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Effects of acute atrial fibrillation and cardioversion on left and right atrial pressures in a dog

Successful surgical attenuation of portosystemic shunt in a dog with imaging-diagnosed portal vein aplasia

Bilateral neoureterocystostomy with distal ureteral tapering in a dog with severe bilateral hydroureteronephrosis

Fetal maceration and partial retention of fetal bones in 2 mares

Successful treatment of 3 naturally acquired cases of canine cheyletiellosis with fluralaner

Separation and confinement anxiety in a golden retriever × standard poodle dog

Antimicrobial resistance in generic *E. coli* isolated from western Canadian cow-calf herds

Age estimation by pulp canal/root ratio in Yorkshire terrier dogs

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1. Toutain C, Seewald T, Jung M. Pharmacokinetics of lotilaner following a single oral or intravenous administration in cats. Parasite Vector. 2018;11:412
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Editorial Éditorial

You can't always get what you want: Managing expectations in the post-pandemic era!

On ne peut pas toujours obtenir ce que l'on veut : gestion des attentes en cette ère post-pandémique



Dr./Dr John Kastelic



Dr./Dr Tim Ogilvie

The overall pace of society in general and of life for most persons seems to be increasing. In the aftermath of the COVID-19 global pandemic, many people are anxious to re-engage and establish themselves in the "new normal." However, in the face of supply-chain issues, rising inflation, challenges to find affordable housing, and — in the context of veterinary medicine — not enough practitioners to address demands for service, many people have expectations that are difficult or impossible to meet. These can occur at every level.

Whereas many clients are reasonable, respectful people who greatly appreciate their veterinarian and the services provided, there are always exceptions. Nearly everyone has Internet access, and "a little bit of knowledge can be dangerous." Many clients will have consulted "Dr. Google" to determine what is wrong with their animal and will arrive with preconceived notions, often completely inappropriate or simply unachievable, regarding the services they think (or perhaps are absolutely convinced) are needed. At the other end of the spectrum is the client with a "vintage" notion of how something should be managed and what it should cost, blissfully ignoring the advances that our profession has made and the cost of providing quality service.

Many practices, especially larger ones, will have people of different ages, from a variety of eras. There is no doubt that general attitudes, expectations, and what is considered "normal" continue to evolve. Those of us who were raised and trained decades ago (*i.e.,* in the last millennium!) are often a product of our times, and sometimes we struggle to understand younger generations. If our coping skills have waned (for example, at the end of a long and challenging day), we may be inclined to regard those much younger than ourselves as being unmotivated or entitled. Although it's very easy to be dismissive and judgemental, sometimes we need to think before we act (or speak) and recognize that not everyone shares our priorities or perspectives — and that is perfectly OK, as genuine diversity is incredibly valuable!

Le rythme semble s'accélérer dans la société en général et dans la vie de la plupart des gens. Au lendemain de la pandémie mondiale de COVID-19, on souhaite tous reprendre nos activités et apprivoiser la « nouvelle normalité ». Cependant, face aux problèmes de la chaîne d'approvisionnement, à la hausse de l'inflation, à la difficulté de trouver un logement abordable et, dans le contexte de la médecine vétérinaire, au manque de praticiens pour répondre à la demande pour les services vétérinaires, bien des gens ont des attentes qu'il est difficile, voire impossible, de satisfaire. Ces attentes peuvent se manifester à tous les niveaux.

Même si la majorité des clients sont des personnes raisonnables et respectueuses qui apprécient grandement leur vétérinaire et les services qui leur sont fournis, il y a toujours des exceptions. Presque tout le monde a accès à Internet, et cela fait parfois plus de mal que de bien. Beaucoup de clients auront consulté « Dr Google » pour déterminer ce qui ne va pas chez leur animal et arriveront avec des idées préconçues, souvent totalement inappropriées ou tout simplement irréalistes, concernant les services qu'ils estiment (ou croient fermement) être nécessaires. À l'autre extrémité du spectre, il y a les clients qui ont une vision archaïque de la prise en charge d'un problème et de son coût et qui ignorent tout des avancées réalisées par notre profession et des frais liés à la prestation d'un service de qualité.

De nombreuses pratiques, en particulier les plus grandes, servent des clients d'âges très variés appartenant à différentes générations. Il ne fait aucun doute que les attitudes et les attentes générales, ainsi que ce qui est considéré comme « normal », continuent d'évoluer. Ceux parmi nous qui ont été élevés et formés il y a plusieurs décennies (c'est-à-dire au cours du dernier millénaire!) sont souvent le produit de leur époque et ont parfois du mal à comprendre les générations plus jeunes. Si nos capacités d'adaptation sont affaiblies (par exemple, à la fin d'une longue et difficile journée), nous pouvons être enclins à considérer ceux qui sont beaucoup plus jeunes que

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Instead of being frustrated, and in turn, frustrating to those around us, it's much more effective to be thoughtful and proactive by managing expectations. Clearly, we are likely to use different approaches in a brief encounter with a client *versus* a long-term working relationship with an employee or business partner, but awareness of some key principles can be helpful. The following advice is based on an online article (1).

First, we should be proactive, make others aware of our expectations, and if necessary, occasionally remind them. It is important to encourage engagement, provide support and mentorship, and solicit feedback. We need to ensure that our expectations are appropriate and achievable. Accountability is important and a 2-way street. We should expect others to be accountable and we should take the lead by being good role models. Finally, we need to be willing to compromise and not always feel like we have to prevail or "win." In other words, pick your battles and before you get on your "high horse," make sure that you have a deep moat to cross!

These are important skills with much relevance for our professional and personal lives. No doubt they are more natural for some than for others, but with patience and practice, we can apply these principles to improve our interactions and our well-being.

In closing, as many of you will assuredly have recognized, the beginning of the title of this editorial was shamelessly borrowed from a classic song by the Rolling Stones (2). It seems appropriate to close this editorial with a few words from that song:

> You can't always get what you want
> But if you try sometimes, well, you just might find
> You get what you need

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2. Wikipedia [Internet]. You Can't Always Get What You Want [updated December 6, 2023]. Available from: https://en.wikipedia.org/wiki/You_Can%27t_Always_Get_What_You_Want Last accessed December 5, 2023. ■

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nous comme étant des personnes qui manquent de motivation ou qui se croient tout permis. Bien qu'il soit parfois tentant de faire preuve de mépris et porter des jugements, il faut réfléchir avant d'agir (ou de parler) et reconnaître que tout le monde ne partage pas nos priorités ou notre point de vue – et c'est tout à fait acceptable, car la diversité est précieuse!

Au lieu d'éprouver de la frustration et, à notre tour, de frustrer ceux qui nous entourent, il est beaucoup plus efficace de réfléchir et de gérer proactivement les attentes. Même s'il est évident que nous utiliserons des approches différentes selon les situations, par exemple pour une brève rencontre avec un client ou pour une relation de travail à long terme avec un employé ou un partenaire d'affaires, il peut être utile de connaître certains principes clés. Voici donc quelques conseils tirés d'un article publié en ligne (1).

Tout d'abord, nous devons être proactifs, en informant les autres de nos attentes et, si nécessaire, en leur rappelant ces attentes de temps à autre. Il est important d'encourager l'engagement, de fournir un soutien et du mentorat, et de solliciter une rétroaction. Nous devons nous assurer que nos attentes sont appropriées et réalistes. La redevabilité est importante et va dans les deux sens. Nous devrions attendre des autres qu'ils soient responsables et nous devons montrer l'exemple. Enfin, nous devons être disposés à faire des compromis et ne pas avoir l'impression de toujours devoir « gagner ». En d'autres termes, choisissez vos batailles et avant de monter sur vos grands chevaux, assurez-vous d'avoir de bonnes raisons de le faire!

Ces compétences sont primordiales, et ont une grande pertinence pour notre vie professionnelle et personnelle. Même si certaines personnes y ont plus naturellement recours que d'autres, avec de la patience et de la pratique, nous pouvons tous appliquer ces principes afin d'améliorer nos interactions et notre bien-être.

Plusieurs d'entre vous auront probablement remarqué que le titre anglais de cet éditorial a été emprunté à la chanson *You Can't Always Get What You Want* des Rolling Stones (2). Il semble donc approprié de conclure en nous inspirant des paroles de cette même chanson : on ne peut pas toujours obtenir ce que l'on veut, mais si on s'y attarde un peu, on constate parfois qu'on obtient ce dont on a besoin.

Références

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Veterinary Medical Ethics
Déontologie vétérinaire

Ethical question of the month — November 2023

You are a recent graduate working in a small animal hospital with a longtime veterinary owner and a loyal clientele. You are presented with a small dog that has a history of frequent bowel movements with small amounts of frank blood evident. The dog appears otherwise healthy, so you recommend fasting and a bland diet for a presumed case of stress colitis. The next day, the client returns to the hospital and asks to have the dog examined by the senior veterinarian as she is dissatisfied with your treatment. The senior veterinarian prescribes antibiotics (which satisfies the pet owner) and explains to you that the owner feels better if she is "giving something" to treat the dog. You feel that this both is inappropriate medically and undermines your credibility. **How do you approach this with your employer? When you encounter the client again, how do you navigate a conversation about the case that defends your approach without undermining your colleague?**

Question de déontologie du mois – Novembre 2023

Vous êtes en début de carrière et vous travaillez dans un hôpital pour petits animaux dont le propriétaire est un vétérinaire d'expérience qui a une clientèle bien établie et loyale. Vous examinez un petit chien qui fait des selles fréquentes avec des traces de sang frais. Comme l'animal semble par ailleurs en bonne santé, vous recommandez un jeûne et une diète non irritante car vous soupçonnez une colite de stress. Le lendemain, la cliente revient à l'hôpital et demande à ce que son chien soit vu par son vétérinaire habituel, car elle n'est pas satisfaite de votre traitement. Celui-ci prescrit un antibiotique (ce qui satisfait la cliente), et vous explique que la cliente préfère quand elle « donne quelque chose » à son chien pour le traiter. Vous estimez que la façon dont il a agi est inappropriée sur le plan médical et nuit à votre crédibilité. **Comment abordez-vous cette question avec votre employeur? La prochaine fois que vous verrez la cliente, comment vous y prendrez-vous pour justifier votre approche sans discréditer votre collègue?**

Challenges arising from inconsistent treatment policies within a clinic — A comment

Some things never change. This same thing happened to me 55 years ago as I started practicing with my father (now deceased), who graduated as a veterinarian in 1950. A similar client complaint was made about wanting to see the "real doctor" because I had not treated the patient after a complete physical. I received the same answer from my then-boss and father that the client should have been given "something," in that case an antibiotic injection, even though I found no reason to do so. Now, with our focus on antimicrobial use (AMU), it is even more important for the new doctor to have a private discussion with their senior partner — and they could use the article on page 1035 in this same *The CVJ* journal to back up their point.

Submitted by Clayton Mackay, DVM,
MacKay Veterinary Consulting, Guelph, Ontario

Ethicists' commentary on medical and professional challenges arising from inconsistent treatment policies within a clinic

A dog with small amounts of blood in the stool, but that otherwise seems healthy, is examined by a newly qualified veterinarian. The veterinarian diagnoses the dog with stress-induced colitis and prescribes fasting and a bland diet. The owner, dissatisfied with the diagnosis and treatment, then visits a senior veterinarian in the same hospital who placates the owner with antibiotics. From what we are told, the senior veterinarian had no other motive for prescribing the antibiotics than to satisfy the client's wish that something is done for the dog.

The behavior of the senior veterinarian is, in our view, problematic for several reasons.

Medically, dispensing antibiotics simply as a method of placating an owner goes against widely accepted norms that antimicrobial use should be restricted to cases in which they are necessary for ensuring a patient's health and welfare. Other uses enhance the threat that antimicrobial resistance may develop, which, in turn, can cause harm to future patients (including humans) who need access to effective antibiotics. Furthermore, providing antibiotics to a patient with gastrointestinal issues may negatively affect the patient's state due to effects on the gut microbiome.

Professionally, the senior colleague's behavior is reprehensible for at least 3 reasons. The first is that it reinforces inappropriate drug use, and thereby contributes to maintaining this practice within the clinic. The second is that the behavior of the senior veterinarian may undermine the veterinarian-client relationship

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between the younger veterinarian and their client. Third, the behavior may undermine the self-confidence of the younger veterinarian.

We have been asked to address 2 questions about this case: How should the younger veterinarian approach this issue with their employer? When the younger veterinarian encounters their client again, how should they navigate the issue without undermining their colleague?

The clinic in this case seems to lack clear and consistent policies on antibiotic prescription. We would thus respond to the first question by encouraging the younger veterinarian to raise the issue with senior management in the clinic, focusing the discussion on developing and enforcing a decision tree based upon the best available evidence for antimicrobial use. Clear and transparent policy would help ensure that clients do not "shop around" within a clinic to find a veterinarian who will prescribe them the drugs they think they need, and would also help in communicating an evidence-based policy to clients when this seems appropriate.

Our answer to the second question presupposes success in our answer to the first. Given that the senior colleague has already undermined the younger veterinarian, we might hope that the former would help to navigate the issue by apologizing to the younger veterinarian, and perhaps by volunteering to attend the next meeting with the client to explain the new policy and to show solidarity. Should this not happen, the younger veterinarian could tell the client about the new policy and underlying rationale, explaining that, now, veterinarians in the clinic will no longer prescribe antibiotics on a precautionary basis.

Drs. Clare Palmer, Peter Sandøe, and Dan Weary

Ethical question of the month – February 2024

While discussing vaccine protocols with the owner of a new puppy, you learn that the owner and head trainer at a local dog education center has also been discussing vaccines with dog owners. Specifically, they have advised that rabies vaccines can cause both behavioral and learning problems in dogs. The trainer also offers advice on how to create or alter a rabies vaccination certificate to allow a dog to cross the Canada-USA border and for kennel admission where vaccination is required. You attempt to educate the owner about the lack of validity of the vaccination concerns and the risks of falsifying documents for a designated reportable disease. You do not know the trainer personally, but you are aware this person is highly regarded in the community. **You are concerned about backlash, especially on social media, if you take action. What do you do under such circumstances?**

Question de déontologie du mois – Février 2024

Alors que vous discutez des protocoles de vaccination avec un client qui a un nouveau chiot, vous apprenez que la propriétaire et principale éducatrice canine d'un centre canin local parle aussi des vaccins avec ses clients. Elle aurait dit que les vaccins contre la rage peuvent causer des problèmes de comportement et d'apprentissage chez les chiens. Elle donne également des conseils sur la manière de créer ou de modifier un certificat de vaccination contre la rage pour qu'un chien puisse franchir la frontière entre le Canada et les États-Unis ou soit admis dans un chenil où la vaccination est exigée. Vous expliquez à votre client que les préoccupations relatives à la vaccination ne sont pas fondées et que la falsification de documents relatifs à une maladie à déclaration obligatoire comporte des risques. Vous ne connaissez pas l'éducatrice canine personnellement, mais vous savez que cette personne est très appréciée dans la communauté. **Vous craignez des réactions négatives, notamment sur les médias sociaux, si vous intervenez. Que faites-vous dans de telles circonstances?**

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 Canadian Veterinary Medical Association, Attn: Journals Department, 339 Booth Street, Ottawa, Ontario K1R 7K1; email (bettinadvm@gmail.com). A longer response may appear as a Letter to the Editor.**

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 avec vos nom et adresse **par la poste (Choix déontologiques, Association canadienne des médecins vétérinaires, À l'attention de : Journals Department, 339 rue Booth, Ottawa, Ontario, K1R 7K1) ou par courriel (bettinadvm@gmail.com). Les réponses plus longues pourraient être publiées dans le courrier des lecteurs.**

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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Letters to the Editor Courrier des lecteurs

Standards of euthanasia for moribund fish in aquaculture — Comments

To the Editors,

After reading the ethical question of the month for August 2023, I am concerned regarding the information presented as "normal aquaculture practices." It read, "During daily (semi-closed or closed systems) or weekly (net pens) mortality collections, moribund and deceased fish are removed from the system and typically placed into dry buckets or bins." As a veterinarian for a leading Atlantic salmon producer in British Columbia, I can personally attest that our mortality collections — from both our hatchery and net pen systems — happen at least daily. Veterinarians from other Atlantic salmon producers confirm that daily collection is also their normal practice. Additionally, the comment, "These moribund fish either suffocate or are crushed to death," is not representative of current practices at British Columbia salmon farming operations. In our freshwater operations, we ensure that all moribunds/mortalities are euthanized in an ethical and humane manner *via* an overdose of an anesthetic agent. At our net pen sites, moribund fish are humanely euthanized by blunt force trauma followed by exsanguination. Further, I would encourage anyone with questions regarding veterinary aquaculture practices to contact the Association of Aquaculture Veterinarians of British Columbia (AAVBC).

Submitted by Patrick Whittaker, DVM, Fish Health Director, Grieg Seafood BC Ltd.

To the Editors,

I am a veterinarian and fish health manager at one of the largest Atlantic salmon aquaculture companies in Canada, based out of British Columbia. Our standard practices are not accurately reflected by the statements in the ethical question. The question states that there are "daily (semi-closed or closed systems) or weekly (net pens) mortality collections," but this is not accurate. Our mortality collection, in both hatchery and marine settings, is performed daily. The question also states that "moribund fish either suffocate or are crushed to death." This is also inaccurate. We have strict requirements regarding humane euthanasia of all fish, moribund fish included. Our current practice is that all fish, in both freshwater and saltwater facilities, are euthanized by either chemical euthanasia (*via* overdose of an anesthetic agent) or blunt force trauma, typically followed by exsanguination (bleeding). To allow a fish to suffocate is explicitly prohibited by our humane euthanasia standard practice and is not "begrudgingly accepted" by veterinarians, fish health staff, or site staff.

If there are any questions regarding standards of veterinary practice or fish welfare in British Columbia, the Association of Aquaculture Veterinarians of British Columbia (AAVBC) is the best source of accurate and updated information.

Submitted by Terra MacDonald, BSc (Hons), DVM, Fish Health Manager, Veterinarian, Mowi Canada West.

To the Editors,

I commend the panel's acknowledgement of sentience in fish and support of improving euthanasia of moribund fish. As the panel highlighted, portable macerators, electric units, and non-penetrating captive-bolt stun guns could prove to be viable solutions, depending on the environment. The challenge still remains in the relatively limited amount of available literature supporting these "tank-side" methods for fish aquaculture and working with site operators to effectively implement these units.

Submitted by Ashley Powell, DVM, CertAqV.

Constructive and professional comments made in the spirit of intellectual debate are welcomed by the Editors. Writers are expected to be respectful of others and to ensure that letters are considerate and courteous. The Editors reserve the right to remove comments deemed to be inflammatory or disrespectful.

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Quiz Corner
Test éclair

1. An 8-year-old neutered male indoor-outdoor cat is presented with tachypnea, fever, and pale mucous membranes. On physical examination, the cat has harsh lung sounds and a respiratory rate of 80 breaths per minute on room air.

The cat has generalized muscle loss; all other physical examination parameters are normal. Thoracic radiographs are shown below (Figure 1 and Figure 2).

1. Un chat mâle castré de 8 ans, qui vit à l'intérieur et va à l'extérieur, est présenté avec une tachypnée, de la fièvre et des muqueuses pâles. L'examen physique révèle de forts bruits pulmonaires et une fréquence respiratoire de 80 respirations par minute.

Vous notez également une perte musculaire généralisée. Tous les autres paramètres de l'examen physique sont normaux. Les radiographies thoraciques sont présentées ci-dessous (figures 1 et 2).

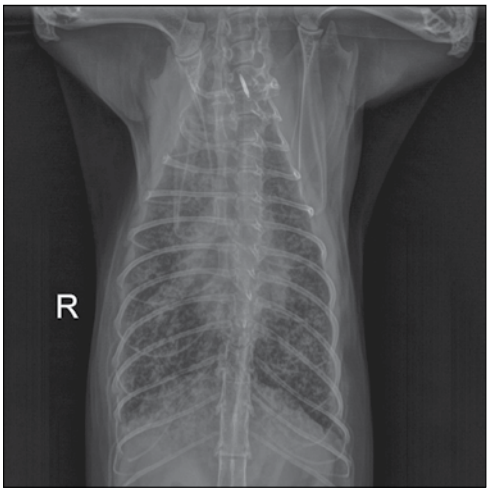


Figure 1.



Figure 2.

Images courtesy of Jen Mahon, DVM, DACVECC./Images fournies par Jen Mahon, D.M.V., DACVECC.

What is the most appropriate next step to assist you in making a definitive diagnosis?

A. Submit urine for fungal antigen testing
B. Abdominal ultrasound
C. Fine-needle aspirates of all peripheral lymph nodes
D. Complete blood (cell) count and blood chemistry
E. Culture of respiratory secretions

Quelle est l'étape suivante la plus appropriée pour vous aider à établir un diagnostic définitif?

A. Prélèvement d'urine pour la détection d'antigènes fongiques
B. Échographie abdominale
C. Aspirations à l'aiguille fine de tous les nœuds lymphatiques périphériques
D. Hématologie et biochimie
E. Culture des sécrétions respiratoires

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2. A brown trout production facility is concerned about a new condition identified in many of its fish after new stock was introduced a few weeks ago. Affected fish have hemorrhages on the tail, fins, and gills, as shown below (Figure 1). Several fish have died. Necropsies of affected fish show necrotic hemorrhages on the muscles and internal organs (especially the spleen and kidneys).

2. Un éleveur de truites brunes est préoccupé par une nouvelle affection constatée chez beaucoup de poissons après l'introduction de nouveaux sujets il y a quelques semaines. Les poissons affectés présentent des hémorragies sur la queue, les nageoires et les branchies (figure 1). Plusieurs poissons sont morts. Les nécropsies des poissons touchés montrent des lésions hémorragiques et nécrotiques affectant les muscles et les organes internes (en particulier la rate et les reins).



Figure 1.

Image: Wikimedia Commons, freely usable from: https://commons.wikimedia.org/wiki/File:Furunculosis_on_Brown_Trout_F12-50.jpg/Image de Wikimedia Commons pouvant être utilisée gratuitement (https://commons.wikimedia.org/wiki/File:Furunculosis_on_Brown_Trout_F12-50.jpg)

What is the recommended treatment based on the top differential diagnosis?

A. Depopulate and restock
B. Scrape off necrotic tissues; lavage with 1% povidone-iodine
C. Flush tanks with clean water and aerate aggressively; add calcium to the feed source
D. Antimicrobials based on culture of lesions
E. Isolate affected fish; raise the pH of the water

Quel est le traitement recommandé en fonction du diagnostic différentiel le plus probable?

A. Procéder à la dépopulation et obtenir de nouveaux poissons
B. Retirer les tissus nécrosés, laver avec de la povidone iodée à 1 %
C. Rincer les bassins avec de l'eau propre et aérer énergiquement; ajouter du calcium à l'alimentation
D. Administrer des antimicrobiens choisis en fonction des résultats de la culture effectuée à partir des lésions
E. Isoler les poissons affectés, élever le pH de l'eau

(See p. 180 for answers./Voir les réponses à la page 180.)

The questions and answers are provided by Zuku Review, online veterinary test prep.

Les questions et les réponses sont gracieusement fournies par le site de préparation aux examens vétérinaires Zuku Review.

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Case Report Rapport de cas

Effects of acute atrial fibrillation and cardioversion on left and right atrial pressures in a dog

Justin Allen, Étienne Côté

Abstract — The occurrence of right-sided congestive heart failure (CHF) in dogs with left-sided heart disease is well-recognized, but its mechanisms are incompletely understood. A 12-year-old Maltese dog was admitted to the clinic for left atrial decompression to treat recurrent CHF due to severe myxomatous mitral valve disease (MMVD). Left atrial decompression was successful but atrial fibrillation (AF) occurred during the procedure. Electric cardioversion restored normal sinus rhythm (NSR) and the dog's recovery was uneventful. This sequence of events made it possible to study intracameral pressures individually in each atrium in a dog with naturally occurring MMVD during AF and again during NSR. Although pressures in both atria declined following cardioversion, the right atrial pressure declined to a greater degree. These findings indicated a disproportionate effect of AF on right atrial pressure. This difference was noteworthy given the long-standing clinical observation that dogs with MMVD have a higher prevalence of right-sided CHF when AF is present.

Key clinical message:
A dog with MMVD had a greater reduction in right atrial pressure than in left atrial pressure when its AF was cardioverted as part of a cardiac catheterization procedure. This observation proposed a mechanism for the well-known but unexplained observation that dogs with MMVD manifest right-sided CHF disproportionately more often when they have AF.

Résumé — Effets de la fibrillation auriculaire aiguë et de la cardioversion sur les pressions auriculaires gauche et droite chez un chien. La présence d'une insuffisance cardiaque congestive du côté droit (ICC) chez les chiens atteints d'une cardiopathie du côté gauche est bien connue, mais ses mécanismes ne sont pas complètement compris. Un chien maltais de 12 ans a été admis à la clinique pour une décompression auriculaire gauche afin de traiter une ICC récurrente due à une grave maladie myxomateuse de la valvule mitrale (MMVD). La décompression auriculaire gauche a réussi, mais une fibrillation auriculaire (FA) s'est produite pendant la procédure. La cardioversion électrique a rétabli le rythme sinusal normal (NSR) et la récupération du chien s'est déroulée sans incident. Cette séquence d'événements a permis d'étudier les pressions individuellement dans chaque oreillette chez un chien atteint de MMVD d'origine naturelle pendant la FA et à nouveau pendant la NSR. Bien que les pressions dans les deux oreillettes aient diminué après la cardioversion, la pression de l'oreillette droite a diminué dans une plus grande mesure. Ces résultats ont indiqué un effet disproportionné de la FA sur la pression auriculaire droite. Cette différence était remarquable compte tenu de l'observation clinique de longue date selon laquelle les chiens atteints de MMVD ont une prévalence plus élevée d'ICC du côté droit en cas de FA.

Message clinique clé :
Un chien atteint de MMVD présentait une réduction plus importante de la pression auriculaire droite que de la pression auriculaire gauche lorsque sa FA était cardiovertie dans le cadre d'une procédure de cathétérisme cardiaque. Cette observation propose un mécanisme pour l'observation bien connue mais inexpliquée selon laquelle les chiens atteints de MMVD manifestent une ICC du côté droit de manière disproportionnée plus souvent lorsqu'ils souffrent de FA.

(Traduit par Dr Serge Messier)

Can Vet J 2024;65:115–118

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A basic principle of cardiovascular pathophysiology is that the clinical manifestations of congestive heart failure (CHF) reflect the side of the heart that is affected by a disease process (1). A frequently observed example in veterinary medicine involves the most common heart disease of dogs, myxomatous mitral valve disease (MMVD) (2). Since the mitral valve is a left-sided cardiac structure, advanced MMVD produces signs of left-sided CHF, such as dyspnea due to cardiogenic pulmonary edema (1,2). However, exceptions exist to this simple principle (3,4). In particular, signs of right-sided CHF can occur more often with MMVD when affected dogs also have atrial fibrillation (AF) (3). This paradox has possible explanations, such as differences in venous capacitance of the systemic and pulmonary vasculatures (5) or the existence of comorbidities; *e.g.,* pulmonary arterial hypertension (4). Investigations of hemodynamic changes caused by AF might offer insights into this paradox, but they are rarely undertaken, perhaps because interventional therapies for treating naturally occurring MMVD are a recent development (6,7). In the case reported here, a disproportionate decrease in right atrial (RA) pressure was documented in association with restoration of normal sinus rhythm (NSR) after AF. This finding offered new information that could be associated with the paradox of the higher prevalence of right-sided CHF associated with AF in dogs with left-sided heart disease compared to dogs with the same diseases who are in NSR.

Case description

A 12-year-old, 4.4-kilogram, neutered male Maltese dog with severe MMVD was admitted to the clinic for treatment including left atrial decompression (LAD), a catheter-based procedure that reduces left atrial (LA) pressure through creation of an atrial septal defect (ASD) (6). The dog had experienced recurrent episodes of left-sided CHF requiring hospitalization, most recently 10 d before the procedure. At a recheck 3 d before the procedure, recurrent pulmonary edema was diagnosed and treated on an outpatient basis with injectable furosemide (3.4 mg/kg, SC). An LAD procedure was recommended at that time, as recurrent CHF despite treatment with medications is an indication for LAD (6). At the time of the procedure, the dog was being managed with furosemide (11.4 mg/kg per day PO, with additional 3.4 mg/kg SC boluses q24h or q12h as needed for dyspnea), pimobendan (1.1 mg/kg per day), and sacubitril/valsartan (11.3 mg/kg, PO, q12h). Echocardiography was completed prior to the procedure, and revealed severe LA enlargement [LA:Ao: 2.61; reference value: 1.00 to 1.68 (8)] and no RA enlargement [RA area index: 8.49 cm^2/m^2; reference value: 4.2 to 10.2 cm^2/m^2 (9)] or other 2-dimensional changes consistent with pulmonary hypertension (4). There was mild tricuspid regurgitation with a measured velocity of 3.21 m/s (reference value: $\leq$ 3.0 m/s) (4). Preoperative radiographs revealed mild pulmonary interstitial infiltrates consistent with pulmonary edema despite treatments described above. Dobutamine was initiated (5 μg/kg per minute, IV) to improve stability during anesthesia prior to LAD. Left atrial decompression results in an immediate and sometimes profound drop in LA pressure, which in our experience may be excessive if preload is already compromised by diuresis. The dog was premedicated with methadone (0.3 mg/kg IV) and midazolam (0.25 mg/kg IV) and induced with ketamine (1 mg/kg IV) and etomidate (1 mg/kg IV, to effect). Anesthesia was maintained with continuous rate infusions of ketamine (15 to 20 μg/kg per minute), remifentanil (15 to 20 μg/kg per hour), and midazolam (0.3 mg/kg per hour), titrated to effect.

Direct measurement of mean RA pressure during NSR, and prior to LAD, was slightly elevated [4 mmHg; reference value: 1.8 ± 0.2 mmHg (10)]. Left atrial decompression was carried out as reported (6). The LAD procedure was successful; an iatrogenic ASD was created and left-to-right flow across it was documented. However, AF occurred during catheter manipulation in the RA. Left atrial and RA pressures were measured during AF directly, *via* intracardiac catheterization (Figure 1). In an attempt to convert the acute AF to NSR, cardioversion was done by delivering 10 J of biphasic direct-current energy transcutaneously. This treatment restored NSR immediately. Left atrial and RA pressures were measured again, this time during NSR (Figure 2). Cardiac catheters were withdrawn, incisions were closed, and anesthetic recovery was uneventful. The dog was discharged the following day; antiarrhythmic medications were not instituted. Medical therapy at discharge included furosemide (8.5 mg/kg per day), pimobendan (1.1 mg/kg per day), sildenafil (1.1 mg/kg, PO, q8h), and clopidogrel (18.75 mg, PO, q24h). Sildenafil was given to unload the right ventricle and reduce the risk of postoperative right CHF, which is common practice postoperatively at our clinic following LAD. The dog remained in NSR without requiring antiarrhythmic medical therapy at the last recheck, 23 mo post-procedure.

Atrial pressures following LAD, during AF, are shown in Figure 1. Pressures were elevated in both atria [mean LA pressure: 22 mmHg, reference value: 6 mmHg (11); mean RA pressure: 18 mmHg]. The effect of AF on atrial waveforms is apparent, with absent A waves and variable peak V wave pressure, depending on coupling intervals. This finding confirmed that AF existed in both atria, which was expected but would not have been verifiable on surface electrocardiograms alone. The large V waves are common in this type of patient, and could be explained by severe atrioventricular valve regurgitation, low atrial compliance (12), and the presence of a left-to-right shunt (the iatrogenic ASD created during LAD) in the case of the RA waveform. Noteworthy changes following cardioversion (Figure 2) included a reduction in atrial pressures and restoration of A waves. Specifically, mean LA pressure decreased to 19 mmHg and mean RA pressure decreased to 12 mmHg. The disparity in the magnitude of reduction in pressures, with the RA pressure (33% decrease) declining substantially more than the LA pressure (14% decrease) despite the presence of left-to-right interatrial shunting that would be expected to contribute to a higher RA pressure (6), was of particular interest.

Discussion

Right-sided CHF is known to be associated with severe MMVD when dogs also have AF. For example, in a series of 155 dogs with degenerative mitral valve disease, right-sided CHF was noted in 13/17 dogs with AF (77%) compared to 10/138 dogs without AF (7%; $P < 0.0001$) (3). Since AF involves both

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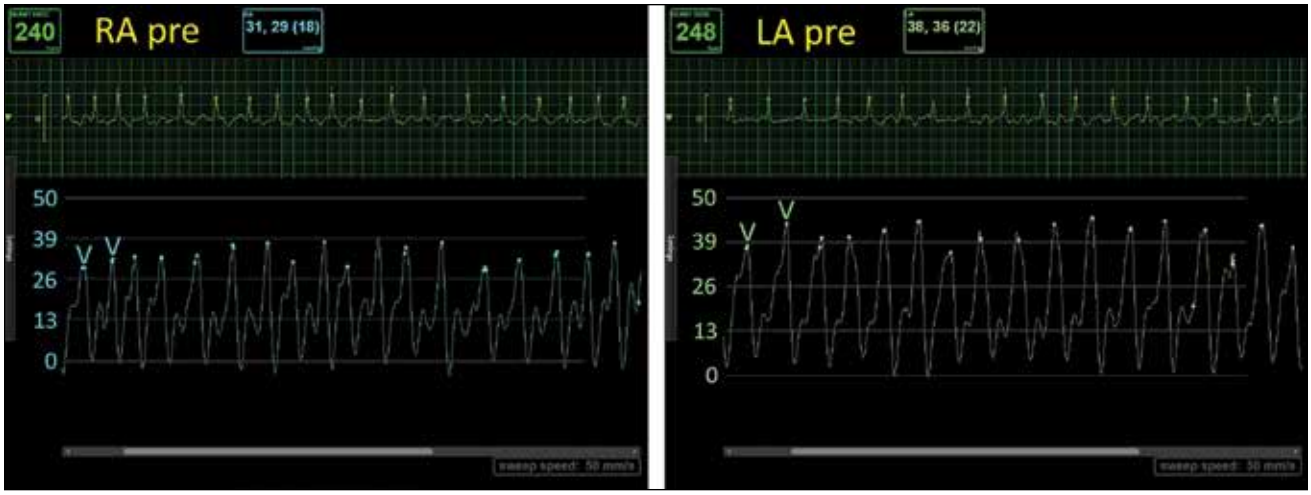


Figure 1. Intracameral pressure tracings of the right (RA) and left (LA) atria in a dog during atrial fibrillation. Mean LA pressure: 22 mmHg; mean RA pressure: 18 mmHg. High-amplitude V waves are attributed to mitral and tricuspid regurgitation; their inconsistent amplitude reflects variable ventricular loading conditions, which is a characteristic of atrial fibrillation. Similarly, no A waves are seen.

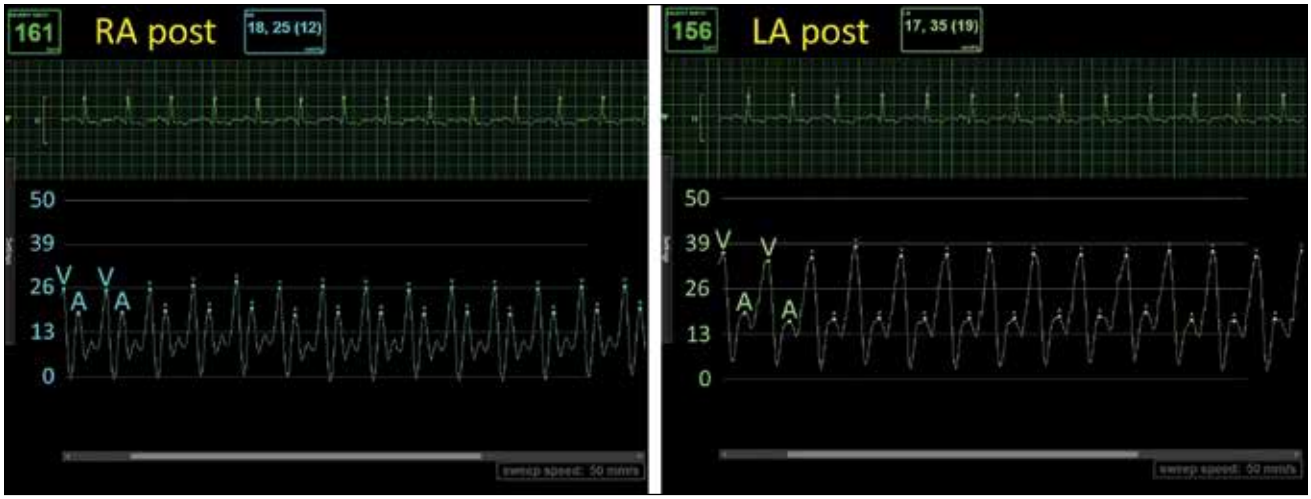


Figure 2. Intracameral pressure tracings of the right (RA) and left (LA) atria in a dog in normal sinus rhythm, following cardioversion from atrial fibrillation. Mean LA pressure: 19 mmHg; mean RA pressure: 12 mmHg. High-amplitude V waves are attributed to mitral and tricuspid regurgitation. A waves are attributed to atrial contraction.

atria, it would be expected to increase pressures in both atria. Therefore, the higher prevalence of right-sided CHF in dogs with MMVD and AF historically has been unexplained, particularly because such patients often have predominantly left-sided heart disease.

The present case demonstrated a disproportionate rise in RA pressure compared to LA pressure when AF was present. Right atrial pressure was slightly elevated before the onset of AF in this dog (mean: 4 mmHg). During AF, mean LA and RA pressures were severely elevated, although the iatrogenic ASD would be expected to have contributed to increased RA pressure. With restoration of NSR *via* cardioversion, a disproportionate effect of AF on pressures in the 2 atria became apparent. In fact, the reduction in RA pressure associated with conversion of AF to NSR likely was undermeasured in this case because left-to-right shunting through the iatrogenic ASD would increase RA pressure. The discordance between RA and LA pressure declines following return to NSR in this dog supported the contention that LA pressure elevation is primarily driven by the presence of severe mitral regurgitation in these patients, whereas pressure elevation in the RA is due to the arrhythmia *per se.* This discordance, as illustrated in the present case, could explain the preponderance of right CHF in animals with MMVD and AF.

Although decreased following cardioversion, the RA pressure remained above the reference interval. This is an expected outcome of the LAD procedure (6). This dog has not developed abdominal effusion or other manifestations of right-sided CHF and remained in NSR at the last recheck, 23 mo postoperatively.

A second important aspect of this case is the response of peracute-onset AF to low-energy cardioversion. In dogs, AF is seldom treated with electrical cardioversion (13), and when it is, AF has usually been present for weeks (median: 30 d) (14). Thus, pretreatment with antiarrhythmic drugs such as amiodarone is recommended. In the present case, AF occurred peracutely. The short duration of AF made successful cardioversion more likely, whereas the presence of MMVD made it

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less likely (14). The low dose of energy that was effective (10 J) corresponded to the previously reported successful median dose of 1.8 J/kg (13).

A limitation of this report is that LA pressure was unknown before the onset of AF. It is reasonable to expect that LA pressure was elevated based on the presence of severe recurrent left-sided CHF in the animal. However, the abrupt onset of AF prevented LA pressure measurements from being made in NSR. A second limitation is the effects of general anesthesia, cardiovascular drugs, and the LAD procedure, although this is offset to some extent by the fact that RA and LA pressures were recorded together during the same anesthetic event.

This case was exceptional because it provided information that is rarely accessible, since so few dogs with naturally occurring MMVD currently undergo cardiac catheterization with direct hemodynamic monitoring of both atria during AF and NSR. Two key findings are presented. First, the conversion of AF to NSR was associated with changes in atrial pressures of different magnitudes in the RA and the LA, with a greater effect noted in the RA. This within-day comparison of atrial pressures during NSR and during AF in a dog with naturally occurring MMVD provides some observational data that could be related to a well-recognized but poorly explained phenomenon: the occurrence of right-sided CHF in dogs with AF and heart disease that is not limited to the right side of the heart. Second, this case demonstrated that acute-onset AF can respond to low-energy cardioversion even when severe MMVD is present, that the resultant NSR provided immediate hemodynamic benefits, and that NSR was sustained for at least 23 mo. CVJ

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Case Report Rapport de cas

Successful surgical attenuation of portosystemic shunt in a dog with imaging-diagnosed portal vein aplasia

Hanna Kim, Ho-Hyun Kwak, Junhyung Kim, Sooyoung Choi, Kyung-Mee Park, Heung-Myong Woo

Abstract — An 8-month-old female Maltese dog was referred for examination with a history of circling, dullness, and drooling. Serum biochemical analysis revealed hyperammonemia, with microhepatica observed on radiography. Computed tomography angiography revealed a portosystemic shunt originating from the right gastric vein and inserting into the prehepatic caudal vena cava. Portal blood flow to the liver was not observed. Based on computed tomography angiography, the dog was tentatively diagnosed with portosystemic shunt with portal vein aplasia. An exploratory laparotomy was done to obtain a definitive diagnosis. The dog had no subjective clinical signs of portal hypertension during a temporary occlusion test of the portosystemic shunt. A thin-film band was placed around the portosystemic shunt to achieve partial attenuation. There was no evidence of hepatic encephalopathy in the long term after surgery, and the dog's liver volume increased over time. Computed tomography angiography at 6 mo after surgery identified well-visualized intrahepatic portal branches.

Key clinical message:
We inferred that a direct occlusion test is a reliable diagnostic technique that overcomes the limitations of diagnostic imaging methods, including computed tomography angiography, and is a good technique for determining whether surgical attenuation is possible in dogs with suspected portal vein aplasia.

Résumé — Atténuation chirurgicale réussie d'un shunt porto-systémique chez un chien avec une aplasie de la veine porte diagnostiquée par imagerie. Une femelle bichon maltais âgée de 8 mois a été référée pour examen avec une histoire de tournis, apathie et salivation excessive. L'analyse biochimique du sérum a révélé une hyperammionémie, avec un petit foie observé lors des radiographies. Une angiographie par tomodensitométrie a révélé un shunt porto-systémique prenant son origine de la veine gastrique droite et s'insérant dans la veine cave caudale pré-hépatique. Le flot sanguin porte au foie n'était pas observé. Sur la base de l'angiographie par tomodensitométrie, un diagnostic présumé de shunt porto-systémique avec aplasie de la veine porte a été émis. Une laparotomie exploratoire a été effectuée afin d'obtenir un diagnostic définitif. Le chien ne présentait pas de signe clinique subjectif d'hypertension portale durant un test d'occlusion temporaire du shunt porto-systémique. Une bande de film mince a été placée autour du shunt porto-systémique pour causer une réduction partielle. Il n'y avait aucune évidence d'encéphalopathie hépatique à long terme après la chirurgie, et le volume du foie du chien a augmenté dans le temps. Une angiographie par tomodensitométrie effectuée 6 mo après la chirurgie a permis de bien visualiser des branches portes intra-hépatiques.

Message clinique clé :
Nous avons déduit qu'un test d'occlusion est une technique diagnostique fiable qui surpasse les limites des méthodes d'imagerie diagnostique, incluant l'angiographie par tomodensitométrie, et est une bonne technique pour déterminer si une réduction chirurgicale est possible chez des chiens chez qui on soupçonne une aplasie de la veine porte.

(Traduit par Dr Serge Messier)

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Aportosystemic shunt (PSS) is a vascular anomaly that allows the portal vein (PV) to communicate directly with a systemic vein, thereby bypassing the liver parenchyma. The portal blood accounts for 75 to 80% of the liver's blood flow (1). Dogs have several clinical signs when portal blood flows throughout the systemic circulation. Such dogs may not thrive from birth and may exhibit changes in behavior, especially after meals, due to hepatic encephalopathy (HE) (2). Furthermore, PSS can be diagnosed using imaging techniques such as ultrasonography or computed tomography angiography (CTA). Dogs diagnosed with PSS are classified according to PSS anatomy. Extrahepatic PSSs usually occur in smaller dog breeds and are generally identified as portocaval, porto-azygos and portophrenic shunts (3).

Most dogs with PSS have a hypoplastic PV. In a previous study, 10 of 135 dogs were diagnosed with PV aplasia due to severe hypoplasia of the PV (4). Most owners request euthanasia because the prognosis for PV aplasia is considered poor (5). Therefore, it is important to distinguish this from PV hypoplasia. However, it is difficult to identify extremely thin blood vessels on CTA imaging, and in the majority of articles, PV aplasia was not confirmed by other imaging techniques such as venography, exploratory celiotomy with temporary occlusion of the shunting vessel, or liver histology (5–8). Therefore, there are no clear criteria for confirming the absence of the PV.

To our knowledge, this is the first case of a dog with imaging-diagnosed PV aplasia that was re-diagnosed with PV hypoplasia by performing a shunt occlusion test. Thus, we suggest that PV aplasia, which is difficult to confirm, can be diagnosed using an occlusion test. In this case, the main reason for the decision to perform surgery was that CTA imaging revealed a branch that was suspected to be the PV. Surgical attenuation after temporary clamping of the PSS was successful. Therefore, if a dog is suspected of having PV aplasia, an occlusion test can be used to differentiate PV aplasia from PV hypoplasia with certainty.

Case description

An 8-month-old female Maltese dog was presented with circling and drooling and in a dazed state. These clinical signs reportedly lasted for more than 8 h on various occasions. Hyperammonemia (377 mol/dL, reference range: 0 to 98 mol/dL) and microhepatica on radiography were revealed at a local hospital. The dog was assumed to have PSS and was given L-arginine (0.5 tablet, PO, q12h), metronidazole (10 mg/kg, PO, q12h), lactulose (1 mL/kg, PO, q12h), levetiracetam (10 mg/kg, PO, q8h), and a liver-specific diet (prescription diet L/d; Hill's Pet Nutrition, Topeka, Kansas, USA). The dog was referred to the Kangwon National University Veterinary Hospital (Korea) for a definitive diagnosis.

Blood analysis confirmed mildly elevated liver enzymes [alanine aminotransferase (ALT): 109 U/L, reference range: 19 to 70 U/L; alkaline phosphatase (ALP): 141 U/L, reference range: 15 to 127 U/L; gamma-glutamyl transferase (GGT): 9 U/L, reference range: 0 to 6 U/L]. Moreover, moderate hypoproteinemia and mild hypoalbuminemia were identified (total protein: 4.4 g/dL, reference range: 5.4 to 7.4 g/dL; albumin: 2.1 g/dL, reference range: 2.2 to 3.9 g/dL). Ammonia concentrations were within the normal range (59 mol/dL, reference range: 0 to 98 mol/dL).

Dual-phase CTA was performed using a nonionic contrast medium (iohexol, 800 mg I/kg). The CT scan was obtained using the following parameters: 120 kVp, 150 mA, and a slice thickness of 1 mm. The portal-phase scan time was obtained 30 s after the start of contrast medium injection using an automatic power injector. Images were identified using a CT image analysis program with 3D capabilities (Xelis; Infinitt Healthcare, Seoul, Korea). Portal-phase CTA confirmed PSS inserting into the prehepatic caudal vena cava (CVC) (Figure 1 A). In addition, the PV could not be identified cranial of the PSS; however, a small vascular branch protruding from the PSS traveled ~2 mm toward the liver but was not visualized thereafter (Figure 1 B). Intrahepatic PV branches were also not visualized (Figure 1 C).

Through 3D reconstruction, a PSS originating from the right gastric vein was confirmed. In addition, a vascular branch traveled to the spleen 10 mm away from the terminal of the PSS, close to the CVC (Figure 1 D, E). Additional ultrasonography did not reveal any intrahepatic portal blood flow. Based on these results, the dog was tentatively diagnosed with PV aplasia due to PSS. However, because it is difficult to confirm PV aplasia with only CT and ultrasound results, additional tests were needed to distinguish between PV hypoplasia and aplasia. We planned an exploratory laparotomy for confirmation and focused on the possibility that the dog had PV hypoplasia.

Three days after the CT scan, the dog had signs of seizures. Despite normal blood ammonia concentrations, HE was not clinically well-controlled. Therefore, the dog was given midazolam (0.03 mg/kg IV) and fluid therapy. The dog was discharged the next day, and the existing dosage of levetiracetam (15 mg/kg, PO, q8h) was increased.

At 7 d after CTA, an exploratory laparotomy was conducted to confirm PV aplasia after obtaining consent from the owner. Fentanyl patches were used before surgery for analgesia. After a median celiotomy, the PSS inserted into the CVC was identified (Figure 2 A). Thereafter, the PSS was temporarily clamped using Satinsky forceps and observed to determine any congestion in the small intestine or pancreas. During the 15 min after clamping, the dog's intestine and pancreas color remained within normal limits (Figure 2 B) and there was no change in the systemic blood pressure. Thus, it was determined that the dog had hypoplastic PV, and a thin-film band was applied around the PSS (Figure 2 C). After attenuation of the PSS, wedge biopsies of the left and right lobes of the liver were obtained using LigaSure (Covidien, Mansfield, Massachusetts, USA). During recovery, the dog received postoperative care with IV fluid therapy, metronidazole (10 mg/kg, IV, q12h), lactulose (1 mL/kg, PO, q12h), levetiracetam (15 mg/kg, IV, q8h), and liver protectants. Postoperatively, the dog had no abnormalities on physical examination and did not have post-attenuation neurological signs or other systemic abnormalities. Thus, the dog was safely discharged 1 d after surgery.

Left and right liver lobes had the same histopathological findings. The liver was composed of relatively small hepatic lobules with closely located portal triads. Portal triads contained scant

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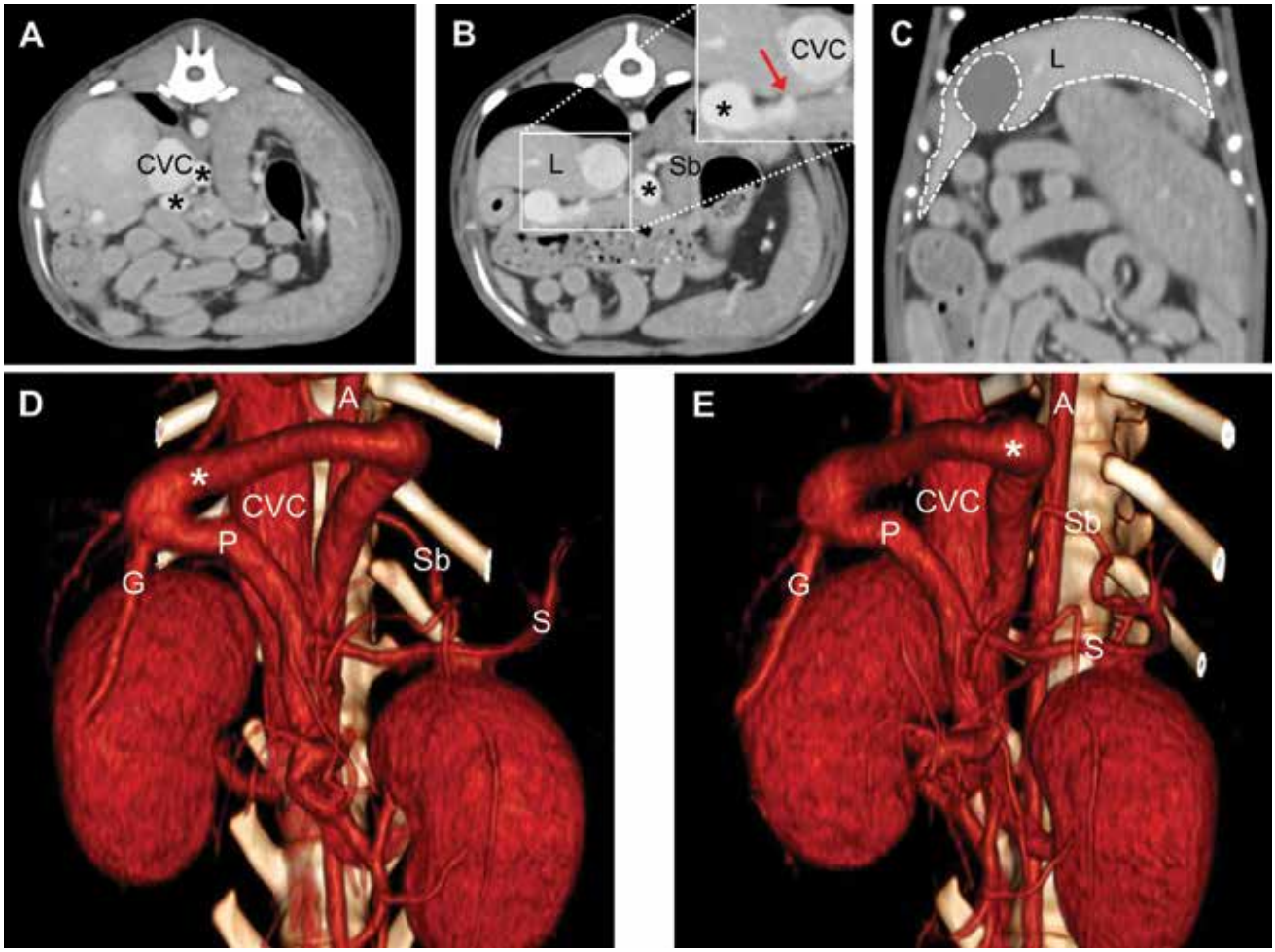


Figure 1. Preoperative transverse (A and B) and sagittal (C) computed tomography (CT) images, and 3D-reconstructed CT images (D and E) of the shunt vessel (asterisks). A – The shunt vessel inserted into the CVC. B – The area indicated by the white square is shown magnified at the top right of the panel. A protruding vascular branch (red arrow) traveled ~2 mm toward the liver. C – Portal branches in the liver (white dashed line) were not visualized. D and E – The G and S entering the P. The shunt vessel that originated from right gastric vein draining into the CVC. The Sb is 10 mm away from the CVC. The portal vein was not identified on CT angiography.

A – Aorta; CVC – Caudal vena cava; G – Gastroduodenal vein; L – Liver; P – Portal trunk; S – Splenic vein; Sb – Splenic branch.

PVs, proliferated hepatic arterioles, and dilated lymphatic vessels. Mild-to-moderate multifocal confluent periportal fibrosis with elongated connective tissue was occasionally observed. Abnormal small blood vessels were observed in most periportal areas and hepatic parenchyma. The small PVs and lymphatic vessels could be distinguished by CD31 immunostaining, which reacts with endothelial cells. Some hepatocytes underwent vacuolar or hydropic degeneration (Figure 3). These characteristic histopathologic features were similar to those of PV hypoplasia with hepatic lobular hypoplasia, hepatocellular atrophy, and increased arterioles.

The dog did not have any signs of seizures after surgery. The dog was managed with L-arginine (0.5 tablet, PO, q12h), metronidazole (10 mg/kg, PO, q12h), lactulose (1 mL/kg, PO, q12h), levetiracetam (10 mg/kg, PO, q8h), and a liver-specific diet for 1 mo. One month after surgery, the dog's PV was identified (diameter of 3.4 mm) on ultrasonography. There have been no signs of seizures, even though levetiracetam has not been administered since that time. Three months after surgery, the dog's blood chemistry values returned to within normal ranges (AST: 20 U/L, ALT: 43.47 U/L, ALP: 95 U/L, GGT: 7 U/L, total protein: 5.6 g/dL, albumin: 2.5 g/dL). Therefore, administration of metronidazole, lactulose, and liver protectants was stopped.

At 3 mo after surgery, CTA imaging revealed that the flow of the PSS toward the CVC was well-attenuated. No recurrence of PSS or acquired PSS due to portal hypertension were observed. The PV diameter gradually increased to 5.8 mm by the 3rd month. The PV was located where the protruding vascular branch was observed before surgery. The protruding branch was thought to be traces of the PV. The PV branches in the liver were also normally visualized. Diameters of the CVC and PSS decreased (Figure 4 A, B, C). At 6 mo after surgery, CTA imaging confirmed that the thin-film band was well-applied. There was no connection between the PSS and CVC (Figure 4 D, E). The liver-specific diet was discontinued and the dog returned

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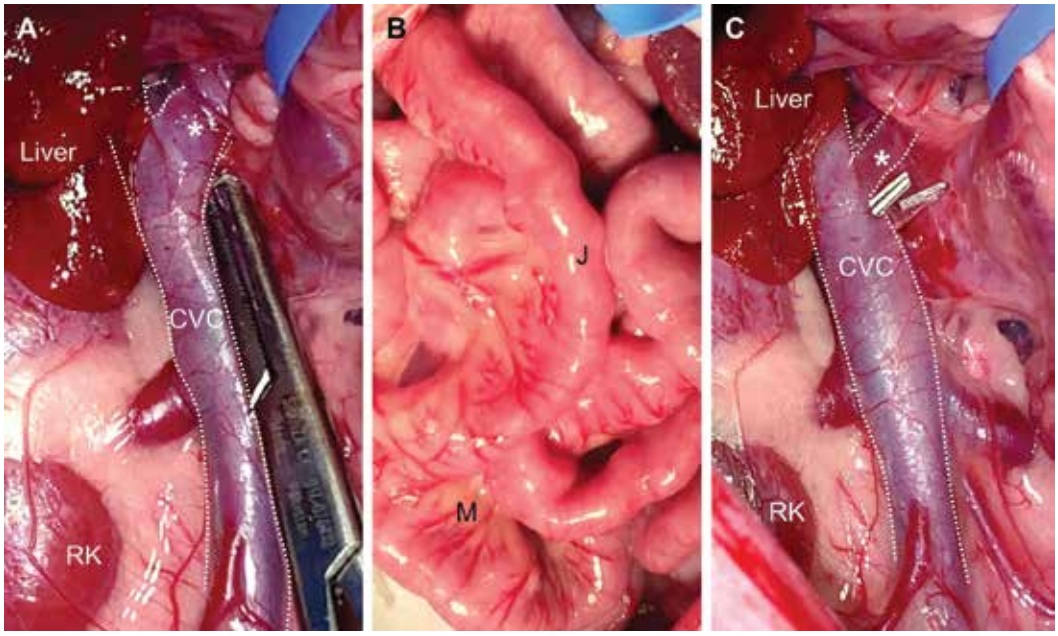


Figure 2. Intraoperative images. After a median celiotomy, the shunt vessel (asterisk) inserted into the CVC was identified (A). During 15 min of clamping the shunt vessel, the dog's bowel color was normal (B). A thin-film band was applied to the shunt vessel (C).

CVC – Caudal vena cava; J – Jejunum; M – Mesentery; RK – Right kidney.

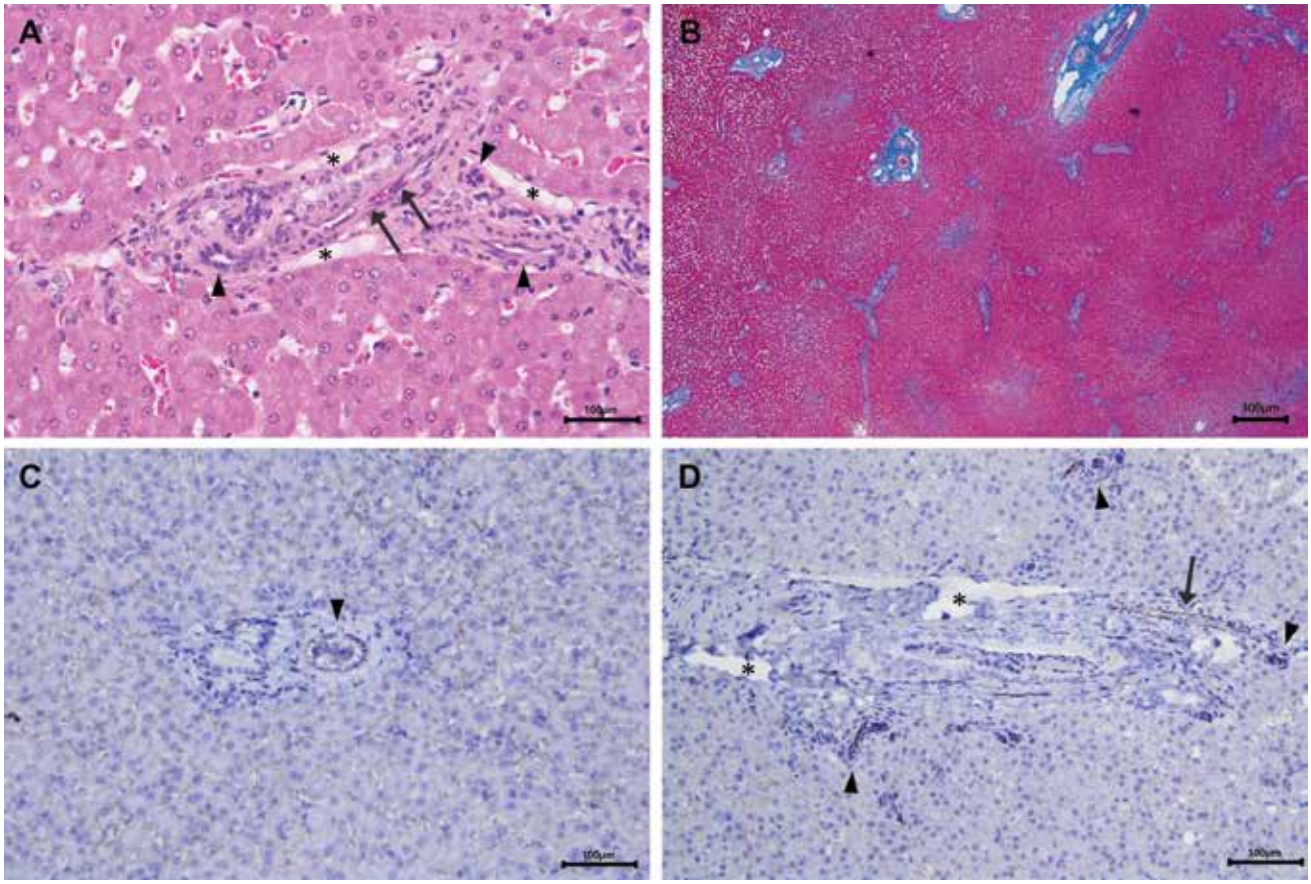


Figure. 3. Hepatic histopathology. Hematoxylin and eosin stain (A), Masson's trichrome stain (B), and immunostaining for CD31 (C and D). Portal triads contained scant portal veins (arrows) and proliferated hepatic arterioles (arrowheads). Thin-walled lymphatic vessels (asterisks) without endothelial cells were dilated. Vacuolar or hydropic degeneration of hepatocytes was observed (A). The liver was composed of relatively small, hepatic lobules with closely located portal triads. Liver fibrosis (blue) was identified using Masson's trichrome stain (B). Small portal triads had no portal veins (C). The CD31 immunohistochemistry confirmed that the small, thin-walled vascular channels in the portal triads were portal veins rather than lymphatic vessels (D). Scale bars: 100 μm (A, C, and D), 300 μm (B).

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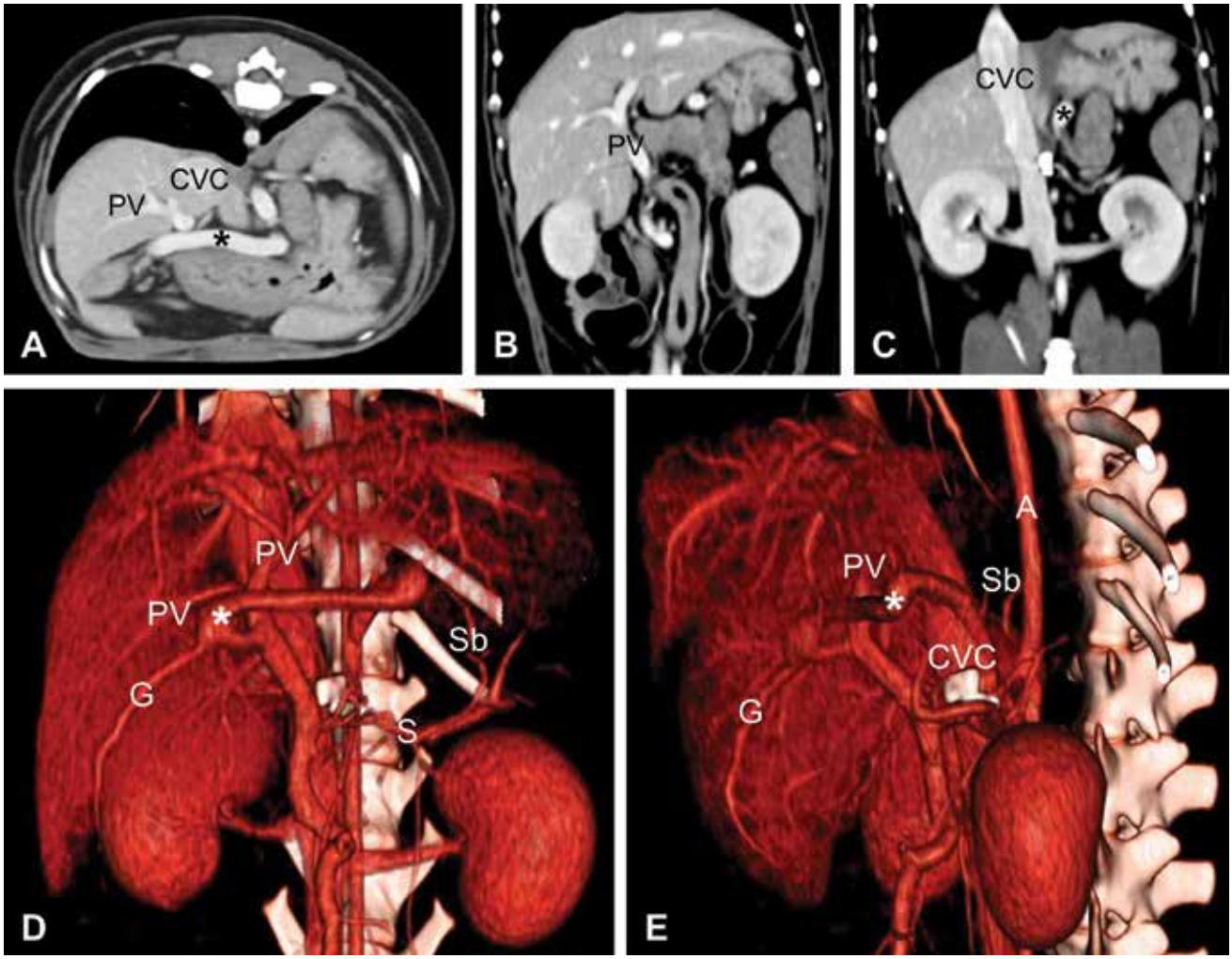


Figure 4. Transverse (A) and sagittal (B and C) computed tomography (CT) images 3 mo after surgery, and 3D-reconstructed CT images (D and E) of the PV 6 mo after surgery. The PV branches in the liver were normally identified (A and B). The shunt vessel (asterisk) maintained its structure but did not communicate with the CVC (C). Left and right branches of the PV were well-visualized (D). The diameter of the shunt vessel decreased, but it maintained its loop shape by the Sb (E).

A – Aorta; CVC – Caudal vena cava; G – Gastroduodenal vein; PV – Portal vein; S – Splenic vein; Sb – Splenic branch.

to a normal diet. During the follow-up *via* telephone with the owner, it was confirmed that the dog was living a normal life without any clinical signs.

Discussion

It is reported that PV aplasia has a poor prognosis and surgical correction is impossible (9,10). However, there have been reports of PV aplasia with other anomalies in dogs (5–8,11). In previous studies, dogs were diagnosed only by ultrasonography, CTA, or exploratory celiotomy; thus, they were only treated with supportive care. It is known that CTA is the most accurate noninvasive method of identifying blood vessel anatomy (12). However, in a previous study, intrahepatic portal branches were less visualized in dogs with PSS derived from the right gastric vein than in dogs with other types of PSS (13). This was considered a limitation of CTA; therefore, we believe that additional tests are required to confirm PV aplasia.

The livers of dogs with PSS and PV hypoplasia have similar histopathologic abnormalities (14). Small PVs relative to the nearby bile ducts and the proliferation of small arterioles are observed within portal triads (15). This histological change is thought to be caused by an increase in hepatic artery blood flow, as PV blood flow towards the liver is reduced in dogs with PSS compared to healthy dogs (16,17). However, there is no standard method of accurately evaluating the histological characteristics of dogs with PV aplasia. In dogs with PV aplasia, it is expected that PVs are absent in the portal triad (16,18,19). The liver biopsy in the current case, taken at time of PSS attenuation, revealed the presence of PVs. Proliferation of small arterioles and lymphatic vessels was also noted, and the dog was diagnosed with PV hypoplasia. However, questions remain regarding whether PV aplasia can be confirmed by examining some lobes of the liver.

Humans with PV aplasia due to PSS are classified as having Abernethy malformation Type 1 (20) and are candidates for liver transplantation because attenuation of the shunt is impossible in these patients (21,22). However, it was reported that PSS could be completely ligated in humans diagnosed with PV aplasia by performing an occlusion test (10,23). If the

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small intestine and pancreas do not have signs of congestion or if congestion improves within 15 min after clamping the shunt, then these patients are considered to have severe hypoplastic PV. In such patients, complete ligation of the PSS was successful, and the intrahepatic PV was normally visualized after surgery without side effects such as portal hypertension. This indicates that temporary occlusion of the PSS redirects blood flow to the liver, thereby expanding the hypoplastic PV and promoting revascularization of the PV (23). Therefore, an occlusion test is recommended even if PV aplasia is diagnosed based on CTA.

In this case, surgery was undertaken for several reasons. Although the portal branches of the liver were not visualized, blood vessels suspected to be the PV were detected ~2 mm toward the liver. Therefore, we considered that, in this dog, the hypoplastic PV was not detected with CTA as it is in humans.

It has been reported that PSS can be attenuated in dogs using minimally invasive laparoscopy (24,25). In this case, attenuation of the PSS through laparoscopy was considered, but we expected access would be difficult because ligation was required near the CVC due to the splenic branch. Therefore, we conducted a vascular occlusion test *via* an open laparotomy, at the owner's request. After occlusion of the PSS, the dog's intestine was not congested and had a normal color. Therefore, the dog tolerated the blood flow to the liver after clamping the PSS and it had a hypoplastic PV that was not revealed by CTA. The PSS could be completely ligated, but a sudden increase in blood flow to the liver after ligating the PSS would damage the hepatocytes (23). In addition, dogs with preoperative HE are vulnerable to complete ligation (26). Because acute portal hypertension is likely to occur when complete ligation is done (1), we decided to attenuate the PSS gradually, using a thin-film band.

In conclusion, there is a possibility that severe PV hypoplasia may not be visualized on CTA imaging and may be diagnosed as PV aplasia. In addition, it is difficult to differentiate between PV aplasia and hypoplasia using a liver biopsy. In such dogs, the shunt occlusion test can distinguish PV hypoplasia and help revascularize the intrahepatic PV by expanding the hypoplastic PV. Attenuating the PSS after confirmation of PV hypoplasia *via* an occlusion test will improve the long-term prognosis. Even if the PV is not identified by imaging, a temporary occlusion test should be done before concluding surgery is impossible. CVJ

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Case Report Rapport de cas

Bilateral neoureterocystostomy with distal ureteral tapering in a dog with severe bilateral hydroureteronephrosis

Agnieszka B. Fracka, Jolene Sun, Boel A. Fransson

Abstract — A 3.5-year-old intact male Labrador retriever was seen for hematuria. The results of clinical pathology tests were unremarkable. However, urinalysis revealed dark, cloudy, alkalotic, and isosthenuric urine containing red and white blood cells, epithelial cells, and struvite crystals. Severe bilateral enlargement of ureters and markedly enlarged kidneys were identified on abdominal radiographs. Computerized tomography revealed extensive bilateral hydroureteronephrosis with no definitive cause of obstruction. The dog underwent bilateral ureteral tapering with bilateral neoureterocystostomy and placement of temporary bilateral ureteral stents and a cystostomy tube. The dog was monitored in the intensive care unit for 7 d after surgery and was discharged 9 d after surgery and after the stent and cystostomy tube were removed. The dog remained clinically normal and was reported to have been euthanized at 11 y of age (2021) due to unspecified causes.

Key clinical message:
There are several potential causes of severe bilateral hydroureteronephrosis in animals. Based on this case report, dogs with severe bilateral hydroureteronephrosis that are clinically asymptomatic may have favorable outcomes following bilateral ureteral reconstruction and neoureterocystostomy, even if a definitive cause is not identified.

Résumé — Néourétérocystostomie bilatérale avec effilement urétéral chez un chien avec hydrourétéronéphrose bilatérale sévère. Un labrador mâle non-castré âgé de 3,5 ans a été vu pour hématurie. Les résultats des tests de pathologie clinique ne présentaient pas d'anomalie. Toutefois, l'analyse d'urine a mis en évidence une urine foncée, trouble, alcaline et isosthénurique, contenant des globules rouges et blancs, des cellules épithéliales et des cristaux de struvite. Une augmentation bilatérale sévère de la taille des urètres ainsi qu'une augmentation de la taille des reins ont été notées lors des radiographies abdominales. Un examen par tomodensitométrie a révélé une hydrourétéronéphrose bilatérale marquée sans cause identifiable d'obstruction. On procéda à un effilement urétéral bilatéral avec néourétérocystostomie bilatérale et mise en place de stents urétéraux bilatéraux temporaires et un tube à cystotomie. Le chien a été sous surveillance à l'unité des soins intensifs pendant 7 j après la chirurgie et a obtenu son congé 9 j après la chirurgie, après que les stents et le tube à cystotomie aient été retirés. Le chien est demeuré cliniquement normal jusqu'à son euthanasie à l'âge de 11 ans (2021) pour des raisons non-spécifiées.

Message clinique clé :
Il y a plusieurs causes potentielles d'hydrourétéronéphrose bilatérale chez les animaux. Sur la base de ce rapport de cas, les chiens avec hydrourétéronéphrose bilatérale sévère qui sont cliniquement asymptomatique un résultat favorable peut être obtenu à la suite d'une reconstruction urétérale bilatérale et une néourétérocystostomie même si une cause définitive n'est pas identifiée.

(Traduit par Dr Serge Messier)

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Hydronephrosis and hydroureter usually occur secondary to obstructive urinary tract diseases such as urolithiasis, ureteral stenosis/stricture, ureteroceles, circumcaval ureters, tumors, trauma, or iatrogenic ureteral ligation (1–7). The condition may also be congenital in origin and has been reported in puppies as a result of ectopic ureters or congenital distal ureteral orifice stenosis (1,6). Numerous surgical techniques to bypass ureteral obstruction or restore patency to the ureter have been described. Although some studies have yielded encouraging results (8), reports have more often cited high complication

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rates (9–11). Reported techniques include subcutaneous ureteral bypass, extravesicular and intravesicular neoureterocystostomy, partial ureterectomy with neoureterocystostomy (end-to-side neoureterocystostomy), ureteroureterostomy, ureterotomy, side-to-side neoureterocystostomy, endoscopic spatulation, and ureteral stent placement (3,9–15). However, one study comparing ureterotomy and ureteral stenting reported a low complication rate (2%) for ureterotomy, but a much higher complication rate with ureteral stents (16). In some cases, ureteronephrectomy may be considered, providing there is good contralateral kidney function. Megaureter, a condition in human children with massively enlarged ureters (10× their normal diameter) (17–20), may occasionally be caused by obstruction (17). In human medicine, if megaureters are obstructed (*e.g.,* secondary to bladder diverticula, ureterocele, or periureteral fibrosis), they are treated surgically with ureteral reimplantation after tapering of the ureter to fit the urinary bladder wall (17,21). Bilateral megaureter has been described as a postmortem finding in a dog with suspected urolith obstruction at the vesicoureteral junctions (22). In humans, megaureter is not normally associated with severe hydronephrosis and rarely leads to renal insufficiency (17,18).

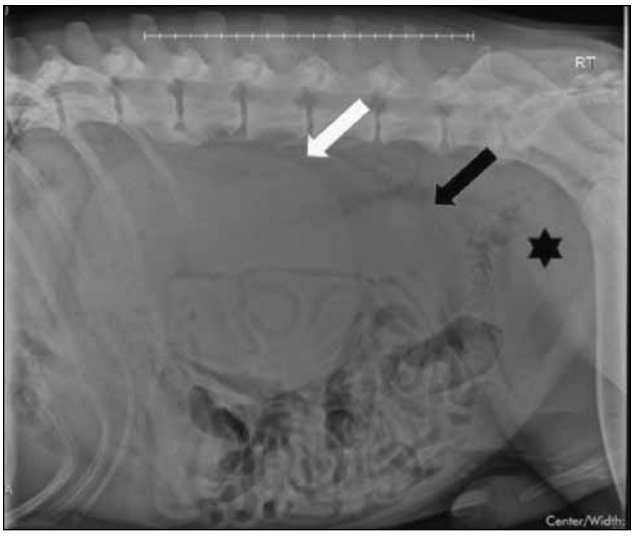


Figure 1. Abdominal radiograph (right lateral view) of a dog. Enlarged kidneys (white arrow) in the retroperitoneal space. It is unclear whether the soft tissue opacity (black arrow) present on lateral view is the contralateral kidney or a dilated ureter. Distended prostate (black star).

Case description

A 3.5-year-old intact male Labrador retriever weighing 43.6 kg was brought to the primary care veterinarian with hematuria (~2 wk duration) and a tense, distended abdomen. Physical examination was unremarkable apart from confirming a mild abdominal distension. A complete blood (cell) count (CBC) and serum chemistry tests were completed, revealing no abnormalities. Urinalysis results were unremarkable apart from presence of red blood cells (RBC). The dog was discharged with a 10-day course of cephalosporin (Cefpodoxime; Dechra, Overland Park, Kansas, USA), 4.5 mg/kg, PO, q24h, for a suspected urinary tract infection. Three days later, the dog was seen at a different primary care clinic for increasing lethargy and hyporexia. Bilateral renomegaly was appreciated on abdominal radiographs. An abdominal ultrasound completed the following day revealed bilateral hydroureteronephrosis. Based on the severity of the changes, a grave prognosis was anticipated. The dog was referred to a tertiary veterinary teaching hospital for further diagnostic tests and treatment. At the time of the appointment, the dog had not received antibiotics in the preceding 2 wk.

Upon examination, the dog was bright, alert, and responsive, with all vital parameters within normal limits. A mass 10 cm in diameter was palpated in the left cranial abdomen and a mass 8 cm in diameter in the right cranial abdomen. No pain was elicited during abdominal palpation. Peripheral lymph nodes were within normal limits on palpation and systolic blood pressure was 165 mmHg. Rectal examination was unremarkable. A CBC revealed a mild eosinophilia [2.35×10^3, reference range (RR): 0 to 1.2×10^3], but other parameters were within normal limits, as was serum chemistry. Urinalysis conducted on a free-catch sample revealed dark brown, cloudy, alkalotic (pH: 8.0) urine with a specific gravity (USG) of 1.014 that was positive for protein (3+) and blood (4+) but negative for ketones, bilirubin, and glucose. A sediment examination revealed 3 to 5 RBC per high-power field (hpf), 6 to 15 white blood cells (WBC)/hpf, and the presence of 3 to 5 squamous/transitional cells/hpf and struvite crystals. Three-view abdominal radiographs were performed, and these identified 2 large, rounded renal silhouettes in the retroperitoneal space (Figure 1). There was an enlarged, rounded, soft tissue opacity superimposed and caudal to the suspected enlarged kidney, which likely represented an enlarged ureter or enlarged contralateral kidney. There was no evidence of abdominal effusion. Computerized tomography (CT), non-contrast- and contrast-enhanced, was performed to completely characterize changes in the urinary system. Plain CT revealed bilateral hydronephrosis and apparent destruction of virtually all renal parenchyma, worse on the left (Figure 2 A). The left and right hydroureters were tortuous and markedly dilated along their entire lengths, measuring up to ~7 cm in diameter (Figure 2 B, C).

Ureterovesicular openings were not evident based on non-contrast study. The urinary bladder was displaced rightward by the enlarged left hydroureter. Multiple small, mineral-attenuating, rounded stones and mineral-attenuating sediment were present within the dependent portion of the urinary bladder. A few small collections of dependent mineral-attenuating sediment were present within the dilated ureters, as well as within the deformed renal pelvis. A urine sample, collected *via* cystocentesis, did not grow any microorganisms. Computerized tomography excretory urography with iodinated nonionic contrast medium (Iohexol, Omnipaque 300; GE Healthcare, Marlborough, Massachusetts, USA) was used to visualize the distal ureters and ureterovesicular junctions (UVJ) and to determine possible reasons for obstruction. However, as a result of peripheral venous catheter dislodgement, it was not possible to infuse the total amount of contrast agent. Given the lack of extra- or intraluminal obstruction, partial obstruction due to distal ureteral/UVJ stenosis was suspected and a decision was made to carry out an abdominal exploratory surgery to identify

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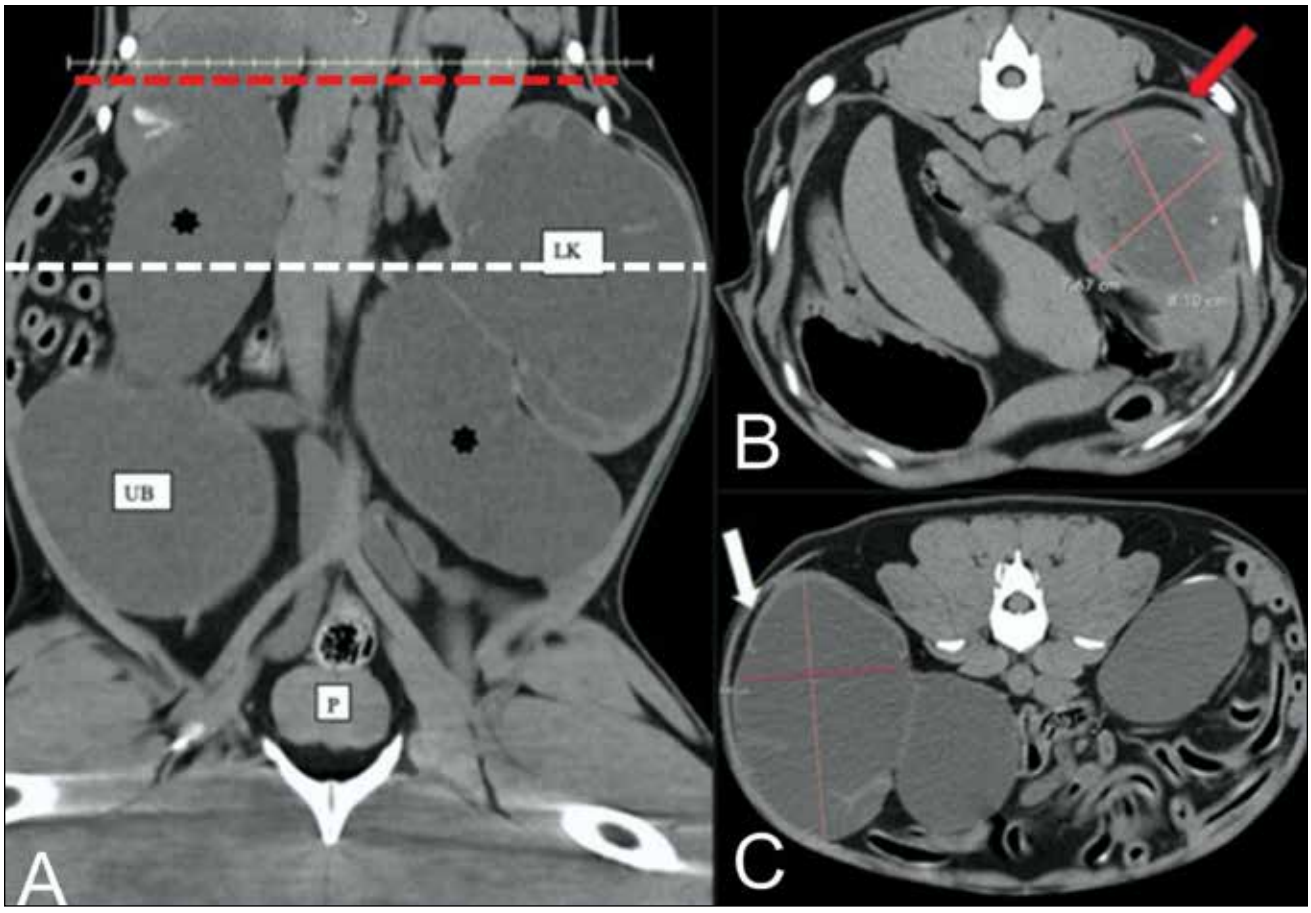


Figure 2. Computerized tomographic (CT) imaging in a dog. A – Coronal view of an abdominal CT image showing the left kidney (LK), urinary bladder (UB), and bilateral hydroureter (black stars). A red dashed line corresponds to the transverse plane in panel B, and a white dashed line corresponds with to transverse plane in panel C. B – Transverse view through the center of the right kidney (red arrow) shows severe hydronephrosis. C – Transverse view through the center of the left kidney (white arrow) shows severe hydronephrosis.

and treat the underlying cause of bilateral hydroureteronephrosis. However, due to the severity of the changes, only a fair prognosis was expected for long-term outcome and quality of life.

The dog was premedicated with dexmedetomidine (Dexdomitor; Zoetis, Parsippany, New Jersey, USA), 5 μg/kg, IM, and hydromorphone (Hydromorphone; Baxter, Deerfield, Illinois, USA), 0.1 mg/kg, IM. Anesthesia was induced with propofol (Propofol-Lipuro Vet; Virbac, Westlake, Texas, USA), 1 mg/kg, IV; the dog was intubated with a size 12 endotracheal tube; and general anesthesia was maintained with inhaled isoflurane in oxygen. An antibiotic, cephalosporin (cefazolin; Apotex Corp, Weston, Florida, USA), 22 mg/kg, IV, was administered 30 min before surgery and repeated every 90 min during surgery. The dog was surgically prepared in dorsal recumbency and an 8 French (Fr) Foley urinary catheter (MILA International, Florence, Kentucky, USA) was placed. A routine exploratory laparotomy was performed through a ventral midline incision. Examination of the urogenital system revealed severe bilateral hydronephrosis and hydroureters without evidence of peritoneal effusion. The bladder was located and isolated with moist laparotomy pads, stay sutures were placed, and a ventral midline cystotomy was completed, extending from the apex of the bladder to the vesicourethral junction. Several cystoliths were identified and collected for stone analysis and for culture. Both ureteral openings were visualized in the trigone area and deemed patent as urine was flowing from the openings. Subjectively, partial stenosis of UVJ was suspected, as retrograde catheterization of the ureters with 3.5 Fr and 5 Fr red rubber catheters was unsuccessful in gaining access to either ureter.

The massively enlarged and tortuous right ureter was dissected from the retroperitoneal fascia and transected 10 cm proximal to the ureteral orifice into the bladder (Figure 3 A). The distal ureteral remnant was ligated at the level of the bladder wall, then excised. Vascular forceps were placed obliquely on the ureter to taper the luminal diameter to ~1 cm over a ~10-centimeter length of the distal ureter. The excess tissue was excised with sharp dissection from the opposing side of the ureteral vasculature (Figure 3 B). The ureteral defect (Figures 3 C, 4) was apposed using 8-0 USP polydioxanone (PDS II Suture; Ethicon, Raritan, New Jersey, USA) in a simple continuous pattern, resulting in a ureter tapering to ~1 cm in diameter at the orifice. A 4-0 USP polydioxanone stay suture was placed in each distal edge of the ureter. Approximately 1-centimeter cystotomy incisions were made in the right and left dorsolateral bladder wall with ~1 cm of tunneling obliquely through the muscularis layer in the dorsal body of the urinary

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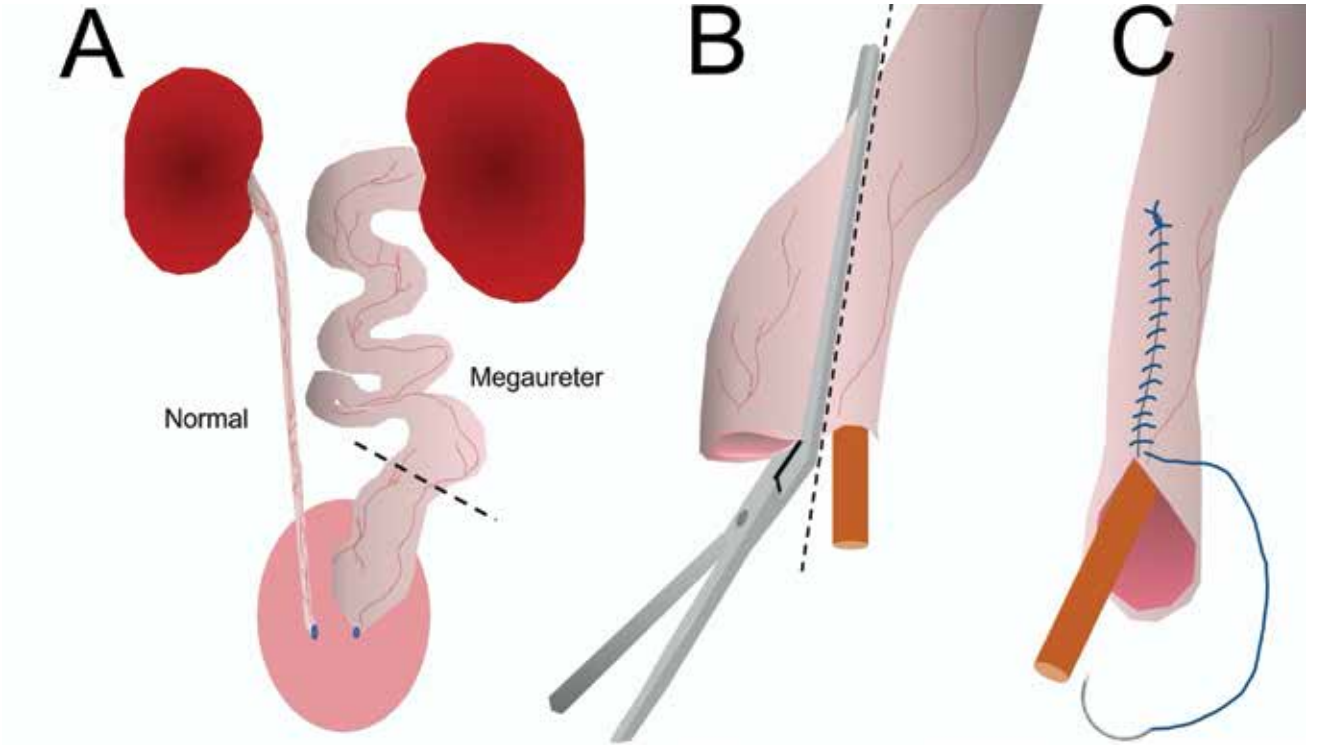


Figure 3. A – Schematic representation of the ureteral tapering procedure in a dog. The dashed line indicates the location of the transection. B – A red rubber catheter (8 Fr) is inserted into the transected ureter for luminal size reference and to ensure patency. The megaureter is transected (dashed line) along atraumatic vascular forceps placed obliquely to the axis of the ureter. C – The transected ureter is sutured in a simple continuous fashion. The tapering facilitates reimplantation into the urinary bladder.

bladder. The ureter was pulled through the bladder wall by traction on the stay suture and the distal ureter affected by the stay suture excised. Ureteral mucosa was sutured to the bladder mucosa using 8-0 USP polydioxanone in a simple interrupted pattern. The same procedure was repeated on the left ureter. Double pigtail ureteral stents (28 cm, 10 F, Endo-Sof; Cook 132 Urological, Spencer, Indiana, USA) were placed bilaterally into the ureters using the guidewires provided in the stent kit, and advanced to a length that approximated the distance from the stoma to the renal pelvis. A 24 F Pezzer cystostomy tube was placed from the apex of the bladder and secured to the bladder wall with 4 interrupted mattress sutures using 2-0 USP polydioxanone for cystopexy around the stoma and tube. The cystostomy tube was placed to facilitate subsequent ureteral stent removal by allowing the sutures from the ureteral stents to be passed through the cystostomy tube lumen, allowing trans-abdominal access. A 10-millimeter Jackson-Pratt drain (MILA international) was placed into the abdominal cavity and exited the right body wall to monitor for possible uroabdomen. The cystostomy tube and drain were secured to the external right abdominal wall with a purse-string and finger-trap suture, each with 2-0 USP nylon (Ethilon; Ethicon). The cystotomy was closed using 3-0 USP polydioxanone suture in a simple interrupted pattern. Aerobic and anaerobic cultures showed no growth from the uroliths. The stone analysis results are not available.

The dog remained in the intensive care unit for 7 d after surgery to allow monitoring of the cystostomy tube and Jackson-Pratt drain, evaluation of urine production, and administration of IV fluids, analgesics, and antibiotics. Isotonic crystalloid fluids (Plasma-lyte A; Baxter, Mississauga, Ontario) were administered IV at a rate of 4 mL/kg per hour for 2 d, then decreased to 2.5 mL/kg per hour for 3 d, then further decreased

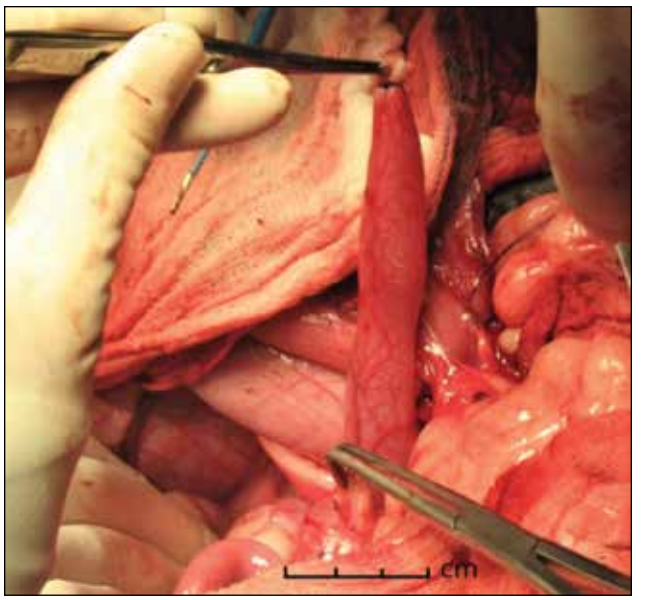


Figure 4. Photograph showing the ureter after the tapering reconstructive procedure starting at the location of the right-angle forceps through the distal 10 cm. The width was reduced from ~2 cm to 1 cm, facilitating passage through the bladder wall and neoureterocystostomy.

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to 0.2 mL/kg per hour for 2 d. Thereafter, fluids were discontinued. Initial postoperative care also included fentanyl (Fentanyl Citrate; Hospira, Lake Forest, Illinois, USA), constant rate infusion of 3 μg/kg per hour for 24 h, and ampicillin-sulbactam (Unasyn; Pfizer, New York, New York, USA), 30 mg/kg, IV, q8h, starting immediately after surgery and continuing for the entire period of hospitalization. Urine production was monitored and ice packs were used over the incision q4h. A blood sample collected 24 h after surgery showed a leukocytosis (WBC: 22.3 × 10^3, RR: 4.5 to 16 × 10^3) with neutrophilia (19.401 × 10^3, RR: 2.8 to 13.4 × 10^3). Serum chemistry demonstrated mild elevations in ALT (131 U/L, RR: 0 to 100 U/L) and ALP (134 U/L, RR: 4 to 113 U/L) accompanied by decreases in creatinine (0.7 mg/dL, RR: 0.8 to 1.6 mg/dL) and TP (4.6 g/dL, RR: 5.5 to 7.5 g/dL). Mild hypoalbuminemia (2.2 g/dL, RR: 2.9 to 3.8 g/dL), hyperglycemia (166 mg/dL, RR: 66 to 123 mg/dL), and hypocalcemia (8.7 mg/dL, RR: 9 to 11.3 mg/dL) were also present. All other serum chemistry parameters were unremarkable. The volume of abdominal fluid collected every 6 h from the Jackson-Pratt drain ranged from 0.02 to 0.1 mL/kg per hour at each collection. The fluid was collected, analyzed for creatinine, and compared to the dog's peripheral blood to monitor for uroabdomen, which was not noted.

On Day 4 after surgery, the dog seemed uncomfortable and developed mild pyrexia (103.2°F) and hyporexia with weakness of the pelvic limbs. A CBC revealed leukocytosis (WBC: 16.1 × 10^3, RR: 4.5 to 16 × 10^3) with neutrophilia (13.52 × 10^3, RR: 2.8 to 13.4 × 10^3), lymphopenia (0.805 × 10^3, RR: 0.9 to 4 × 10^3), and monocytosis (1.610 × 10^3, RR: 0 to 1.3 × 10^3). Serum chemistry showed mildly elevated ALT (119 U/L, RR: 0 to 100 U/L) and ALP (114 U/L, RR: 4 to 113 U/L) and mild hypoproteinemia (TP: 5.4 g/dL, RR: 5.5 to 7.5 g/dL) and hypoalbuminemia (2.5 g/dL, RR: 2.9 to 3.8 g/dL). Urine was collected from the urinary catheter. Urinalysis showed brown/red, cloudy, and alkalotic urine (pH: 7.5) with a USG of 1.014, proteinuria (3+), hemoglobinuria (4+), and bilirubinuria (2+). The urine was negative for ketones and glucose. Sediment examination revealed > 75 RBC/hpf, 51 to 75 WBC/hpf with clumps of WBC appreciated, 0 casts/hpf, 0 to 2 transitional epithelial cells/hpf and the presence of struvite crystals. Abdominal fluid from the Jackson-Pratt drain was bloody/hazy with a specific gravity of 1.024, a protein level of 3.5 g/dL, a nucleated cell count of 2490 cells/μL, and a PCV of > 2%. Cytological analysis of the abdominal fluid revealed a modified transudate containing numerous RBC and lesser numbers of nucleated cells (69% mildly degenerate neutrophils, 25% macrophages, 5% eosinophils, and 1% small lymphocytes). There was no evidence of microorganisms. Therefore, the presence of fluid was likely secondary to inflammation. Cultures of peritoneal fluid and urine were negative for aerobic and anaerobic bacteria. Due to pyrexia, hyporexia, and a left shift on hematology in the face of ongoing treatment with ampicillin-sulbactam (Unasyn; Pfizer), enrofloxacin (Baytril; Bayer, Shawnee Mission, Kansas, USA), 10 mg/kg, PO, q24h, was added to the dog's postoperative care regimen on the 4th d after surgery. On the following day, the abdominal effusion stabilized at 0.05 mL/kg per hour and the Jackson-Pratt drain was removed. The pyrexia resolved on Day 6. At this time, the dog was eating and drinking, urine production was > 2 mL/kg per hour, and pelvic limb weakness had improved. Following removal of the urinary catheter on Day 7, the dog was noted to be voiding urine normally.

On Day 8 of hospitalization, a positive contrast fluoroscopic cystoureterogram (ISO-C fluoroscopy C-arm; Siemens, Malvern, Pennsylvania, USA) was completed under general anesthesia by infusing iodinated contrast (Iohexol, Omnipaque 300; GE Healthcare) through an 8 Fr Foley urinary catheter placed at the neck of the bladder. Patency of the ureters was confirmed, as was the integrity of the bladder wall, with no leakage noted from the 2 neoureterocystostomy sites. The cystostomy tube and ureteral stents were removed by gentle traction. An abdominal CT scan was then obtained to compare with preoperative images. A mild improvement in renal and proximal ureteral dilation (by ~1 cm in diameter bilaterally) was noted, although the kidneys and ureters remained markedly dilated and tortuous bilaterally. Lactated Ringer's solution (Vetivex; Dechra) was administered at 4 mL/kg per hour, IV, 1 h before and 1 h after CT contrast injection, to assist with renal clearance of the contrast solution, after which fluids were discontinued.

The dog was sent home on Day 9 after surgery for continued monitoring. Management at home included 5 d of treatment with enrofloxacin (Baytril; Bayer), 10 mg/kg, PO, q24h and 5 d of treatment with amoxicillin/clavulanic acid (Clavamox; Zoetis), 17 mg/kg, PO, q12h. Tramadol (Tramadol; Teva Pharmaceuticals, North Wales, Pennsylvania, USA), 5 mg/kg, PO, q8h, was dispensed for analgesia, and the dog was fed a renal diet. At-home care included incision monitoring and monitoring for the development of polyuria, polydipsia, anorexia, weight loss, vomiting, or lethargy. Exercise was restricted for 1 wk until skin staples were removed. Wound recheck and staple removal were scheduled with the primary care clinic. The owner was advised to take the dog for quarterly recheck examinations with urinalysis and CBC/chemistry profiles (to monitor renal and urine changes) and follow-up CT imaging in 6 mo.

The owner was contacted by telephone every day for 5 d after discharge from the hospital as they reported the dog was lethargic, inappetent, and urinary incontinent. The owner was advised to take the dog to the primary care veterinarian on Day 2 after discharge. A physical examination and the incision site were deemed unremarkable. A CBC and serum chemistry were done and did not show any abnormalities apart from slightly increased BUN (30 mg/dL, RR: 7 to 27 mg/dL). Urinalysis was not completed at that time. Previously prescribed medications were continued, and dietary suggestions made to increase fluid intake and food palatability. In the next few days, the dog's appetite and demeanor improved and pelvic limb weakness resolved. Some urinary incontinence was still present and was occurring mostly at night. Urinalysis was repeated 45 d after surgery at the primary care clinic and no abnormalities were noted in the medical record. All follow-up appointments from July 2013 until the time of euthanasia in March 2021 were coordinated through the dog's primary care veterinarian. Medical records showed recheck visits occurred annually to biannually, with

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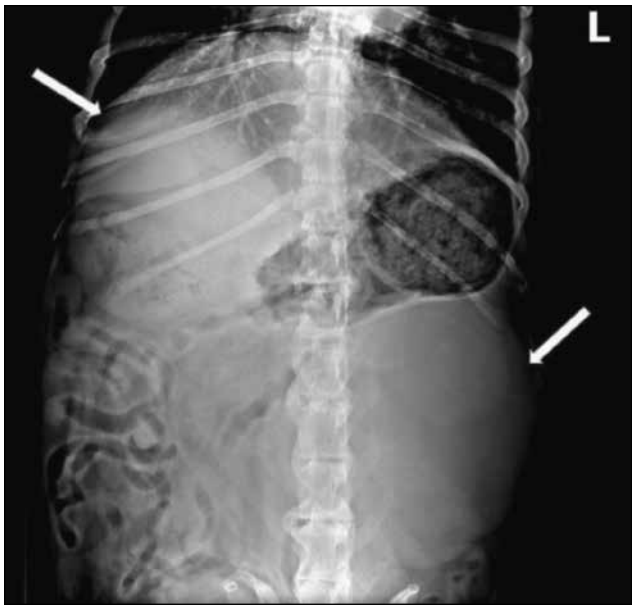


Figure 5. Abdominal radiograph (ventrodorsal view) of a dog, performed 8 y postoperatively, showing enlarged kidneys (white arrows) in the retroperitoneal space.

intermittent CBC and serum chemistry assessments, for the first 2 y after surgery. All values remained within reference intervals. Physical examinations were unremarkable aside from consistent findings of alopecia on the dorsal tail base and a diagnosis of flea bite dermatitis in 2016. The final visits with the primary veterinarian in February 2021 included presentation for lethargy, loose stool, hyporexia, and a potbellied appearance. A CBC showed leukocytosis (WBC: 25.9 $\times$ 10^3, RR: 4 to 15 $\times$ 10^3) characterized by neutrophilia (83 $\times$ 10^3, RR: 60 to 77 $\times$ 10^3) and thrombocytosis (675 $\times$ 10^3, RR: 170 to 400 $\times$ 10^3). Serum chemistry revealed elevated ALP (271 U/L, RR: 5 to 131 U/L) and a mild increase in BUN (34 mg/dL, RR: 6 to 31 mg/dL), but creatinine was within normal limits (1.0 mg/dL, RR: 4 to 27 mg/dL). Thyroxine was mildly depressed (0.6 μg/dL, RR: 0.8 to 3.5 μg/dL). Urinalysis of a free-catch sample revealed the urine was light brown, turbid, and mildly concentrated, with a USG of 1.013 and normal pH (6.0). Moderate proteinuria (2+) with evidence of occult blood (3+), 21 to 50 WBC/hpf, 21 to 50 RBC/hpf, and 4 to 10 fat droplets/hpf were identified. Abdominal radiographs identified severe spondylosis of the lumbar spine; large, oval masses in the cranial abdomen, consistent with dilated kidneys; and thickening of the right femoral neck (Figure 5). An abdominal ultrasound was recommended through a nearby emergency clinic, but the results were lost to follow-up. The dog was presented to the primary care veterinarian 3 wk later, in March 2021, for euthanasia at 11 y and 3 mo of age, without clear indication of the dog's status.

Discussion

The main clinical presentation in this case was hematuria associated with marked bilateral hydroureteronephrosis in an otherwise healthy dog. Based on the severity of changes and expected progression of the disease, the dog was given a grave prognosis by the primary care clinician and euthanasia was discussed as an alternative to treatment. However, after bilateral neoureterocystostomy, the dog lived an additional 8 y with a normal quality of life and without apparent renal function deterioration. It is impossible to state a causative relationship between surgery and survival, as we do not know if the outcome in this case would have been the same without the surgical procedure. However, with partial obstruction of both ureters as the most likely underlying pathology, relief of the potential obstruction, rather than conservative management, was considered the optimal treatment.

Haematuria in adult dogs is usually associated with urogenital tract disease, including infection, urolithiasis, and renal hematuria, all of which were considered potential etiologies in this case (23–25). Severe bilateral hydroureteronephrosis may develop secondary to ureteral obstruction, such as extrinsic or intrinsic stenosis, urolithiasis, congenital fibrosis, or dysplasia (1,11,20,22,26). To the authors' knowledge, severe bilateral hydroureteronephrosis in a young adult dog with long-term follow-up has not been reported previously. One dog with ectopic bilateral ureteral orifice stenosis was described among a series of cases treated by endoscopic laser ablation, but the clinical findings and outcome were not specified in that particular case (3). The pathogenesis of bilateral hydroureteronephrosis remained unclear in this case. However, mild stenosis at the UVJ causing slow, progressive dilation of the ureters and renal pelves was considered the most likely explanation, given the lack of any other obstructive lesion and the subjectively narrowed ureteral orifices seen in surgery. The diagnosis of UVJ stenosis is usually made based on confirmation of marked hydroureteronephrosis on abdominal ultrasound scan (3). In dogs, ultrasonography of the UVJ may be diagnostic to determine ectopic ureteral jet location, but determining stenosis is challenging since visualization of the ureteral jet may be obscured for several reasons; hydroureteronephrosis may cause bladder displacement or the view may be obscured from formation of gas in the colon (27). Advanced imaging, such as CT contrast cystourethrogram or pyelography, combined with either fluoroscopy or cystoscopy may lead to a more accurate diagnosis, but the latter were unfortunately not available at our institution at the time of this case (12,28,29). When the ureters are patent, contrast CT is very useful in the assessment of the ureter and distal ureteral papilla in dogs with normal or ectopic ureters. When there is distal ureteral stenosis, the sensitivity of the technique may not be sufficient to support accurate identification of either the location or the extent of the stenosis (3). Mild stenosis was suspected in our case and was likely congenital, given the bilateral disease; however, stenosis or stricture from ureteral inflammation, debris, blood clots, or passage of uroliths cannot be completely ruled out (30,31). A more recent study suggested that hydroureteronephrosis in young dogs can be a result of a relatively rare condition, congenital distal ureteral orifice stenosis (CDUOS), which should be taken into consideration if other more common causes have been ruled out (3). Our case shared similarities to CDUOS; the main difference was that the suspected stenosis was less readily apparent compared to cases described in the latter study (3).

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Megaureter is a rare urinary anomaly that has been reported as another reason for hydroureter. The condition can be congenital in human children (19) or can occur as a non-congenital disease in adult humans and domestic animals (22,32). To our knowledge, there is no definition for megaureter in the veterinary literature. The diagnosis of megaureter is therefore determined using a classification from human medicine, which includes a ureter that is 10× the diameter of a normal ureter (18,19). The normal diameter of the canine ureter is between 2.0 mm and 2.5 mm, compared to the ureteral diameter of 69 to 71 mm in this case (33). In humans, megaureters may result from muscle dysplasia of the ureter (34). Primary megaureter from vesicoureteral reflux cannot be fully ruled out given the lack of histopathology in this case, but is not commonly associated with such a severe hydronephrosis as was observed (17,18).

In the current case, ureteral reimplantation was elected to address potential ureteral orifice stenosis to minimize progression of renal damage over time. Due to the severe dilatation and elongated, tortuous nature of the ureters, a 10-centimeter ureteral shortening and a tapering procedure was elected, similar to that recommended for reimplantation of megaureters in human children (17,21). Despite the high-morbidity open surgery, long hospitalization, and temporary urinary incontinence, no major complications following surgery were reported in this case, aside from pyrexia that resolved with medical management. The bilateral ureteral stents likely increased the length of hospitalization; however, they were placed to minimize the risk of perioperative ureteral obstruction secondary to swelling at the new ureterovesical junction. A cystostomy tube was placed to enable stent removal without repeat surgery. In the future, we would likely forego the stent placement in a similar case, as the resulting ureteral openings were quite large (~1 cm in diameter) at the neoureterocystostomy site, and the risk for obstruction was probably low. Hospitalization time would have been minimized with a minimally invasive approach such as UVJ ballooning or cystoscopic-guided laser ablation, which is currently our preferred surgical option for stenosis of ectopic ureteral orifices and an established treatment for UVJ stenosis in humans (35). Cystoscopic-guided laser ablation has been shown to be a quick and safe procedure, with fewer complications and similar efficacy compared to traditional open surgery (3,29), and is the preferred option if CDUOS is suspected. However, at the time of this case (in 2013), a minimally invasive surgical option had not been described for dogs and was not available at our institution. We therefore elected to perform open ureteral surgery, which at that time was considered to have an acceptable risk of complications such as stenosis, chronic urinary tract infection, hematuria, or uroabdomen (30). However, more recent literature has noted fewer and milder complications (16), especially with minimally invasive techniques (36,37). We suspected that any further progression of this dog's disease would place renal function at risk. Ureteronephrectomy could not be considered as a viable option in this case due to involvement of both kidneys and ureters. The owner in our case considered euthanasia as an option, but due to the dog's overall lack of clinical signs, alternative treatment was elected.

According to the owner and the primary veterinarian, the dog continued a seemingly normal life for almost 8 y after surgery and was euthanized at 11 y and 3 mo of age. Based on blood results, the dog's kidney parameters remained within normal limits and azotemia was not detected before or after surgery. However, azotemia usually is an uncommon finding in dogs with marked hydroureteronephrosis (3). For that reason, symmetric dimethylarginine could have been a valuable diagnostic tool for detecting early renal insufficiency in our case, and to monitor the progression (38). In this case, the dog was intermittently incontinent for 2 mo after surgery, which could have been associated with inflammation, urethral sphincter irritation secondary to the surgical procedure, small bladder capacity, or urethral sphincter mechanism incompetence (29,36,37). In our experience, transient urinary incontinence and pollakiuria are common after extensive open bladder surgery such as end-to-side neoureterocystostomy and are expected to resolve within 10 to 14 d after surgery. Likewise, incontinence in this dog subsequently resolved. Unfortunately, as the owner declined repeat diagnostic imaging, the extent of hydroureteronephrosis progression or resolution is unknown. Radiographs obtained 3 wk before euthanasia indicated refractory hydronephrosis or hydroureter, or both. It was reported that only half of dogs treated for ureteral stenosis had reductions in upper urinary tract dilation (27). Persistent hydronephrosis and hydroureter were noted despite successful treatment (27). One possible explanation for the unresolved hydroureteronephrosis in this case is the severity of the condition, which was long-lasting and caused an irreversible distension of the ureteral muscular layer. Other reasons for the persistent and severe hydroureteronephrosis may be associated with chronic functional obstruction, absence of peristalsis, vesicoureteral reflux, pyelonephritis, or congenital anomalies such as defect of the ureteral wall (3,29).

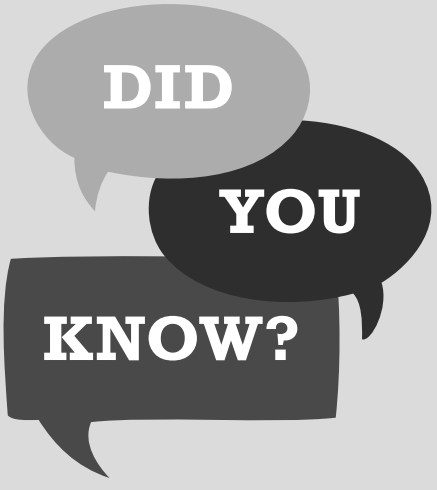
In conclusion, this case adds evidence that surgical treatment for confirmed or presumed ureteral stenosis of the UVJ with severe hydroureteronephrosis may lead to long-term survival with a normal quality of life. Euthanasia or nephrectomy may not be called for in such cases. CVJ

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Case Report Rapport de cas

Fetal maceration and partial retention of fetal bones in 2 mares

Jennifer Morrissey, Tova Pinsky, Marie-France Roy

Abstract — Pregnancy loss after Day 40 in mares usually results in the expulsion (abortion) of the fetus and placental membranes. However, fetal retention within the uterus is also a possible outcome, leading to either fetal mummification or maceration. Fetal maceration is septic decomposition of fetal tissues within the uterus following failure of expulsion. It requires the presence of bacteria and oxygen within the uterus, likely originating from an open cervix, and results in tissue autolysis, leaving only fetal bones remaining in the mare. Fetal maceration is a rare complication of pregnancy in mares that is usually associated with a recent history of abortion, a persistent vaginal discharge, and retention of numerous fetal bones. Here, we report 2 cases of fetal maceration with retention of only a few fetal bones in mares that were presented without noticeable clinical signs.

Key clinical message:
The unusual presentation of fetal maceration in these mares (only a few fetal bones and no noticeable clinical signs) brings attention to the potential insidious nature of fetal retention. It highlights the importance of a thorough reproductive examination before breeding, along with careful and ongoing monitoring after breeding and throughout pregnancy.

Résumé — Macération fœtale et rétention partielle d'os fœtaux chez 2 juments. L'interruption de gestation après le Jour 40 chez les juments résulte généralement par l'expulsion (avortement) du fœtus et des membranes fœtales. Toutefois, une rétention fœtale dans l'utérus est également un résultat possible, entraînant soit une momification ou une macération fœtale. La macération fœtale est la décomposition septique des tissus fœtaux à l'intérieur de l'utérus à la suite d'un échec d'expulsion. Elle nécessite la présence de bactéries et d'oxygène dans l'utérus, résultant probablement d'une ouverture du cervix, et résulte en une autolyse des tissus, laissant uniquement des os fœtaux à l'intérieur de la jument. La macération fœtale est une complication rare de la gestation chez les juments qui est généralement associée avec une histoire récente d'avortement, une décharge vaginale persistante, et la rétention de nombreux os fœtaux. Nous rapportons ici 2 cas de macération fœtale avec rétention de seulement quelques os chez des juments présentées avec aucun signe clinique notable.

Message clinique clé :
La présentation inhabituelle de macération fœtale chez ces juments (uniquement quelques os fœtaux et aucun signe clinque notable) met en lumière la nature potentiellement insidieuse de la rétention fœtale. Elle souligne l'importance d'un examen reproducteur complet avant l'accouplement, avec un suivi minutieux et continu après l'accouplement et durant toute la gestation.

(Traduit par Dr Serge Messier)

Can Vet J 2024;65:133–137

Loss of pregnancy in mares can occur at any time during gestation and is designated as early embryonic or fetal loss, depending on the timing of death before or after 40 d of gestation (1). Fetal death usually results in expulsion (abortion) of the fetus and placental membranes, which may not always be noticed, especially early in pregnancy. However, fetal retention within the uterus is also a possible outcome, perhaps due to uterine inertia, failure of the cervix to dilate, or fetal misposition (2). Retention of a dead fetus, if not recognized and treated appropriately, can lead to fetal mummification or maceration. Mummification and maceration can only ensue if the death of the fetus occurs after formation of bones, as death of the fetus

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before this will result in rapid tissue autolysis and resorption (3). Mummification is the sterile dehydration of fetal tissues within the uterus in the absence of oxygen and bacteria. These conditions usually imply a closed cervix to prevent contamination with putrefactive organisms. Conversely, fetal maceration is the septic decomposition of fetal tissues within the uterus following failure of expulsion. It requires the presence of putrefactive bacteria and oxygen within the uterus, likely originating from an open cervix, resulting in tissue autolysis and leaving only fetal bones remaining inside the mare (3,4). Fetal maceration is a rare complication of pregnancy in mares that is usually associated with a recent history of abortion or fetal death (4–8), a persistent vaginal discharge (5,6,8–10), and retention of a large number of fetal bones (4,5,7–12).

Here, we report 2 cases of fetal maceration with retention of only a few fetal bones in mares that presented without noticeable clinical signs. The unusual presentation of fetal maceration in these mares highlights the importance of thorough reproductive examination before breeding, along with ongoing monitoring after breeding and throughout pregnancy.

Case descriptions

Case 1

A 14-year-old Percheron mare was presented in May 2019 for pre-breeding preparation prior to live cover. The mare had been in the current owner's possession for 1 y and had failed to become pregnant following live cover in 2018. Breeding history before acquisition was unknown. No abnormalities of the external genitalia were noted. Initial reproductive ultrasound examination revealed normal ovarian follicles, a corpus luteum, a small amount of uterine edema, and a small amount of hyperechoic fluid within the uterus. Cytologic evaluation of a uterine sample identified significant uterine inflammation. The mare was treated in hospital for 7 d with high-volume intrauterine lavage with lactated Ringer's solution (LRS). For the first 3 d of treatment, intrauterine antimicrobials were administered immediately following each lavage, with 2 g of gentamicin, 5 million IU of sodium penicillin, and 20 mL of 8.4% sodium bicarbonate. On Days 4 and 5, 20 USP units of oxytocin were administered IM following uterine lavage and repeated 3 h later. On Day 7, a transrectal ultrasound examination of the reproductive tract was done and revealed signs consistent with impending ovulation [multiple ovarian follicles 20 to 47 mm in diameter on both ovaries and Grade-2 to -3 endometrial edema (13)]. A final uterine lavage was performed and the uterus was confirmed to be fluid-free. The mare was given deslorelin (Deslorelin Acetate; Trutina Pharmacy, Ancaster, Ontario), 1.5 mg, *via* IM injection, and discharged to be sent for live cover.

Four days later, the mare was presented to the clinic for postbreeding lavage and possible vulvoplasty. Transrectal ultrasonography revealed 2 corpora lutea on the left ovary and minimal uterine edema (Grade 0 to 1), consistent with diestrus. There was a small amount of moderately hyperechoic fluid within the uterus. At this time, 2 linear hyperechogenic structures ~30 mm long were noted: 1 at the base of the right horn and 1 in the uterine body. A uterine lavage was performed with 1 L of LRS. The mare was confirmed fluid-free following the lavage; however, the foreign bodies were still present. A sterile, gloved hand was inserted into the vagina. The structures were mobile but could not be manipulated transrectally close enough to the cervix to facilitate removal, and the cervical diameter was insufficient to allow manual removal. A lavage was performed using a sterile nasogastric tube and 5 L of LRS; however, the objects could not be removed. On the following day, a small amount of hyperechoic fluid was identified in 1 area of the uterine body and the 2 foreign objects were still present. Uterine lavage was performed with 2 L of LRS, and 20 USP units of oxytocin were administered IV at completion. At this point, the mare's owners elected to terminate the potential pregnancy, dilate the cervix, and remove the foreign bodies. The mare was given 300 μg of cloprostenol IM to induce luteolysis.

Hysteroscopy was performed to determine the nature of the objects and formulate a plan for removal. The mare was sedated with 100 mg of xylazine and 5 mg of detomidine, IV, for the procedure. Uterine endoscopy revealed the presence of 2 solid foreign bodies at the base of the right horn (Figure 1 A). A small volume of mucopurulent secretion was also present. The left horn did not present any abnormalities. The foreign bodies were > 60 cm from the vulva and could not be reached by hand. Additionally, they could not be grasped with the endoscopic biopsy forceps because of their hard surfaces, and endoscopic snares were unavailable.

Four days later, the mare was sedated with 8 mg of detomidine, 3 mg of butorphanol, and 100 mg of xylazine, IV, for an attempt at retrieving the foreign objects. The mare was also given 600 mg of flunixin meglumine and 20 mg of hyoscine butylbromide, IV. The cervix was dilated to a 4-fingers width at this time. *Via* ultrasound guidance, a sterilized object with a scooped end was inserted into the uterus; however, the foreign objects could not be retrieved. A uterine lavage with LRS was completed, following which 1 of the objects within the uterus had moved closer to the cervix. Using successive uterine lavages, the object was brought close enough to the cervix to allow digital removal. Upon retrieval, the object was identified as a long bone of a limb (Figure 1 B). Between the removal of the first bone and attempt to remove the second bone, the mare had accumulations of fluid within the uterus and was treated with daily uterine lavages and oxytocin injections to clear this fluid.

For removal of the second bone, the mare was sedated with 8 mg of detomidine, 5 mg of butorphanol, and 200 mg of xylazine given IV. Furthermore, 80 mg of hyoscine butylbromide was added to sterile lubricant and massaged into the cervix. Using uterine endoscopy, the remaining fetal bone was visible at the tip of the right horn. Using endoscopic visualization and a suture loop mounted on a long sterile metal rod, the bone was captured and retrieved (Figure 1 C). Although small amounts of mucopurulent secretions were also present, endoscopic examination of the uterine horns and body confirmed that the uterus was now free of fetal bones. The following day, a transrectal ultrasound examination of the uterus revealed Grade-2 edema and a moderate amount of hyperechoic fluid. Uterine samples were collected for culture and cytology. Examination of a uterine cytology smear revealed moderate inflammation, and culture of the uterine swab yielded significant growth of

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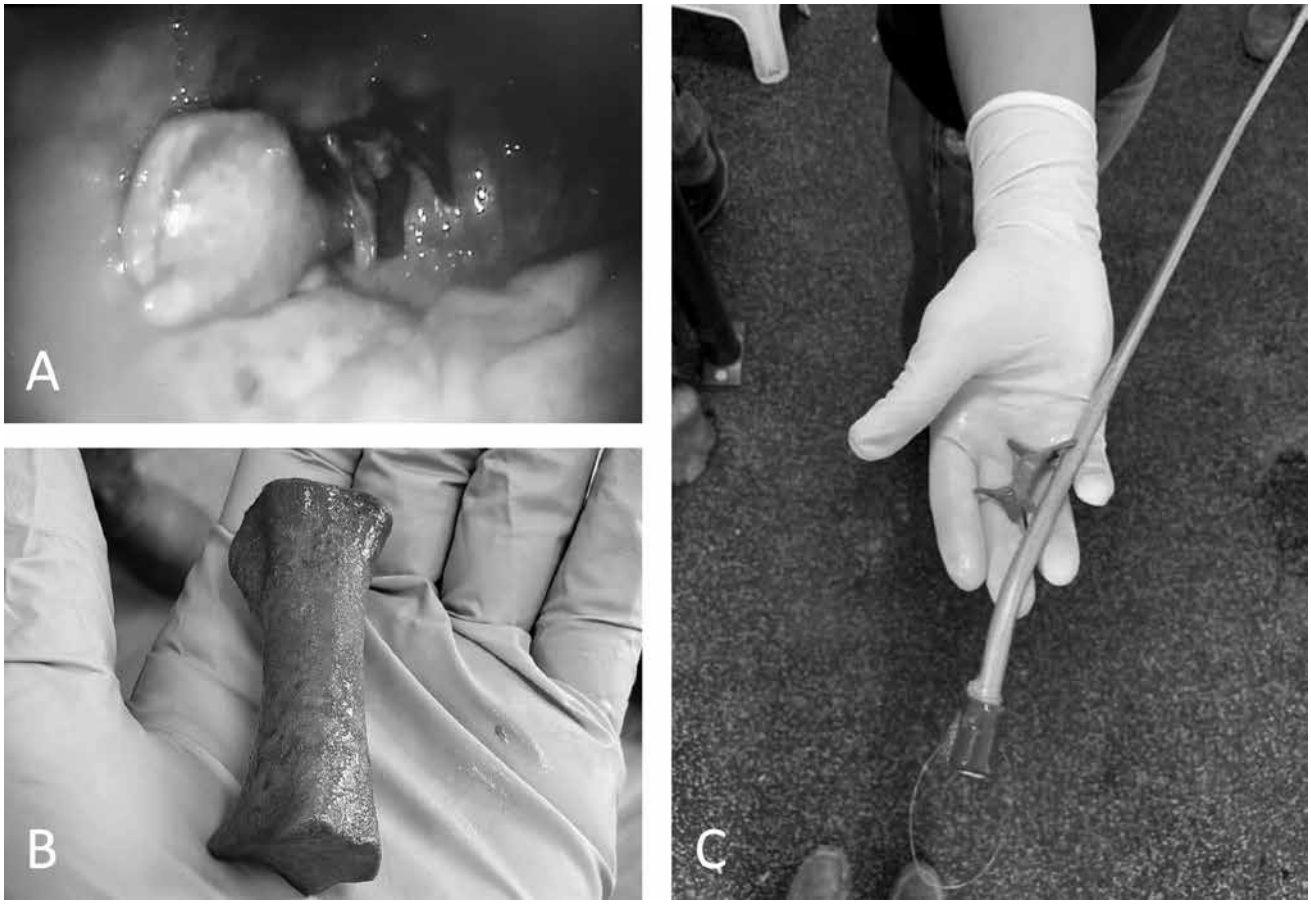


Figure 1. Images from Case 1. A – Hysteroscopic view of the base of the right uterine horn with 2 fetal bones visible. B – Fetal long bone retrieved following repeated uterine lavages. C – Fetal vertebrae retrieved under endoscopic guidance and use of a suture loop mounted on a long, sterile, metal rod.

Streptococcus dysgalactiae. On the following day, a uterine lavage was performed with 2 L of LRS and 2 IM doses of 20 USP of oxytocin, 3 h apart. The mare was discharged at the owner's request, and a follow-up inquiry revealed the mare was sold the following year without attempting rebreeding.

Case 2

A 15-year-old Canadian warmblood maiden mare was bred with fresh-cooled semen on June 20, 2019 and confirmed pregnant by transrectal ultrasonography on July 8. The mare had no further examinations and did not display any abnormal clinical signs throughout the winter. On April 20, 2020, the mare was presented for examination due to the owner's concern that she did not appear to be progressing in her pregnancy as expected. Transrectal ultrasound examination on presentation revealed that the mare was not pregnant. Her ovaries had multiple, mid-size ovarian follicles along with a dominant, 51-millimeter follicle, and hyperechoic structures within the uterus were suggestive of fetal remnants. The mare was admitted to the hospital for further diagnostics and treatment. A uterine lavage was performed with 2 L of LRS that resulted in 2 fetal mandibular bones and 1 rib being recovered (Figure 2). Ultrasound examination revealed suspected fetal remnants located deeper in the uterus. On the following day, hysteroscopy was performed. The mare was sedated with 9 mg of butorphanol and 8 mg of detomidine, IV. Hysteroscopy revealed small puddles of purulent fluid and 3 small fetal bones in the right uterine horn (Figure 2 A). Hyoscine butylbromide (40 mg) in sterile lubricant was applied to dilate the cervix. Under endoscopic guidance, a sterile, gloved hand was inserted into the uterus to manually remove the remaining fetal bones, which included 2 ilia and 1 vertebra (Figure 2 B, C). Uterine lavage was completed with 1 L of LRS. The mare was given 500 mg of flunixin meglumine IV and prescribed 2 additional days of anti-inflammatory treatment. Subsequent ultrasound examinations revealed no fetal bones remaining. Culture and cytological examination of the uterus were completed before rebreeding. Cytology indicated no signs of inflammation, and the culture report revealed suspected contaminant bacteria but not a true uterine infection. The mare was treated with pre-breeding uterine lavages and artificially inseminated with fresh-cooled semen. At Day 15, the mare was diagnosed pregnant. The mare successfully foaled in the spring of 2021 and again in the spring of 2022.

Discussion

In this report, we described 2 cases of fetal maceration with retention of only a few fetal bones in mares that presented without noticeable clinical signs. These mares were not known to have aborted, had no vaginal discharge, had only a small amount of fluid in the uterus at the time of examination,

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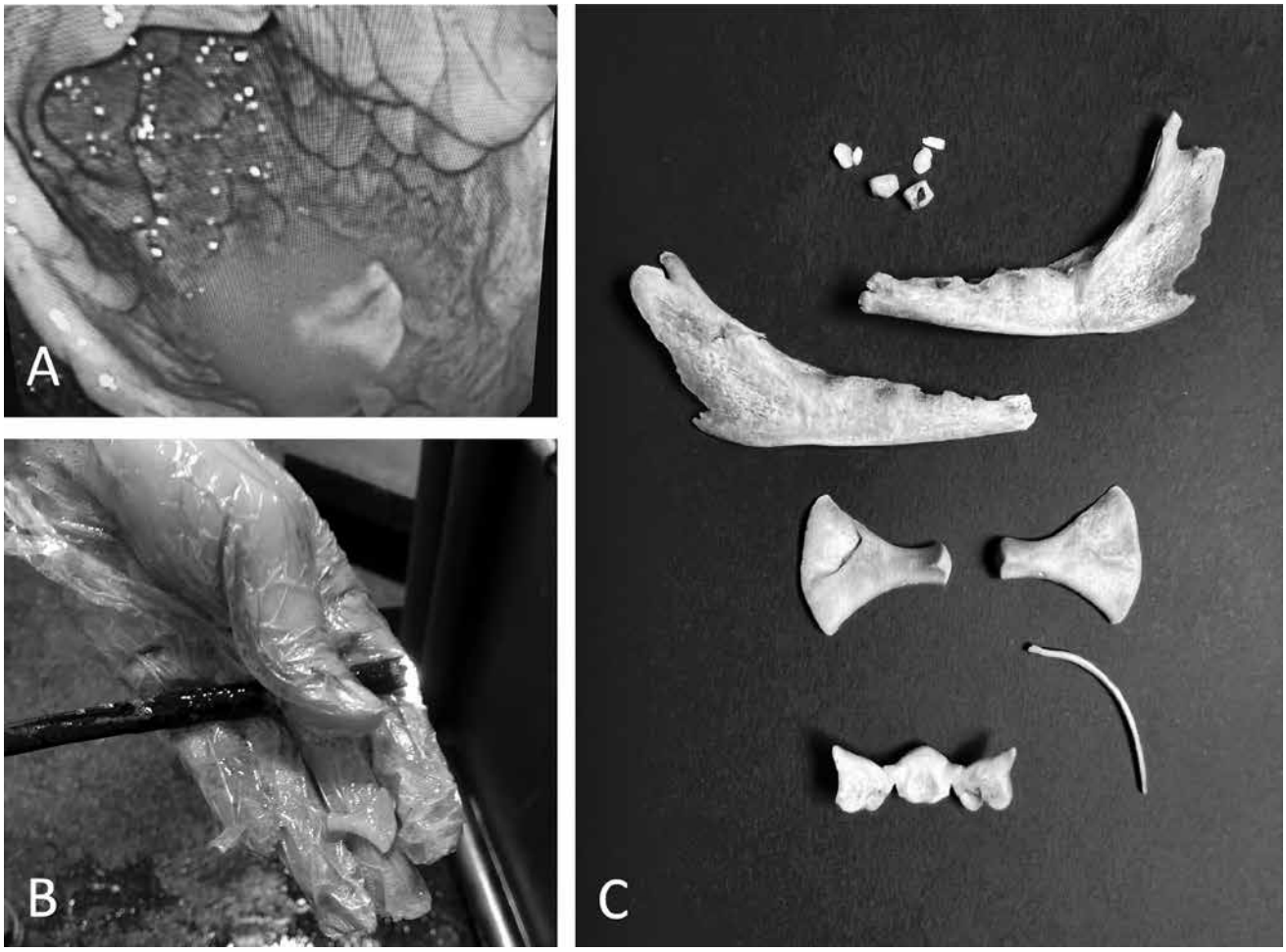


Figure 2. Images from Case 2. A – Endoscopic view of the right uterine horn with residual fetal bones and a small amount of purulent fluid visible. B – Fetal ileum retrieved manually under endoscopic guidance. C – Fetal bones retrieved from this mare.

and had retained only a few fetal bones. This report brings attention to the potential subclinical nature of fetal death and retention in mares, highlighting the importance of thorough pre-breeding examination and ongoing monitoring after breeding and throughout pregnancy.

Contrary to the 2 cases presented here, most cases of fetal maceration reported in the literature had some clinical evidence of a potential reproductive abnormality. Some had a recent history of abortion (4–6), whereas 2 mares were known to be carrying a dead fetus (7,8). In addition, in all reported cases, persistent purulent vaginal discharge (5,6,8–10) or obvious accumulation of fluid within the uterus (4–12,14) was evident. Finally, whereas the 2 mares described here retained 2 and 6 fetal bones, respectively, most reported cases of fetal maceration involved retention of a large number of bones within the uterus: 4 mares retained between ~18 and 40 bones (4,5,11,12), 2 mares retained nearly complete skeletons (9,10), and 3 mares had complete retention of the fetal skeleton (7,8,14). The presence of only a few fetal bones remaining in the uteri of the 2 mares presented here probably contributed to the lack of clinical signs, with no vaginal discharge and minimal uterine fluid accumulation apparent at the time of examination.

Two cases reported in the literature appear to have involved more subclinical presentations, similar to those described here. One mare, known to have aborted over the winter given the discovery of a placenta in her paddock, never had any purulent vaginal discharge despite the fetal retention (4). Following rebreeding in the spring, the mare had a bloody vaginal discharge that led to reproductive examination and detection of an enlarged and crepitant right uterine horn with retention of fetal bones. One additional mare was presented due to abnormal findings during a routine reproductive examination (11). That mare had no vaginal discharge; however, transrectal palpation revealed asymmetry between both uterine horns, with fluid accumulation and retention of numerous fetal bones.

Surprisingly, many cases of fetal maceration reported in the literature were known to have aborted (4–6) or to be carrying a dead fetus (7,8). In those cases, it seems that lack of veterinary examination at the time of abortion or failure to ensure complete expulsion of the fetus led to fetal maceration, retention of fetal bones, and endometritis, with accumulation of purulent material within the uterus. In one of the cases, maceration and retention of the entire fetus, combined with improper treatment, eventually led to acute sepsis and death of the mare (7). In another case, the mare was allowed to carry a known macerated fetus for at least 9 mo (8) before veterinary treatment resolved the fetal retention.

Fetal maceration implies septic decomposition of fetal tissues within the uterus following fetal death and failure of expulsion.

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Despite the obvious bacterial contamination and proliferation involved in fetal maceration, most mares do not experience systemic illness, possibly because the endometrium heals quickly following placental separation (2). However, in rare instances, the process of maceration, especially if not addressed properly and in a timely manner, can lead to severe sepsis and death (7). Laminitis, a common complication of acute metritis and placental retention in mares, was suspected to be due to fetal maceration and associated pyometra in 1 case (12). This illustrates that, in some instances, fetal maceration can affect the health of the mare. Finally, a mare was reported to have lost a substantial amount of weight while carrying a known dead and macerated fetus for at least 9 mo, but her body condition improved after the macerated fetus was removed (8).

Although routine ultrasound examination of a mare's reproductive tract should allow diagnosis of fetal maceration and retention, the first case described in this report highlights the potential difficulty in diagnosing partial retention of fetal bones. In this mare, the bones were not noted during initial examinations, potentially due to the large size of the mare (draft breed) and the small amount of hyperechoic uterine fluid potentially masking the 2 retained fetal bones. This emphasizes the importance of thorough ultrasound examinations completed following resolution of hyperechoic fluid to ensure the fluid had not concealed objects within the uterus. In addition, it should be noted that small bones retained in the uterus could be confused with the presence of air pockets in the uterine lumen, since the hyperechoic appearance of both air and bone is very similar. The second case described in this report stresses the importance of ongoing pregnancy monitoring for early detection of fetal death and prevention of fetal maceration and retention, as a lack of clinical signs does not necessarily imply ongoing, normal pregnancy. Early detection of fetal death and prompt removal of fetal remnants are likely important for the reproductive future or health of the mare. If retained fetal remnants are diagnosed, efforts must be made to remove the remnants in a timely manner to reduce the risk of ongoing inflammation, infection, irreversible damage to the mare's reproductive tract, systemic illness, and even death.

In the cases reported here, resolution of the retained fetal bones was achieved using a combination of uterine lavages and manual or snare removal under hysteroscopic guidance. Uterine lavages can be used as a first line of treatment to remove more mobile fetal remnants; however, hysteroscopy and snares may be necessary to accomplish removal of more difficult or potentially embedded pieces. Hysteroscopy, when available, is certainly beneficial for visualization and removal of remnants, to ensure no fetal bones are left behind, and to assess uterine health. Achieving good cervical dilation is essential for successful resolution of fetal bone retention in mares. In the cases we describe, this was facilitated through systemic administration or cervical application of hyoscine butylbromide. The importance of achieving optimal cervical dilation is illustrated by a previous case (12) in which an ovariohysterectomy was necessary to resolve the fetal bone retention and associated pyometra in a mare because of failure to achieve adequate cervical dilation.

Ultrasonographic examinations are commonly recommended at 14 to 15 d post-ovulation for pregnancy diagnosis and screening for twin embryos, as well as at ~24 to 27 d post-ovulation for confirmation of a heartbeat (15,16). After these examinations, ultrasound for pregnancy monitoring is usually presented as optional to owners. The cases presented here demonstrate that ongoing monitoring throughout pregnancy is potentially important and could allow early identification and treatment of issues such as fetal death and fetal maceration. At a minimum, mares should be monitored daily by caregivers, and they should always be examined by a veterinarian if abnormal clinical signs or vaginal discharge are noted. However, the lack of clinical signs in the mares discussed here illustrates the potentially subclinical nature of fetal death, maceration, and retention, and supports regular ultrasound examinations irrespective of clinical signs.

In conclusion, the cases reported here were unusual presentations of a rare phenomenon in mares: fetal maceration and partial retention of fetal bones. This report highlights important points, including the potential insidious nature of fetal bone retention in mares, difficulties in detecting and removing fetal remnants in some cases, and recommendations for thorough prebreeding examination along with ongoing pregnancy monitoring to allow rapid identification and treatment of fetal death and maceration. CVJ

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Case Report Rapport de cas

Successful treatment of 3 naturally acquired cases of canine cheyletiellosis with fluralaner

Christian Hansen-Jones, Tomer Ronai

Abstract — Three dogs were diagnosed with naturally occurring cheyletiellosis based on clinical signs and visualization of parasites and ova. Treatment with fluralaner (orally) resulted in a rapid resolution of clinical signs with no evidence of mites or ova at 1 or 2 mo post-treatment. This is apparently the first published report of an isoxazoline being used to successfully treat cheyletiellosis in veterinary medicine. Therefore, fluralaner may be an effective option for treatment or prevention of canine cheyletiellosis, although research is needed to confirm its effectiveness for treatment of cheyletiellosis in dogs and other species.

Key clinical message:
This is apparently the first published report of an isoxazoline being used to successfully treat cheyletiellosis in companion animal practice. These parasites are both contagious and zoonotic and there are currently no approved products for treatment or prevention of cheyletiellosis.

Résumé — Traitement réussi de 3 cas de cheylétiellose canine acquis naturellement avec du fluralaner. Trois chiens ont été diagnostiqués avec une cheylétiellose acquise naturellement sur la base des signes cliniques et la visualisation des parasites et des œufs. Un traitement avec du fluralaner (oralement) a résulté en une résolution rapide des signes cliniques sans aucune évidence de mites ou d'œufs à 1 ou 2-mois post-traitement. Ceci semble être le premier rapport publié d'un isoxazoline utilisé pour traiter avec succès la cheylétiellose en médecine vétérinaire. Ainsi, le fluralaner serait une option efficace pour le traitement ou la prévention de la cheylétiellose canine, bien que de la recherche soit nécessaire pour confirmer son efficacité pour le traitement de la cheylétiellose chez les chiens et les autres espèces.

Message clinique clé :
Ceci semble être le premier rapport publié de l'utilisation d'un isoxazoline pour traiter avec succès la cheylétiellose en pratique des animaux de compagnie. Ces parasites sont contagieux et zoonotiques et il n'y a à l'heure actuelle aucun produit approuvé pour le traitement ou la prévention de la cheylétiellose.

(Traduit par Dr Serge Messier)

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Case descriptions

Case 1

A 12-year-old (34.2 kg) neutered male mixed-breed dog was presented for a second opinion on recurrent pruritus and alopecia. The dog had been managed with oral corticosteroids for the past 5 y for a poorly defined chronic skin condition and severe pruritus. Previous records were sporadic, but the initial dermatologic presentation was for a multifocal alopecia with erythematous crusting lesions over much of the trunk. Previous treatments included numerous courses of various oral antibiotics, ranging from 1 to 4 wk in duration, plus prolonged use of oral prednisone. The prednisone was eventually tapered to 12.5 mg q24h and reduced the pruritus to the point where it no longer interrupted the dog's sleep; however, the owner reported that the dog was still considerably more pruritic than normal. There were reported attempts to reduce the prednisone dose, which always resulted in a near-immediate relapse of pruritus. The owner also reported that, approximately twice per year, she would need to bathe the dog with a chlorhexidine shampoo daily for 5 to 10 d and increase the prednisone to 25 mg daily during that time due to recurrence of the skin lesions and worsening of pruritus to the point of needing to physically restrain

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the dog to prevent self-trauma. During this time, there were progressive polyuria, polydipsia, and panting, plus worsening of coat quality. There had been a large amount of scale reported on the dog's dorsum and convex aspects of the pinna since the dermatologic disease started; those had fluctuated in severity but never resolved. The owner reported no history in the past 5 y of personal dermatologic concerns, including papules or rashes. There were no other pets in the house.

The dog was on a commercial dry diet (numerous formulae within the same brand). Apart from daily prednisone and topical chlorhexidine, the dog had received no other medications or supplements in the past 12 mo. The dog was not receiving any endoparasitic or ectoparasitic treatments, with no record of previous administration in the past 5 y. On physical exam, the dog was overweight, with a body condition of 7/9 but with a mild reduction in muscle mass. There was evidence of a distended abdomen, with liver palpable past the last rib. The hair coat was coarse, with a mild, generalized alopecia, and marked alopecia over the tail, ventrum, axilla, and neck (corresponding to collar location). The dog demonstrated marked scaling on the dorsum, particularly on the convex surfaces of both ears. A sample of the scale and adhered hairs was removed by hemostat, and cytological analysis of the underlying skin was done with a cotton swab dampened with sterile saline. Cytology was mostly unremarkable, but several ovoid, non-operculated ova were seen. The trichogram demonstrated numerous broken hairs, with all hairs examined to be in telogen, as well as several ova. The scale was examined by mechanically breaking it down and placing in mineral oil. Numerous ova were seen, with 1 to 3 per field using the 4× objective. Two mites were seen; these were round, with 4 pairs of long legs and prominent hooked palpal claws.

The dog was diagnosed with cheyletiellosis and suspected iatrogenic hyperadrenocorticism. The client was financially constrained and all testing and treatments not related to the presenting complaints of chronic pruritus and scale were deferred.

The dosage of prednisone was increased to 25 mg (0.74 mg/kg), PO, q24h, and the dog was treated with 1000 mg of oral fluralaner (Bravecto; Merck Canada, Kirkland, Quebec).

After 7 d, the dog was no longer pruritic and the prednisone dosage was tapered to 12.5 mg (0.37 mg/kg) q24h. After 21 d, the prednisone was tapered further, to 12.5 mg q48h. At 29 d after the initial visit, the dog was still free of pruritus; however, there was still marked scaling noticed within the hair. A flea comb was used to collect hair and scale by brushing over the dorsum and convex surfaces of the ears, and additional samples were collected by hair-plucking with a hemostat. No mites or mite eggs were seen after 12 slides of hair and scale were examined. At 37 d after the initial visit, the dog was still free of pruritus and prednisone was discontinued. Two months after the initial visit, the dog showed no evidence of pruritus, and previously reported polyphagia and polydipsia had resolved. There was still some scale within the hair coat, but it appeared further distally along the hair shafts than previously observed. Collection of hair and scale was done as previously described, and no evidence of mites or eggs was seen after review of 12 slides. At 5 mo after the initial visit, the owner reported the dog was showing no sign of pruritus, with no scale on physical examination, and previous alopecia was improved. At 11 mo after the initial visit, the dog remained free of pruritus and scale, and all previously described alopecia had resolved.

Cases 2 and 3

A 4-year-old (9.2 kg) spayed female cocker spaniel was presented because of a 5-week history of progressive pruritus that had progressed to the point of interrupting the dog's sleeping, eating, and playing. The pruritus was predominantly present over the dorsum and caudal legs. An 18-month-old (10.1 kg) neutered male cocker spaniel in the same household had also developed pruritus over the previous 3- to 4-week period that had slowly progressed to the point of interfering with the dog's sleeping, although neither eating nor play were affected. Both dogs slept in the same bed as the owners, and the female owner had several pruritic, raised, red lesions on the inside of her left forearm and elbow. The owner reported these had developed over the past 7 to 10 d and she had to cover the lesions to prevent self-trauma due to the degree of the pruritus. Neither dog was currently receiving ectoparasite prevention, although both had been previously treated with fluralaner, 154 d before presentation. The dogs were not receiving any medications or supplements and were fed a balanced commercial kibble with no diet changes or new treats added in the preceding 3 mo. In addition, neither dog had a previous history of dermatologic disease and there were no other animals in the household.

The physical examinations for both dogs were unremarkable, except for mild scaling, more pronounced on the dorsum. Each dog displayed pruritic behaviour when their dorsum was brushed with a flea comb, although no erythema, skin lesions, flea dirt, or visible parasites were identified on flea combing. On examination of hair and scale collected by flea comb (5 slides for each animal), 1 to 2 ovoid, non-operculated ova were seen per slide. The trichogram showed several broken hairs, and there were 3 mites identified from samples collected from the female dog and 2 from samples from the male dog. The mites were round, with 4 pairs of long legs and prominent hooked mouth parts. Skin scrapings and cytological samples collected with a moistened cotton swab in 2 locations on both dogs revealed no obvious parasites or other pathology.

The dogs were diagnosed with cheyletiellosis and were prescribed oral fluralaner (Bravecto; Merck Canada): 250 mg (27 mg/kg) for the female and 500 mg (49 mg/kg) for the male. After reviewing this diagnosis with her physician, the owner was prescribed a topical hydrocortisone cream for relief of pruritus.

At 28 d after the initial visit, both dogs had marked reduction in pruritus, with both dogs described as slightly itchier than normal, but not to the point where itching was interfering with sleeping, eating, or playing. On physical examination, there were no obvious dermal lesions; and on examination of 12 slides for each animal of hair and scale collected by flea comb and hair-plucking, there was no evidence of parasites or ova. The owner reported she had developed no further lesions. At 62 d, the owner reported her lesions had resolved completely. No pruritus was reported in either animal, and there were no ova or parasites seen by examination of hair samples as previously

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described. Examination revealed that scaling and dermatologic abnormalities had resolved in both dogs' hair coats. Six months after initial presentation, the owner reported she was still free of pruritus or papular lesions, neither dog was displaying pruritus, and there were no dermatologic abnormalities detected.

Discussion

Cheyletiellosis is caused by infection with *Cheyletiella* mites and is both contagious and zoonotic. *Cheyletiella* species are obligate parasites and spend their lives on the epidermal layer of the host, although adult female mites can survive for 10 d off the host (1). Eggs are bound to hair shafts, which can cause environmental contamination (1). Infection can occur by direct transmission or *via* fomites such as bedding, leashes, or other arthropods (2,3). Typical clinical signs of cheyletiellosis in dogs are pruritus and scaling that can be profound, leading to the colloquial name "walking dandruff" (2,3). Whereas *Cheyletiella* mites are generally host-specific, there can be cross-infestation among veterinary species, including dogs, cats, rabbits, and horses. *Cheyletiella yasguri* is the species considered to be present primarily on dogs, whereas *Cheyletiella blakei* is the species that affects cats. *Cheyletiella* spp. cannot reproduce on humans but can cause a transient infestation resulting in pruritic papular lesions (2,3). Cheyletiellosis is a somewhat uncommon diagnosis in companion animal medicine; however, the infectious and zoonotic nature of this parasite makes it an important differential diagnosis when examining an animal with pruritus or excessive scale.

This is apparently the first published report of an isoxazoline being used to treat cheyletiellosis in companion animal medicine. Isooxazolines are a class of ectoparasiticides that act by inhibiting the glutamate- and gamma-aminobutyric acid-gated chloride channel located in invertebrate nervous systems. Isoxazoline products have significantly more affinity to the insect glutamate-gated chloride channel receptors than to mammalian receptors, providing a relatively high safety profile in most companion animal species (4). This class of drug has been previously used successfully to treat a variety of ectoparasites in veterinary medicine, including *Demodex* spp., *Otodectes cynotis, Sarcoptes* spp., *Cutarebra* spp., ticks, and fleas (5–10). Although there are currently no products approved for treatment of cheyletiellosis in companion animals, selemectin, moxidectin, ivermectin, milbemycin oxime, and fipronil were reported to be effective (11–14).

The low sensitivity of common methods for diagnosis of cheyletiellosis was a limitation in these cases. Samples collected by tape, flea combs, skin scrapings, floatation after preparation with potassium hydroxide, and fecal analysis have all been described for diagnosis of this parasite (2). However, accuracy of these methods has been variable (1–3,12,13). There is no described "gold standard" test for diagnosis of this parasite, and an acaricide trial is often used to confirm a diagnosis when there has not been positive mite identification (1). For the current cases, sustained resolution of clinical signs and a lack of obvious mites or ova after treatment were supportive of successful treatment. It is possible that clinical signs in these animals resolved for reasons unrelated to treatment of cheyletiellosis and the results of cytological assessments done on follow-up visits were false negatives; however, this was considered unlikely.

Based on these cases and the efficacy of this class of drugs against numerous other external parasites, consideration could be given to using these drugs for treatment or prevention of cheyletiellosis in dogs. However, further study is needed to determine whether the success rate for treatment of cheyletiellosis with fluralaner or another isoxazoline is similar to those for previously described treatments. In addition, further study is needed to determine success in the treatment or prevention of cheyletiellosis in cats or rabbits.

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Case Report Rapport de cas

Separation and confinement anxiety in a golden retriever × standard poodle dog

Anneliese Heinrich, Christine Calder

Abstract — An 8-month-old spayed female golden retriever × standard poodle dog was presented for assessment because of vocalization, destructive behavior, and urination when left home alone and confined in a crate. Previous treatments included multiple medications, graduated departures, decoupling of departure cues, and punishment-based techniques. Adverse reactions to paroxetine and lorazepam were noted before successful treatment with clomipramine, "safe haven" training, and behavior modification.

Key clinical message:
Separation anxiety is a common behavioral disorder in dogs. It is often treatable but may require changes in the approach to both medication and behavior modification based on patient and client factors.

Résumé — Anxiété de séparation et de confinement chez un chien croisé golden retriever × caniche standard. Une chienne golden retriever × caniche standard stérilisée âgée de 8 mois a été présentée pour évaluation à cause de vocalisation, comportement destructeur, et urination lorsque laissée seule à la maison et confinée dans une cage. Des traitements antérieurs incluaient plusieurs médications, des départs progressifs, la dissociation des signes de départ, et des techniques basées sur des punitions. Des réactions adverses au paroxetine et au lorazepam ont été notées avant qu'un traitement positif ne soit obtenu avec de la clomipramine, un entraînement « lieu sûr », et une modification du comportement.

Message clinique clé :
L'anxiété de séparation est un problème de comportement fréquent chez les chiens. Il est souvent possible de la traiter mais peut nécessiter des changements dans l'approche vis-à-vis la médication et des modifications du comportement en fonction de facteurs liés au patient et au client.

(Traduit par Dr Serge Messier)

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Separation anxiety is one of the most common reasons dogs are referred to veterinary behaviorists, rehomed, and relinquished to shelters (1). The underlying cause of separation anxiety, or separation-related behaviors, is unknown, with the same clinical signs representing different etiologies among dogs (2,3). DeAssis *et al* (2) identified 7 principal components representing underlying motivations for clinical signs commonly attributed to separation anxiety, including exit frustration, social panic, elimination, redirected frustration, reactive communication, immediate frustration, and noise sensitivity. Common clinical signs include vocalization, destructive behavior, and house-soiling occurring in the absence, or perceived absence, of the owner (4). Neutered and mixed-breed dogs are overrepresented, along with dogs that have experienced trauma or a change in routine, those obtained from pet stores and shelters or at a young age, and those whose owners have certain cognitive biases and attachment styles (5). There is no breed predisposition (5), although a genetic component is suspected since some puppies display signs of separation anxiety from the first instance of being left alone and do not become accustomed to separation from people. Comorbidities such as noise phobias (6,7), pain (8), and other fears and phobias (9) are common; and pharmaceutical intervention with medications that inhibit reuptake of serotonin were demonstrated to be effective (*e.g.,* 10,11). In Canada, for treatment of separation anxiety, there are currently 2 approved medications: clomipramine (Clomicalm; Elanco, Guelph, Ontario), a tricyclic antidepressant; and fluoxetine (Reconcile; Virbac, Cambridge, Ontario), a selective serotonin reuptake inhibitor (SSRI). This case report describes a dog that did not respond to fluoxetine or paroxetine (another SSRI) but responded positively to clomipramine.

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Case description

An 8-month-old spayed female golden retriever × standard poodle (golden doodle) dog was presented for assessment because

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of vocalization, destructive behavior, and urination while alone. The dog was purchased at 8 wk of age from a breeder and was the only pet of a married couple living on the 3rd floor of an apartment building with neither a balcony nor a yard. The living arrangements at the breeder and early socialization and training techniques were not disclosed at the time of purchase. However, the couple subsequently learned that this puppy's mother displayed similar behaviors when left alone. The clients started crate-training at 8 wk of age; however, the puppy would vocalize uninterrupted for at least 1 h each time she was crated, even with the clients present.

At 13 wk of age, the dog was left home alone for the first time, for 2 h. She urinated and defecated in the crate during the absence and was vocalizing and panting upon the clients' return. After this incident, the crate was replaced with an exercise pen and the dog was left home alone for 1 h so the clients could determine if confinement was the primary problem. During this time, the dog escaped from the pen, vocalized, destroyed her bed, and scratched and chewed walls and a door frame. She also urinated on the floor near the exit. Upon their return, the dog jumped on the clients, panting and whining. These incidents were not filmed. At this time (5 mo of age), the couple consulted with their primary veterinarian, who prescribed trazodone [50 mg (3.5 mg/kg), PO, q12h]. There were no notable changes to the dog's behavior, but she was lethargic. Therefore, trazodone was discontinued and fluoxetine [20 mg (1.1 mg/kg), PO, q24h] was prescribed.

Three weeks after the dog started receiving fluoxetine, a trainer was consulted and a behavior modification program initiated. The trainer instructed the clients to crate the dog and leave the home while the trainer remained in the home. During these sessions, each time the dog started to vocalize, the trainer would bang on top of the crate. The owners were not comfortable with this protocol and terminated the program after the second session. They noted the dog would now struggle and pant when they attempted to crate her.

A consultation with another trainer was scheduled and confinement of any kind was discontinued. The second trainer planned to desensitize the dog to predeparture cues (*e.g.,* picking up keys) and started graduated timed departures with the trainer observing *via* a remote camera. During these sessions, the dog was observed licking her abdomen. The primary veterinarian increased the fluoxetine dosage to 30 mg (1.5 mg/kg), PO, q24h, and treated a moist dermatitis with a tapering course of trimeprazine tartrate with prednisolone. Licking of the dog's abdomen appeared to cease after treatment.

After the dose of fluoxetine was increased, the dog's owners noted that she appeared more relaxed around certain predeparture cues (*e.g.,* keys being moved), but she continued to follow the clients to the front door with each departure, panting and salivating. On camera, she was observed pacing by the door within 60 to 90 s after the door closed and started to vocalize (bark, whine, and howl) within 3 to 4 min after the departure. Nonstop vocalization continued while they clients were away (which, at this stage, never exceeded a period of 8 min). Upon their return, she continued to whine and pant for several minutes. Neither urination nor destructive behavior occurred during these departures, although it was not clear if this was because of the increased fluoxetine dose or the short duration of the absence. After 6 wk, this protocol was discontinued due to cost and the clients' judgment of minimal improvement. They stopped leaving the dog home alone and enrolled her in day care; however, this was not considered financially sustainable.

The owners next discontinued the fluoxetine and referred the dog for a behavior consultation. During the consultation, the dog appeared relaxed; she settled within a few minutes after the start of the consultation and slept for the duration without alerting to movements from either owner. She had a body condition score of 4/9 and physical, orthopedic, and neurological examinations revealed no significant findings. Complete blood count, blood chemistry, and total T4 had been assessed by the referring veterinarian 4 mo before the appointment, with no significant findings. A urinalysis was recommended; however, since urination in the home had ceased, it was declined.

The diagnosis was separation and confinement anxiety because the dog's clinical signs (vocalization, panting, pacing, destruction, elimination) only occurred when left alone free in the house or in her crate without people (2,5). She displayed clinical signs (panting, pacing, whining) associated with predeparture cues (4,7) and was highly aroused when the owners returned (4). The dog refused to enter her crate voluntarily, and when confined, would bark and scratch on the tray near the door. As these behaviors were displayed when the dog was confined, regardless of the clients' presence, confinement anxiety was also diagnosed (7).

Differential diagnoses included hyper-attachment disorders (12,13); noise phobias and storm phobias (6,7,14); frustration (2); isolation distress; territorial aggression; compulsive disorder; generalized anxiety; incomplete housetraining; pain (8); cardiovascular, renal, hormonal, or urinary tract disease; hepatic encephalopathy; or seizures (8,15). Since the dog did not display evidence of hyper-attachment (following the owner around the house), this was an unlikely cause for her behavior (16). Noise or storm phobias were ruled because noises were not detected on video when the dog was home alone, and she did not react to storm events or other noises in a fearful manner. Compulsive disorder, generalized anxiety, and territorial behavior were unlikely, as the dog's clinical signs occurred exclusively in the clients' absence and within minutes after their departure. Incomplete housetraining was ruled out since urinary or fecal accidents were no longer observed when the clients discontinued leaving the dog home alone. Pain on physical exam was not detected or observed during or after activity. No changes in separation-related behaviors were observed after a trial of a nonsteroidal anti-inflammatory medication (meloxicam, 0.01 mg/kg q24h) and gabapentin (4.4 mg/kg q12h) after her ovariohysterectomy. Cardiovascular disease was unlikely due to normal thoracic auscultation, and renal or hepatic disease were not indicated on recent blood work. No seizure activity had been observed.

Treatment included management, pharmaceuticals, and behavior modification. The clients were advised to create a "safe space" in the home that was not confining but prevented access to the front door. They were instructed on how to shape

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relaxation in this space by providing a comfortable bed; using a calming pheromone, Adaptil (Ceva Animal Health) (17), or lavender (18); playing classical music (7,19); and providing a long-lasting treat such as a food-dispensing or puzzle toy, for enrichment (19). The clients were instructed to not give treats or any food outside of mealtime, with the hypothesis that pairing of a high-value food item with the space (and eventually, with departure) would help to countercondition the negative emotional response of being left alone. They were asked to take the dog to this spot daily, leaving her to consume the food but not leaving the apartment together. When each client left individually, the person left at home was instructed to avoid interacting with the dog but not to ignore her. This was to reduce arousal immediately before departure (20). Upon returning home, the clients were instructed to speak to the dog in a calm voice and reward calm behaviors (*e.g.,* all 4 feet on the floor) rather than escalating her arousal by matching her greetings (20,21). They were also advised against the use of positive punishment (21,22).

Pharmaceutical therapy with paroxetine was initiated at a dosage of 10 mg (0.4 mg/kg), PO, q24h for 7 d, to minimize adverse effects (23,24); it was then increased to 20 mg (0.8 mg/kg), PO, q24h. As an SSRI, paroxetine blocks the serotonin reuptake transporter, resulting in increased serotonin availability for neurotransmission (25,26). Dosage recommendations for paroxetine in dogs range from 0.5 to 2.0 mg/kg q24h (25,26). Potential adverse effects include inappetence, vomiting, diarrhea, agitation, urinary retention, and dry mouth (26). In addition, lorazepam [1 mg (0.04 mg/kg)] was prescribed with instructions to give this PO 60 min before departures (if both owners were required to leave the house and there was no alternative). Lorazepam, a benzodiazepine, is used to treat anxiety-based disorders in human psychiatry and veterinary medicine (27,28). Benzodiazepines bind to GABA-A receptors to enhance GABAergic neurotransmission (27). Potential adverse effects include vomiting, diarrhea, sedation, ataxia, paradoxical excitement, increased appetite, increased aggression, memory deficits, and chemical dependency (27). Off-label use of both medications was discussed.

At a 2-month follow-up, the owners noted the dog was now vocalizing more when they were present and following the female owner around the home. The couple had chosen their office as the "safe space," and they had been able to leave the dog with the door closed for up to 30 min while at home. Unfortunately, the owners had continued to leave the home despite being instructed not to do so, citing frustration and compassion fatigue and lack of improvement in the dog's behavior. Lorazepam was given once, but it was discontinued because the dog was excessively vocal and mobile (would not lie down). The couple had begun interviewing potential new homes for the dog.

Medication was changed to clomipramine at 25 mg (1.1 mg/kg), PO, q12h for 14 d, to minimize side effects, subsequently increasing to 37.5 mg (1.65 mg/kg), PO, q12h. Before starting the clomipramine, paroxetine was decreased in 50% increments per week over the course of 2 wk, then discontinued for 48 h before starting clomipramine. Switching between psychopharmaceutical classes is poorly described in veterinary literature; however, in human psychiatric literature, this is considered an appropriate switch between pharmaceutical classes (29). Clomipramine is a tricyclic antidepressant that blocks reuptake of both serotonin and norepinephrine. It is given at 1.0 to 3.0 mg/kg, PO, q12h, in dogs (26). It is approved as Clomicalm (Novartis) to treat separation anxiety in dogs, with several published studies documenting improvement in various clinical signs of separation anxiety (11,30,31). Potential adverse effects include decreased appetite, lethargy, vomiting, diarrhea, constipation, dry mouth, urinary retention, arrhythmia, and elevated intraocular pressure (25).

Two months after the dog started receiving clomipramine, the clients noted she appeared more relaxed when home alone. She would enter the office on cue, wait for her puzzle toy and, on video, was lying down for 30 min after the clients' departure. Occasionally she was observed rising, exploring, and sniffing the room. She would bark occasionally, but there was no panting, whining, repeated barking, or elimination. However, the dog's vocalization when the clients were home (new behavior after starting paroxetine) had not normalized. Therefore, the clomipramine dose was increased to 50 mg (2.1 mg/kg), PO, q12h. One month later, minimal barking was noted when the clients were present, and the dog could be left alone for up to 2 h at a time. On camera, the dog was observed lying down or eating for the full duration of most departures, whereas at other times she would walk around and vocalize once or twice. This behavior was markedly reduced compared to before treatment. The clients could not identify a pattern or trigger for the inconsistency in her behavior — only that it continued to decrease over time. At this visit, the clients were instructed to continue relaxation exercises in the dog's "safe space" and maintain the dose of clomipramine.

One year after the initial appointment, the dog could be left home alone for 2 to 3 h without observable clinical signs. One of the clients was working from home, so longer-duration absences had not been attempted. The clients had stopped looking to rehome the dog. At 1.5 y after the initial appointment, routine blood work revealed no significant findings. Ideally, blood work would have been repeated within 1 y after starting medication; however, this timing coincided with high rates of COVID-19 at this location, and so the blood work was delayed. The clomipramine dose was maintained due to the couple's upcoming move. A slow wean-off will be considered if the dog's behavior remains stable in the new home.

Discussion

This dog suffered from both confinement anxiety and separation anxiety. Confinement anxiety can be misdiagnosed as separation anxiety if the dog is only confined when home alone; however, this dog experienced anxiety in the crate while people were present, before ever being left alone. Since she was subsequently left alone while confined, her confinement anxiety may have contributed to her separation anxiety. Furthermore, since her dam also demonstrated separation-related behaviors, this dog may have developed the same clinical signs regardless of the confinement, although the latter may still have been an epigenetic contributor. During initial treatment, the dog was

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punished for vocalizing in the crate, which is contraindicated as treatment for behavior disorders (32) due to the potential to induce fear and anxiety. The use of punishment in this case may have exacerbated both the dog's confinement anxiety and separation anxiety. When the dog vocalized in the crate with the first trainer, it is presumed she was vocalizing because of confinement, not separation, since she could attend day care or be with people other than the clients without any signs of anxiety. If this was the case, this dog's separation anxiety could be accurately termed isolation distress; however, the literature does not clearly differentiate isolation distress from separation anxiety in dogs.

Pain can contribute to behavior in myriad ways. Behavior changes may be the first sign of a behavior problem, including separation anxiety (8). Radiographs of hips, stifles, and elbows were discussed to rule out congenital orthopedic or other pain-inducing conditions but were declined. Gabapentin and meloxicam were given after ovariohysterectomy but did not decrease the separation-related behaviors. However, the dose of gabapentin was low and unlikely to be efficacious for either pain or anxiety (33).

Minimal behavior modification was recommended in this case because the clients were overextending themselves with an intensive program and experiencing compassion fatigue, which is common for owners of dogs experiencing separation anxiety (34). The behavior-modification plan was simply to teach the dog that the office, whether she was alone there or with people, was a safe place and an area where she would receive high-value food and toys regardless of whether the clients were leaving the home. Whereas many behavior-modification programs for separation anxiety rely on unpredictability (*e.g.,* picking up keys does not necessarily mean imminent departure), this strategy relies on providing predictability and routine with respect to the anxiety-inducing event (7,35).

Several medications were trialed before an effective medication and dose range was achieved. For treatment of depression in humans, psychiatrists often trial antidepressant choice and dose (36). Brain chemistry can influence effectiveness of these medications. Tricyclic antidepressants such as clomipramine inhibit norepinephrine reuptake inhibition and have antihistamine properties. A tricyclic antidepressant can be a better choice in some anxiety patients due to the broader spectrum of neurotransmitters targeted compared to SSRIs, which are more selective for serotonin reuptake inhibition (36). Because of this, paroxetine was specifically chosen over other SSRIs due to its effect on norepinephrine reuptake as well as some mild anticholinergic effects (36). It was hypothesized this anticholinergic effect might help reduce urinary accidents and salivation occurring during separation, though this has not been confirmed in the canine literature. Instead, the anticholinergic effects likely produced the onset of vocalization in situations where the dog had not previously vocalized. This vocalization resolved eventually after changing medications; however, vocalization when the clients were absent was the last separation-related behavior to resolve. It was hypothesized that the vocalization would persist, as reported in some studies (37). In addition, dogs without separation-related behaviors do move around the home vocalizing occasionally (38). Alternatively, it is possible that separation anxiety was not in remission and vocalization only resolved because the dog learned that it was not effective for achieving safety — in this case, the return of a person to the home — and so she "gave up." This phenomenon is referred to as "learned helplessness," and has been described in both humans and animals, including dogs (39). However, this dog was observed resting, eating, and exploring her environment, which is more consistent with a reduction of anxiety than an experience of learned helplessness.

No situational, or short-acting, medication was used in this case. Trazodone had been trialed initially, and although the dose was low, did not improve separation-related behavior and resulted in sedation. Trazodone has been used in dogs to aid in treatment of a variety of stressful or fear-inducing events, including separation anxiety (40). The dose of trazodone given to this dog was towards the lower end of the range of effective doses. Lorazepam was also trialed; however, the dog became extremely agitated. Paradoxical excitement from lorazepam was suspected and it was discontinued.

The criteria for discontinuing medication for separation anxiety are patient-dependent. As changes in routine are associated with separation anxiety in dogs (5) and these clients were moving, it was decided not to discontinue clomipramine in this case.

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Article

Antimicrobial resistance in generic *E. coli* isolated from western Canadian cow-calf herds

Jayce D. Fossen, John R. Campbell, Sheryl P. Gow, Nathan Erickson, Cheryl L. Waldner

Abstract

Objective

To examine antimicrobial resistance (AMR) in commensal fecal *Escherichia coli (E. coli)* from extensively managed beef calves and cows in western Canada and describe the differences among cows and calves in the spring and fall.

Animal

Beef cattle, cow-calf.

Procedure

Antimicrobial susceptibility testing was conducted on generic *E. coli* isolates collected from 388 calves and 387 cows from 39 herds following calving in 2021, 419 calves from 39 herds near weaning, and 357 cows from 36 herds at pregnancy testing. Minimum inhibitory concentrations were measured with the NARMS CMV5AGNF plate for Gram-negative bacteria and interpreted using Clinical and Laboratory Standards Institute standard breakpoints for humans.

Results

Only 16% (242/1551) of all isolates from 97% (38/39) of herds were resistant to ≥ 1 antimicrobial. Generic *E. coli* isolates were most commonly resistant to sulfisoxazole (11%, 175/1551), followed by tetracycline (9.3%, 145/1551) and chloramphenicol (3.5%, 55/1551). Isolates from calves in the spring were more likely to be resistant to sulfisoxazole, tetracycline, and chloramphenicol than those from cows in the spring or calves in the fall. Multiclass-resistant isolates were identified in 5% (39/807) of calves. Only 2 isolates recovered from cows were resistant to antimicrobials of very high importance for human health.

Conclusion and clinical relevance

Most generic *E. coli* isolates were pansusceptible. The observed resistance patterns were consistent with earlier studies of AMR from commensal *E. coli* in this region. Baseline AMR data for cow-calf herds are not currently collected as part of routine surveillance, but are essential to inform antimicrobial use policy and stewardship.

Résumé

Résistance aux antimicrobiens chez *E. coli* générique isolé dans des troupeaux vache-veau de l'Ouest canadien

Objectif

Examiner la résistance aux antimicrobiens (RAM) chez *Escherichia coli* de la flore fécale commensale (*E. coli*) provenant de veaux et de vaches de boucherie en élevage extensif dans l'ouest du Canada et décrire les différences entre les vaches et les veaux au printemps et à l'automne.

Animal

Bovins de boucherie, vache-veau.

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Procédure

Des tests de sensibilité aux antimicrobiens ont été effectués sur des isolats génériques d'*E. coli* collectés auprès de 388 veaux et 387 vaches de 39 troupeaux après le vêlage en 2021, de 419 veaux de 39 troupeaux à l'approche du sevrage et de 357 vaches de 36 troupeaux lors des tests de gestation. Les concentrations minimales inhibitrices ont été mesurées avec la plaque NARMS CMV5AGNF pour les bactéries à Gram négatif et interprétées à l'aide des seuils standard pour les humains du *Clinical and Laboratory Standards Institute*.

Résultats

Seulement 16 % (242/1 551) de tous les isolats provenant de 97 % (38/39) des troupeaux étaient résistants à ≥ 1 antimicrobien. Les isolats génériques d'*E. coli* étaient le plus souvent résistants au sulfisoxazole (11 %, 175/1 551), suivi de la tétracycline (9,3 %, 145/1 551) et du chloramphénicol (3,5 %, 55/1 551). Les isolats provenant des veaux au printemps étaient plus susceptibles d'être résistants au sulfisoxazole, à la tétracycline et au chloramphénicol que ceux provenant des vaches au printemps ou des veaux à l'automne. Des isolats résistants à plusieurs classes ont été identifiés chez 5 % (39/807) des veaux. Seuls deux isolats récupérés chez des vaches étaient résistants à des antimicrobiens de très haute importance pour la santé humaine.

Conclusion et pertinence clinique

La plupart des isolats génériques d'*E. coli* étaient sensibles à l'ensemble des antimicrobiens. Les profils de résistance observés concordaient avec les études antérieures sur la RAM provenant d'*E. coli* commensal dans cette région. Les données de base sur la RAM pour les troupeaux vache-veau ne sont pas actuellement recueillies dans le cadre de la surveillance de routine, mais elles sont essentielles pour éclairer la politique et la gestion de l'utilisation des antimicrobiens.

(Traduit par Dr Serge Messier)

Can Vet J 2024;65:146–155

Introduction

Canadian cow-calf herds are typically more extensively managed than other production animal commodities such as swine, poultry, dairy, and feedlot cattle. Whereas the literature regarding antimicrobial resistance (AMR), the role of antimicrobial use (AMU), and drivers of AMR in livestock is growing for other sectors (1–3), very few reports describe AMR in cow-calf herds, including those in western Canada. Antimicrobial resistance in commensal enteric bacteria is of interest because there is potential for transmission of mobile genetic elements between bacteria and for spread of resistant bacteria between animals and to humans through direct contact, food, or the environment (4). Generic *Escherichia coli (E. coli)* is commonly used as a sentinel organism in surveillance programs because it is easy to culture from both mammals and birds, facilitating comparisons among species and environments. In addition, *E. coli* can carry a relatively large number of resistance markers and is a sensitive indicator for AMR (4).

Although pooled fecal samples were collected for AMR testing from western Canadian beef cows in 2014 (5) and beef herds in eastern Canada in 2001 and 2002 (6), the relative frequencies of AMR in enteric organisms based on individual-animal data have not been measured in Canadian cow-calf herds in almost 2 decades. Individual-animal data are necessary to determine if the frequency of AMR is changing within herds. In western Canada, AMR was evaluated in commensal *E. coli* isolates obtained from individual fecal pats of beef calves and cows in the spring and calves in the fall of 2002 (7,8). In addition, *E. coli* isolates from individual fecal samples from cow-calf pairs were also examined in 2003 (8), and individual samples were tested from beef cows from the United States in 2008 (9).

Antimicrobial resistance could be more seasonal in cow-calf herds than in other commodities as disease and resulting AMU are linked to the cow-calf production cycle, which is more seasonal than for most other livestock species (7,8,10,11). Canadian cow-calf herds also differ in that beef cows are typically managed outdoors on pasture for much of the year, potentially affecting the risk for environmental transmission of AMR from cow-calf herds through soil and water. The 54 000 cow-calf herds in Canada (12) substantially outnumber operations for more intensively managed commodities such as dairy, pork, and poultry, making surveillance of AMR crucial in this commodity. Furthermore, cow-calf herds are a potential direct source of resistant enteric organisms in the human and pet food chains through the sale of cull cows and bulls to processors. Finally, cow-calf herds are the primary source of cattle for backgrounding and feedlot operations, which provide most beef to consumers.

Although the Canadian Public Health Agency leads a surveillance program in feedlot cattle monitoring resistance of *E. coli* to antimicrobials of interest to human health, there is no similar initiative in cow-calf herds (13). Comparable, current, and more complete AMR data are needed from cow-calf herds to provide a baseline for measuring the effects of stewardship initiatives, as well as to target the most appropriate age groups and seasonal timing for future on-farm sampling programs. Previous work has documented higher relative frequencies of AMR in generic *E. coli* isolated from calves in the spring as compared to cows in the spring and from calves in the spring as compared to calves in the fall (7,8). The objectives of this study were to describe the relative frequency of AMR in fecal generic *E. coli* isolated from beef cows and calves from western Canada and to compare the relative frequencies of *E. coli* AMR between cows and calves in the spring and the fall.

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Materials and methods

This project was approved by the University of Saskatchewan's Animal Research Ethics Board (AREB) under the Animal Use Protocol # 2014003.

Producer recruitment

The Canadian Cow-Calf Surveillance Network (C3SN) is a national program funded by the industry through a federal support program. Its goals are to monitor herd productivity, production-limiting diseases (14), AMU (11), and AMR in Canadian cow-calf herds. Participants were recruited to the network during 2018 and 2019 through consultation with veterinarians, producer organizations, and word of mouth. Recruitment targeted herds with $>$ 40 breeding animals for which pregnancy checking, basic records for calving and production, and access to email were reported (15).

For this study, 50 participants were recruited from 98 producers from western Canada who completed an AMU survey for C3SN in 2020 (11). The survey questions asked about record collection, whether individual- or herd-level records were available, and if producers would be willing to share records. Producers who agreed to share animal health records in 2021 were contacted in December of 2020, *via* email, to determine their interest in participating in collection of fecal samples and analysis for AMR.

The 50 herds recruited to participate in the fecal AMR project included 25 from Alberta, 12 from Saskatchewan, 8 from Manitoba, and 5 from British Columbia. Veterinarians were asked to collect fecal samples on-farm in 2021, using sample kits and instructions supplied by the study team. Convenience samples were collected from 10 cows and 10 calves per operation following calving (spring) and near the time of weaning and pregnancy testing (fall). The age of calves at sampling was recorded in the spring.

Random sampling of cattle in the spring during busy calving season was not considered feasible, nor was repeatedly sampling the same animals in the fall. Samples were collected either directly from the rectum or from fresh fecal pats observed to have dropped from the animal. Samples were packaged in a cooler with ice packs and shipped *via* overnight courier to Prairie Diagnostic Services (Saskatoon, Saskatchewan), for bacterial culture and susceptibility testing.

Laboratory methods

The fecal samples were weighed and 4.0 g were transferred into 50-milliliter centrifuge tubes containing 36 mL 1% buffered peptone water. The mixture was vortexed thoroughly and placed in a mixer for 1 h. The pre-enrichment mixtures were incubated at 35°C for 18 to 24 h under normal atmospheric conditions.

MacConkey agar (Difco Laboratories, Detroit, Michigan, USA), a selective medium for *Enterobacteriaceae,* was inoculated with 10 μL of the pre-enrichment mixture. The plates were streaked to obtain isolated colonies and incubated at 35°C for 18 to 24 h under ambient atmospheric conditions.

After incubation, the plates were examined for lactose-fermenting colonies consistent with *E. coli* grown on MacConkey agar. Individual colonies were then subcultured onto 5% sheep blood agar to obtain pure colonies. The subcultured plates were incubated at 35°C for 18 to 24 h under 5% CO_2. The colonies grown on blood agar were identified using MALDI-TOF MS (Bruker, Vancouver, British Columbia). A MALDI-TOF score $>$ 2 indicated secure species-level identification. Only isolates that had secure species identification were selected for further analysis. Three isolates per sample of the target organism were saved in Tryptic Soy Broth (TSB; Difco Laboratories) containing 15% glycerol and stored at −80°C.

Minimum inhibitory concentrations (MICs) were measured for an *E. coli* isolate from the most prominent colony in each sample according to the Clinical and Laboratory Standards Institute standard breakpoints for humans (Table 1) (16) using NARMS CMV5AGNF plate for Gram-negative bacteria (TREK Diagnostic Systems, East Grinstead, UK).

A bacterial broth (0.5 McFarland turbidity equivalent) was prepared from a pure bacterial isolate using the Sensititre Nephelometer (ThermoFisher Scientific, Nepean, Ontario). The dosing broths were prepared by transferring 10 μL of the suspension to 11 mL of a Sensititre Cation Adjusted AutoRead Muller-Hinton Broth w/TES (ThermoFisher Scientific). The dosing broth was inoculated onto a Sensititre plate using a Sensititre AIM Automated Inoculation System (ThermoFisher Scientific). The inoculated plates were tightly sealed and incubated at 35°C for 18 to 24 h under normal atmospheric conditions. A BioMic V3 system (Giles Scientific, Santa Barbara, California, USA) was used to report MICs. A manual mirror box was used to confirm shallow bacterial growth. Bacteria were classified as either susceptible or resistant, with intermediate MIC values classed as susceptible.

Data management and analyses

Data were managed using commercial spreadsheet and database programs (Microsoft Access and Excel; Microsoft, Redmond, Washington, USA) and analyzed using a commercial software program (STATA Version 16.1; StataCorp, College Station, Texas, USA).

Random effects logistic regression was used to estimate differences in the relative frequencies of resistance between seasons for cows and calves and between cows and calves within each season. Outcomes considered included resistance to each antimicrobial where the relative frequency of resistance $\geq$ 5%, multiclass resistance, and pansusceptibility. Pansusceptibility was defined as isolates that were susceptible to all tested antimicrobials, whereas multiclass resistance was defined as isolates resistant to $\geq$ 3 classes of antimicrobials (17). Models included a random effect for herd and fixed effects for season, cow *versus* calf, and the interaction between animal type and season. Odds ratios (OR) described the relative differences in outcomes among groups, and $P < 0.05$ was reported as statistically significant. In addition, intracluster correlation coefficients (ICCs) were reported as a measure of clustering of resistance outcomes within the herd after accounting for differences between cows and calves and spring and fall.

Random effects logistic regression was similarly used to evaluate the association between calf age and the occurrence of AMR

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Table 1. Minimum inhibitory concentration (MIC) breakpoints (16).

	Breakpoints (μg/mL)		
Antimicrobial	Susceptible	Intermediate	Resistant
Category I: Very high importance[a]			
Amoxicillin/clavulanic acid	≤ 8	16	≥ 32
Ceftriaxone	≤ 1	2	≥ 4
Ciprofloxacin	≤ 0.06	0.12 to 0.5	≥ 1
Colistin	N/A	≤ 2	≥ 4
Meropenem	≤ 1	2	≥ 4
Category II: High importance[a]			
Ampicillin	≤ 8	16	≥ 32
Azithromycin	≤ 16	N/A	≥ 32
Cefoxitin	≤ 8	16	≥ 32
Gentamicin	≤ 4	8	≥ 16
Nalidixic acid	≤ 16	N/A	≥ 32
Trimethoprim/sulfamethoxazole	≤ 2	N/A	≥ 4
Category III: Medium importance[a]			≥ 32
Chloramphenicol	≤ 8	16	≥ 32
Sulfisoxazole	≤ 256	N/A	≥ 512
Tetracycline	≤ 4	8	≥ 16

N/A — Not applicable.
[a] Categories of antimicrobial drugs based on importance in human medicine — antimicrobial resistance (18).

outcomes in the spring, as previously described, after accounting for clustering by herd.

Antimicrobials were summarized based on Health Canada's categorization of importance to human health (18): Category I: very high importance, Category II: high importance, Category III: medium importance, and Category IV: low importance (not currently used in human medicine) (18).

To simplify the description of AMR relative frequency throughout the paper, terms used in the European Union and European Economic Area (EU/EEA) for reporting AMR data were followed as a guide (19): rare: < 0.1%, very low: 0.1 to 1.0%, low: > 1.0 to 10%, moderate: > 10 to 20%, high: > 20 to 50%, very high: > 50 to 70%, and extremely high: > 70%.

Results

Study population

Of the 50 herds enrolled, 39 herds provided fecal samples from calves in both the spring and fall: 20 (51%) herds from Alberta, 9 (23%) herds from Saskatchewan, 5 (13%) herds from British Columbia, and 5 (13%) herds from Manitoba.

The median number of cows calving in the sampled herds was 244 (range: 46 to 1044, mean: 212). Of the enrolled herds, all were identified as having some commercial cattle (range: 10 to 90%); 15 were identified as having some seedstock, ranging from 2 to 90% of the herd consisting of purebred cattle.

In the spring of 2021, *E. coli* was recovered from 99.5% (388/390) of fecal samples from calves and 100% (387/387) of samples from cows. Participating herds started calving between December 2020 and May 2021; most calved in March (33%, 13/39) and April (28%, 11/39). Samples following calving (spring) were collected in the months of March through August, with 59% (23/39) in June. The average age at sampling for calves in the spring was 8 wk (SD: 5 wk, range: 1 to 23 wk).

Similarly in the fall of 2021, *E. coli* was recovered from 100% (419/419) of sampled calves and 99.4% (357/359) of cows. Three herds did not submit cow samples in the fall, but rather submitted 20 samples from calves. The fall samples were collected in the months of September through January, with most in October (33%, 13/39) and November (44%, 17/39). Age at sampling was not available for calves in the fall. Four herds collected cow and calf samples on different days: 3 herds sampled within 1 wk and 1 herd sampled cows in October and calves in January.

Antimicrobial resistance

Sixteen percent (242/1551) of all isolates from 97% (38/39) of the herds enrolled in the study were resistant to ≥ 1 antimicrobial. Overall, resistance was low or moderate across all animal classes and seasons, with no single animal class in either season having more than 20% of isolates resistant to a single antimicrobial (Table 2).

The highest resistance relative frequency across all seasons and animal classes was to sulfisoxazole (11.3%, 175/1551), followed by tetracycline (9.3%, 145/1551) and chloramphenicol (3.5%, 55/1551). *Escherichia coli* isolates were also resistant to ampicillin (1.4%, 21/1551) in both cows and calves in the spring and fall (Table 2).

Isolates resistant to trimethoprim/sulfamethoxazole were recovered from 2 calves in the spring and 1 cow in the fall. Two isolates resistant to gentamicin were recovered from calves in the spring (Table 2). One calf isolate from the spring and 2 cow isolates from the fall were resistant to cefoxitin. Only 2 isolates were resistant to any of the Category I antimicrobials tested: 1 isolate from a cow in the spring and 1 isolate from a cow in the fall were resistant to amoxicillin/clavulanic acid (Table 3).

Overall, 8.5% (132/1551) of isolates were resistant to just 1 antimicrobial class and 7.1% (110/1551) of isolates were resistant to > 1 antimicrobial class (Table 3). An extremely high proportion of isolates (84.4%, 1309/1551) were pansusceptible. Resistance to ≥ 3 antimicrobial classes was detected in 3.0% (46/1551) of the isolates (Table 3).

The most common resistance pattern from calf isolates recovered during the spring that were resistant to > 1 antimicrobial

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Table 2. Relative frequencies of antimicrobial resistance [% (observed frequency)] for *Escherichia coli* isolates recovered from 39 cow-calf herds in spring and fall of 2021.

	Spring 2021		Fall 2021	
Antimicrobial	Calves (n = 388) Resistant	Cows (n = 387) Resistant	Calves (n = 419) Resistant	Cows (n = 357)[b] Resistant
Category I: Very high importance[a]				
Amoxicillin/clavulanic acid	0% (0)	0.3% (1)	0% (0)	0.3% (1)
Ceftriaxone	0% (0)	0% (0)	0% (0)	0% (0)
Ciprofloxacin	0% (0)	0% (0)	0% (0)	0% (0)
Colistin	0% (0)	0% (0)	0% (0)	0% (0)
Meropenem	0% (0)	0% (0)	0% (0)	0% (0)
Category II: High importance[a]				
Ampicillin	2.3% (9)	0.8% (3)	1% (4)	1.4% (5)
Azithromycin	0% (0)	0% (0)	0% (0)	0% (0)
Cefoxitin	0% (0)	0.3% (1)	0% (0)	0.6% (2)
Gentamicin	0.5% (2)	0% (0)	0% (0)	0% (0)
Nalidixic acid	0% (0)	0% (0)	0% (0)	0% (0)
Trimethoprim/sulfamethoxazole	0.5% (2)	0% (0)	0% (0)	0.3% (1)
Category III: Medium importance[a]				
Chloramphenicol	9% (35)	0.3% (1)	3.1% (13)	1.7% (6)
Sulfisoxazole	17.8% (69)	2.3% (10)	11.9% (50)	12.9% (46)
Tetracycline	17.8% (69)	4.7% (18)	9.8% (41)	4.8% (17)

[a] Categories of antimicrobial drugs based on importance in human medicine — antimicrobial resistance (18).
[b] Samples submitted from 36 herds.

Table 3. Relative frequencies of resistance patterns based on antimicrobial class [% (observed frequency)] for *Escherichia coli* isolates recovered in 2021 from 39 cow-calf herds.

Resistant to	Spring calf (n = 388)	Spring cow (n = 387)	Fall calf (n = 419)	Fall cow (n = 357)[a]
Pansusceptible	76% (294)	94% (365)	83% (348)	85% (302)
1 class	7.7% (30)	3.4% (13)	11% (46)	12% (43)
> 1 class	17% (64)	2.3% (9)	6.0% (25)	3.4% (12)
2 classes	9.3% (36)	2.1% (8)	3.3% (14)	1.7% (6)
3 classes	7.0% (27)	0% (0)	2.4% (10)	0.8% (3)
4 classes	0.3% (1)	0.3% (1)	0.2% (1)	0.8% (3)
Multiclass-resistant ≥ 3 classes	7.2% (28)	0.3% (1)	2.6% (11)	1.7% (6)
Resistance to a Category I antimicrobial	0% (0)	0.26% (1)	0% (0)	0.28% (1)

[a] Cow samples submitted from 36 herds.

class was to tetracycline and sulfonamide (42%, 27/64). The most common resistance patterns detected to ≥ 3 antimicrobial classes included tetracyclines, phenicols, and sulfonamides (86%, 24/28), followed by tetracyclines, phenicols, and penicillins (7%, 2/28). Nine isolates from cows sampled in the spring were resistant to > 1 antimicrobial class, and 6 of these isolates (67%) were resistant to tetracycline and sulfonamide.

As with calves in the spring, the combination of tetracyclines and sulfonamides accounted for most (40%, 10/25) resistance to > 1 antimicrobial class from isolates from calves in the fall. In addition, 9 (36%) isolates from this group were resistant to tetracyclines, sulfonamides, and phenicols. The most common resistance pattern to > 1 antimicrobial class for cow isolates in the fall was to tetracyclines and sulfonamides (42%, 5/12).

One calf isolate from the spring, 1 cow isolate from the spring, 1 calf isolate from the fall, and 3 cow isolates from the fall were each resistant to 4 classes of antimicrobials (tetracyclines, phenicols, sulfonamides, and aminoglycosides).

The relatively frequency of herds with AMR in ≥ 1 sample varied from 36% of herds for cows in the spring to 82% of herds for calves in the spring (Table 4). Within herd, sample frequency was most variable for sulfisoxazole resistance, followed by tetracycline (Table 4).

Differences among susceptibility of isolates from cows and calves from the spring and fall

Three antimicrobials were identified for additional analysis: sulfisoxazole, tetracycline, and chloramphenicol. For calves sampled in the spring, the odds of being resistant to sulfisoxazole (OR: 0.90, 95% CI: 0.82 to 0.99; P = 0.03) and tetracycline (OR: 0.89, 95% CI: 0.82 to 0.96; P = 0.005) decreased with increasing calf age in wk, but the decrease in odds of resistance to chloramphenicol (OR: 0.90, 95% CI: 0.80 to 1.01, P = 0.08) was not significant.

Isolates from calves in the fall were less likely to be resistant to sulfisoxazole, tetracycline, and chloramphenicol compared to isolates from calves in the spring (Table 5). Isolates from calves in the fall were also less likely to be multiclass-resistant as well as be resistant to ≥ 1 antimicrobial compared to isolates from calves in the spring (Table 5). Furthermore, isolates from calves in the fall were more likely to be pansusceptible than isolates recovered from calves in the spring (Table 5).

Table 4. Comparison of the proportions of resistance-positive herds as well as the average within-herd relative frequencies for resistance-positive herds.

	Spring calf (n = 39 herds)			Spring cow (n = 39 herds)			Fall calf (n = 39 herds)			Fall cow (n = 36 herds)		
		Within-herd percentage for resistant herds			Within-herd percentage for resistant herds			Within-herd percentage for positive herds			Within-herd percentage for positive herds	
Antimicrobial	% (#) of resistance-positive herds	Mean	Min and Max	% (#) of resistance-positive herds	Mean	Min and Max	% (#) of resistance-positive herds	Mean	Min and Max	% (#) of resistance-positive herds	Mean	Min and Max
Category I: Very high importance[a]												
Amoxicillin/clavulanic acid	0% (0)	0%	0%, 0%	2.6% (1)	10%	10%, 10%	0% (0)	0%	0%, 0%	2.8% (1)	10%	10%, 10%
Ceftriaxone	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%
Ciprofloxacin	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%
Colistin	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%
Meropenem	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%
Category II: High importance[a]												
Ampicillin	13% (5)	18%	10%, 30%	7.7% (3)	10%	10%, 10%	10% (4)	10%	10%, 11%	11% (4)	13%	10%, 20%
Azithromycin	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%
Cefoxitin	0% (0)	0%	0%, 0%	2.6% (1)	10%	10%, 10%	0% (0)	0%	0%, 0%	5.6% (2)	10%	10%, 10%
Gentamicin	2.6% (1)	17%	17%, 17%	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%
Nalidixic acid	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%
Trimethoprim/sulfamethoxazole	5.1% (2)	14%	8%, 20%	0% (0)	0%	0%, 0%	0% (0)	0%	0%, 0%	2.8% (1)	10%	10%, 10%
Category III: Medium importance[a]												
Chloramphenicol	51% (20)	18%	10%, 63%	2.6% (1)	10%	10%, 10%	23% (9)	13%	10%, 30%	14% (5)	12%	10%, 20%
Sulfisoxazole	67% (26)	27%	8%, 80%	26% (10)	10%	10%, 10%	62% (24)	19%	5%, 70%	53% (19)	24%	10%, 80%
Tetracycline	72% (28)	25%	10%, 75%	31% (12)	15%	10%, 20%	56% (22)	17%	10%, 40%	36% (13)	13%	10%, 30%
Pansusceptible	100% (39)	76%	20%, 100%	100% (39)	94%	70%, 100%	100% (39)	83%	30%, 100%	100% (36)	85%	20%, 100%
Herd with ≥ 1 resistant isolate	82% (32)	30%	10%, 80%	36% (14)	16%	10%, 30%	79% (31)	10%	10%, 11%	64% (23)	24%	10%, 80%
Multiclass-resistant	41% (16)	18%	10%, 30%	2.6% (1)	10%	10%, 10%	21% (8)	13%	10%, 20%	14% (5)	12%	10%, 20%
Resistant to ≥ 1 Category I antimicrobial	0% (0)	0%	0%, 0%	2.6% (1)	10%	10%, 10%	0% (0)	0%	0%, 0%	2.8% (1)	0%	0%, 0%

Max — Maximum; Min — Minimum.

[a] Categories of antimicrobial drugs based on importance in human medicine — antimicrobial resistance (18).

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Table 5. Summary of relative differences in antimicrobial resistance outcomes of interest for *Escherichia coli* isolates collected from cows and calves in the fall and spring of 2021, accounting for clustering within 39 herds using generalized estimation equations.

	Fall calf *versus* spring calf[a]				Spring cow *versus* spring calf				Fall cow *versus* fall calf				Fall cow *versus* spring cow				
		95% CI				95% CI				95% CI				95% CI			
Antimicrobial	Odds ratio	Lower	Upper	*P*-value	Odds ratio	Lower	Upper	*P*-value	Odds ratio	Lower	Upper	*P*-value	Odds ratio	Lower	Upper	*P*-value	ICC
Chloramphenicol[b]	0.31	0.16	0.6	0.001	0.02	0.00	0.19	< 0.001	0.51	0.19	1.38	0.18	6.49	0.77	54.5	0.09	0.19
Sulfisoxazole[b]	0.62	0.41	0.93	0.20	0.11	0.06	0.22	< 0.001	1.05	0.68	1.64	0.82	5.79	2.85	11.8	< 0.001	0.13
Tetracycline	0.47	0.31	0.73	0.001	0.22	0.12	0.37	< 0.001	0.46	0.26	0.84	0.01	1.02	0.51	2.03	0.95	0.10
Pansusceptible[b]	1.61	1.13	2.29	0.009	5.64	3.43	9.27	< 0.001	1.15	0.77	1.70	0.50	0.33	0.19	0.55	< 0.001	0.09
Multiclass-resistant[b]	0.33	0.16	0.68	0.003	0.03	0.00	0.23	0.001	0.61	0.22	1.68	0.34	6.51	0.78	54.7	0.08	0.21
≥ 1 resistant isolate[b]	0.63	0.44	0.89	0.009	0.18	0.11	0.29	< 0.001	0.87	0.59	1.29	0.5	3.06	1.81	5.17	< 0.001	0.09

CI — Confidence interval; ICC — Intracluster correlation coefficient.

[a] All odds ratios reflect the relative difference in the odds of the listed outcome between the first listed group and the second. For example, the odds of chloramphenicol resistance are 0.3× as high in calves in the fall as in calves in the spring. The odds of the isolate from a calf being pansusceptible are 1.6× higher in a calf from the fall as in a calf from the spring.

[b] Interaction between type of animal and antimicrobial ($P < 0.01$).

Isolates recovered from cows in the fall were more likely to be resistant to sulfisoxazole than those from cows in the spring (Table 5). Also, fall cow isolates were more likely to be resistant to ≥ 1 antimicrobial compared to isolates from cows in the spring (Table 5). In contrast to the observed pattern in calves, isolates from cows in the spring were more likely to be pansusceptible compared to isolates from cows in the fall (Table 5).

Isolates from calves in the spring were more likely to be resistant to chloramphenicol, sulfisoxazole, and tetracycline, as well as multiclass-resistant and resistant to ≥ 1 antimicrobial, compared to isolates from cows in the same season (Table 5). Isolates from cows in the spring were more likely to be pansusceptible than isolates recovered from calves in the spring (Table 5). The only difference between cows and calves in the fall was that isolates from calves were more likely to be resistant to tetracycline than isolates from cows (Table 5).

The ICC values determined from the herd random effect for the complete models ranged from 0.09 to 0.21, suggesting a moderate level of clustering of AMR by herd (Table 5). The highest levels of clustering were observed for chloramphenicol resistance and multiclass resistance.

Discussion

The intent of this study was to describe the relative frequency of AMR of interest for human health for generic *E. coli,* a commensal enteric organism isolated from cattle feces in western Canada. As an indicator organism, *E. coli* has some advantages over other enteric organisms such as *Campylobacter* spp., *Salmonella* spp., and *Enterococcus* spp., including the number of studies available for comparison for cattle and across other commodities, ease of culture and high expected isolation rates, and relatively well-established interpretation criteria for antimicrobial susceptibility (1,4–9). Overall, the relative frequency resistance in the current study of the cow-calf industry was moderate, with 16% of all isolates resistant to ≥ 1 antimicrobial class. This was notably lower than on-farm resistance reported for other commodities in 2019, such as feedlot cattle, pork, and chicken, for which resistance to ≥ 1 antimicrobial class was 52, 78, and 66%, respectively (20).

In contrast to the individual animal samples reported in the present study, 2 previous Canadian studies of cow-calf herds, including the only report within the last decade, examined pooled fecal samples. In the most recent Canadian study, pooled samples were collected from 20 cows per herd in the fall of 2014 (5). Three *E. coli* isolates from each pool were tested for AMR, compared to the single isolate per animal in the current study. Despite the differences in sampling methods, tetracycline resistance was similar for cows in the fall (5). However, both sulfisoxazole resistance (13%) and resistance to ≥ 1 antimicrobial (15%) were higher for cows in the fall of 2021, compared to 3 and 4% in 2014 (5). Only a single isolate from each of the 2014 and 2021 studies was resistant to any antimicrobial very important to human health: amoxicillin/clavulanic acid (5). Nevertheless, the percent of herds with AMR would very likely have been underestimated in 2014 as compared to 2021 because there were only 3 isolates per herd, compared to 10 in the present study.

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Pooled fecal samples were also collected from cows and nursing calves in 13 Ontario beef herds from January through August in 2001 (6). As in the current study, tetracycline resistance was highest in cow-calf herds, although the overall crude prevalence was lower than in the current study, at 9.6% in pooled fecal samples (6). The relative frequency of tetracycline resistance in the Ontario study was, however, almost identical to that for the time-matched spring data, when current tetracycline resistance was adjusted to reflect the relative contribution of cows and calves from the Ontario sampling scheme (6). Also similar to the 2021 data, 89% of all cow and 81% of calf isolates from Ontario were pansusceptible (6). The disadvantage of these previous pooled studies was they did not provide a baseline by which to assess whether the frequency of AMR is changing within herds over time.

Like the current study, 2 other comparable reports from the United States and Canada described AMR based on individual samples. Tetracycline resistance (16%) was higher in the 2008 individual cow samples from the United States than for the 2021 samples from western Canada, which averaged 4.7% for both seasons (9). Sulfisoxazole resistance in cows was similar, with 6.7% in the 2008 isolates compared to 7.2% in 2021. The only previous Canadian data with individual cow sample results comparable to the American data and the cow data from the current study were from 69 herds sampled in the spring of 2002 (8). The 2002 Canadian data also mirrored the American data, in that sulfamethoxazole resistance for cows in the spring was nearly identical to that from 2021, at 7.1% (8). However, also as in the American data, tetracycline resistance was slightly higher in 2002, at 8.7%, as compared to 4.7% in 2021 (8).

Single isolates recovered from cows in the spring of 2002 and from the 2008 American study were resistant to ceftiofur (8,9). No 3rd-generation cephalosporin resistance was detected in the current study, despite reports of ceftiofur use in some participating herds (21,22). Ceftiofur was not included on the current MIC plate, which reflects drugs important in human medicine; rather, ceftriaxone alone represented the 3rd generation cephalosporins.

Also similar to findings in the current study, resistance to antimicrobials of high or very high importance to human health was also very low for individual calf samples from 91 herds in the spring and 45 herds in the fall of 2002 (7). In both 2021 and 2002, calves in spring were more likely to have ≥ 1 resistant isolate than calves sampled in the fall and cows sampled in the spring (7,8). In addition, cow-calf pairs were examined from 10 herds in 2003 with a similar higher prevalence in calves than cows (8). Resistant isolates were recovered from both the cow and calf from the same pair in only 5% of pairs sampled (8).

Selection pressure associated with AMU (5) could contribute to the observed differences between calves in the spring and fall and between calves and cows. The most common targets of AMR in the present study, tetracycline and sulfisoxazole, were also consistent with described AMU patterns. In western Canada in 2019 to 2020, 84% of herds reported using oxytetracycline on their operation at least once (11); 33% reported using injectable sulfadoxine/trimethoprim in any animal and 40% reported using sulfamethazine oral boluses in calves (11). Most treatments administered to calves for neonatal diarrhea and respiratory disease typically occur in the first 3 mo after birth (10). Calves are also more likely to be treated than cows in the spring, potentially explaining the difference in AMR between calves and cows (21). However, AMU differences do not explain the higher prevalences of AMR to both tetracycline (46%) and sulfamethoxazole (43%) reported in calves in the spring of 2002 (7).

Another potential factor contributing to differences in resistance levels between calves in the spring and the fall is physiological differences associated with calf age (7). In the present study, there was a decrease in the frequency of AMR with increasing age for calves within the spring sample period after accounting for clustering by herd. Gow *et al* had previously documented age differences in AMR in neonatal beef calves, with an increase immediately after birth followed by a decrease to weaning (7). Hoyle *et al* also reported that calves had fewer resistant *E. coli* relative to susceptible *E. coli* as they aged (23).

The potential role of transmission in explaining the observed AMR patterns is not as obvious. Tetracycline and sulfamethoxazole resistance in cows was previously shown to be a predictor of resistance in calves in the same herd (7), suggesting the potential for transmission of AMR from cows — either directly from the dam or from other cows or calves through the environment. Whereas dam to calf transmission is very likely, one previous study reported no evidence that dam and calf status were strongly associated within 105 cow-calf pairs (8). Typically, cattle are managed under a relatively higher degree of confinement during and following calving season, providing opportunities for indirect environmental transmission of enteric organisms among all cows and calves in the same management group. Recent research has linked spring management activities and failure to disperse cattle following calving with increased risk of neonatal infectious disease (10).

Interestingly, chloramphenicol resistance was noted among calves and cows in different seasons, to varying degrees, with the highest frequency from calves in the spring. However, chloramphenicol is banned for use in food-producing animals in Canada due to the risk associated with aplastic anemia in humans (24). One potential reason for the observed resistance to chloramphenicol could be the use of florfenicol on cow-calf operations. Florfenicol has consistently been 1 of the 3 most reported antimicrobials used within this cohort of cow-calf operations, together with tetracyclines and all products containing sulfonamides, with 81 and 73% of herds reporting use at least once in both of 2014 and 2020 (11,21). Florfenicol is a structural analog of chloramphenicol approved for treating respiratory disease. The observed resistance might be attributed to a chromosomal *flo* gene that confers resistance to both florfenicol and chloramphenicol (25).

We inferred that, whereas the relative frequencies for resistance to individual antimicrobials have varied over time, the types of antimicrobials for which resistance is most common and the frequency of resistance to antimicrobials most important to human health have remained relatively unchanged across available reports. There are, however, some limitations in the available data. The choice of *E. coli* as an indicator organism limits the

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assessment of resistance to macrolides, an important class of drug in the beef industry and to human health. The only macrolide included on the MIC plate chosen for this study was azithromycin, to which *E. coli* was completely susceptible. However, *E. coli* is intrinsically resistant to many of the macrolides used in veterinary medicine due to the impermeability of the outer membrane (26,27). Because validated cut points for most veterinary macrolides of interest are not available for enteric commensal organisms, additional data were gathered for macrolides of interest to human health. Investigators examined various *Enterococcus* species from these same samples using Sensititre plates appropriate for Gram-positive bacteria that include macrolides; the results of this examination will be presented elsewhere.

Although several significant associations consistent with previous reports were identified, the power of the study was lower than originally intended, with only 39 herds providing samples in both the spring and fall sampling periods. The current protocol allowed for convenience sampling of 10 calves and 10 cows in the spring and fall; however, with only 10 calves and 10 cows, the samples would not fully represent the herd. Therefore, caution is needed in making generalizations, even though the number of isolates per herd was consistent with that reported for *E. coli* in a larger report from the United States in 2008 (9). Further as individual animals were not repeatedly sampled in both seasons, it was not possible to measure the change in status of individual animals from the spring to the fall.

Finally, because the herds enrolled in this study were part of a larger network, the sample population likely represented relatively progressive, intensively managed operations. The enrollment criteria included some basic record management and participation in industry best management practices such as pregnancy checking. Thus, whereas the data give some insight into *E. coli* resistance, this study reflects 1 segment of the western Canadian cow-calf industry and should be directly compared to data from herds of similar size and with comparable management practices. The herds were, however, recruited using very similar protocols to those reported for previous Canadian studies (5–8,28), facilitating direct comparisons to previous work. Herd-level AMU data from herds enrolled in this study are published elsewhere (11).

Additional studies are needed to better understand the now-repeated observations of higher relative frequency of AMR in calves than in cows and decreasing relative frequency in calves from the spring to the fall. If cow-calf herds were added to federal AMR surveillance initiatives, the existing information would be of value to inform on the potential effect of targeting sampling to cows or calves or to specific seasons. Although lower than for calves, the relative frequency of AMR for cows in the fall was higher than for cows in the spring. This was new information, as the previous comparable study (8) did not sample cows in the fall. Cows are typically culled in the fall, and these culls have the closest connection to the food chain and potential risk for human or pet foodborne exposure.

Evidence of moderate clustering of AMR outcomes should be considered in planning future studies, and the reported ICCs can be considered in sample size calculations. The observed clustering could result from a common management or AMU practice associated with AMR or be evidence of contagious transmission within a herd. Regardless, clustering suggests that the sample size per herd to detect common AMR outcomes might be lower than otherwise necessary without herd-level determinants. However, as clustering is only moderate, very small sample sizes per herd would still be likely to miss important information.

Other subsequent epidemiologic analyses using individual animal treatment data are also necessary to also examine the potential contribution of AMU to AMR. Future genomics studies could provide more insight into the observed AMR profiles (29). In addition, genomics studies could help to identify the role of contagious transmission in explaining observed patterns in AMR and any connections to environmental *E. coli.*

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Article

Age estimation by pulp canal/root ratio in Yorkshire terrier dogs

Joana Pereira, Michèle Venturini, Daniel Ferro, Herbert Corrêa, Raquel Matos, João Requicha

Abstract

Background

The study of the morphological parameters of teeth on dental radiographic images, especially evaluation of the pulp canal/root ratio (PCRR), has been presented as a reliable method to estimate age both in humans and animals. Evaluating PCRR involves a simple, nondestructive procedure that can be used both in living individuals and in cadavers. There is a scarcity of studies assessing the relationship between PCRR and age in dogs *(Canis lupus familiaris)*.

Objective

The aim of this study was to evaluate the relationship between PCRR and age in Yorkshire terrier dogs.

Animals and procedures

Dental radiographs of 53 Yorkshire terrier dogs from the database of the Odontovet Veterinary Dentistry Center (Brazil) were analyzed. Using ImageJ software, 3 consecutive measurements of the widths of 2 roots (mesial and distal) and their respective pulp canals were taken at both mandibular molar teeth (left, 309 and right, 409). The PCRR was then calculated using width means.

Results

The PCRR decreased with increasing age in both mesial (0.21 ± 0.09 in animals aged < 24 mo, 0.12 ± 0.04 in animals aged between 25 and 96 mo, and 0.09 ± 0.03 in dogs aged > 96 mo) and distal (0.24 ± 0.11, 1.01 ± 0.03, and 0.09 ± 0.03, by the same order) roots. A statistically significant, moderate negative correlation was demonstrated between age and PCRR of the mesial [$rs\ (97) = -0.545$; $P < 0.001$] and distal [$rs\ (98) = -0.578$; $P < 0.001$] roots.

Conclusion and clinical relevance

This work contributes to the knowledge of PCRR in dogs and its relationship with age, paving the way for further studies using larger samples in different canine breeds.

Résumé

Estimation de l'âge par le rapport canal pulpaire/racine chez des chiens de race Yorkshire

Contexte

L'examen des paramètres morphologiques des dents sur des radiographies dentaires, particulièrement l'évaluation du rapport canal pulpaire/racine (PCRR), a été présenté comme une méthode fiable d'estimer l'âge chez les humains et les animaux. L'évaluation du PCRR est faite au moyen d'une procédure simple et non-destructive qui peut être utilisée autant chez les individus vivants que sur des cadavres. Il y a peu d'études évaluant la relation entre le PCRR et l'âge chez les chiens (*Canis lupus familiaris*).

Objectif

L'objectif de la présente étude était d'évaluer la relation entre le PCRR et l'âge chez des chiens de race Yorkshire.

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Animaux et procédures

Les radiographies dentaires de 53 chiens de race Yorkshire provenant de la base de données du Centre de dentisterie vétérinaire Odontovet (Brésil) ont été analysées. À l'aide du logiciel ImageJ, 3 mesures consécutives de la largeur de 2 racines (mésiale et distale) et de leur canal pulpaire respectif ont été prises au niveau des dents molaires mandibulaires (gauche, 309 et droite, 409). Le PCRR a par la suite été calculé utilisant les moyennes des largeurs.

Résultats

Le PCRR diminuait avec une augmentation de l'âge autant pour la racine mésiale (0,21 ± 0,09 chez les animaux âgés de < 24 mo, 0,12 ± 0,04 chez les animaux âgés entre 25 et 96 mo, et 0,09 ± 0,03 chez les chiens de > 96 mo) que pour la racine distale (0,24 ± 0,11, 1,01 ± 0,03, 0,09 ± 0,03, dans le même ordre d'âge). Une différence statistiquement significative, corrélation modérément négative a été mise en évidence entre l'âge et le PCRR pour la racine mésiale [rs (97) = −0,545; $P < 0,001$] et la racine distale [rs (98) = −0,578; $P < 0,001$].

Conclusion et pertinence clinique

Cette étude contribue à la connaissance du PCRR chez les chiens et sa relation avec l'âge, ouvrant la voie à des études ultérieures avec un échantillonnage plus grand et différentes races de chien.

(Traduit par Dr Serge Messier)

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Introduction

Anatomically, the teeth of dogs *(Canis lupus familiaris)* are divided topographically into crown and root and comprise enamel, cementum, dentin, and dental pulp. Most of a mature tooth consists of dentin, which is continuously produced by odontoblasts located on the surface of the pulp tissue in contact with it. The dental pulp innervates and provides nutrition to dentin through dentinal tubules (1,2).

In the last decades, veterinary dentistry has evolved to become an integral part of the services offered by veterinarians in their daily practices. The combination of an adequate dental examination with intraoral radiographic images allows for the objective diagnosis and classification of dental and periodontal diseases. Dental radiographs can serve as a treatment guide, allowing for the maintenance and preservation of medical records. They are also valuable client education tools (3–5).

The analysis of dental radiographic images is not invasive and can be easily applied in forensic veterinary medicine (6–8), making it possible to estimate the ages of domestic animals. This method has been used in domestic cats (9) and in archaeological dog remains (10).

The aim of the present study was to investigate the relationship between the pulp canal/tooth root ratio (PCRR) of the first mandibular molar tooth and age in Yorkshire terrier dogs. As secondary objectives, this study also included the evaluation of the relationship between PCRR and sex, and the evaluation of possible differences in PCRR between the mesial and distal roots of the specified teeth and between both mandibular dental quadrants.

Materials and methods

Animals

The studied series comprised 53 Yorkshire terrier dogs admitted to the Odontovet Veterinary Dentistry Center (São Paulo, Brazil): 23 (43.4%) males and 30 (56.6%) females aged between 8 and 192 mo (average: 107.46 mo). The youngest individual was 8 mo (0.67 y) old and the oldest was 192 mo (16 y) old. The animals included in this study each had a previous clinical diagnosis of oral or dental disease with indication of a comprehensive oral health assessment and treatment that included a dental intraoral radiographic exam under general anesthesia. Dogs with any oral or systemic disease that could compromise dental health were excluded from the study.

Studied images

Intraoral dental radiographs of both mandibular first molar teeth were obtained by using a size 2 direct digital sensor (Acteon Micro Image, São Paulo, Brazil) and the parallel technique. This technique was carried out by placing the digital sensor on the lingual side of the mandible and the X-ray beam centered on the gingival margin and angled perpendicularly to the plane of the intraoral film and the tooth, thus minimizing the distortion of the obtained image.

The teeth were selected for morphometric analysis if they were entirely visible on the dental radiographs and the obtained images had no shape distortion artifacts such as foreshortening or elongation associated with incorrect technique. First mandibular molar teeth showing discoloration, fractures, or dental wear and radiographic signs of periodontal disease Stages 3 to 4 (moderate to advanced periodontitis), endodontic pathology, or periapical pathology were excluded from the study.

Morphometric analysis

The pulp canal and root widths of both mesial and distal roots of mandibular molar teeth [teeth number 309 at left and 409 at right, according to the modified Triadan system (Floyd, 1991) (11)] were measured. Radiographic images had a resolution of 840 × 606 pixels (509 040 pixels), a depth of 8 bits (grayscale level of 256), and 64 pixels/inch. Images in .jpeg format were analyzed using ImageJ software (National Institutes of Health, Bethesda, Maryland, USA). As illustrated in Figure 1, a line was created from the beginning of the pulp canal, considering the anatomical landmark of the cementoenamel junction, to the end of the dental root. At the midpoint of this line, 2 perpendicular lines were drawn that corresponded to the width of

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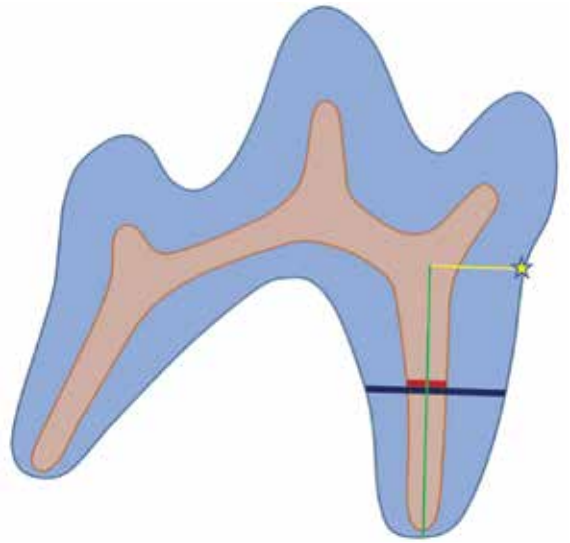


Figure 1. Schematic representation of the technique for measuring the widths of the pulp canal (red line) and the mesial root (blue line) of the first mandibular molar tooth. The yellow line defines the beginning of the root canal, taking into account the anatomical landmark of the cementoenamel junction.

the dental root and the width of the pulp canal. Both measurements were made in triplicate by the same observer, who was blind to the animal's age. The PCRR was calculated using the mean of the 3 measurements. Since the units of measurement used correspond to pixels, PCRR is considered adimensional.

Statistical methods

Statistical analysis was carried out using SPSS Statistics 24.0 software (International Business Machines, Armonk, New York, USA). Bivariate correlation was used to determine Spearman's correlation coefficients. Comparison between 2 continuous or interval variables was conducted using the Mann-Whitney U test, with the Bonferroni correction applied for multiple comparisons. For the comparison of 3 or more variables, the Kruskal-Wallis H test was used, followed by the Dunn's *post hoc* test, with the Bonferroni correction applied for multiple comparisons. The Wilcoxon test was also used to compare the mean values of the paired samples. When this test could not be applied (due to the distribution of the difference variable not being symmetrical), the sign test was used. A value of $P < 0.05$ was considered statistically significant.

Results

A total of 103 radiographic images were selected for the morphometric study. From these images, it was possible to analyze both the mesial and the distal roots of a total of 51 left first mandibular teeth and 52 contralateral right teeth (Figure 2).

Comparisons between measurements of pulp canal and dental roots

Exact sign tests were conducted to compare pulp canal and root widths of the right- and left-side tooth from complete sets of teeth.

Mesial root. A total of 48 sets of teeth were used to compare widths on the mesial root. The pulp canal width was larger on the right side in 12 sets of teeth, smaller in 35 sets, and equal in 1 set. There was a statistically significant median difference between the right (8.11) and left (8.98) sides ($z = -3.209$; $P = 0.001$). The root width was larger on the right side in 29 sets of teeth and smaller in 19. However, no significant median differences were identified between the right (median: 77.98) and left (median: 79.86) sides ($z = 1.299$; $P = 0.194$).

Distal root. Comparisons of distal root widths were made on 49 sets of teeth. The pulp canal width was larger on the right side in 18 sets of teeth and smaller in 31. No significant median differences were identified between the right (7.71) and left (10.33) sides ($z = -1.714$; $P = 0.086$). Median differences between the right (84.73) and left (82.32) sides of the root width were also not significant ($z = -0.857$; $P = 0.30$).

Pulp canal/tooth root ratios of mesial and distal roots

For the calculation of PCRR, each tooth was studied as an independent unit. A Wilcoxon signed rank test was used to compare PCRR on the right and left side of mesial roots for 48 sets of teeth. The median PCRR on the right side (0.1012) of 14 sets of teeth was significantly lower than that on the left side (0.1145) ($z = -3.6$; $P < 0.001$). No significant median differences were identified between PCRR on the right (0.0907) and left (0.1180) sides ($z = -1.714$; $P = 0.086$) of the distal roots in 49 sets of teeth.

Comparison of pulp canal/tooth root ratios between age groups

To analyze the relationship between PCRR and age, the sample was divided into 3 age groups: i) group 1: animals aged up to 24 mo ($n = 7$), ii) group 2: animals aged between 25 and 96 mo ($n = 21$), and iii) group 3: animals aged over 96 mo ($n = 24$).

To assess whether there were statistically significant differences between the PCRR and the different defined age groups, the Kruskal-Wallis H test and the Dunn's *post hoc* test with Bonferroni correction were used.

Median mesial root ratios were statistically significantly different between the different age groups [X^2 (2) = 32.696; $P < 0.001$]. Subsequently, pairwise comparisons were conducted using Dunn's procedure with a Bonferroni correction for multiple comparisons. Adjusted *P*-values are presented. This *post hoc* analysis revealed statistically significant differences in median mesial root ratios between groups 3 (mean rank: 35.71) and 1 (mean rank: 86.23) ($P < 0.001$), groups 2 (mean rank: 54.20) and 1 ($P = 0.001$), and groups 2 and 3 ($P = 0.009$).

Statistically significant differences were also identified between distal root ratios [X^2 (2) = 40.076; $P < 0.001$]. *Post hoc* analysis using Dunn's procedure with Bonferroni correction revealed the existence of statistically significant differences between groups 3 (mean rank: 35.17) and 1 (mean rank: 90.50) ($P < 0.001$), groups 2 (mean rank: 54.13) and 1 ($P < 0.001$), and groups 2 and 3 ($P = 0.008$).

Regarding the correlation between age and PCRR, there was a statistically significant, negative moderate association both

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Figure 2. Representative intraoral radiographs of the mandibular molar teeth of dogs from different age groups: A – Group 1, aged up to 24 mo; B – Group 2, aged between 25 and 96 mo; C – Group 3, aged over 96 mo.

between age and the mesial root's PCRR [rs (97) = −0.545; $P < 0.001$] and between age and the distal root's PCRR [rs (98) = −0.578; $P < 0.001$].

Comparison of pulp canal/tooth root ratios between males and females

Statistical differences in PCRR of the distal mesial roots between males and females were assessed using the Mann-Whitney U test. Distributions of the engagement scores for males and females were not similar, as assessed by visual inspection.

The mesial root PCRR in group 1 was statistically significantly lower in males (mean rank: 3.50) than in females (mean rank: 8.56) (U = 32; z = 2.160; P = 0.034). No significant differences were identified in group 2 (U = 184; z = −0.604; P = 0.546) or group 3 (U = 228.0; z = −0.095; P = 0.924). The distal root PCRR was also determined to be significantly lower in males (mean rank: 2.50) than in females (mean rank: 9.50) (U = 40; z = 2.828; P = 0.005) from group 1. No significant differences were identified in group 2 (U = 220; z = 0.598; P = 0.563) or group 3 (U = 244.0; z = 0.092; P = 0.926).

Discussion

The present study verified that the PCRR represents an effective method for estimating age. To the best of the authors' knowledge, this is the first such work carried out on a specific breed, the Yorkshire terrier.

The maturation of permanent teeth can be used as a tool to estimate age as evidenced by the increasing thickness of the dentin wall and decreasing width of the pulp chamber and the root canal with increasing age (2). However, this phenomenon can be affected by the presence of dental diseases. According to Gioso and collaborators (2001), in small-breed dogs, the mandibular first molar tooth is proportionally larger in relation to the height of the jaw when compared to dogs of larger size (12). This factor contributes to dental crowding, which facilitates plaque accumulation, increasing the susceptibility of small dogs to periodontitis (12). At this stage, the dental apex may lose the attachment and the blood supply to the compromised pulp tissues, leading to endodontic disease (13).

From the results obtained, it was possible to verify the presence of an inverse relationship between age and PCRR, meaning that increasing age is accompanied by a decrease in PCRR. These results are in line with those of other published studies, both in animals (cats, African wild dogs, coyotes) and in humans (9,14,15,16,17). Park and collaborators (2014) reported a ratio of 0.56 in cats < 6 mo old, 0.27 in animals 12 mo old, 0.18 in animals 32 mo old, and 0.15 in animals 60 mo old (9).

Studies carried out in humans using different imaging technologies, namely computed tomography and magnetic resonance, show results similar to those of the present work. According to Ge *et al* (2015, 2016), Rai *et al* (2016), and Nemsi *et al* (2017), the use of PCRR calculated using computed tomography images is a tool of satisfactory precision in the assessment of age, and it can be used in different dental regions (18,19,20,21). According to Tobel and collaborators (2017), the PCRR calculated with magnetic resonance imaging can be used to estimate age (22). In the canine first mandibular molar teeth, Marron and colleagues (2017) reported a lack of agreement between measurements of root and root canal width by digital intraoral radiography and microcomputed tomography. These authors concluded that it is challenging to develop a standardized protocol for measuring this anatomical region. In this sense, although our data contributes to the knowledge of this method of age estimation, it must be analyzed carefully considering the limitations of intraoral radiography (23).

Regarding the differences between the PCRR of the mesial and distal roots of the group younger than 24 mo (group 1), these were significantly lower in males. Kershaw *et al* (2005) reported a physiological difference between wild dogs of different sexes, with males in their study showing greater variability in the decreasing pulp canal width with age when compared to females. These authors related their findings to possible differences in testosterone levels between animals of different sexes and the action of this hormone on calcium metabolism (14). White and colleagues (2016) also determined that female lions had a slightly lower PCRR than males of the same age (24).

According to Lorber and colleagues (1979), regarding sexual dimorphism, male dogs have canine teeth that are not only larger but also have wider roots. They continue to claim that tooth growth can be modified by circulating steroids, which result in dimorphism (25). The existence of sexual dimorphism is also described in humans, with male individuals having wider teeth than females (26). The differences identified in the present study, regarding the PCRR of the mesial and distal roots between males and females in the group younger than 24 mo, may be related to these data, requiring further studies that analyze potential differences between the teeth of individuals of both sexes. In the present work, the pulp of the mesial root of the teeth on the right side had a median dimension significantly

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lower than that on the left. Teeth on the right side also presented a median PCRR of the mesial root significantly lower than that of those on the left.

Periapical radiographs are a convenient, simple, and inexpensive method that can be used in veterinary dentistry. In the present study, radiographic images of mandibular first molars were chosen because architecture and anatomical proportions remain intact in their radiographic images. Studies can be found in the literature that corroborate these as teeth that can be used with satisfactory results in the estimation of age. According to Shah and Venkatesh (2016), mandibular molar teeth are reliable for estimating age; and according to Ge and collaborators (2015), the volume of the pulp chamber of the first molar is a useful index for estimating the age with reasonable accuracy in humans (18,27).

Different teeth can be used to estimate age. Cameriere and colleagues (2012, 2013) reported that premolar teeth are useful for estimating age in humans and are more reliable than incisor teeth (28,29), adding that canine teeth are also a precise tool for estimating age in humans (30). In the future, further studies will be needed to define which dental pieces are most suitable for this purpose in companion animals.

The identification of the ages of living and dead individuals is an important aspect of forensic sciences. Most of the techniques described in the literature for age estimation are based on the tooth, since it is the most resistant structure of the human body; undergoes physiological changes related to age; and is less vulnerable to postmortem changes such as humidity, high temperatures, microbial agents, and mechanical forces. In forensic veterinary medicine, the estimation of age in domestic animals is important in the identification of animals both *in vivo* and postmortem (14,31,32).

The results of the present study suggest that, in Yorkshire terrier dogs, the PCRR of the mesial and distal roots decreases with age, with a statistically significant, negative, and moderate association between age and PCRR of both roots. Because breed differences can influence oral anatomy, it will be essential to carry out new studies to validate the applicability of this method for estimating age in breeds of different sizes and using different teeth.

The main limitations of this study were the unavailability of software for visualization and analysis that could be used by the veterinarian conducting intraoral radiography, and the fact that the 2-dimensionality and the quality of the digital intraoral radiographic images could affect the accuracy of the morphometric analyses.

Considering this proof-of-concept work, conducting new studies will be crucial to optimize the methodology and techniques used to estimate age, through the analysis of dental radiographic or tomographic images, in dogs of different breeds for which the history or identity is unknown.

Acknowledgments

This work was supported by the projects UIDB/CVT/00772/2020 and LA/P/0059/2020 and the Scientific Employment Stimulus — Institutional Call — CEECINS/00127/2018 (J.F. Requicha) funded by the Portuguese Foundation for Science and Technology (FCT). CVJ

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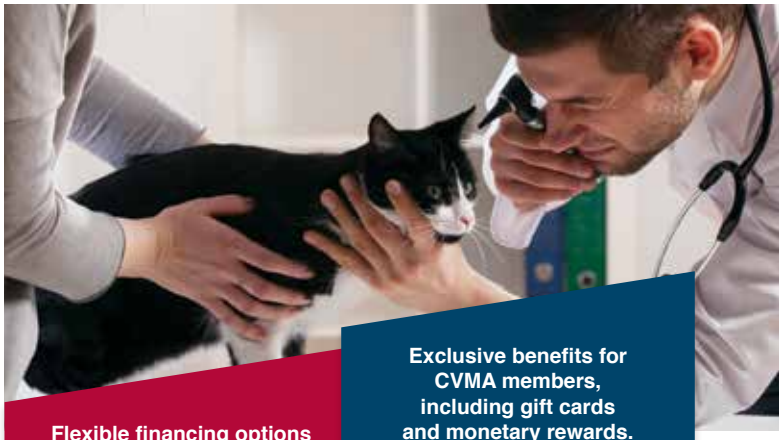
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Review Article Compte rendu

Basic triage in dogs and cats: Part I

Elizabeth Thomovsky, Laura Ilie

Abstract

Background

Emergency cases can present at any time of the day or night. All small animal practitioners need to have the skills to triage and stabilize common emergency cases even if they ultimately aim to refer the patient to another facility.

Objectives and procedures

The first part of this 3-part review article series covers respiratory distress and seizures. A stepwise approach to categorize and stabilize these cases is outlined, along with helpful tips to optimize the referral experience, if indicated.

Results

Having a strong methodical approach to animals in respiratory distress optimizes treatment. Similarly, achieving cessation of seizures, along with having a good understanding of the causes of seizures, allows for patient stabilization.

Conclusion and clinical relevance

Do NOT refer emergent cases before completing basic stabilization. Many emergency cases do not require emergent referral and can be worked up by the primary veterinarian or sent to a referral clinic on an appointment basis after appropriate stabilization steps are completed.

Résumé

Triage de base chez les chiens et les chats : Partie I

Contexte

Les cas urgents peuvent se présenter à tout moment du jour ou de la nuit. Tous les médecins vétérinaires en pratique des petits animaux doivent avoir les compétences pour effectuer un triage et stabiliser les cas urgents fréquents même s'ils prévoient ultimement référer le patient à un autre établissement.

Objectifs et procédures

La première partie de cet article de revue en 3 parties traite de la détresse respiratoire et des convulsions. Une approche progressive pour catégoriser et stabiliser ces cas est présentée, avec des conseils utiles pour optimiser l'expérience de référencement, si nécessaire.

Résultats

Avoir une approche méthodique solide lors de cas de détresse respiratoire chez les animaux permet d'optimiser le traitement. De manière similaire, être capable de maîtriser les convulsions tout en ayant une bonne compréhension de leurs causes, permettent une meilleure stabilisation du patient.

Conclusion et pertinence clinique

Ne PAS procéder au référencement de cas urgents avant d'avoir terminé une stabilisation de base. Plusieurs cas urgents ne nécessitent pas d'être référé en urgence et peuvent être pris en charge par le médecin vétérinaire primaire ou transféré à une clinique de référence après la prise d'un rendez-vous une fois qu'une stabilisation adéquate ait été complétée.

(Traduit par Dr Serge Messier)

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Introduction

Most veterinarians and veterinary staff carry out triage unconsciously. Triage is a system by which patients are sorted or separated based on their needs for medical care in situations when all patients cannot be examined immediately (due to factors such as limited resources and/or staff, or large numbers of patients).

Although victims have been sorted based on injury severity for > 2 centuries (1), "triage" was first used in medicine during World War I, when the approach was as follows:

> *"…a single case, even if it urgently required attention, should wait if it would absorb a good deal of time. In the same time frame a dozen others might be treated. The greatest good for the greatest number of people was the rule"* (1).

Patients with the best chances of survival were treated or operated on first, whereas those with lower chances of survival were not treated, to preserve time and resources (2).

The civilian medical world adopted the idea of triage and has applied it in busy emergency rooms. Civilian triage is geared towards treating the sickest first, whereas more stable patients will receive medical care when possible.

Veterinary medicine has adopted the human civilian concept of identifying and prioritizing treatment of critically ill patients. This is not true "triage," as we do not select and treat patients with higher chance of survival and ignore those with limited or no chance of survival. Veterinarians conducting triage prioritize animals that need immediate care *versus* those that are more stable and with conditions that will not be jeopardized by delayed treatment.

Triage assessments involve a rapid, but thorough, physical examination coupled with a classification system to categorize patients (3). A standardized veterinary triage list (3) was adapted and modified into a flow chart (Figure 1). In that chart, the color red denotes the need for immediate medical care, followed, in order of decreasing immediate need, by orange, yellow, and green (most stable) groups. Each group classification includes respiratory, cardiovascular, neurologic, gastrointestinal, obstetric, urogenital, trauma, and general illnesses.

First-line veterinarians in general and emergency practice often conduct basic triage and stabilize animals from red or orange groups before referral. This article is the first in a series of 3 reviews that outline the most frequently encountered emergency situations leading to referral in dogs and cats and provide guidelines on stabilizing patients for safe transit. A simplified triage flowchart (Figure 2) describes how to work from the most to the least life-threatening conditions among those most commonly encountered and referred.

Section 1: Acute respiratory distress

Respiratory distress should *not* be immediately referred without being stabilized. Dogs and cats in overt respiratory distress may die suddenly in your clinic or during transportation to a referral center. Figure 3 provides an overview of stabilization of canine and feline respiratory emergencies.

Step #1: Oxygen

When you have identified respiratory disease in a dog or cat based upon your triage examination, the first priority is to provide oxygen therapy with minimal stress. In most cases, initial oxygen administration *via* flow-by oxygen therapy is the fastest option (Figure 4) and facilitates concurrent examination. Placing a small dog or cat into an oxygen cage or chamber is an effective, low-stress option, but limits the ability to examine the animal. Most general practices do not have a dedicated oxygen cage (Figure 5 A), but many have a plastic door to place on a cage to contain oxygen (Figure 5 B) or may have smaller, exotic-animal incubators suitable for a small dog or cat.

Oxygen can be provided without a true oxygen cage. Alternatives include placing a cat-sized or small dog-sized carrier into a plastic bag filled with oxygen (Figure 5 C), using an Elizabethan collar covered with plastic wrap to contain oxygen, covering an existing cage door to create an oxygen chamber, or using a plastic box as an oxygen chamber (Figure 5 D). Intranasal cannulas can also be used in dogs (particularly for longer-term hospitalization) but are usually too large for cats.

Oxygen chambers are the easiest and least stressful option to provide oxygen to small dogs or cats. However, if a dog or cat is too large relative to the cage or if a dog is panting, it may quickly become hot or humid in the cage. Check the temperature regularly with a thermometer or your hand. Opening the oxygen cage door quickly decreases oxygen concentrations; therefore, an oxygen cage is not appropriate if you need frequent access to the animal.

Step #2: Categorize the type of respiratory distress

Once you have provided oxygen, categorize the respiratory distress as UPPER airway or LOWER airway.

Upper airway disease

Upper airway disorders are usually accompanied by loud breathing (stertor or stridor), inspiratory dyspnea, visible anxiety, and sometimes, cyanosis (4,5).

Background

Dogs. Upper airway disorders are more common in dogs than in cats. The most common disorders in dogs are brachycephalic airway syndrome, laryngeal paralysis, and collapsing trachea. Brachycephalic airway syndrome occurs in breeds such as pugs and bulldogs, laryngeal paralysis occurs in Labrador retrievers and other large-breed dogs such as Newfoundlands and golden retrievers, and collapsing trachea occurs in small-breed dogs such as Yorkshire terriers.

Cats. Upper airway disorders are relatively rare in cats but are commonly due to oropharyngeal masses. Masses occur secondary to infectious diseases such as viral infections, are neoplastic, or, in kittens or younger cats, may be nasopharyngeal polyps (6–8). In 1 study, 20% of cats with upper respiratory tract infections had dyspnea; > 1/2 also had sneezing and ocular or nasal discharge (7). Although uncommon, cats can present with laryngeal paralysis (8) due to trauma (iatrogenic after surgery or anesthetic interventions) or secondary to neoplasia (either paraneoplastic

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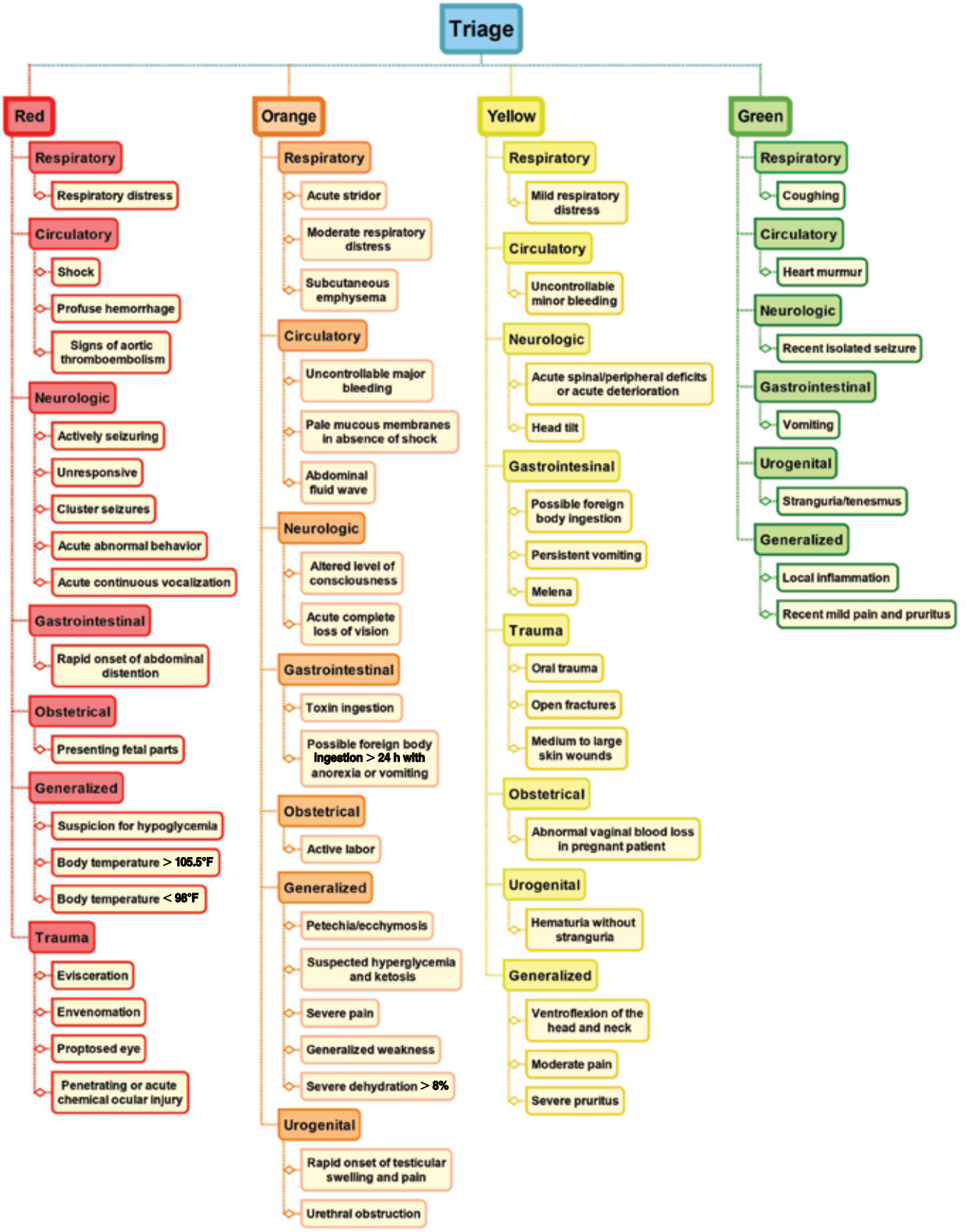


Figure 1. Veterinary triage list.
Adapted from Ruys *et al* (3).

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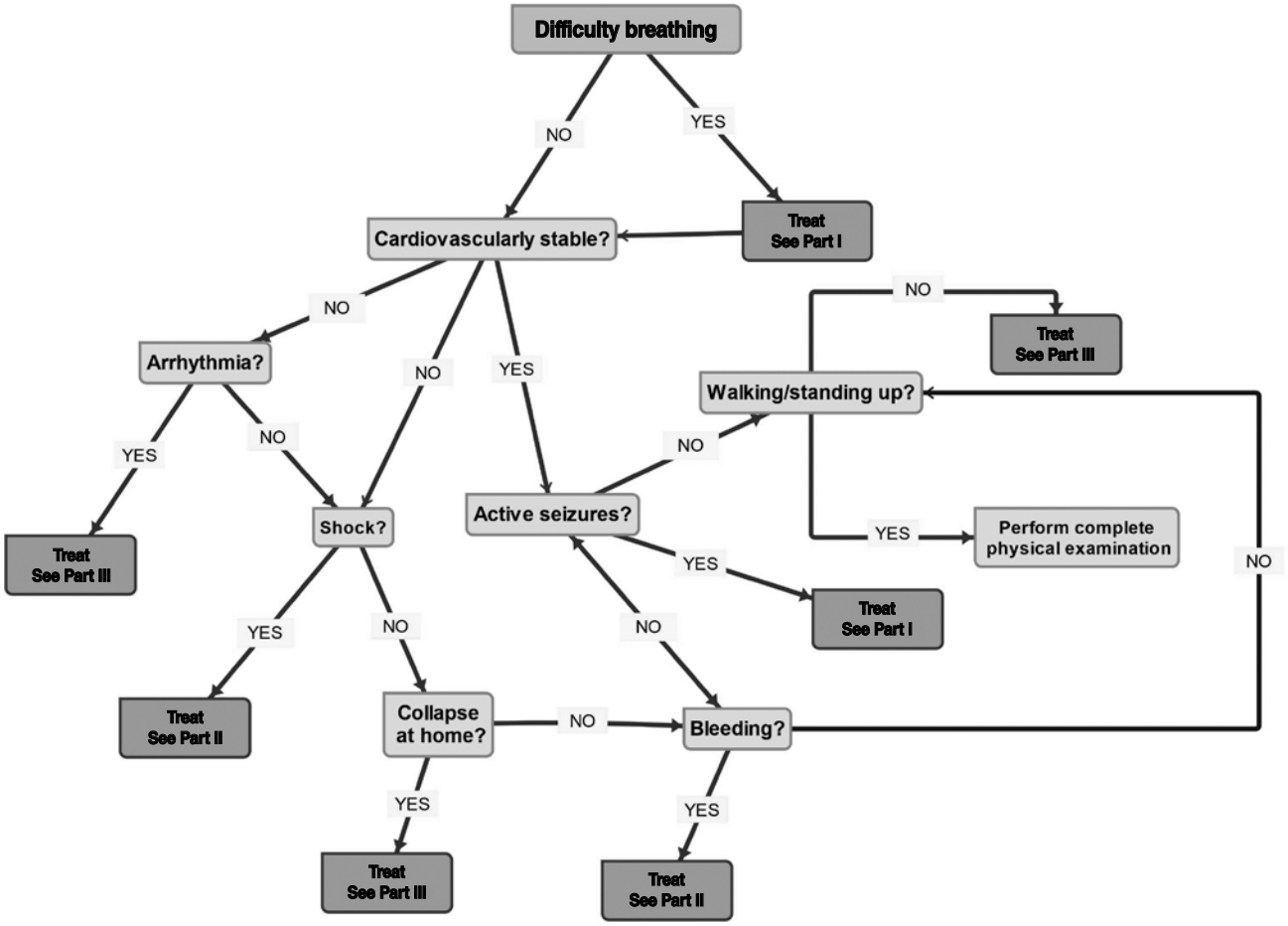


Figure 2. Simplified triage flow chart.

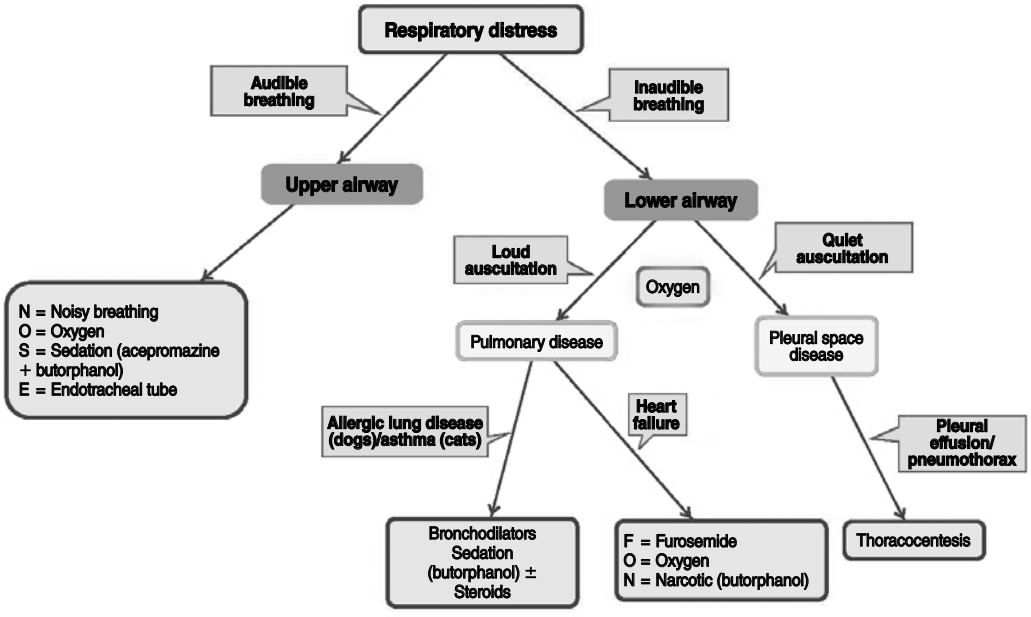


Figure 3. Stabilization of respiratory distress in dogs and cats.

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Figure 4. Flow-by oxygen therapy in a dog.

effects or primary neoplasia in the laryngeal or oropharyngeal region) (8,9).

Emergency stabilization

Acute treatment of upper airway disease can be achieved by following the mnemonic **NOSE**: **N**oisy breathing means **O**xygen, **S**edation, and **E**ndotracheal tube placement (intubation), if needed.

Oxygen. Administer oxygen with minimal stress, as described in Step #1.

Sedation. Sedation can be achieved with butorphanol (0.2 to 0.5 mg/kg IV or IM) and/or acepromazine (0.01 to 0.2 mg/kg IV or IM). Butorphanol has a rapid onset of activity but acepromazine can take 20 to 30 min to reach full effect; refrain from re-dosing acepromazine prematurely. For acepromazine, $>$ 0.5 mg/kg will not increase sedation. Dexmedetomidine is also used for sedation (2 to 10 μg/kg in dogs or 5 to 20 μg/kg in cats, IV or IM). It is given as a constant-rate infusion (CRI) (1 to 3 μg/kg per hour) after a bolus for sustained sedation. Dexmedetomidine may cause emesis in cats, especially if given IM.

Endotracheal tube placement. If there is no improvement or worsening after oxygen and sedation, the animal may need to be intubated. Do not wait to intubate in severe cases. Propofol (IV to effect) is easiest, or else alfaxalone (1 to 3 mg/kg, IM or IV to effect). Alternatively, ketamine-diazepam, IM or IV to effect (dogs: 5 mg/kg ketamine with 0.1 to 0.4 mg/kg diazepam; cats: 10 mg/kg ketamine with 0.5 mg/kg diazepam) will facilitate endotracheal tube placement.

Keep the animal relaxed and comfortable with repeated doses of propofol (or other injectable anesthetics) as needed for *at least* 30 to 60 min. Avoid inhalant anesthetics due to risk for hypotension or respiratory depression. Many cases of upper airway disease can be extubated and will have improvement or resolution of clinical signs. However, some will have respiratory distress after endotracheal tube removal (despite sedation) requiring re-intubation pending definitive diagnostics and treatment. If an "awake" animal tolerates the tube, leave it in place.

Administer flow-by oxygen into the distal end of the endotracheal tube or 100% oxygen from an anesthesia circuit. Do not occlude the tube completely with flow-by oxygen, as animals must exhale. Oxygen therapy is often not required unless there is concurrent lower airway disease; establishing an airway with an endotracheal tube often relieves the distress.

Practice tips

1. If there is an upper airway obstruction, check for hyperthermia, as these obstructions interfere with cooling. Dogs or cats will pant or have open-mouthed breathing when overheated (mimicking respiratory distress). Obesity, stress, and being in an oxygen cage can cause hyperthermia.
2. Some animals will have concurrent oropharyngeal inflammation secondary to their disease process or how hard they are breathing. An anti-inflammatory dose of steroids (dexamethasone sodium phosphate 0.07 to 0.14 mg/kg) can be given IM or IV.

Lower airway disease

Lower airway disease in dogs commonly increases respiratory rate, with an occasional cough, whereas cats often lack an obvious cough (5). Dogs and cats can have open- or closed-mouth breathing ± markedly increased respiratory effort. Unlike upper respiratory cases, where thoracic auscultation is difficult due to referred upper airway noise, auscultation of the thorax is important in lower respiratory disease to divide cases into "loud" *versus* "quiet" auscultation.

"Loud" auscultation

Dogs or cats with "loud" thoracic auscultation (*i.e.,* crackles and wheezes) have pulmonary parenchyma involvement. In dogs, the most common diseases are i) *non-cardiogenic pulmonary edema,* ii) *cardiogenic pulmonary edema,* or iii) *pneumonia* of bacterial or viral origin. In cats, the 3 most common diseases are i) *non-cardiogenic pulmonary edema,* ii) *cardiogenic pulmonary edema,* or iii) *feline asthma.* Cats rarely have *pneumonia.*

Background

Pulmonary edema usually occurs when fluid fills the interstitial space between the alveolus and capillary, limiting oxygen diffusion. With non-cardiogenic pulmonary edema, fluid buildup occurs secondary to increased permeability of capillary walls, leading to fluid extravasation into the pulmonary interstitium. Cardiogenic pulmonary edema occurs when increased fluid volume in capillaries increases hydrostatic pressure, with fluid moving into interstitial tissue or the alveolus.

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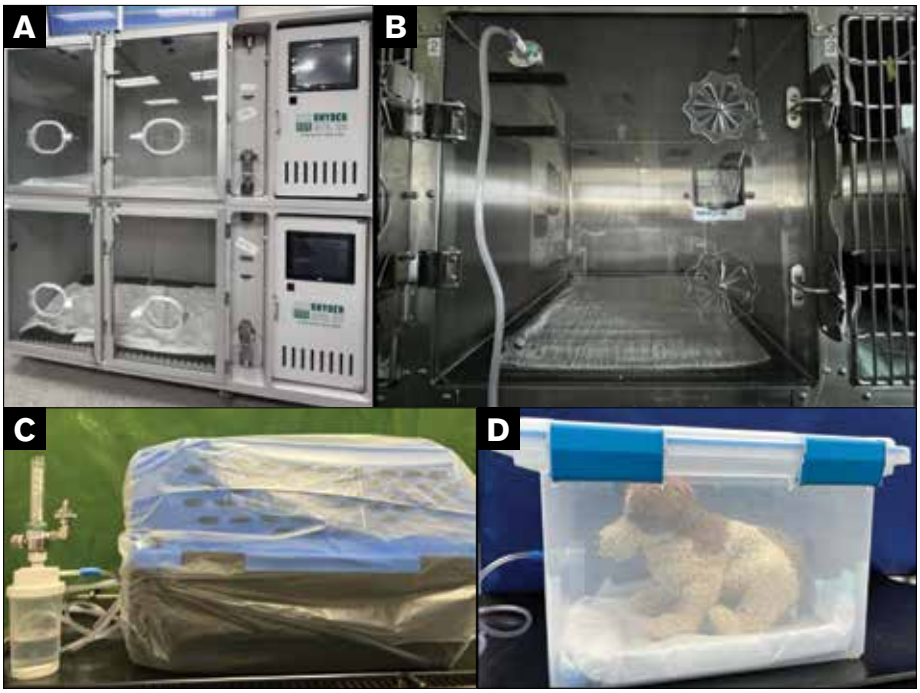


Figure 5. A – Commercial oxygen cage. Note the screen on the right, which allows for control of temperature, humidity, and oxygen concentration. B – Cage door converting a standard cage to an oxygen chamber. The monitor on the right-hand side of the cage reports temperature and humidity. C – Pet carrier enclosed in a plastic bag with oxygen tubing, creating a makeshift temporary oxygen chamber. A hole should be placed on the back side of the plastic bag to vent carbon dioxide and heat. D – Alternative oxygen cage created from a plastic container with holes inserted to allow oxygen into the container. It is important to also create exhaust holes (> 1) to vent carbon dioxide and heat.

Dogs. *Non-cardiogenic pulmonary edema* in dogs has been reported after toxin inhalation (*e.g.,* smoke or ozone), prolonged seizure activity, electrocution, blood transfusion, drowning, and systemic inflammatory diseases (pancreatitis, neoplasia, anaphylaxis) (10,11). However, the most common cause of non-cardiogenic pulmonary edema [38% (7) to 45% (12)] is secondary to upper airway obstruction (*e.g.,* tracheal collapse, brachycephalic airway syndrome, or choking). It is more common in younger dogs but can occur at any age (10,11).

Cardiogenic pulmonary edema tends to occur in middle-aged or older dogs, but heritable heart disease can cause earlier onset of congestive heart failure. The most common type of heart disease in dogs is myxomatous mitral valve disease (13,14), although dogs go into heart failure secondary to dilated cardiomyopathy. Breeds commonly affected with myxomatous valve disease include the Cavalier King Charles spaniel, dachshund, Chihuahua, and shih tzu (13). Large- and giant-breed dogs (including Doberman pinschers) commonly have dilated cardiomyopathy. Dogs with mitral valve disease consistently have a heart murmur at the time of diagnosis of heart failure but rarely have an arrhythmia (14); dogs with dilated cardiomyopathy infrequently have a heart murmur but often have an arrhythmia [atrial fibrillation; see Section 1 in Part III of this review (15) and (16,17)].

Pneumonia can occur in dogs of any age and may cause a fever and/or an elevated white blood cell count on a CBC (18,19). Pneumonia in dogs can be community or hospital-acquired bacterial or viral pneumonia (*e.g.,* canine infectious respiratory disease complex), fungal pneumonia, or aspiration pneumonia. Brachycephalic dogs are predisposed to aspiration (18), but aspiration can occur in dogs of any age or breed, especially with a comorbidity causing vomiting or regurgitation or a history of sedation or anesthesia. Obtain a complete history, including regarding recent travel, mingling with other dogs in a boarding-type situation, or recent vomiting or regurgitation. A complete physical examination to identify signs such as draining skin lesions indicative of fungal disease can provide valuable clues.

Cats. *Non-cardiogenic pulmonary edema* in cats has been reported after toxin inhalation (*e.g.,* smoke or ozone), prolonged seizure activity, electrocution, blood transfusion, drowning, and systemic inflammatory diseases (pancreatitis, neoplasia, anaphylaxis) (10,11,20). It is more common in younger cats but can occur at any age (10,11).

Cardiogenic pulmonary edema tends to occur in middle-aged or older cats [*i.e.,* aged 5 to 11 y (21)], although certain breeds, such as the Maine coon, are believed to have heritable heart disease and can go into heart failure at 1 to 5 y of age (21). The most common heart disease in cats is hypertrophic cardiomyopathy (HCM), although cats rarely have congenital cardiac malformations or valvular disease. In 1 large study of cats and heart disease, up to 82.4% of those with HCM had an auscultable murmur (21), although anecdotally, it is not uncommon

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that cats presenting acutely in heart failure may not have had a murmur previously auscultated. Some cats with HCM will have an arrhythmia (12.7%) or gallop rhythm (11.2%) (21).

Feline asthma can occur at any age but classically occurs in young, indoor-outdoor cats. Clinical signs are acute in onset, with or without previous shorter bouts of similar signs. Asthmatic cats will often have a history of open-mouthed breathing and/or coughing (often attributed to retching or "gagging up hairballs"). Feline asthma is an inflammatory condition leading to airflow obstruction secondary to bronchoconstriction and increased bronchial mucous production resulting from antigen-induced IgE-mast cell interactions (22).

Pneumonia can occur in cats of any age, but infectious pneumonia is most common in younger cats (especially those from shelter backgrounds) infected with calicivirus and/or feline herpesvirus. When viral pneumonia is suspected, cats often have a history of upper respiratory congestion and nasal discharge (7). Cats with feline asthma can also have secondary bacterial pneumonia.

Emergency stabilization ("loud" auscultation)

Pulmonary parenchymal diseases commonly causing loud auscultation are differentiated based on radiographic pattern and location. Patients with severe dyspnea should NOT undergo radiography until after stabilization. Point-of-care ultrasound may differentiate congestive heart failure from other lung diseases causing dyspnea (23) and determine if a dog with a heart murmur has congestive heart failure (24), but may be too stressful before stabilization.

To alleviate respiratory distress in dogs and cats before obtaining radiographs or ultrasound imaging, consider giving the following "cocktail:" oxygen, 1 dose of furosemide, and 1 dose of butorphanol (Table 1). If feline asthma is strongly suspected, inhaled corticosteroids and/or inhaled bronchodilators can be used in lieu of or in addition to injectable steroids and bronchodilators (25,26) (Table 1).

Table 1. Emergency treatment options for lower respiratory disease in a dog or cat characterized by "loud" lung sounds.

Presumed cause	Emergency treatment	Comments
Non-cardiogenic pulmonary edema	**Oxygen therapy**	Oxygen cage, flow-by oxygen, or other oxygen chamber.
		These cases require ≥ 24 h to improve and they may initially worsen. In severe cases, mechanical ventilation can be used. No treatment aside from oxygen is proven to work.
		Butorphanol (0.2 mg/kg) to reduce anxiety.
		Consider bronchodilators (terbutaline, 0.01 mg/kg, SC).
		Furosemide's diuretic effects are not helpful.
Cardiogenic pulmonary edema	**F** Furosemide	2 mg/kg, IM or IV, every 20 to 30 min, to a maximum of 6 to 8 mg/kg.
		Furosemide increases fluid removal in renal tubules and has bronchodilatory effects.
	O Oxygen	Oxygen cage, flow-by oxygen, or other oxygen chamber.
	N Narcotics	Butorphanol (0.2 mg/kg IV or IM).
Feline asthma	**Oxygen**	Oxygen cage, flow-by oxygen, or other oxygen chamber.
	Bronchodilators	Terbutaline (0.01 mg/kg) SC or IM, or inhaled bronchodilator from a metered dose inhaler (*e.g.,* albuterol) (25,26).
		Bronchodilators quickly resolve clinical signs.
	Steroids	Dexamethasone sodium phosphate (0.07 to 0.14 mg/kg IV, IM, or SC) or inhaled steroid from a metered dose inhaler (25,26).
		Injectable steroids can worsen cardiac disease and take > 60 min to take effect; avoid if heart disease suspected.
Pneumonia	**Oxygen**	Bacterial, viral, and fungal pneumonia are treated with antibiotics, supportive therapy, and anti-fungals, respectively.
		Treatments do not provide acute stabilization.

Practice tips

1. One dose of any medication listed in Table 1 will not have detrimental effects and may help to stabilize a dog or cat, even without a diagnosis.
2. Based on clinical observations, IM furosemide in dogs and cats works approximately as quickly as IV furosemide and can be much less stressful in dyspneic animals.
3. Butorphanol, the bronchodilatory effects of furosemide, and other bronchodilators anecdotally have rapid effects (usually within 10 to 15 min). Reduction of capillary fluid volume (cardiogenic pulmonary edema) with furosemide and maximal effects of steroids take longer (≥ 30 to 60 min or more, in the authors' experience).

"Quiet" auscultation

When dogs or cats with lower airway disease have "quiet" auscultation, the most common differential diagnoses are *pneumothorax* or *pleural effusion*. These animals often have a paradoxical respiratory pattern (exaggerated abdominal effort alternating with exaggerated chest excursions). Perform thoracocentesis to relieve signs and determine fluid *versus* air. Obtain radiographs in minimally affected animals; however, if the animal is dyspneic, perform thoracocentesis BEFORE radiography! Point-of-care ultrasound can confirm fluid or air with less stress than radiographs but should not replace immediate thoracocentesis in severely affected animals (27,28). Negative taps have minimal adverse effects.

Background

Dogs. *Pneumothorax* in dogs can be spontaneous or secondary to trauma. Spontaneous pneumothorax is rare in dogs; it occurs

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with bullae or bleb formation in the lungs, pulmonary neoplasia or other chronic lung disease, and migrating pulmonary foreign bodies (29). Certain breeds, *e.g.,* Siberian huskies, are prone to spontaneous pneumothorax, but it can occur in any breed (29). Traumatic pneumothorax is more common in dogs, often after motor vehicle accidents or bites (30,31).

Pleural effusion can occur in dogs of any breed or age and may be caused by toxins (*e.g.,* anticoagulant rodenticide-hemothorax), transudate from heart failure, chylothorax, trauma, neoplasia, or pyothorax. A heart murmur or fever in addition to history can suggest a cause, but fluid analysis is definitive.

Cats. *Pneumothorax* in cats is either traumatic or spontaneous; the latter is rare but results from primary lung diseases such as blebs or bullae that spontaneously rupture. Spontaneous pneumothorax also occurs secondary to chronic lung diseases such as inflammatory airway disease (*i.e.,* asthma), neoplasia, lungworm infection, heartworm infection, or pneumonia ± pulmonary abscess formation (32,33). Trauma in cats can occur with blunt force injury to the chest wall, bite wounds or other penetrating injuries of the chest wall, or after iatrogenic damage to the trachea or airways during anesthesia.

Pleural effusion in cats has various causes, most commonly congestive heart failure (40.8%) and neoplasia (25.8%), with 24% of cases due to pyothorax, chylothorax and feline infectious peritonitis (34). As in dogs, fluid analysis is definitive.

Emergency stabilization ("quiet" auscultation)

The only way to stabilize a cat or dog with pleural effusion or pneumothorax is therapeutic thoracocentesis (Box 1). This can be done blindly or *via* ultrasound guidance and may require sedation (*e.g.,* butorphanol, 0.2 mg/kg, IV or IM). More definitive diagnostics and treatment are predicated on recovery of fluid or air and cytology of pleural effusions. Quantify air or fluid recovered and save fluid samples in both purple-top and red-top tubes.

If a pneumothorax is continuous (negative pressure indicating completion of thoracocentesis does not occur), a thoracostomy tube may be required (consult other resources for placement technique).

Practice tips

1. "Quiet auscultation" does not mean that nothing can be heard; lung sounds are typically audible but more blunted and quieter than expected based on respiration rate and effort.
2. A history of coughing or retching/vomiting occurs with pneumothorax in both species.
3. Blood biomarkers tested in point-of-care kits, such as N-terminal pro B-type natriuretic peptide (NT-proBNP), may differentiate cardiac *versus* non-cardiac causes of disease in dogs (35) and cats (36–38), but blood collection may be unsafe in dyspneic animals. There is some overlap of NT-proBNP values in dogs with respiratory distress from cardiac and non-cardiac causes, resulting in false positives and negatives, even at the ideal NT-proBNP cut-off value (81.1% sensitivity and 73.1% specificity) (35). High NT-proBNP levels can overdiagnose feline heart disease (72% specificity; thus, 28% of positives do not have heart disease) (36).

Box 1. How to perform thoracocentesis.

1. Position animal in sternal recumbency with flow-by oxygen. Sedate if necessary.
2. Clip fur between the 4th to 12th rib spaces on lateral thorax.
3. Sterile skin preparation.
4. Use a 19- or 21-gauge butterfly needle or a 2.5-centimeter, 18- to 22-gauge needle with attached IV extension tubing. The needle must be long enough to reach thorax. Do not use a needle smaller than 20 gauge for viscous fluid.
5. Attach 3-way stopcock to butterfly or extension tubing. Turn stopcock off to tubing and attach a 10-milliliter or larger syringe to stopcock.
6. Use ultrasound to locate fluid or find 7th to 9th rib space.
7. Insert the needle to the hub perpendicular to the skin in the 7th to 9th rib space at the widest point of the chest, or where the ultrasound revealed fluid. After the needle is inserted, position the needle until it is roughly parallel to the body wall.
8. Turn the stopcock off to the environment and apply gentle traction to syringe.
9. When syringe is full, turn stopcock off to animal and empty syringe (collect fluid samples).
10. Continue suctioning until negative pressure occurs, indicating end of tap in that area.
11. If you are using ultrasound, check for visible fluid in another location. If you are tapping blindly, enter another rib space in the 7th to 9th range, either cranial or caudal to your current rib space or on the contralateral hemithorax, and attempt another tap. Thoracocentesis is completed when minimal fluid is visible on ultrasound or after 2 negative taps on both sides.

Preparing to refer a dog or cat with respiratory distress

- The time to refer a dog or cat with respiratory signs is *after* treating respiratory distress. Avoid transporting an animal in fulminant respiratory distress (they may die).
  - — Follow the NOSE protocol for upper airway disease.
  - — Tap the chest when there is pleural effusion or pneumothorax and remove as much fluid or air as possible.
  - — Administer treatments in described Table 1.
- Before transportation, give additional butorphanol and/or other medications to sedate.
- Record doses and timing of all drugs given, plus results of any thoracocentesis (volume of fluid or air removed and side).
- When animals are very oxygen-dependent (usually with lower airway disease), transportation with a portable oxygen tank (or inside a carrier within a plastic bag filled with oxygen) may be useful for long trips, if local regulations and liability concerns permit. Consider a portable oxygen concentrator for transport (Figure 5 C, D).
- If a continuous pneumothorax and recurrent respiratory distress are present, insert a thoracostomy tube (to be emptied by a staff member or trained owner during transit).
- Alert referral institution to the incoming patient and its status.

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Section 2: Seizures

A seizure is a clinical manifestation of abnormal electrical activity in the brain (39). Status epilepticus (SE) is commonly defined as seizure activity for > 5 min, or ≥ 3 seizures within 24 h without complete return of normal mentation between episodes (40,41). Cluster seizures (CS) are ≥ 2 seizures within 24 h with normal mentation between episodes. This section focuses on emergency situations involving a patient in SE or with CS.

Clinical signs in emergent cases range from patients in SE actively having a seizure to those that had a seizure before presentation. Seizures can include whole-body convulsions, hypersalivation, altered mentation, urination and/or defecation, or vocalization. Hyperthermia or lung crackles (seizure-induced non-cardiogenic pulmonary edema) are caused by seizure activity. Seizures in cats are often more violent.

After seizure activity (postictal phase), patients may be ambulatory but ataxic, have neurologic deficits and altered mentation, or be completely comatose and nonresponsive. Patients can also present as seemingly normal or mildly hyperactive, especially after CS.

Step #1: Is the animal having a seizure now?

If yes, *treat the seizure*.

Topical toxin

If a cat was given a topical medication (*e.g.,* permethrin, fipronil) that can cause seizures or tremors, bathe them with dish soap and lukewarm water to limit uptake.

- Methocarbamol, 50 to 150 mg/kg initial IV bolus (titrate up; do not exceed 330 mg/kg per day). If only oral form is available, dissolve in water and give rectally.
- Administer benzodiazepine (*i.e.,* diazepam or midazolam, 0.25 to 0.5 mg/kg IV).

No IV catheter

- Midazolam, 1 mg/kg IN. Diazepam, 1 mg/kg given rectally (up to 2 mg/kg if on concurrent oral phenobarbital).
- Repeat doses as needed every 2 to 3 min, maximum 3 times.

IV catheter

- Diazepam or midazolam, 0.5 mg/kg IV (in dogs).
- Repeat doses as needed every 2 to 3 min, maximum 3 times.
- Start long-acting antiepileptics, regardless of response to benzodiazepine.
- Levetiracetam, 60 mg/kg IV as loading dose. If only oral form is available, give orally (if patient can swallow) or rectally (42).
- Phenobarbital, 16 mg/kg loading dose (4 doses of 4 mg/kg every 0.5 to 4 h).
- If seizures persist, CRI of diazepam or midazolam, 0.1 to 0.5 mg/kg per hour for at least 6 h (then taper if no seizures).
- Propofol CRI, 1 to 3.5 mg/kg up to 6 mg/kg, slow IV to effect, to induce anesthesia. Give 25% of the calculated dose every 30 s until seizures stop, followed by a CRI (0.1 to 0.25 mg/kg per minute) for 6 to 12 h. Then, taper by 25% every 2 to 4 h, to recovery (43).

Propofol can cause hemolytic or Heinz body anemia in cats. Minimize dose and duration.

Table 2. Common categorical reasons for seizures in dogs and cats.

Systemic causes	Intracranial causes
• Hypoglycemia/hyperglycemia	• Tumors (lymphoma, meningioma, glial cell tumors, metastatic, *etc.*) (45)
• Electrolyte abnormalities: hypocalcemia; hypo- or hypernatremia	• Cerebrovascular disease including infarct or hemorrhage (rare in cats)
• Toxin ingestion Dogs: antifreeze, recreational drugs, fluorouracil, sago palm, mushrooms, ivermectin, rodenticides, xylitol Cats: permethrin, fipronil, pesticides (44)	• Trauma • Meningoencephalitis • Congenital malformations • Idiopathic epilepsy • Toxin
• Liver disease (*e.g.,* portosystemic shunt) (46)	• Infectious diseases Dogs: *Toxoplasma,* blastomycosis, cryptococcosis, distemper, *Neospora, etc.* Cats: Feline infectious peritonitis, FeLV, FIV, *Toxoplasma,* cryptococcosis, blastomycosis, *etc.* (47,48)
• Kidney failure (*e.g.,* uremic encephalopathy)	
• Anemia or severe hemoconcentration	
• Severe thrombocytopenia leading to intracranial bleeding	
• Thiamine deficiency (cats)	

Step #2: Why is the dog or cat having a seizure?

Once the animal is stabilized, determine the seizure cause; *i.e.,* systemic/metabolic or intracranial (Table 2).

Background

Signalment and history are important. Seizures can have hereditary components, particularly for golden or Labrador retrievers, border collies, German shepherds, Bernese mountain dogs, and vizslas. Some etiologies have age associations (*e.g.,* idiopathic epilepsy and brain tumors in younger and older dogs, respectively). In cats, intoxication is more common at 2 to 3 y, brain tumors at 7 to 8 y, and metabolic causes at 10 to 11 y of age (44–48). Regardless, seizures are possible in any species or breed at any age.

Obtain a rapid but thorough history regarding previous seizures, anti-seizure medications, seizure onset, seizure duration, what the animal was doing and how it was acting before the seizure, other medical conditions, and potential toxin ingestion. Common categorical causes of seizures are presented in Table 2.

Emergency stabilization (systemic/metabolic causes)

In addition to antiepileptic treatments, baseline electrolytes, blood glucose, PCV/TP, and possibly a chemistry panel are highly recommended. Not all metabolic causes can be treated before referral; however, treat hypoglycemia and hypocalcemia immediately.

Hypoglycemia. Hypoglycemia can *cause* a seizure or occur after prolonged seizure activity and cause seizure *persistence.* If blood glucose is < 60 mg/dL, give 25% dextrose (2 mL/kg IV) and recheck in 3 to 5 min. If hypoglycemia persists with seizures, repeat the dextrose dose [see Table 4 in Section 1 in Part II of this review (49)].

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Hypocalcemia. Hypocalcemia causing a seizure is most common during pregnancy or lactation. In addition, hypoparathyroidism (dogs) and other systemic diseases can decrease calcium concentrations and cause seizures. Give 10% calcium gluconate (1 mL/kg IV) slowly over 15 min, monitor with ECG, and decrease the rate of administration if bradycardia or arrhythmia are present.

Step #3: Other stabilization steps

Temperature

Check body temperature, as prolonged seizures can cause severe hyperthermia.

Emergency stabilization. Consider cooling measures if temperature is > 40.6°C [see Box 3 in Section 1 in Part II of this review (49)] and stop cooling measures at 39.4°C. Once a seizure is controlled, body temperature usually decreases.

Increased intracranial pressure

Dogs or cats with prolonged seizure activity develop cerebral edema, which elevates intracranial pressure. Alternatively, intracranial disease (*e.g.,* tumor) can increase intracranial pressure, causing seizures. Regardless of cause and effect, elevated intracranial pressure is suspected in obtunded or stuporous animals with pupils that are fixed, dilated, or nonresponsive to light, or when there is bradycardia (< 60 bpm in dogs or < 140 bpm in cats) with high blood pressure (> 160 mmHg systolic).

Emergency stabilization. Give mannitol (0.5 to 1 g/kg IV) slowly over 15 to 30 min (use a blood filter as mannitol crystallizes rapidly) or give hypertonic saline (7.2% NaCl; 4 to 5 mL/kg IV) over 5 min. Stop all other IV fluids when administering mannitol or hypertonic saline. Beware that hypertonic saline can cause hypernatremia; monitoring electrolyte concentrations, especially with repeated dosages, is advised. Use both mannitol and hypertonic saline with caution in hypernatremic animals, since both can cause fluid shifts into the vascular space that can rapidly drop sodium concentrations.

Lung crackles

If a dog or cat has auscultable crackles or increased respiratory rate and effort even after a seizure has stopped, the top concerns are seizure-induced non-cardiogenic pulmonary edema (*i.e.,* neurogenic pulmonary edema) or aspiration pneumonia. There may be a history of concurrent disease (*e.g.,* cardiogenic pulmonary edema).

Emergency stabilization. Treat any respiratory distress (see Figure 3 in Section 1).

Practice tips

The owner of a dog or cat with SE or CS must understand the following:

1. Lifelong anti-seizure medications are likely required (unless seizures are due to a toxin).
2. The long-term objective is to reduce seizure frequency and intensity, not eliminate seizures (unless toxin-induced).
3. Medications (usually oral, perhaps multiple) will need to be given daily at regular times. Transdermal phenobarbital is an option for cats that are difficult to medicate orally (50).

Preparing to refer a dog or cat with status epilepticus or cluster seizures

- Refer *after* seizures have stopped and blood glucose and body temperature are stable.
- Administer at least 1 dose of a long-acting antiepileptic before transfer.
- If possible, ensure a patent IV catheter is in place before transfer.
- Do not transport a hypoglycemic animal. If the animal is hypoglycemic on presentation and transport will exceed 30 to 60 min, provide dextrose for oral or IV administration during transit.
- For reduced mentation, consider giving mannitol before referral to reduce intracranial pressure.
- Communicate with referral institution to obtain an estimate and set client expectations.

Refer to Part II of this review [Basic triage in dogs and cats: Part II (49)] for information on stabilization of bleeding and animals that have acutely collapsed. CVJ

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Brief Communication Communication brève

Small intestinal obstruction secondary to kinetic sand ingestion in a dog

Andrew J. Trempe, Jeanine M. Persano

Abstract

Objective

To describe a case of small intestinal obstruction secondary to kinetic sand ingestion in a dog.

Animal

An 11-year-old neutered male shih tzu dog with a 2-day history of anorexia.

Procedure

Abdominal radiographs revealed a small intestinal bowel loop dilated with radiopaque material, consistent with sand ingestion. The dog's only sand exposure was to kinetic sand. After 8 h of medical management, radiographs were consistent with a small intestinal obstruction.

Results

The dog underwent exploratory laparotomy, which revealed distal jejunal and ileal distention with palpable soft foreign material that could not be milked into the colon. The sand was removed through a single enterotomy. The dog was discharged 4 d after surgery.

Conclusion and clinical relevance

The hydrophobic properties of kinetic sand may make it more likely than regular sand to cause intestinal obstruction that requires surgery. With the increasing popularity and availability of kinetic sand for domestic use, clinicians should have a high index of suspicion for kinetic sand impaction and secondary intestinal obstruction.

Résumé

Obstruction du petit intestin à la suite de l'ingestion de sable à modeler (Kinetic Sand) chez un chien

Objectif

Description d'un cas d'obstruction du petit intestin secondaire à l'ingestion de sable à modeler chez un chien.

Animal

Chien shih tsu mâle castré âgé de 11 ans avec une historique d'anorexie depuis 2 jours.

Procédure

Des radiographies abdominales ont révélé une anse du petit intestin dilatée avec du matériel radio-opaque, compatible avec une ingestion de sable. Une exposition à du sable à modeler était la seule exposition connue pour ce chien. Après 8 h de gestion médicale, les radiographies étaient compatibles avec une obstruction du petit intestin.

Résultats

Une laparotomie exploratoire a révélé une distension du jéjunum distal et de l'iléon avec du matériel étranger mou palpable qui ne pouvait être transité dans le côlon. Le sable a été retiré à la suite d'une entérotomie simple. Le chien a obtenu sont congé médical 4 j après la chirurgie.

Conclusion et signification clinique

Les propriétés hydrophobes du sable à modeler le rendent plus propice que le sable régulier à causer une obstruction intestinale et de nécessiter une chirurgie. Avec la popularité et disponibilité grandissante du sable à modeler pour usage domestique, les cliniciens devraient avoir un degré élevé de suspicion pour l'impaction par le sable à modeler et l'obstruction intestinale secondaire.

(Traduit par Dr Serge Messier)

Can Vet J 2024;65:173–176

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Sand impaction in dogs is an infrequently reported problem; however, it is likely seen more commonly in practice. Sand ingestion can cause severe enteritis as well as a small intestinal obstruction. Large intestinal impaction has also been reported (1). Small intestinal impactions can be treated medically or surgically (2,3). Medical management typically involves rehydration with intravenous (IV) fluids. In medically treated patients, close monitoring for resolution of impaction is necessary. Monitoring for the development of sepsis in these dogs is also vital, as the presence of sand can cause mucosal wall irritation and damage secondary to supraphysiologic intraluminal and intramural pressures (4). Surgical treatment involves removal of the sand either by milking the contents into the large intestine or *via* enterotomy. The mortality rate in dogs for removal of gastrointestinal foreign bodies has been reported to be < 1% with enterotomy (5). Of those requiring enterectomy, 26% had anastomotic leakage that significantly affected outcome (6), with the odds of enterectomy dehiscence being 6× the odds for enterotomy (7). In comparison, overall survival rates for sand impaction treated either medically or surgically have been reported to approximate 90% (3).

An 11-year-old neutered male shih tzu dog was brought to the emergency service of a tertiary referral hospital because of a possible intestinal obstruction. The dog had a 2-day history of anorexia with no vomiting or diarrhea. The dog had a history of ingesting foreign material and, 3 d before admission, ate a piece of paper. Also, the dog had a history of allergies but was otherwise healthy. Upon examination by the referring veterinarian, the dog was seen to be 5% dehydrated with a nonpainful, doughy abdomen and leakage of gelatinous, blue-grey-tinged fluid from the rectum. In-clinic serum biochemistry analysis revealed mild hyperglycemia [161 mg/dL; reference range (RR): 70 to 143 mg/dL], mild hyperproteinemia (8.3 g/dL; RR: 5.2 to 8.2 g/dL), and mild elevations in alkaline phosphatase (303 U/L; RR: 23 to 212 U/L) and alanine aminotransferase (161 U/L; RR: 10 to 125 U/L). Hematology revealed mild neutrophilia (13.34 K/μL; RR: 2.95 to 11.64 K/μL) and lymphopenia (0.78 K/μL; RR: 1.05 to 5.10 K/μL), consistent with a stress leukogram. A canine pancreatic lipase SNAP test was normal. Three-view abdominal radiographs revealed multiple loops of small bowel in the mid-abdomen that were dilated with radiopaque material. The gastric pylorus also contained the same radiopaque material, which appeared consistent with sand. Upon further questioning of the owner, the dog's only sand exposure was to blue kinetic sand, a creative play item for the children in the house. The dog received subcutaneous (SC) fluids (24 mL/kg), ondansetron (0.48 mg/kg SC), and maropitant (1.2 mg/kg SC), and was then referred for possible surgery.

Upon presentation to the referral hospital, the dog's physical examination findings were unchanged from those of the referring veterinarian. An abdominal-focused assessment with sonography for tracking did not show abdominal effusion. The dog was hospitalized and administered IV fluids using lactated Ringer's solution (Vetivex; Dechra, Overland Park, Kansas, USA), 6 mL/kg per hour, to see if the small bowel material would move with rehydration. Follow-up radiographs obtained 8 h after starting IV fluids revealed most of the gastric material had advanced into the duodenum. However, the small bowel material had not visibly moved and there was now marked dilation cranial to the material (Figure 1). With a concern for ongoing obstruction based on progressive dilation and mismatch of the bowel on radiographs, and because the dog had by then been clinical for 2 d, it was decided to carry out an exploratory laparotomy.

The dog was taken to emergency surgery, where the distal jejunum and ileum were seen to be erythematous, bruised, and distended with palpable soft foreign material. The stomach was also markedly dilated with fluid. Intestinal milking was undertaken in an effort to move the foreign material into the colon. The material would not readily pass through the ileocolic junction. The attempt was discontinued due to the occurrence of some serosal tearing in the distal ileum and the risk of further iatrogenic injury. A jejunal enterotomy was completed and a large quantity of sand was removed through suction and lavage at the incision site (Figure 2). The surgeon noted greater difficulty and longer time involved to break down and remove the impaction with kinetic in comparison to normal sand. The enterotomy site was closed and tested for leakage; the section of bowel was noted to have good peristalsis and pulses and improved color, leaving the surgeon confident with the choice of enterotomy over a resection and anastomosis. A serosal patch over the enterotomy site was placed with an adjacent loop of jejunum using 2 lines of 3-0 polydioxanone simple interrupted sutures. Bupivacaine liposome (Nocita; Elanco, Greenfield, Indiana, USA), 6.3 mg/kg, was infused into the SC incision upon closure. The dog recovered from anesthesia uneventfully.

Methadone (Akorn, Lake Forest, Illinois, USA) administration was continued after surgery at 0.2 mg/kg, IV, q6h initially and then as needed for pain. Ampicillin + sulbactam (Piramal Critical Care, Bethlehem, Pennsylvania, USA), 30 mg/kg, IV, q8h, was started at the time of surgery; and enrofloxacin (Baytril; Elanco US, Shawnee, Kansas, USA), 10 mg/kg, IV, q24h, was added postoperatively. It has been reported that 63% of dogs with sand ingestion had dual antibiotic coverage (3). The decision for addition of antibiotics was based on evidence of serosal tearing at the time of surgery and risk of particulate contamination of the abdomen, given the difficulty of sand removal. There was also concern for mucosal damage and potential bacterial translocation secondary to the inherently abrasive properties of sand. After surgery, the dog developed blood-tinged, sandy diarrhea. Continued treatments included lactated Ringer's solution, IV, at a variable rate depending upon the level of hydration; maropitant (Cerenia; Zoetis, Kalamazoo, Michigan, USA), 1 mg/kg, IV, q24h; ondansetron (Fosun Pharma, Princeton, New Jersey, USA), 0.5 mg/kg, IV, q8h; and sucralfate (Par Pharmaceutical, Chestnut Ridge, New York, USA), 62 mg/kg, PO, q8h. Two days after surgery, capromorelin (Entyce; Elanco, Greenfield, Indiana, USA), 3 mg/kg, PO, q24h, was started due to anorexia. Later that day, the dog developed regurgitation and was given metoclopramide (Hospira, Lake Forest, Illinois, USA), 2 mg/kg per day, IV continuous rate infusion; and erythromycin (Hospira), 0.5 mg/kg, IV, q8h. Due to persistent anorexia 3 d after surgery, a nasogastric (NG) tube was placed to begin enteral feedings using Royal Canin GI Low Fat Liquid (Royal Canin, North Sioux City, South Dakota, USA) at 1/4 resting

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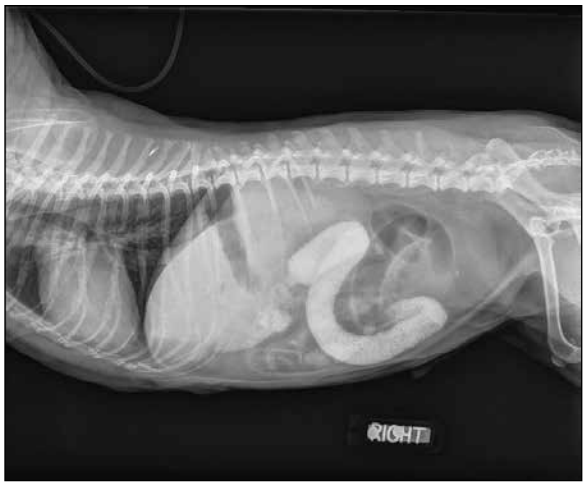


Figure 1. Recheck right lateral abdominal radiograph of an 11-year-old shih tzu dog.



Figure 2. Photograph of the enterotomy site in an 11-year-old shih tzu dog, showing kinetic sand removal.

energy requirements. Four days after surgery, the dog's appetite was improving, and due to financial concerns, was discharged to continue both oral and NG tube feedings at home. Six days after surgery, the dog was rechecked at the authors' hospital. The NG tube was removed as the dog's appetite had returned to normal. The dog was noted to be doing well clinically and at home.

Kinetic sand is regular sand coated with polydimethylsiloxane (PDMS), a silicone oil (8). The PDMS gives kinetic sand viscoelastic properties (9). The resulting product is hydrophobic, sticks to itself, and does not dry out. Kinetic sand is currently used in various educational and therapeutic settings, from helping children on the autism spectrum to those with attention deficit hyperactivity disorder (8,10). It is also becoming a more common play item for families with young children, as the sand feels wet and can be molded into various shapes, but does not stick to hands and so is easy to clean up. With the popularity of kinetic sand increasing, more animals are exposed, leading to more reported cases of ingestion. From 2002 to 2022, the ASPCA Animal Poison Control Center opened 536 cases regarding kinetic sand ingestion, with 80 of those in 2022 alone (Nicole Martin, ASPCA; personal communication, 2022). Kinetic sand is nontoxic, as PDMS is chemically inert (9). Yet, any sand ingested in a large enough quantity can lead to intestinal impactions. Because kinetic sand sticks to itself and is hydrophobic, even a small amount can act like a solid foreign body — less likely to break apart in water and potentially more likely to result in intestinal obstruction.

A previous retrospective study showed 50% of sand impactions could be treated without requiring surgery (3). However, when looking at small intestinal obstructions due to all causes, $<$ 20% resolved with medical management (11). Once medical management is started, there is no recommended time period to wait before proceeding with surgery, as this is very much dependent on each individual patient. One study showed no difference in outcome between immediate and delayed surgery (12). In this dog, medical management was attempted for ~8 h before electing surgery, with the decision for surgery based on recheck radiographs. On radiographs in dogs, if the ratio of the maximum small intestinal diameter to the midbody height of the 5th lumber vertebra is $>$ 2.4, then intestinal obstruction is probable (13). Initial radiographs of this dog showed the ratio to be 2.8, and recheck radiographs taken 8 h later showed a ratio of 2.9. Compared to regular sand, the inherent properties of kinetic sand, which cause it to hold together and not dry out, may contribute to a higher likelihood of causing an intestinal obstruction and failing medical management.

Recently, the use of polyethylene glycol solution was reported to resolve sand impaction in 3 dogs (14). Polyethylene glycol is a nonabsorbable compound that acts as an osmotic laxative (15). The hydrophobic properties of kinetic sand could, in theory, make it less susceptible to the effectiveness of osmotic laxatives. In this dog, the decision for surgery was based on the fact that the dog was anorexic for 2 d before presentation, the persistent obstructive pattern seen on recheck radiographs, and the unknown responsiveness of kinetic sand to continued medical management.

In conclusion, this case highlights the unique properties of kinetic sand, which may make kinetic sand impaction more likely than regular sand impaction to cause an intestinal obstruction and require surgery. With the increasing popularity and availability of kinetic sand for domestic use, clinicians should have a high index of suspicion for kinetic sand impaction and secondary intestinal obstruction.

Acknowledgments

The authors would like to thank the ASPCA Animal Poison Control Center for their information regarding phone calls received for kinetic sand ingestion. CVJ

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Commentary Commentaire

Convocation address to the Ontario Veterinary College '23 graduating students, June 16, 2023

Michelle Lem

A graduate of the University of Guelph's Ontario Veterinary College, Dr. Michelle Lem is a leader and advocate in the field of veterinary and human health. She was a 2023 recipient of a Doctor of Laws degree, *honoris causa,* at the University of Guelph, and provided the convocation address to the Ontario Veterinary College class of 2023. *The CVJ* is pleased to publish Dr. Lem's convocation address as a Commentary.

Thank you to Chancellor Chambers, members of the University of Guelph Senate, Board of Governors, Board of Trustees, faculty members, and community.

Miigwech. I would also like to acknowledge that the land on which we are gathered is the traditional territory of the Mississaugas of the Credit First Nation and ancestral homelands of the Anishinaabek Peoples. I acknowledge my responsibilities as a settler, including a commitment to respectful and reciprocal relationships with the original peoples of this place.

Congratulations to the graduating students, and their families and friends who are celebrating with us today.

Quick poll before I get started: Has anyone here heard of "imposter syndrome?" Has anyone here experienced imposter syndrome? Did anyone seated behind me put up their hand?

Of course, as veterinarians, it's almost a prerequisite. You know it's only funny because it's true. Would you be surprised to know that I feel like an imposter right now? I actually do feel uncomfortable, hearing the citation of "me" and to be standing here in front of all of you and receiving this honor alone. Because when one hears the citation, one might make some incorrect assumptions.

There are two that I'd like to speak about today. The first assumption is that I somehow did all this on my own, which clearly, I didn't. I am here today because of my parents, friends, family, teachers, colleagues, and mentors. And I am here, of course, because of the inspiring dedication, compassion, and service of our Community Veterinary Outreach family, our Board of Directors, our incredible Regional Directors and volunteers, community partners, supporters, and sponsors.

Michelle Lem, DVM, is a distinguished University of Guelph alumna and president, founder, and director of Community Veterinary Outreach. Dr. Lem is based at Capital City Specialty & Emergency Animal Hospital in Kanata, Ontario.

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At this time, I invite new graduates to reflect on who in your life supported you to achieve this accomplishment we are celebrating today. They may be people you knew well or peripherally; it may be someone whose impact you didn't recognize at the time, but now you do; and they may also not all be people, as perhaps there was a special animal relationship. We need to look around us and acknowledge all those who supported us, past and present, so that we can do our part to support others, give back, and pay it forward. Because the truth is that none of us gets to where we are on our own. All of us have stood on the shoulders of giants. Too often, we take credit for accomplishments that our not solely our own.

It's important that we acknowledge this, not only for our own sense of individual gratitude and humility, but also because of the global sociopolitical climate that is pervasive at this moment in time. Current individualist social ideologies are truly and deeply problematic, and we are all influenced by these structural and systemic forces because we all have to operate and interact within them. They influence both how we perceive ourselves and how we perceive others, and how we experience the world. The imposter syndrome that I mentioned earlier is a good example of this — how systemic bias and exclusion are the true roots of imposter syndrome, but instead tend to pathologize individuals. But more on that later.

So, how do we get from "me" to "we?" We make choices each day to show gratitude and acknowledge our privilege. We cultivate empathy and compassion with ourselves and others. When we don't understand the actions of others, we make the most generous assumptions we can, and we action the understanding that our health and well-being are intricately tied to the health and well-being of others, including other people, animals, and our environment. It is ultimately our choices and actions, rather than our words, that define us. And it is our actions during challenging and difficult times that are the true test of our values, beliefs, character, and integrity.

The second possible assumption when one hears the citation is that, somehow, I planned for all this to happen, that my outreach career was a steady and linear path, each step leading towards the next goal. The truth is that I typically don't know what I am doing next week, let alone in the next 5 years. I know that a lot

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of popular advice is that, in order to achieve one's goals, one has to make plans and to stick with them. I'm not opposed to goals or plans, but I prefer to hold them lightly. I like to think that this kind of mindset has contributed to the success of our outreach work and has been critical in identifying and addressing systems gaps that are what I am most passionate about.

"To hold plans lightly" means to have a thought, an idea — really, it's a *curiosity.* Knowing the first step to actioning that idea, which, for me, is typically spending time reflecting, researching, or mulling it over with trusted friends or colleagues, inevitably leads to more questions. This whole time, though, it remains a thought, a possibility, a potential goal…kind of like that anatomical "potential space" we learned about but that I never really understood.

I let go of all the steps in between the first step and the potential goal. I let go of how it all unfolds, including how I hope and think it "should" unfold. "Letting go" means letting go of any certainty or knowing if, or how, it's all going to work out. For me, this has been one of the most important lessons I've learned in life and work.

We all struggle with uncertainty, and therefore with the need to try and control it, because uncertainty almost always means expecting and accepting some discomfort. But it is the not knowing that allows for the curiosity and questioning — and therefore, *change.* If one truly "knew," then one would not question. However, *not* knowing allows for reflections, connections, and relationships to be formed that could not have been planned or anticipated. In this way, I learned to see uncertainty as an opportunity for a future I could not have imagined, rather than something to be feared, and therefore intricately planned and controlled.

The truth is that none of us "knows" the future, and I can say with full honesty that I still don't know what I want to be when I grow up! All I can say is that right here, right now, I am truly happy in my current professional role as veterinary social worker, being a mother to the 2 best kids EVER, and being a super-intense horse lover.

It's OK to not "know." Yes, it feels uncomfortable, but we can learn to expect and accept the discomfort, knowing it leads to questioning, and therefore, to change.

In my newest role as veterinary social worker, embracing the uncertainty and not knowing were critical components of the experience that I intentionally sought out. Although I know other veterinary social workers, and veterinary social work (VSW) programs, I also knew that this context was unique and that we had a rare opportunity to build something different. How many times would I have the chance to impact the culture, experience, and relationships in a brand-new specialty and emergency clinic with a new, 95-person team? The practice owners, managers, specialty and emergency teams, and I were committed to doing things differently; this was the opportunity to prove how systems and practices can be changed, that we can do better to meaningfully support team members, clients, and our patients. That we can both *do well* and *be well* in this profession.

But for change to happen, we have to *be* the change, and that often means *we* have to change. It means no longer accepting the status quo. However, humans generally resist change, and when faced with a choice, often choose the *status quo.* Because it is the thing that is *known,* the things that feels the most comfortable, most familiar, and therefore, the safest.

But our new team didn't want to accept the *status quo.* We didn't want to accept the "known" things. In the past, we had just "gotten used to" patterns and processes that have been perpetuated over and over yet are inherently flawed.

For me, resisting the *status quo* also meant resisting the natural inclination to follow or compare the VSW program I was developing to others that already existed, and to compare myself to other vet social workers. Even though VSW is a new and emerging field, I recognized the uniqueness of this opportunity and my situation, along with what I bring with my own lived experience. I also had strong desire to make my own mistakes. This may sound like individualism or even hubris, but it isn't, I assure you. I am but one of a large team and have phenomenal clinical supervision and a strong network of support in social work practice. What was important for me was to discover my own path, and that of my colleagues, rather than walk someone else's. As a team, we are each questioning things, including the influence of knowledge and power in relationships. Through this, we are connecting and relating to each other in new ways and establishing new patterns and processes. Real change happens with others who are questioning, and it is not tied to outcome, but rather to shared values and process.

Even while recognizing the value and need for uncertainty in order to effect systemic change, I still had doubts and uncertainties. Doubts about my capabilities, my knowledge, my ability to help or to create change. I didn't, and couldn't, know if we would be effective or successful. Once again, I felt like an imposter. But as before, the gifts of doubt and uncertainty are that it leads to questioning and curiosity.

In a 2020 review, up to 82% of people experience imposter syndrome. The concept was developed in 1978 by psychologists Pauline Rose Clance and Suzanne Imes, who were researching the experiences of high-achieving women. However, as Tulshyan and Burey point out in a 2021 Harvard Business Review article (1), "The development of this concept excluded the effects of systemic racism, classism, xenophobia, and other biases, and took a fairly universal feeling of discomfort, second-guessing, and mild anxiety in the workplace and pathologized it, especially for women…Even as we know it today, imposter syndrome puts the blame on individuals, without accounting for the historical and cultural contexts that are foundational to how it manifests... Imposter syndrome directs our view toward fixing women at work instead of fixing the places where women work."

A personal example is that, at one point early in my career, I considered being a mixed-animal vet. However, there was a discourse in various circles that, as a female, small-framed individual and urban-raised Asian, I may not "fit in," "be accepted," or be physically capable. This kind of biased discourse strongly influenced how I thought about myself and my abilities at the time.

What we know today is that imposter syndrome, much like other issues facing our society, is *not* a failing on the part of individuals, but rather a failing on the part of systems and structures in which we live, learn, and work. Social change always requires action by individuals, groups, and communities.

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In order to meaningfully combat imposter syndrome, we need to combat systemic racism, ableism, classism, and gender bias. Individually, pushing up against imposter syndrome means pushing up against the ideals of being or the need to be perfect, an expert, or a hero or saviour, and the need to accomplish or find success all on our own.

I will leave you with this: It's OK to not know. When you don't know, try to know yourself, your values, priorities, what you truly believe. When we don't know what to do, all we can do is be open and curious. To do this, we have to grow our capacity and tolerance for uncertainty and discomfort. Make choices that honor who you truly are, without any labels; honor your beliefs and values and how you want to walk through the world. Lean into the uncertainty, lean into the discomfort, because that is what cultivates questioning and curiosity, and that is what is needed in the world today for innovation and change. Thank you, and once again, congratulations to all of you.

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Answers to Quiz Corner
Corrigé du test éclair

1. A) Based on the cat's indoor-outdoor lifestyle, the results of clinical examination, and the radiographs, pulmonary histoplasmosis is the top differential diagnosis. Submit urine for fungal antigen testing to confirm.

Histoplasma capsulatum is present in soil and bat/bird feces worldwide but exists at higher concentrations in endemic areas. Outdoor cats have a higher rate of exposure to fungal organisms than indoor cats. Infection is seen occasionally in dogs but is rare in other species.

The chest radiographs show a diffuse, miliary-to-nodular interstitial pulmonary pattern, with hilar lymphadenopathy. The cardiovascular structures and pleural space are normal.

Other methods of diagnosing histoplasmosis include demonstration of the organism on histopathology or cytology. The lack of lymphadenomegaly on physical examination makes lymph node aspiration a low-yield test for this patient.

Avoid fungal culture of any tissue when histoplasmosis is suspected, as the fungus could infect laboratory staff as it grows.

Cats with histoplasmosis tend to have nonspecific findings on CBC and chemistry. Abdominal ultrasound may demonstrate hepatomegaly or splenomegaly if the disease is disseminated, but these are nonspecific findings and many cats with fungal pneumonia have a normal abdominal ultrasound.

Reference

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1. A) D'après le mode de vie du chat (chat d'intérieur qui va à l'extérieur), l'examen clinique et les radiographies, l'histoplasmose pulmonaire est le diagnostic différentiel le plus probable. Il convient de soumettre un échantillon d'urine pour un test de détection d'antigènes fongiques afin de confirmer le diagnostic.

Histoplasma capsulatum est présent dans la terre et les excréments de chauves-souris et d'oiseaux partout dans le monde, mais à des concentrations plus élevées dans les zones endémiques. Les chats qui vont à l'extérieur sont plus exposés aux organismes fongiques que les chats d'intérieur. L'infection est observée occasionnellement chez les chiens, mais elle est rare chez les autres espèces.

Les radiographies des poumons montrent un patron interstitiel diffus, miliaire à nodulaire, avec une lymphadénopathie hilaire. Les structures cardiovasculaires et l'espace pleural sont normaux.

La détection de l'organisme est aussi possible à l'histopathologie ou à la cytologie. L'absence de lymphadénomégalie à l'examen physique fait du prélèvement d'échantillons des nœuds lymphatiques par aspiration à l'aiguille fine une option moins intéressante dans le cas de ce patient.

En cas de suspicion d'histoplasmose, il faut éviter la culture fongique de tout tissu, car l'agent fongique pourrait infecter le personnel de laboratoire durant sa croissance.

Les chats atteints d'histoplasmose ont tendance à présenter des résultats non spécifiques à l'hématologie et à la biochimie. L'échographie abdominale peut mettre en évidence une hépatomégalie ou une splénomégalie si la maladie est disséminée, mais ces observations ne sont pas spécifiques, et l'échographie abdominale est normale chez beaucoup de chats atteints de pneumonie fongique.

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2. D) Treat these trout for suspected furunculosis with antimicrobial therapy chosen based on culture of the lesions. Furunculosis, caused by the Gram-negative bacteria *Aeromonas salmonicida*, is one of the most common bacterial conditions in farmed salmonids. It causes focal, necrotic hemorrhages ("furuncles") on the tail, fins, gills, internal organs, and muscles. These hemorrhages progress to deep skin abscesses or necrotic tissue (especially in the kidneys and spleen).

Culture infected tissue (or take a blood sample) and choose antimicrobials based on the results. Treatment is often successful. A vaccine is available and appropriate quarantine helps prevent disease.

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2. D) Il convient de traiter ces truites présumément atteintes de furonculose par un antimicrobien choisi en fonction des résultats de la culture effectuée à partir d'échantillons prélevés sur les lésions. La furonculose causée par la bactérie à Gram négatif *Aeromonas salmonicida* est l'une des affections bactériennes les plus courantes chez les salmonidés d'élevage. Elle provoque des lésions hémorragiques et nécrotiques focales (« furoncles ») sur la queue, les nageoires, les branchies, les organes internes et les muscles. Ces lésions évoluent vers des abcès cutanés profonds ou des tissus nécrosés (en particulier dans les reins et la rate).

Il est recommandé d'effectuer une culture du tissu infecté (ou de prélever un échantillon de sang) et de choisir un traitement antimicrobien en fonction des résultats. Le traitement est souvent efficace. Un vaccin est disponible et une quarantaine appropriée aide à prévenir la maladie.

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The vital connection between emotional intelligence and well-being — Part 1: Understanding emotional intelligence and why it matters

Debbie L. Stoewen

The term "emotional intelligence" (EQ) was coined by psychologists Peter Salovey and John D. Mayer (1) in the 1990s and popularized by Daniel Goleman (1995) in his best-seller, Emotional Intelligence: Why It Can Matter More Than IQ (2). Defined as "the subset of social intelligence that involves the ability to monitor one's own and others' feelings and emotions, to discriminate among them, and to use this information to guide one's thinking and actions" (3), it quickly became a concept of importance in education, business, and popular culture. It served as the missing link to explain an unexpected finding: 70% of the time, people with average IQ (cognitive intelligence) outperform those with the highest IQ (4). This was puzzling because IQ was considered a strong predictive measure of workplace performance and, for many, was assumed to be the sole source of success. Now we know that IQ accounts for only about 25% of the success in one's career (5). Emotional intelligence is the critical differentiator. People who are successful at work aren't just smart — they have high EQ.

High EQ is especially important for those who work in emotionally demanding occupations such as healthcare. In veterinary medicine, this is particularly true in companion animal practice. With most families considering their pets members of the family, and veterinary teams committed to delivering high-quality healthcare services, emotions can often run high. In the emotionally complex world of veterinary practice, the ability to understand and manage emotions is critical (6). In fact, it may be just as critical to veterinarians' well-being and career longevity as the ability to proficiently carry out the technical aspects of their work (7).

At first glance, the connection between EQ and well-being may not seem readily apparent; however, research indicates otherwise. Studies have shown that higher EQ leads to lower levels of stress, higher rates of positive emotional states and happiness, and better health and well-being (6,8–10). Studies have also determined EQ is associated with healthier coping skills, suggesting that growing EQ may improve coping with stress (6,8). Although research on EQ in the veterinary profession has been limited, a recent study with veterinary students identified a negative correlation between EQ and stress, anxiety, and depression (SAD) (11). Students with higher EQ have lower levels of SAD, and those with lower EQ tend to have higher levels of SAD. Considering today's mental health challenges (high levels of stress, anxiety, and depression); the consequential burnout, compassion fatigue, substance use and abuse, and suicidality; and the associated rise in turnover and attrition, EQ may be more relevant than ever before as a means to enhance health and well-being and preserve career longevity.

This article is the first of a 3-part series with the goal of supporting veterinary well-being. The series will cover what EQ is, the relevance of EQ to professional health and well-being, and how to develop and improve one's EQ. This article focuses on understanding EQ and its relevance to well-being. The next 2 articles will offer a range of strategies to strengthen one's EQ, focusing on the EQ competencies. Growing EQ offers a unique opportunity to improve professional health and well-being.

Understanding emotional intelligence

After decades of research, analysis, and scientific investigations, there are 3 major models to conceptualize EQ (12,13). This article focuses on the Emotional and Social Intelligence Leadership Competency Model as developed by Daniel Goleman and Richard Boyatzis (13,14).

According to Goleman and Boyatzis, EQ is an array of competencies that fall within 4 domains. The first 2 domains, *self-awareness* and *self-management,* have to do with *our ability to relate to ourselves,* reflecting "*personal* competence." The other 2 domains, *social awareness* and *relationship management,* have to do with *our ability to relate to others,* reflecting "*social* competence." Nested within the 4 domains are 12 EQ competencies: emotional self-awareness, emotional self-control, adaptability, achievement orientation, positive outlook, empathy, organizational awareness, influence, coaching and mentoring, conflict management, teamwork, and inspirational leadership (Table 1) (15). These are learned and learnable.

What emotional intelligence looks like

Although we cannot "see" EQ, we can see how it (and the lack of it) manifests in people's behaviors. People with low EQ get stressed easily; they're twice as likely to experience anxiety, depression, substance abuse, and even thoughts of suicide. They

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Table 1. Emotional intelligence domains and competencies (15).

Self-awareness	Self-management	Social awareness	Relationship management
Emotional self-awareness	Emotional self-control	Empathy	Influence
	Adaptability	Organizational awareness	Coaching & mentoring
	Achievement orientation		Conflict management
	Positive outlook		Teamwork
			Inspirational leadership

have a limited emotional vocabulary, and thus don't know how to accurately identify, and appropriately address, how they're feeling. They mask their negative emotions with positivity that isn't genuine or productive rather than express what they're truly feeling. They often feel misunderstood because they don't deliver their message in a way that others can understand. They blame other people for how they're feeling rather than taking responsibility for their own emotions. They have difficulty asserting themselves, and when crossed, default to passive or aggressive behavior. They make assumptions quickly and defend them vehemently, even with evidence to the contrary. They hold grudges, and in this way, prevent reconciliation. They don't let go of their mistakes, and thus are unable to adapt and adjust for future success. They don't know their triggers, the situations and people that "push their buttons" and cause them to act impulsively. And they're easily offended since they lack self-confidence. All of these behaviors are the hallmarks of low EQ (16).

In contrast, people with high EQ *respond* to people and situations instead of reacting to them. They're aware of their feelings, and of why they are feeling as they do, and can manage their emotions better than most. They sense the feelings of the people they interact with and understand others' way of seeing things. They're able to cut through the drama and stick to the facts. They can guide a tough conversation to a satisfactory agreement and help settle conflicts. They take in the whole view of the problem and look at all sides of the issue. They keep their focus on the main goals and know the steps it takes to get there. They're naturally positive and optimistic and can recover quickly when they get upset. They're aware of their limitations as well as their strengths. All of these behaviors are the hallmarks of high EQ (17,18).

Higher EQ means improved stress management, interpersonal functioning, leadership abilities, and job satisfaction (19). Emotional intelligence affects nearly everything we say and do, and in this way, influences nearly every outcome. Its intangible nature makes it difficult to know how emotionally intelligent any one of us may be. If you're wondering where you stand on the scale of low to high EQ, there are a variety of tools to measure it (20). Two such tests that are available online at no cost include those offered by Psychology Today (21) and Frameworks (22).

The relationship of IQ to emotional intelligence

An IQ is a measure of cognitive ability — the ability to learn and synthesize information. Although IQ depends on basic cognitive abilities (such as attention, perception, memory, and language), it also depends on interacting with others, and in this way is related to EQ. As neuroscientist Aron Barbey affirmed, "We're fundamentally social beings and our understanding not only involves basic cognitive abilities, but also applying those abilities to social situations so that we can navigate the social world and understand others" (23). A person's IQ typically remains the same throughout life; it's the same at age 15 as it is at age 50 (15). One's EQ, on the other hand, can improve over time (4,22). Although some people are naturally more emotionally intelligent than others, anyone, at any time in life, can grow their EQ.

Growing emotional intelligence

Although you can't change your IQ, you *can* change your EQ. This is because of neuroplasticity. "Neuroplasticity" is the term used to describe the brain's ability to change — to continue growing and evolving in response to life experiences. To understand how EQ can grow, it's helpful to understand what EQ is as it relates to the structure and function of the brain.

The brain is made of 3 functional layers: the brain stem (instinctive brain), the limbic system (emotional brain), and the cortex (rational brain) (24). The emotional and rational brains are highly connected to one another through billions of neuronal connections. It's the free flow of information along these neuronal connections between the emotional and rational brains that "is," in essence, EQ.

Remember the saying, "Neurons that fire together wire together" (25)? Every experience (*i.e.,* thought, feeling, and behavior) you have triggers thousands of neurons that form a neural network. When an experience is repeated again and again, the brain learns to trigger the same neurons each time. Over time, these neurons will branch off small "arms" (similar to the branches of a tree) to connect with other neurons in a type of "chain reaction" (4). This neuronal growth *strengthens* the connections. So, when you repeatedly engage in new, emotionally intelligent behaviors, the billions of neurons along the path between the emotional and rational brains will grow, building the pathways needed to make these behaviors into habits (4,16). Practicing emotionally intelligent behaviors "trains your brain." Before long, you'll be responding with EQ without even having to think about it.

Making the commitment

Growing your EQ is a worthwhile pursuit. It can enable you to i) *better manage stress,* thus reducing the risk of anxiety, depression, burnout, compassion fatigue, substance use and abuse, and suicidality; ii) *better get along with others,* thus both

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preventing and more effectively resolving conflict, reducing stress, and enhancing job satisfaction; and iii) *reach your highest potential* (*i.e.,* self-actualize) through higher social and emotional functioning, thus enhancing your ability to express your unique leadership qualities (26). Emotional intelligence matters and, if cultivated, affords you the opportunity to realize a happier, healthier, and more fulfilled life.

Are you thinking you might benefit from a little more EQ? The next 2 articles will explore a range of strategies to grow EQ and help you take inspired action toward doing so. Growing EQ is not just possible — it's doable! It takes commitment, but in the world of veterinary medicine, where so much is about emotions and relating well with others, it is well worth the effort.

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Food Animal Matters
Défis du secteur bioalimentaire

A role for registered veterinary technicians in food animal practice

Robert Tremblay

Introduction

In June 2022, the Canadian Veterinary Medical Association convened a Veterinary Workforce Congress. Among the priorities identified from the Congress was one focused on building and managing effective veterinary teams, including by using the full knowledge and capacity of registered veterinary technicians (RVTs) (1).

There is limited published research on the use and impact of RVTs in food animal practice in Canada. A survey in Ontario in which most respondents were primarily based in small-animal practice determined that, for each additional RVT/veterinarian in the practice, the gross income for each veterinarian increased by almost $80 000 CAD (2). Research in the United States also suggests that practices making use of RVTs and other non-medical staff also increased revenue and productivity. In that study, researchers determined that use of RVTs and other non-medical staff in small-animal and mixed-animal practices increased practice revenue by 17% and increased veterinary productivity by 14% (3). Mixed-animal practices were defined as those having at least 25% bovine and equine activity. In an earlier survey in the United States, use of veterinary technicians was also associated with increased income; however, the practice type was not specified (4).

In this column, Irene Moore explains the training process for RVTs and their required capabilities in relation to food animal practice. Kristen Edwards describes how Tavistock Veterinarians in Ontario works with RVTs not only to perform individual clinical tasks but also to implement entire programs on its clients' dairy farms. Jessica Law and Teryn Girard describe how their practice works with RVTs to extend the services they can provide to their swine and poultry clients in Alberta.

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The Food Animal Matters column is a regular feature of *The CVJ,* coordinated by Dr. Robert Tremblay and intended to inform food animal veterinarians and others who want to understand more about the day-to-day professional activities of food animal veterinarians.

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Leveraging registered veterinary technicians in large animal practices: How can they help?

Irene Moore, DVM, MSc, BSc (Agr), Ridgetown Campus, University of Guelph, Ontario

There is a worldwide shortage of veterinary professionals. In particular, there is a dearth of large-animal practitioners, particularly in remote and rural areas in many parts of Canada. Although increased attention is being paid to how registered veterinary technicians (RVTs) can help alleviate workloads for companion animal veterinary practitioners, less has been published about leveraging RVTs in large-animal practices. As a veterinarian involved in veterinary technology education for decades, I feel there is a largely untapped pool of talent that can help provide veterinary services in large-animal practice. Many practitioners are unaware of the breadth and depth of knowledge that RVTs possess.

What is a registered veterinary technician?

Registered veterinary technicians are graduates of an accredited veterinary technology or animal health technology program. They also must have written the Veterinary Technician National Examination, which is taken by graduates across North America to assess entry-level knowledge. They must maintain their credentials through mandatory continuing education. Some provinces have additional requirements for achieving or maintaining credentials, such as completing a professionalism and ethics course or undergoing a police background check.

In Canada, there are 18 RVT programs accredited by the CVMA. One program (at Thompson Rivers University, British Columbia) has a totally online option, whereas 2 programs (at University of Guelph Ridgetown Campus, Ontario and Olds College, Alberta) have alternative or blended program options. To become accredited, programs must demonstrate and document that students have acquired a number of essential, hands-on skills in addition to didactic knowledge. Whereas many of the skills are transferable between companion animal and large-animal practice, there are specific skills required for equines and ruminants. Equine skills include restraint and handling, jugular venipuncture, equine tail and leg wraps, and various parenteral

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injections. Optional skills include nasogastric tubing and preparing mares for vaginal exams and cervical culture testing. Ruminant skills include restraint and handling, various injection techniques including intradermal injections and intramammary medications, administering medication with a balling gun, and operating a cattle chute. Some programs also have students learn to use an oral speculum and stomach tube. In addition to these skills, students learn procedures used in all species, including those related to hematology, biochemical testing, microbiology, parasitology, anesthesia, and aseptic techniques. They also learn about necropsy procedures, which involves collecting and processing samples and sending them for analysis.

What can they *not* do?

Although each province regulates veterinary technicians differently, there is consistency regarding which tasks veterinarians are not allowed to delegate to anyone other than to another veterinarian. These include diagnosis, prognosis, prescription, and performing major surgery. This means there are numerous procedures that can be delegated to RVTs. Veterinary practitioners may not be aware of what they can delegate, or they may be hesitant because they are concerned that they are ultimately responsible for potential negative outcomes. Nonetheless, veterinarians who have allowed RVTs to expand their scope of practice experience are able to assist more clients and accomplish tasks more efficiently, leading to a better work/life balance for everyone.

So, what *could* they do?

Many practices are already utilizing RVTs to help with administrative tasks in the clinic. Some veterinarians are having their RVTs accompany them on herd-health visits to help with tasks such as vaccinations, TPRs, and dehorning. In equine practices, RVTs may help with lameness exams, teeth floating, semen evaluation, radiographs, *etc.* For all species, they can perform local anesthesia, prepare surgical sites, and assist with surgical procedures. However, with the increased availability of teleconferencing, RVTs could potentially do even more. For instance, an RVT could be sent to do a postmortem examination on an animal and send pictures or video of the gross findings to the veterinarian. The veterinarian could then determine whether a diagnosis can be made or indicate which samples the RVT should take for further analysis. An RVT could also be sent to attend medical cases where they could perform physical exams and communicate their findings to the supervising veterinarian. They could either administer treatments on the farm or take blood, urine, or cytology samples. They could also complete follow-up farm calls to ensure animals are progressing as expected. The RVTs could also be involved extensively in client education, animal welfare, and public health.

Next steps

Since the vast majority of RVTs work in companion animal practice, most colleges focus their training on skills transferable to both large and small animals. However, if there were more opportunities for graduates in food animal and equine practices, many would be interested in providing more training and education in those areas. The University of Guelph Ridgetown Campus, for instance, is looking at offering a post-diploma specialization in food animal and equine practice. Practitioners interested in expanding the role of RVTs in their practices should discuss where potential gaps in knowledge or skills exist specific to large animals, to determine the best way to fill them.

Leveraging RVTs has additional benefits for the veterinary practice. By providing opportunities for RVTs to expand their role, practices are more likely to attract and retain RVTs. By having RVTs perform tasks that would otherwise be performed by the veterinarian, there is also an opportunity to provide better compensation for the RVT. Finally, with more veterinary personnel available to provide services, producers and the health of their livestock will benefit.

Working with registered veterinary technicians in dairy programs

Kristen Edwards, BSc, DVM, Tavistock Veterinarians, Tavistock, Ontario

The field of bovine veterinary medicine is experiencing a shortage of veterinarians, creating a pressing need to reevaluate the way services are provided to farmers. Traditionally, veterinarians have been tasked with both consultation and technical services. However, as the demand for more consultation-level services grows, there is a recognized need to delegate technical tasks more effectively. Registered veterinary technicians (RVTs), with their specialized training, are well-suited to undertake these technical services, allowing veterinarians to focus on providing consultative advice and comprehensive strategies for herd-health management. This shift not only addresses the scarcity of bovine veterinarians but also ensures that farmers receive more targeted and valuable support. By strategically working with technicians in various facets of the practice, veterinarians can provide more comprehensive services to their clients.

Vaccination, dehorning, and castration

This is perhaps the most traditional way in which veterinary technicians have been employed. By taking on routine procedures such as vaccination, dehorning, and castration, veterinary technicians "free up" veterinarians to focus on more complex cases while providing a valuable service to farmers who otherwise may not prioritize these tasks. This not only maximizes productivity but also ensures that each animal receives timely care.

Data management in calf-health programs

Veterinary technicians can be invaluable in gathering data for calf-health programs. This includes weighing calves, collecting blood for serum total protein assessments, routine performance of thoracic ultrasound evaluations, and performing hygiene audits using a luminometer (5). By diligently capturing and managing these data, technicians enable veterinarians to analyze the data and create detailed reports for clients with actionable recommendations for improving calf health.

Fresh cow monitoring programs

Veterinary technicians can spearhead fresh cow monitoring programs, collecting a variety of data on parameters such as

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temperature, heart rate, respiration rate, fecal consistency, California Mastitis Test results, rumen motility, and blood ketones. This comprehensive data collection helps veterinarians assess a farm's transition cow program and overall health of fresh cows and suggest necessary protocol or management changes based on their analysis.

Calf barn ventilation assessments

Ensuring optimal ventilation in calf barns is essential for maintaining good health. Veterinary technicians can collect data relating to barn dimensions, air speed, and air exchanges per hour to help assess the effectiveness of a barn's ventilation system. These data can then be analyzed by veterinarians to provide feedback on areas for improvement. The RVTs' assessments can be key in identifying changes that can significantly affect calf well-being.

DairyComp data entry

Veterinary technicians can assist in streamlining herd health visits by inputting relevant data into the DairyComp herd management tool (6), which is especially helpful for farmers who do not use computer software programs to monitor pregnancy diagnoses. By generating lists for these visits, technicians ensure that veterinarians can focus on specific needs and concerns, enhancing the precision and efficiency of the visit.

Charging for services

Depending on the service provided, clients are charged either an hourly RVT rate (for individual animal procedures such as dehorning) or a program fee (if the service is part of a program such as a calf program or fresh cow program).

How registered veterinary technologists contribute in a swine and poultry practice

Jessica Law, DVM and Teryn Girard, BSc, MSc, DVM, Prairie Livestock Veterinarians, Red Deer and Lethbridge, Alberta

Prairie Livestock Veterinarians (PLV) is a food-production veterinary clinic specializing in swine and poultry medicine in western Canada. The registered veterinary technologists (RVTs) at this clinic are integral to the success of our practice through their support of client retention and relationships with our clients.

Our RVTs' professional activities at the clinic level focus on managing sample collection, laboratory submissions, and on-farm relationships with clients. Unique to PLV is the integration of our RVTs into our on-farm services through data management, production audits, and vaccination audits. It became apparent early on that the RVTs have the skills required to offer a range of services at the farm and producer levels. They can devote more time to a few producers rather than being spread thin across many.

Our RVTs relate well with producers and have a deep understanding of barn and staff management. This has created a unique niche for our RVTs, enabling producers to consult with the RVT team regarding optimal management, diagnostic sample collection and submission, vaccination management, and appropriate vaccination protocols. Expanding the roles of RVTs allows veterinarians to focus on herd and flock health specifically. The day-to-day relationship with producers now includes not only the veterinarians and the front-office staff, but also our veterinary technologists. This gives us the ability to provide a whole-team approach to the care of the farms. This ability to serve our clients at multiple levels also allows greater flexibility in how the clinic provides services. The active role that RVTs play on clients' farms has led to the RVTs at PLV being seen not just as an extension of the veterinarians but also as professionals providing an additional service.

Opportunities to expand registered veterinary technologists' credentials and skill sets

As the roles of the RVT team evolved to meet the needs of the swine and poultry industries, amplifying their continuing education became both a necessity and a more rewarding part of their job. As their knowledge evolved, the PLV RVTs identified areas they were passionate about and within which they wanted to develop their skills. For one RVT, this meant developing a new service within the clinic that focused on small-flock and small-herd management and welfare. Another of our RVTs expanded her skills in hatchery and breeder-farm management, with specific focus on bird welfare, ventilation, and biosecurity. Providing and allowing for diversification in the RVTs' experience and skill sets increased their job satisfaction and our ability to retain staff. This has been fundamental to the success of the clinic's growth.

Charging for services

Similar to the way we charge veterinary service fees, PLV charges either an hourly RVT fee for specific services or an RVT retainer fee determined by contract when providing comprehensive services for animal husbandry and welfare. A useful guideline for determining the appropriate charge for RVT services is to use the veterinary service fees as a benchmark. Depending on the service provided, the RVT charge may be valued as equivalent to a veterinarian's service fee time, or it may be charged at a lower cost. The cost per hour will depend on the cost of overhead and the needs of the clinic compared with demand and would be specific to individual clinics.

The role of the RVT will continue to evolve at PLV to meet the needs of our clients. The goal of the veterinary team at PLV is to continue to harness the passion and skill of the RVTs so they can continue to be part of the evolution in the industries to which they are integral.

Conclusion

The impact of having RVTs as active members of the veterinary service team is not well-researched in food animal practice. A review of the intrinsic and extrinsic rewards valued by RVTs, relying primarily on data from companion animal practice, contained the following statement: "This survey indicates the presence of multiple intrinsic rewards within the [RVT] profession including the ability to affect the well-being of animal patients, the formation of relationships with pet owners and coworkers, managing a variety of challenges, problem solving, having opportunities to maintain competence in medical/surgical/technology topics, contributing as part of a larger health

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care team, and feeling that clients respect their professional advice" (7). It is probable that RVTs in food animal practice would value very similar intrinsic rewards from being part of a veterinary care team.

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Animal health in the face of unprecedented global change

Craig Stephen

THE PROBLEM

Protecting animal health should be a socially relevant activity. Social relevance is gained by answering questions that society asks or solving problems it faces. Societies now face the problem of too many problems. Food insecurity, emerging diseases, habitat loss, pollution, climate change, and social conflict are happening concurrently, rather than in isolation. Despite global changes such as urbanization, the extinction crisis, habitat degradation, and globalization being the sources of arguably the most important health challenges of the 21st century, veterinary engagement and leadership on these issues remain hard to find.

Life comprises multiple, simultaneous assets, deficits, and problems that interact to pull us closer to or farther from critical tipping points. Unfortunately, we still largely train animal health professionals to simplify and attack health threats one at a time. Health gains in the 19th and 20th Centuries were largely from advances in knowledge of individual drivers of death and diseases. This strategy is growing increasingly less effective as the pace, scale, and variety of harbingers of doom pile on us.

Some have turned to One Health as the solution to our problem-by-problem approach to health. One Health emerged as a framework in the early 2000s to promote intersectoral actions among human, animal, and ecosystem health sectors. To date, the vast majority of intersectoral actions taken under the banner of One Health have focused on proximate human health risks and needs, such as zoonotic disease management and food insecurity (1). However, One Health has come under scrutiny for being too anthropocentric and failing to include adequate attention to nonhuman well-being (2). One Health has largely looked to manage animal health not for the moral and ecological value of healthy animals, but rather to the extent that poor animal health affects human health and well-being. The preoccupation of One Health on zoonotic diseases for public health purposes has led to an emphasis on epidemiological approaches rather than socio-ecological systems approaches when conducting One Health research and practice (1). Putting humans at the top of a hierarchy of human, animal, and environment health has resulted in some suggesting that One Health reproduces a Western-centric biomedical epistemology rather than enabling novel intersectoral actions on interdependencies among human, animal, and environmental health (3). In this light, One Health seems an inadequate solution for animal health professionals — those members of society expected to be animal health stewards and champions.

Solutions to modern health problems require us to maintain adaptable functionality so we can adjust to expected, unexpected, and interrelated threats by preserving the social and environmental assets that are the foundation of human and animal health. Too often, the bulk of training for animal health professionals targets the pathophysiologic or etiologic origins of a harm rather than considering actions coordinated with society to preserve and protect health. Veterinary medicine is *de facto* training disease-service specialists as dictated by national licensing expectations rather than holistic health professionals. Veterinary colleges tell their students that there are opportunities to learn about issues such as conservation, sustainability, or ecosystem health; however, the vast majority of veterinary training deals with questions such as, "Why is this animal sick and how can I return it to an 'unsick' state?" Despite clear and escalating signs of increasing vulnerability to environmentally derived health threats, the global response has been muted and efforts continue to fall far short. There have been calls for decades in the animal health realms for attention and investment on fostering healthy relationships with the world around us… yet action remains limited.

Although the response from the animal health professions continues to gain momentum, the current approach is not future-ready. The combination of health crises such as extreme weather events and epidemics plus the current high profile of One Health provides a unique opportunity for course-correction in how animal health is conceived and delivered. Change often is launched in response to a crisis.

THREE PROPOSED CHANGES

Preserving animal health gains and preventing backward momentum requires substantial reimagining of how to inspire and sustain the organizational and individual changes needed to concurrently care for the health of animals, societies, and ecosystems. Below, I propose 3 actions that must occur to position animal health professionals as socially relevant actors in the war against global health threats.

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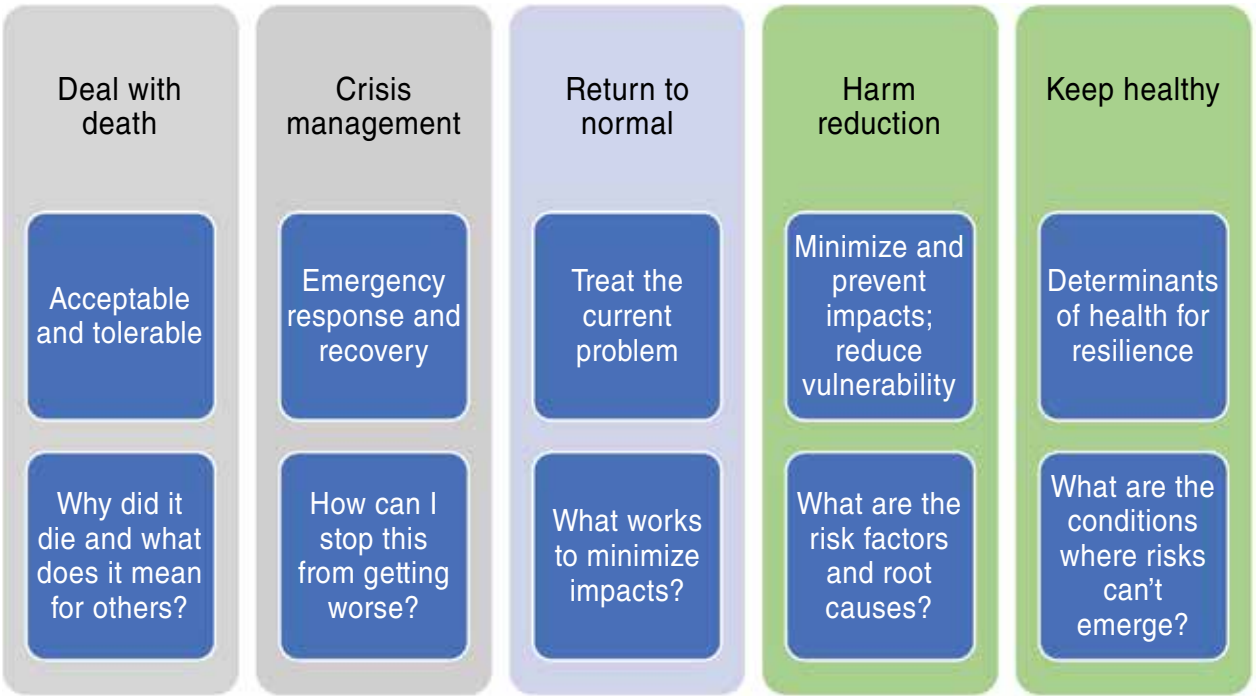


Figure 1. Animal health continuum of care.

Focus on health

To be healthy, an individual or population needs to have a minimum set of resources, functions, and capabilities that operate within an environment that enables them to access their needs for daily living and cope with challenges to meet expected end points. Given the growing number, frequency, and interconnectedness of threats to health, future-ready animal health programs must ensure that animals can remain healthy in an uncertain future. This is much more than simply responding to and preventing disease. A focus on the determinants of animal health requires attention to a wide suite of mechanisms to promote and protect health; it is beyond the scope of 1 organization or discipline to fulfill all requirements for healthy animals.

Animal health professions must strive to understand why some populations are healthier than others. To foster conditions conducive to health, they need perspectives, skills, and capacities to deploy 4 key strategies: i) build management and health policies that protect determinants of animal health, ii) focus on creating healthy environments that support sustainable access to determinants of health, iii) strengthen collaborative actions, and iv) reorient animal health from disease management only to providing a continuum of care (4).

Animal health as collective action

It is hard to argue against the propositions that animal health is utterly dependent on a healthy biosphere and that many of the most pressing health problems shared by people and animals, *e.g.,* climate change and pandemics, cannot be addressed without partnerships and collaborations. Given that extreme weather, emerging infections, declining air quality, and food security crises are now commonplace, it is equally hard to argue against the need to reimagine how animal health practice creates and applies intersectoral means to move beyond its preoccupation with diseases and economic productivity.

The challenge for animal health professionals is to identify the roles and responsibilities they can credibly fulfill to remain socially relevant as global changes affecting animal health become more pervasive, impactful, and locally relevant. If there is a gap between their desired impacts and their legitimate scope of practice, there are 2 options: expand training or expand partnerships.

An animal health department cannot single-handedly achieve interspecies health equity, eliminate global health threats, or address all determinants of animal health. Therefore, it is important to recognize and acknowledge the extent of a problem's causal web. This opens you up to looking at the multiple factors that influence the problem and identifying potential partners in the problem-solving process.

To effectively tap into the diverse skills and knowledge that influence animal health, we will need to reframe how we "do" animal health. We need to start talking about animal health-care systems rather than the roles and responsibilities of professions isolated from one another. Animal health professions cannot, and should not, be solely defined by legislated roles set out in veterinary Acts or by professional licensing bodies. A useful starting point for action revolves around the question, "What needs to be done?" rather than, "How can I fix it?" Creating an ethic of intersectoral cooperation and developing skills for effective collective action are essential for training 21st Century animal health professionals. "Boundary people" (those trained and interested in building intersectoral alliances) are needed to enable and empower collective actions on collective animal health goals.

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Create an animal health system that provides a continuum of care

Figure 1 outlines an animal health continuum of care, with 5 categories of action, each with its own focus and guiding questions.

The levers for action in each of these themes are controlled by different expertise and legislation that operate through networks of roles, relationships, and interactions. All these entities contribute to animal health and its contributions to ecosystems and societies. Veterinarians are major players in this continuum of care; however, they cannot independently provide the full spectrum of essential health services. Future-ready animal health workers need to be able to recognize the multiple factors that influence a health problem, understand how their contributions affect progress toward goals, and identify partners in the problem-solving process. The goal is not to establish strict boundaries, but instead to reflect on the nature of the problems, how standard approaches may fail, and how new collaborations may help. Currently, we rely on informal arrangements to ensure coordination across this continuum, and even these are rare occurrences. Going forward, a systematic, coordinated, and sustained approach to delivering a collective animal health-care system is a prerequisite for efficient use of resources, to avoid unintended consequences and to get ahead of the onslaught of new problems.

CONCLUSION

Until the animal health community highlights the critical influences of global changes on long-term animal health, it will continue to miss the real point: action to maintain the complex social and ecological systems that support health and life is not someone else's concern; instead, it is a foundational responsibility of those charged by society to care for animals' health. Animal health professionals will need to embrace a dual loyalty both to animals and to struggles occurring outside of their workplaces in the surrounding communities and ecosystems. They will need to combine holistic health literacy (which includes environmental awareness and interest in the state of the world) with ecological citizenship that focusses attention on the duties and responsibilities to ensure sustainable ecological footprints and a just distribution of ecological spaces to support both humans and nonhumans. They will need to reframe animal health as a collective activity rather than a legislated speciality.

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