is a type 1 hypersensitivity reaction causing pruritic skin disease in cats associated with the presence of skin-fixed or circulating immunoglobulin E (IgE) antibodies specific to environmental antigens (allergens) (1,2). Feline atopy is regarded as the second most common allergy in cats after flea allergy dermatitis (3). In a retrospective study with data collected over 11 years (2001 to 2012) disease prevalence of feline atopy was reported to be 12.5% (4).

Increasingly, similarities between feline atopy and atopic dermatitis in humans and dogs are being documented. As in canine atopic dermatitis, feline atopy seems to be caused by an exaggerated IgE and immunoglobulin G (IgG) response to environmental allergens (5,6), but measurement of allergen-specific IgE does not help discriminate between normal and atopic cats (7). While cutaneous changes on skin biopsy from atopic cats are well-described and histopathologic findings of feline atopy have been studied in detail (8), it is not a reliable diagnostic tool. Histopathologic studies have helped us to understand the pathogenesis and similarities to atopic dermatitis in other species, including characterization of infiltration of activated antigen-presenting cells and T-lymphocytes in the skin of atopic individuals. Increased numbers of dermal mast cells, the predominance of CD4+ T-cells in lesional skin of cats with allergic dermatitis as well as increased CD4+ T-cells in non-lesional skin of affected cats compared with the skin of healthy cats are comparable to findings in the skin of human atopic patients (8).

As would be expected in an allergic patient, indoor and/or outdoor environmental allergens including insects play a role in exacerbating symptoms. Various studies have demonstrated effects of seasonality as well as the common allergens involved in the disease, which are likely affected by geographical variations and cultural differences that affect patient lifestyle. Clinically,
Clinical signs and diagnosis

The primary symptom exhibited by an allergic patient (Figures 1, 2) is pruritus (including over-grooming). However, some feline patients may not present with a history of pruritus as they may exhibit such signs only privately, termed “silent grooming.” Pruritus and/or cutaneous lesions secondary to feline atopy may be exhibited seasonally or non-seasonally, based on the specific offending allergens. Diagnosis is not straightforward due to lack of a unique presenting picture of the typical feline atopic patient. Some cats may present with self trauma leading to bilateral symmetrical alopecia, while others may exhibit excoriations. Recurrent otitis externa, miliary dermatitis, head and neck scratching, and eosinophilic granuloma complex lesions are other presenting patterns associated with feline atopy. These varied presenting complaints make the differential list for feline atopic dermatitis long (Table 1).

Miliary dermatitis and eosinophilic granuloma complex are distinctive clinical patterns associated with feline atopy that are not reported in dogs and humans (1). As cats with flea allergy or cats with food allergy can also develop these lesion patterns, they are not considered specific for atopy but are a generic manifestation of allergies in cats. Eosinophilic granuloma complex lesions include indolent ulcer, eosinophilic granuloma, and eosinophilic plaque lesions.

Historically, it was believed that allergic cats rarely developed secondary skin infections. However, secondary cutaneous infection is increasingly apparent in feline atopic patients, including pyoderma and Malassezia dermatitis (4,10). Eosinophilic plaques and indolent ulcers may also represent pyoderma (11). Methicillin resistant staphylococcal infections are also noted in cats affected by cutaneous disease in general, including cats affected by allergic skin disease. Young cats are predisposed to atopy, with most (more than 75% of cases) showing clinical signs within the first 3 y of life (1,4,12). As up to 22% of atopic cats may exhibit onset of signs after 7 y of age (4), environmental allergies should not be ruled out solely based on age of presentation.

No single diagnostic test is available that can reliably diagnose feline atopy. A diagnosis is made based on suggestive historical information, clinical symptoms, and the exclusion of differential diagnoses (see Table 1). Due to varied presentations of the disease, a thorough diagnostic workup is usually required including a diet elimination trial of 8 to 12 wk (some patients may require multiple diet trials and possible restriction to indoor-only environment), flea prevention for a minimum of 8 wk (including all other household pets), treatment of secondary infections, dermatophyte culture, and monitoring by the pet owner for improved patient comfort, or a lack thereof. Skin biopsy is usually an unhelpful test as it does not add information with regard to the cause of allergic dermatitis (e.g., food versus environmental allergens), but can be useful to help rule out some differential diagnoses.

Commercial serologic allergy tests that help detect allergen-specific IgE for common regional allergens are available, but it should be kept in mind that serology does not distinguish between normal and atopic cats. Intrinsic atopic patients produce a low level of allergen specific IgE, thus reducing the role of IgE antibodies in the workup of these individuals. Intradermal allergy testing is primarily performed by and available through veterinary dermatologists. With the increased diagnostic accuracy of this test due to incorporation of intravenous fluorescein.
The purpose of allergy testing is to select allergens to include for allergen specific immunotherapy and to gain knowledge about allergen avoidance measures indicated for the specific patient.

Treatment and management

Management for feline atopy is life-long and usually involves various treatments and lifestyle changes or adjustments for the patient as well as pet owners. Depending on severity of the disease, patient and owner compliance as well as overall patient health, an individualized treatment plan is usually designed. While drug-based treatment trials should not be a replacement for appropriate workup, symptomatic treatment of pruritus with glucocorticoids or cyclosporine is usually helpful in providing patient comfort. As cats are generally more resistant to the adverse effects of glucocorticoid therapy, this form of therapy tends to be used more frequently than in dogs, although long-term corticosteroid therapy demands baseline testing as well as ongoing monitoring along with client education about the potential for adverse effects. If corticosteroid therapy is continued beyond the stage of patient workup, use should be tapered down to the lowest possible frequency. Although used fairly often by some practitioners, long-acting injectable steroids should be used only as a last resort because life-threatening cardiac effects have been identified in up to 11% of cats (2). Other systemic adverse effects include diabetes and urinary tract infection.

Cyclosporine (Atopica) is licensed for use in cats at 7 mg/kg body weight (BW) once daily and can be particularly helpful for cats that do not tolerate glucocorticoids or have been diagnosed with diabetes. It is very well-tolerated in cats, has few adverse effects and is efficacious in cats affected by allergic skin disease (13,14). Many cats can be maintained on pulse therapy to help control symptoms long-term. This treatment is not recommended for cats that go outdoors, are known hunters, or are raw meat eaters as toxoplasmosis can result from the inhibition of T-lymphocyte function due to cyclosporine. Pruritus control may also be achieved with antihistamines or essential fatty acid supplements, although few patients are well-managed on one of these modalities alone. Essential fatty acids can be helpful due to their synergistic effect when administered in combination with other therapies. Oclacitinib (Apoquel) therapy has been attempted recently with short-term benefits noted in some patients but long-term studies or studies on a large set of atopic cats are lacking. Use of Apoquel in cats is considered “off label” therapy.

Allergen specific immunotherapy (ASIT) is a long-term treatment that is considered to be safe and effective with success rates range from 60% to 78% (15). The goal of immunotherapy is to successfully reduce or eliminate clinical signs associated with repeated exposure to causative allergens. A 50% to 100% improvement in clinical signs or decreased use of anti-pruritic drugs is usually regarded as a successful patient outcome. Clinical improvement is usually noted within 3 to 8 mo but can take up to 1 y in some cats. Allergen avoidance and control forms an essential component of managing a feline atopic patient, similar to canine and human counterparts. Most easily applied allergen avoidance measures are specific to house dust mite allergic patients including the use of air filters, treatment of carpets and mattresses, or use of dehumidifiers. The prognosis for an atopic feline patient is good for most cats in which some degree of allergen avoidance, allergen specific immunotherapy, and/or pruritus control can be implemented for improved comfort and prevention of secondary infections. Successful management, however, usually requires ongoing therapy.

References


Table 1. Differential diagnoses for feline atopic dermatitis.

<table>
<thead>
<tr>
<th>Primary diseases</th>
<th>Secondary diseases</th>
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<tbody>
<tr>
<td>Flea bite hypersensitivity</td>
<td>Otitis externa</td>
</tr>
<tr>
<td>Food allergy</td>
<td>Otitis media</td>
</tr>
<tr>
<td>Mosquito bite hypersensitivity</td>
<td>Pyoderma — superficial or deep</td>
</tr>
<tr>
<td>Demodicosis</td>
<td>Malassezia dermatis</td>
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<td>Dermatophytosis</td>
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<td>Otoedectic mange</td>
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<td>Cheyletiellosis</td>
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<td>Psychogenic alopecia</td>
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<td>Pemphigus foliaceus</td>
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Commentary  Commentaire

Change is needed to correct the lack of veterinary dental education at the undergraduate level

David J. Kerr

I am mad as [heck] and I’m not going to take it anymore. This was the character Howard Beale’s famous line from the 1976 movie Network lamenting the poor rating his network was experiencing. Well, I feel the same way about one aspect of our profession. I love veterinary medicine and have been trying to get it right for over 30 years. Many things have changed during my time in practice making it more exciting, challenging, and rewarding. One of the changes is the invention of teeth in animals. When I graduated in the dark ages we knew that animals had teeth, but we didn’t really look at them. With the advent of veterinary dentistry we as general practitioners have increased our knowledge in all-things-dental and some have made the enormous struggle and have risen to the ranks becoming true veterinary dentists. The age of teeth is upon us.

The reason I am as testy revolves around our esteemed veterinary teaching institutions’ lack of recognition of animal teeth and the teachings the undergraduates receive in “all things mouth.” There is very little, if any, useful information taught at the undergraduate level in any of the Canadian universities. This is similar south of the border.

I can discuss, and only briefly, the offerings at our local university. Currently students are exposed to 4 hours of lecture from a boarded dentist along with an option to take an online course offered by the University of Illinois. Theory only, no practical skill development and with this education, newly graduated veterinarians are expected to be able to perform oral examinations, basic dental procedures, take dental radiographs, and supervise their technicians who often know more than the veterinarians doing the supervising. I equate this amount of education to having an online course for surgery and then expecting new graduates to perform an ovariohysterectomy without ever having touched a scalpel or any other surgical instruments. Not ideal in the best of worlds.

Our new and not-so-new graduates have had no effective formal undergraduate education in veterinary dentistry. The consequences of this lack of undergraduate veterinary dental education are many. In Ontario over the last 5 years there have been 14 cases referred to complaints and discipline concerning veterinarians and their dental skills. A local insurance provider has paid multiple claims concerning malpractice with respect to veterinary dentistry. In my few dealings with mentoring veterinarians in commonly used dental skills, knowledge of these skills is not evident.

There are many schools across Canada offering courses to train veterinary technicians. As part of Ontario Association of Veterinary Technicians (OAVT) by-laws, newly graduated technicians need to show proficiency in oral care including scaling, polishing, and dental radiographs. Newly graduated veterinarians are supposed to be able to assess the skills and the work of their technicians; with the training veterinary students receive, this is not the case.

The Ontario Veterinary Medical Association (OVMA) identifies dental treatment as a major profit center and more veterinarians in general practice are heeding the call and educating themselves in oral care for animals. This training has always been self-directed with mostly good but sometimes disastrous outcomes. It is time for our learning institutions nationwide, which we entrust to teach and shape the new generation of veterinarians, to recognize the overwhelming need to teach skills new veterinarians will need on a daily basis when they enter our profession.

Our veterinary medical degree gives us the right to practice medicine with animals. Our veterinary profession and the animals we serve are at a disadvantage with the lack of skills we as a profession possess in the area of veterinary dentistry. It is time to change this. The change will be slow and it may be painful, but it needs to happen. We as a profession must stop exposing our new graduates to increased chances of malpractice and client complaints. We need to protect our patients from harm. Let us all be mad and not take it anymore. Let us all recognize animals have teeth and those teeth need to be properly cared for. We as professionals need to learn and teach how to provide that care.
History and clinical signs

An 8-year-old female Huacaya alpaca (*Vicugna pacos*) was examined by the ophthalmology service at the Western College of Veterinary Medicine for a painful left eye (Figure 1). She was found squinting and tearing with a defect in her left eye 5 d before presentation. The owner reported decreased appetite and lethargy with redness and increased discharge from the eye 2 d prior to presentation. Neuro-ophthalmic examination confirmed a negative left menace response, and marked corneal opacification that precluded evaluation of a left anterior chamber and the pupillary light reflex (PLR). There was no consensual PLR from left to right eye. The right eye had a positive menace and direct PLR. Palpebral and occulocephalic reflexes were present bilaterally. Direct examination confirmed marked purulent ocular discharge, blepharospasm, peripheral corneal vascularization, marked diffuse corneal edema, and a 10 × 14 mm corneal perforation with iris prolapse. Biomicroscopic examination (Kowa SL-14; Kowa Optimed, Torrance, California, USA), identified collagenolysis, anterior synchiae, iris prolapse, and a marked uveitis with fibrin in the anterior chamber. The lens was not visible and the corneal edema precluded intraocular biomicroscopic and indirect ophthalmoscopic examinations. Following application of 0.5% Mydryacil (Alcon Canada, Mississauga, Ontario), bimicroscopy and indirect ophthalmoscopy (Heine Omega 200; Heine Instruments Canada, Kitchener, Ontario) were completed on the right eye and no abnormalities were detected. Ultrasonographic examination (iU22; Philips Healthcare, Bothwell, Washington, USA) confirmed anterior chamber debris and collapse of the left anterior chamber; the lens was normal and the retina remained attached.

What are your clinical diagnoses, diagnostic and therapeutic plans, and prognosis?

Discussion

Our clinical diagnoses were left corneal perforation with iris prolapse, anterior uveitis, and a melting corneal ulceration. An important differential etiology to consider was corneal perforation with phacoclastic uveitis. The normal ultrasound examination made phacoclastic uveitis less likely.

Corneal perforations are diagnosed based on clinical signs including a corneal defect with a shallow anterior chamber, anterior synchiae, and iris prolapse. These signs are usually accompanied by corneal edema, collagenolysis, blepharospasm, mucopurulent discharge, corneal vascularization, lens rupture, and cataract. At the time of presentation corneal perforations
may be leaking aqueous fluid or sealed with a fibrin clot. A Sidel test may be used to confirm leakage of aqueous humor, but it is seldom completed by the veterinary ophthalmologist as a thorough biomicroscopic examination usually will confirm corneal perforation. A Sidel test is completed by applying sodium fluorescein onto the eye and a prompt biomicroscopic examination of the pooled stain will reveal dark riverlets of aqueous humor streaming through the pooled stain over the corneal perforation.

Corneal perforations are best treated surgically. Eye and vision sparing surgical options include a conjunctival pedicle graft, conjunctival island graft, and corneal conjunctival transposition. These surgical procedures warrant referral to a veterinary ophthalmologist. Enucleation is also an alternative that may be considered if referral is not an option and the eye is blind. Medical management should be instituted promptly and include topical atropine to relieve ciliary spasm, topical antibiotic, and a non-steroidal anti-inflammatory drug, all q6h. Once the pupil is dilated the atropine may be applied when the pupil constricts. Corneal disease is common in camelids and is frequently associated with ocular trauma and fungal infection (1–4). The literature on surgical corneal repair in alpacas is limited to the use of a conjunctival pedicle graft both in traumatic corneal perforation with iris prolapse (5) and 1/11 alpacas in a fungal keratitis study (3).

A pre-surgical physical examination, serum biochemistry, and complete blood (cell) count (CBC) were completed. The biochemistry was within normal limits. The CBC indicated a mild left shift with toxic change indicative of acute inflammation. Excluding the ocular abnormalities the physical examination was otherwise within normal limits. Ciprofloxacin hydrochloride 0.3% (Sandoz Canada, Boucherville, Quebec), q6h, 1% Isosoptro atropine sulfate (Alcon), and diclofenac sodium (Apotex, Richmond Hill, Ontario), q6h medications were administered topically and a conjunctival pedicle graft surgery was scheduled for the following day. An intravenous catheter was placed in the jugular vein and fluoxetine meglumine (Pfizer, Kirkland, Quebec) and sodium penicillin (Fresenius Kabi, Toronto, Ontario), 22 000 IU/kg body weight (BW) were administered, IV within an hour of induction. The alpaca was sedated with xylazine (Rompun; Bayer, Mississauga, Ontario), 0.2 mg/kg BW and fentanyl (Sandoz Canada), 0.005 mg/kg BW, IV, and then induced using diazepam (Sandoz Canada), 0.3 mg/kg BW and ketamine (Narketan; Vétouquino, Lavaltrie, Quebec), 5 mg/kg BW, IV. She was intubated and maintained on sevoflurane gas.

A 5-0 monosoft stay-suture was placed in the ventro-medial episclera to assist the surgeon throughout the procedure. The corneal defect was measured with Jamison’s calipers and determined to be 14 × 10 mm. A conjunctival pedicle graft was prepared from the dorsolateral bulbar conjunctiva using Wescott scissors and 0.5 mm conjunctival collirbiois. The peripheral margins of the corneal perforation and the iris prolapse were excised with Wescott scissors. A large purulent-fibrin clot was removed from the anterior chamber with curved Ogawa forceps. All excised tissues were submitted for histologic examination and anaerobic, aerobic, and fungal culture. The anterior chamber was inflated with 2% hydroxypropyl methylcellulose solution (OcuCoat Viscoelastic; Bausch and Lomb, St. Louis, Missouri, USA) and the lens was evaluated for capsular tears and cataracts and neither were observed. The conjunctival graft was sutured into the corneal defect using 7-0 vicryl in a simple interrupted pattern. A sub-palpebral lavage system was placed in the ventral conjunctival fornix anterior to the third eyelid. Recovery from anesthesia was uneventful.

The alpaca was discharged on 1% Isopto Atropine sulfate (Alcon) to effect, ciprofloxacin hydrochloride 0.3% (Sandoz Canada), q6h, and 0.1% diclofenac sodium (Apotex), q6h. Actinomyces species were isolated on bacterial culture and Kirby-Bauer antibiotic sensitivity testing identified multiple antibiotic resistance with susceptibility to tetracycline therefore additional therapy of tetracycline hydrochloride ointment (T-1%; Anivet, Victoria, Quebec) was initiated q6h.

The histologic diagnosis was severe suppurative keratitis with intraleisional Gram-positive cocci and Gram-negative bacilli.

The alpaca returned for recheck examination 3 weeks following the surgical treatment and the eye was visual, the pupil was dilated and the eye appeared comfortable (no blepharospasm), the conjunctival pedicle graft was well-incorporated and had a healthy vascular supply (Figure 2). The peripheral margin of the pedicle graft was missing and assumed to have been torn by self-induced trauma. The pupil was dilated and dyscoric and the eye was visual based on a brisk menace response. All medications were discontinued and the sub-palpebral lavage was removed.

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