Australian
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## Morbidity and mortality in tawny frogmouths (*Podargus strigoides*) presented for veterinary care

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AUSTRALIAN SMALL ANIMAL VETERINARIANS

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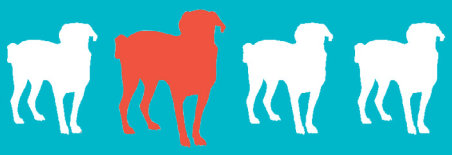

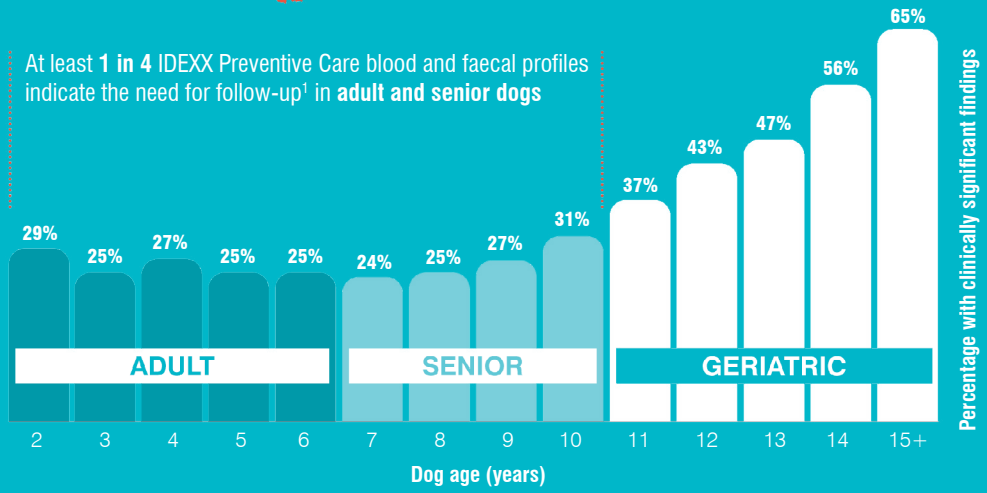


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Cover photo courtesy BW Parry


AUSTRALIAN SMALL ANIMAL VETERINARIANS

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# A few words from the editor

Welcome to the June issue of the AVP, where there are 4 thought-provoking case reports and a review article 'with a difference'. They show the remarkable diversity of cases and species that find their way to veterinary practices on a regular basis.

I hope that you find this issue both useful and interesting. Perhaps it will also prompt you to consider sharing an interesting or unusual case that you have seen? Writing a scientific paper may seem daunting at first, but it is no more difficult than performing a thorough clinical examination and formulating a treatment plan. If you are tempted to give it a go, contact me for assistance.

Meanwhile, have a read of these articles.....

**Campbell, Pan and Doneley**, from The University of Queensland at Gatton, review the outcomes for injured tawny frogmouths presented to the veterinary teaching hospital over a 9-year period and propose a simple flowchart to assist clinicians with the triage of such cases. An interesting study, even if you do not see these statuesque birds amongst the wildlife cases entering your practice (pp. 84-95).

**McGregor, O'Brien, Harrington and Donato**, from the Royal Veterinary College in London, present a case of leptospirosis in a puppy and focus on the abdominal ultrasonography, which revealed bilateral nephropathy, retroperitoneal fluid and a large amount of heterogeneous hyperechoic material within the gallbladder lumen. Unfortunately, the puppy's condition worsened and he was euthanased. Post mortem examination allowed correlation of ultrasound images and necropsy findings, which established a diagnosis of a haemocholecyst. See pp. 97-102 to test your imaging interpretations.

**Tardiani, Goldsmid and Chau**, from the Animal Referral Hospital in Homebush, discuss a couple of young male dogs with urinary incontinence. An unusual occurrence per se, made the more interesting when computed tomography permitted a diagnosis of congenital prostatic urethral dilation in both dogs (one castrated and the other entire). How would you treat such a case? Read more on pp. 104-113.

**Vila, Wolf, Garcia, da Costa, Froes and Sousa**, from the Federal University of Paraná in Brazil, were referred a German shepherd puppy for investigation of lethargy, exercise intolerance and a grade V/VI systolic murmur. Sounds simple, but thanks to echocardiography and computed tomography, a complex set of cardiac abnormalities were revealed. Another case to hone your imaging skills (pp. 114-124).

Finally, **Wun, Cook and Malik**, from the Animal Referral Hospital Brisbane and the Centre for Veterinary Education (Sydney), have a kitten that developed a hoarse, raspy breathing pattern the day after being spayed under a general anaesthetic but without endotracheal intubation (pp. 125-129). What are your differential diagnoses for such a dyspnoeic case?

Stay COVIDsafe.

**Regards, Bruce**

**Professor emeritus Bruce W. Parry**

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# Morbidity and mortality in tawny frogmouths (*Podargus strigoides*) presented for veterinary care

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**ABSTRACT** The tawny frogmouth (*Podargus strigoides*) is commonly presented to veterinary clinics by members of the public for assessment and treatment. However, little information exists on the treatment and outcomes of commonly occurring injuries. In the present study, records of these birds admitted to the University of Queensland Veterinary Teaching Hospital (UQVTH) between 2012-2020 were reviewed for the reasons for presentation, their diagnosis and the case outcome.

The most common reason for presentation was motor vehicle impact, with wing fractures the most common diagnosis. More than half of the admissions (57%) resulted in euthanasia.

These findings provide a guide for the prognosis of the most common injuries and the most likely outcomes for these birds at the UQVTH. Using this information, a flowchart was created to provide a simple and user-friendly way for veterinary clinics to triage injured tawny frogmouths.

**KEYWORDS** tawny frogmouth, Podargus strigoides, triage, wildlife

**ABBREVIATIONS** UQVTH, University of Queensland Veterinary Teaching Hospital

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*Podargus strigoides*, commonly known as the tawny frogmouth, is found only in Australia.[1] This species is a nightjar, belonging to the order Caprimulgiformes, although it is commonly mistaken by both the public and veterinarians as an owl. It is classified as least concern on the IUCN Red List, as they have adapted well to urbanisation and there are stable populations scattered across Australia (except in drier areas).[2]

Their adaptation to urban life frequently brings them into conflict with humans and technology. As human activities such as farming, housing, road construction, and the associated infrastructure continue to expand, increased interaction and conflict between humans, other animals, and tawny frogmouths must be expected.

The consequences of these interactions and conflicts include a reduced ability to forage, reduced prey or food availability, altered immune function (e.g. through chemical exposure), and diminished breeding success. Changes to any of these life traits can compromise the persistence of native fauna populations in the wild.[3]

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Despite, or perhaps due to, their wide distribution, vast populations, and least concern conservation status, there are few studies regarding how commonly and why these birds are presented to veterinary clinics for medical attention, and the outcome after presentation.

A review of presentations and treatment outcomes in a veterinary hospital will lead to a better understanding of why these birds come into care and help develop a triage protocol for admissions to gain better patient outcomes, and perhaps reduce the number of birds referred by veterinary practices to wildlife hospitals.

## METHODS AND MATERIALS

### Study site

Hospital records were examined from the University of Queensland Veterinary Teaching Hospital (UQVTH) in Gatton, Queensland. The UQVTH has collected data from all wildlife admissions since its opening in 2010. Gatton is in the Lockyer Valley, 90 km west of Brisbane. This area is in the centre of the proposed western corridor, linking Brisbane and Toowoomba, and is rapidly becoming more urbanised. Nevertheless, vegetable and other small crop farming is the main land use in the region.

The majority of UQVTH admissions come from an area with an approximate radius of 100 km, covering western Brisbane to Toowoomba, and often from further west. The estimated population in the Lockyer Valley is 42,000 people. This area is predominantly open farmland with clumps of native vegetation, especially on hills and ridges, and several small towns. Rainfall is lower than in the coastal regions and drought is not uncommon. Temperatures average 24.4 °C (January) to 13.4 °C (July), although extremes are not uncommon.

The UQVTH is staffed all year, 24-hours-a-day, with small animal emergency care clinicians available around the clock. The hospital's primary focus is teaching final year veterinary and veterinary technology students. Student participation in wildlife care is required and maximum use is made of every learning opportunity (unless patient welfare would be compromised). These learning opportunities are included in the UQVTH budget and supported by philanthropic donations. As a result, patient evaluation and treatment is often at a higher level than achievable in privately-owned (and often financially constrained) veterinary practices. Long-term rehabilitation facilities are not available onsite. Animals requiring rehabilitation are transferred to wildlife carers and wildlife hospitals after initial treatment.

Approximately 2,000 wildlife patients, of all species, are admitted and treated annually (unpublished data).

### Data collection and analysis

The study was carried out by extracting the data on all admissions of tawny frogmouths to the UQVTH from the onsite database (RxWorks™) from 2012-2020. The total number of avian wildlife admissions during this period was also determined.

Data were examined by calendar year and by quarter (December-February, March-May, June-August, September-November) to produce a seasonal trend pattern.

Seven records were lacking in detail, but the remaining data were analysed and categorised to identify the reasons for presentation, diagnosis of their condition, and the outcome for each. No details on diagnostic testing or imaging or treatment were evaluated. The reasons for presentation were categorised and ranked from the highest occurrence to the lowest. The same was done for conditions diagnosed after

examination and the outcomes for each case. Several duplications were noted where birds were presented with multiple diagnoses. In such cases, the most severe injury (i.e. the injury most likely to prevent rehabilitation and release) was the deciding factor in the triage process. However, such entries were infrequent and so it was assumed they had minimal impact on the overall data.

These reasons for presentation were then plotted against the outcomes and the number of times each scenario occurred was recorded.

### Study Limitations

Several limitations were identified in assessment of the data. The largest was the completeness of the medical records. With multiple staff inputting data, at different times of the day, and the background pressure of clinical duties, record-keeping was not always optimal.

Another limitation was following birds after discharge to carers and wildlife hospitals. Feedback from these groups was often non-existent and so final outcomes (died in care, euthanased elsewhere, or released) were unknown for many birds.

Finally, the inexperience of staff in identifying bird species may have resulted in the misclassification of tawny frogmouths as owls, thus under-counting of the number of tawny frogmouths.

## RESULTS

Out of 1440 birds that were presented to the UQVTH over the 9-year period, 263 (18%) were tawny frogmouths. The majority of tawny frogmouth admissions were in spring and summer (Table 1, Figure 1).

The most common reasons for presentation were vehicular trauma, (31%), 'found on ground' (19%), and 'found on road' (13%), although these may all have been the result of vehicular trauma. Wire 'hits' (collisions with wire fences and high-tension wires) accounted for another 6% of presentations. Attacks by domestic pets were low (dogs 2%, cats 1%). In many cases, however, the reason for presentation was unclear (Table 2). When the diagnosis was grouped more broadly, traumatic injuries (associated with motor vehicles, fences, and domestic pets) were the most common reason for presentation, with 63% of presentations directly attributed to some form of trauma.

Fractures involving the long bones of the wing and the legs were the most common injury (25%), followed by eye injuries (hyphaema, retinal detachment, globe collapse, and uveitis; 14%) and neurological signs (13%; Table 3). Less common injuries and diseases included fractured scapulae, fractured coracoid bones, possible clavicular fractures, beak injuries, haemorrhage from the mouth, emaciation, haematoma, heat stress, and possible neoplasia. Many of these conditions were uncommon, some being diagnosed only once.

The majority (57%) of all admissions were euthanased (Table 4). When the number of tawny frogmouths that died in the clinic from their injuries is included, 59% of admissions resulted in death (Table 4).

Euthanasia was the predominant outcome for those birds that were suffering from severe trauma (i.e. traumatic injuries, such as open fractures, fractures involving joints, or loss of sight in one or both eyes, that would make rehabilitation and release unlikely). This included 70% of those believed to have been hit by a vehicle, 75% of those caught in fences (75%), and 57% of those attacked by other animals (cats 100%, dogs 40%). Those least likely to be euthanased were orphaned nestlings, those with medical issues (such as emaciation, heat stress, inappetance, and toxicosis), or those with mild neurological signs (Table 5 and Figure 2).

Based on these findings an algorithm was developed for the triage of tawny frogmouths admitted for veterinary attention (Figure 3).

**Table 1.** Seasonal pattern in numbers seen annually (averaged by season), 2012-2020

| | Summer (Dec-Feb) | Autumn (Mar-May) | Winter (Jun-Aug) | Spring (Sep-Nov) | Total (Annual) | Mean (Monthly) | SD | SE |
|---|---|---|---|---|---|---|---|---|
| 2012 | 0 | 1 | 0 | 0 | 1 | 0.08 | 0.50 | 0.14 |
| 2013 | 4 | 1 | 0 | 4 | 9 | 0.75 | 2.06 | 0.60 |
| 2014 | 6 | 4 | 4 | 3 | 17 | 1.42 | 1.26 | 0.36 |
| 2015 | 3 | 6 | 8 | 8 | 25 | 2.08 | 2.36 | 0.68 |
| 2016 | 9 | 1 | 0 | 5 | 15 | 1.25 | 4.11 | 1.19 |
| 2017 | 10 | 15 | 6 | 18 | 49 | 4.08 | 5.32 | 1.53 |
| 2018 | 17 | 13 | 10 | 15 | 55 | 4.58 | 2.99 | 0.86 |
| 2019 | 24 | 14 | 9 | 11 | 58 | 4.83 | 6.66 | 1.92 |
| 2020 | 10 | 6 | 10 | 8 | 34 | 2.83 | 1.91 | 0.55 |
| Total (Season) | 83 | 61 | 47 | 72 | 263 | | | |
| Mean (Season) | 9.22 | 6.78 | 5.22 | 8.00 | | | | |
| SD | 7.43 | 5.78 | 4.35 | 5.83 | | | | |
| SE | 2.48 | 1.93 | 1.45 | 1.94 | | | | |

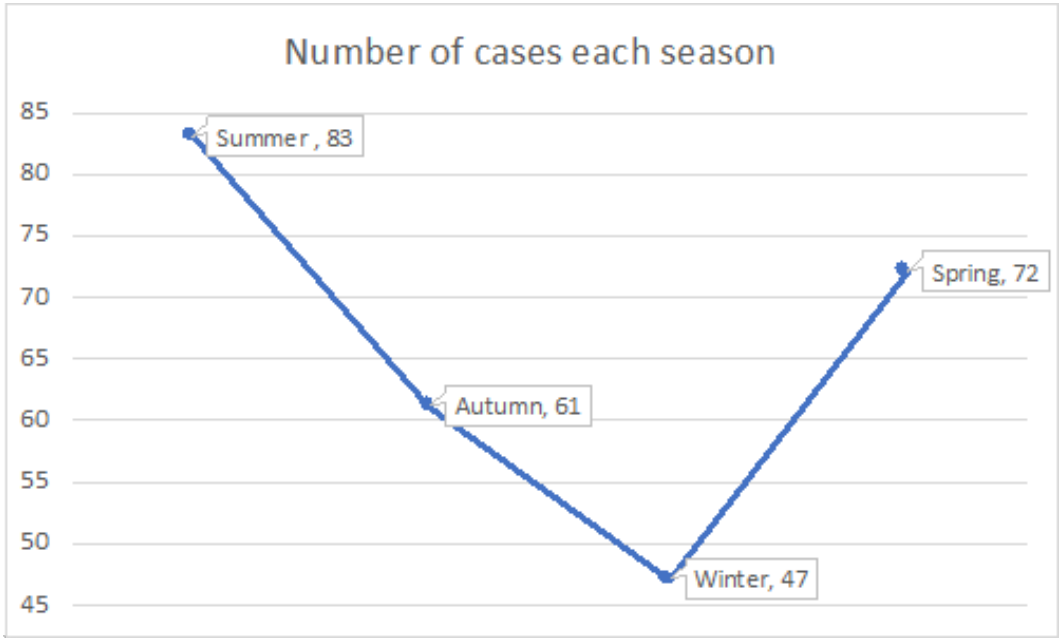



**Figure 1.** Seasonal pattern in numbers of tawny frogmouths seen annually (total by season), 2012-2020

**Table 2.** Reasons for presentation of tawny frogmouths, 2012-2020, ranked by frequency of occurrence

| Reason for presentation | Number | % |
|---|---|---|
| Hit by car | 82 | 31 |
| Found on ground | 51 | 19 |
| Found on road | 34 | 13 |
| Unable to fly | 26 | 10 |
| Not supplied | 24 | 9 |
| Caught in fence | 16 | 6 |
| Attacked by birds | 6 | 2 |
| Dog attack | 5 | 2 |
| Chronic regurgitation | 3 | 1 |
| Injured wing | 3 | 1 |
| Cat attack | 2 | 0.8 |
| Assumed injured wing | 1 | 0.4 |
| Caught in high tensile wires | 1 | 0.4 |
| Feathers missing | 1 | 0.4 |
| Found on car roof | 1 | 0.4 |
| Head trauma | 1 | 0.4 |
| Inappetence | 1 | 0.4 |
| Left in box at front gate | 1 | 0.4 |
| Orphaned nestling | 1 | 0.4 |
| Paresis | 1 | 0.4 |
| Possible attack by dogs | 1 | 0.4 |
| Unable to stand | 1 | 0.4 |
| **Total** | **263** | **100** |

**Table 3**. Diagnoses of tawny frogmouth cases presented for care 2012-2020, ranked by frequency of occurrence

| Diagnosis | Number | % |
|---|---|---|
| Fractured wing | 59 | 20 |
| Not recorded | 44 | 15 |
| Eye injury | 41 | 14 |
| Neurological signs | 37 | 13 |
| No abnormalities detected | 35 | 12 |
| Fractured leg | 10 | 3 |
| Deep wounds | 8 | 3 |
| Ruptured air sac | 8 | 3 |
| Fractured coracoid | 6 | 2 |
| Infection | 5 | 2 |
| Superficial wounds | 4 | 1 |
| Shock | 4 | 1 |
| Fractured beak | 3 | 1 |
| Toxicosis | 3 | 1 |
| Fractured clavicle | 3 | 1 |
| Possible wing fracture (not specified) | 3 | 1 |
| Subluxation of wing | 2 | 0.7 |
| Inappetence | 2 | 0.7 |
| Subluxation of coracoid | 2 | 0.7 |
| Orphaned nestling | 1 | 0.3 |
| Fractured scapula | 1 | 0.3 |
| Emaciated | 1 | 0.3 |
| Haematoma | 1 | 0.3 |
| Heat stress | 1 | 0.3 |
| Possible clavicular fracture | 1 | 0.3 |
| Haemorrhage | 1 | 0.3 |
| Beak injury | 1 | 0.3 |
| Possible neoplasia | 1 | 0.3 |
| Possible coracoid fracture | 1 | 0.3 |
| **Total** | **289*** | **100** |

* Some birds had more than one diagnosis, hence total is greater than the 263 birds that were seen

**Table 4.** Treatment outcomes for tawny frogmouths presented for care 2012-2020

| Outcomes | Number | % |
|---|---|---|
| Euthanasia | 164 | 57 |
| Died before treatment | 3 | 1 |
| Died after treatment | 2 | 1 |
| Released to carer with treatment - same day | 21 | 8 |
| Released to carer with treatment - within 3 days | 11 | 4 |
| Released to carer with treatment - after 3 days | 6 | 2 |
| Released to carer without treatment | 22 | 8 |
| Not supplied | 47 | 18 |
| **Total** | **263** | **100** |

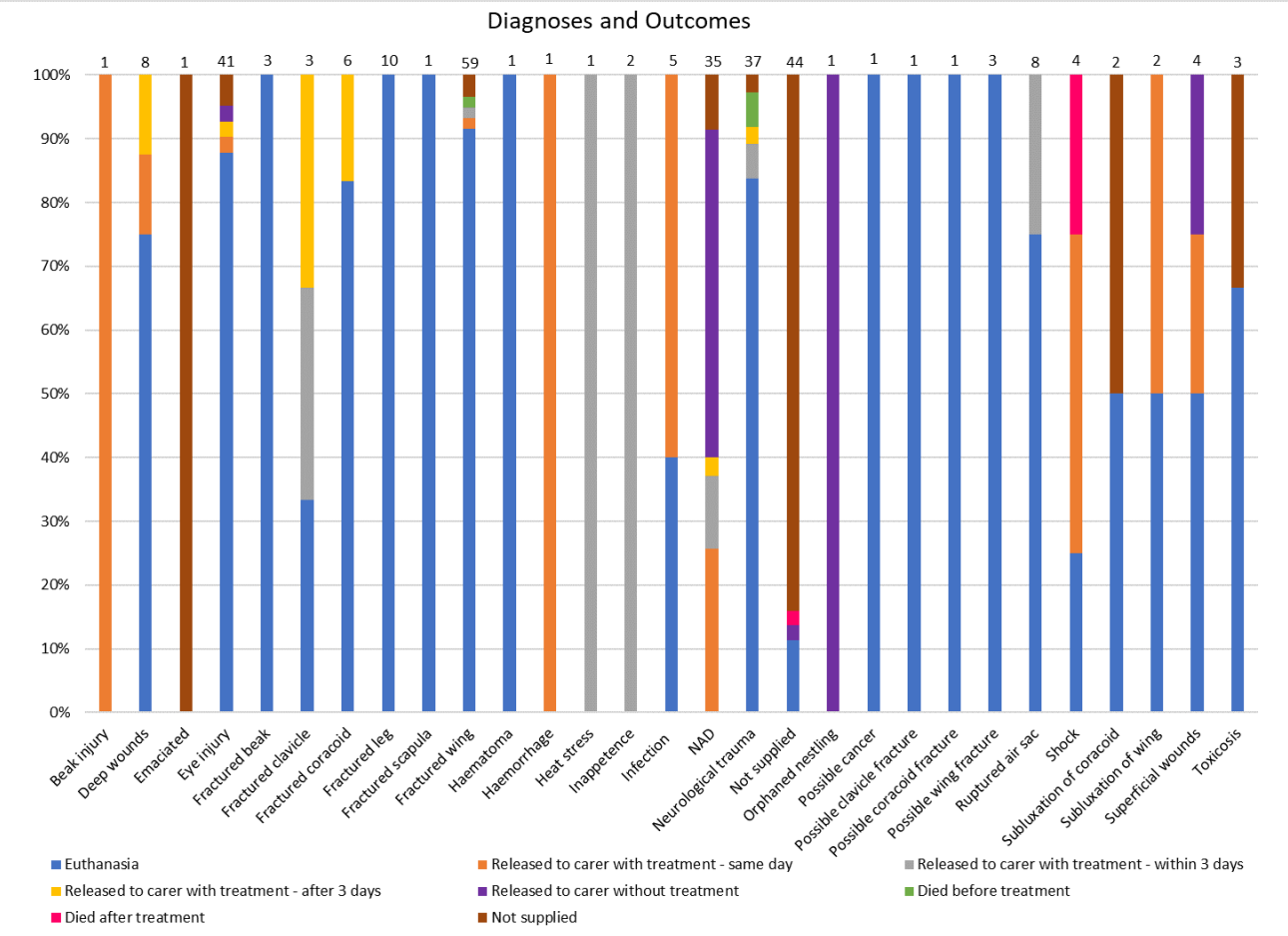


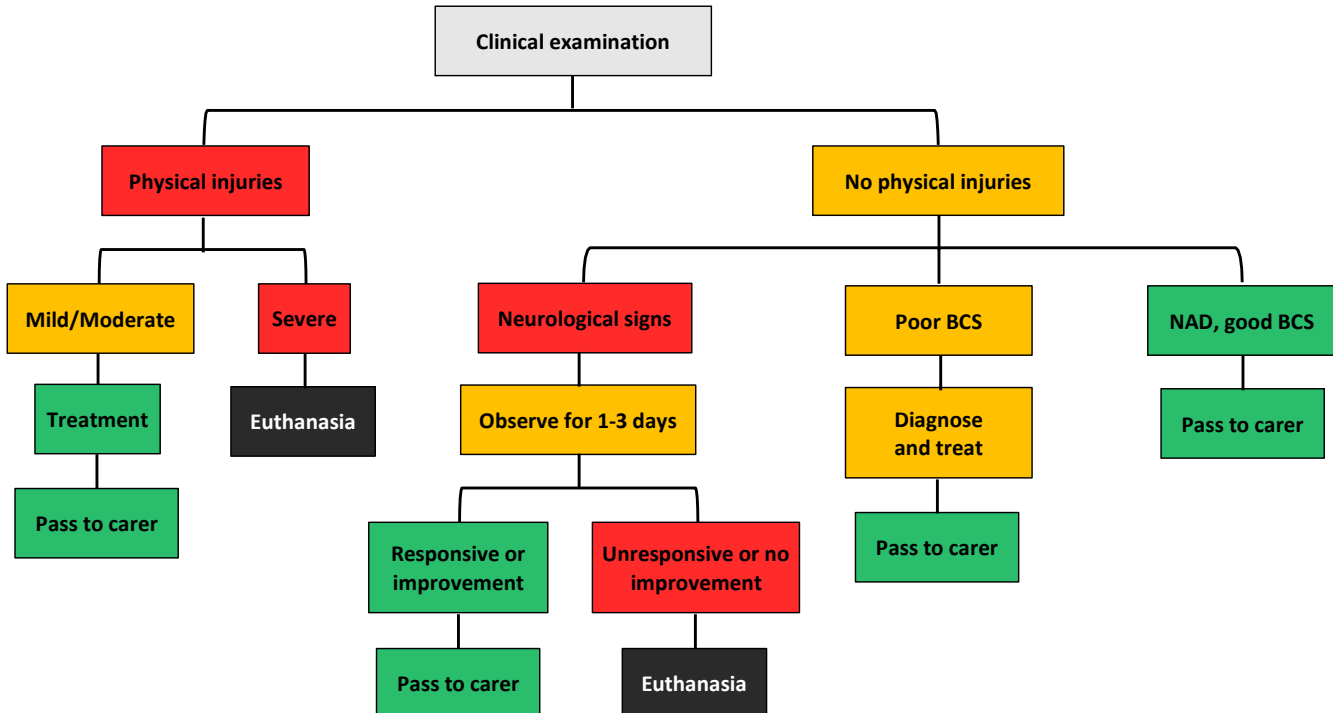

**Figure 2.** Diagnosis vs Outcome for tawny frogmouths presented for care, 2012-2020

**Table 5**. Diagnoses and outcomes for tawny frogmouths presented for care 2012-2020

| Diagnosis | Outcome; number of animals and (%) | | | | |
|---|---|---|---|---|---|
| | Euthanased | Died | Released to a carer | Not recorded | Total |
| Fractured wing | 54 (92%) | 1 (2%) | 2 (3%) | 2 (3%) | 59 |
| Not supplied | 5 (11%) | 1 (2%) | 1 (2%) | 37 (84%) | 44 |
| Eye injury | 36 (88) | 0 | 3 (7%) | 2 (5%) | 41 |
| Neurological signs | 31 (84%) | 2 (5%) | 3 (8%) | 1 (3%) | 37 |
| No abnormalities detected | 0 | 0 | 33 (91%) | 3 (9%) | 35 |
| Deep wounds | 6 (75%) | 0 | 2 (25%) | 0 | 8 |
| Fractured coracoid | 5 (83%) | 0 | 1 (17%) | 0 | 6 |
| Superficial wounds | 2 (50%) | 0 | 2 (50%) | 0 | 4 |
| Shock | 1 (25%) | 1 (25%) | 2 (50%) | 0 | 4 |
| Toxicosis | 2 (67%) | 0 | 0 | 1 (33%) | 3 |
| Infection | 2 (40%) | 0 | 3 (60%) | 0 | 5 |
| Ruptured air sac | 6 (75%) | 0 | 2 (25%) | 0 | 8 |
| Fractured clavicle | 1 (33%) | 0 | 2 (67%) | 0 | 3 |
| Fractured beak | 3 (100%) | 0 | 0 | 0 | 3 |
| Subluxation of wing | 1 (50%) | 0 | 1 (50%) | 0 | 2 |
| Inappetence | 0 | 0 | 2 (100%) | 0 | 2 |
| Subluxation of coracoid | 1 (50%) | 0 | 1 (50%) | 0 | 2 |
| Fractured scapula | 1 (100%) | 0 | 0 | 0 | 1 |
| Emaciated | 0 | 0 | 0 | 1 (100%) | 1 |
| Haematoma | 1 (100%) | 0 | 0 | 0 | 1 |
| Heat stress | 0 | 0 | 1 (100%) | 0 | 1 |
| Possible clavicle fracture | 1 (100%) | 0 | 0 | 0 | 1 |
| Haemorrhage | 0 | 0 | 1 (100%) | 0 | 1 |
| Beak injury | 0 | 0 | 1 (100%) | 0 | 1 |
| Possible neoplasia | 1 (100%) | 0 | 0 | 0 | 1 |
| Possible wing fracture | 3 (100%) | 0 | 0 | 0 | 3 |
| Possible coracoid fracture | 1 (100%) | 0 | 0 | 0 | 1 |
| Fractured leg | 10 (100%) | 0 | 0 | 0 | 10 |
| Orphaned nestling | 0 | 0 | 1 (100%) | | 1 |

* Some birds had more than one diagnosis, hence total is greater than the 263 birds that were seen

**Figure 3.** Triage flowchart for tawny frogmouths presented for veterinary care




## DISCUSSION

Tawny frogmouths are commonly presented to the UQVTH. An internal review of the hospital caseload showed that they were the most common wild avian species presented for care, (9.3% of admissions) while lorikeets (*Trichoglossus spp*) and kookaburras (*Dacelo novaeguineae*) ranked a close equal second with 8.9% each (Doneley, unpublished data). This figure is lower than another study[3] that showed tawny frogmouths made up 17.3% of all wild birds admitted to a large wildlife hospital in a coastal region over an 11-year period. The latter study also showed that this grouping (lorikeets, tawny frogmouths and kookaburras) were the most common wild birds presented for veterinary care in coastal Queensland.

The difference in admissions between the studies likely reflects the difference in species distribution and population densities (both human and avian) between the Lockyer Valley and coastal Queensland. Tawny frogmouths are commonly found where trees, open spaces, and reliable water sources are available, such as terrestrial shrublands, forests, and grasslands.[2] They are less likely to be found in densely forested regions but can be found on fringes of rainforests and in suburban areas where they appear to thrive near people.[4,5] Although they are considered one of the most common nocturnal avian species, they are rather elusive and not sighted as frequently as expected despite their wide distribution.[4]

The lower number of case presentations during winter in the present study is consistent with other papers.[3,6] This may be explained by the bird's natural biology. It appears that they are less active and may even undergo shallow torpor for several hours during the cold nights or early mornings of winter to conserve their body heat and energy.[7] Tawny frogmouths may be able to do this as they appear to accumulate fat in preparation for the winter when resources are low.[8] This would influence the movement of birds; during the warmer months they are actively hunting at night but are much less active throughout winter, and therefore less

likely to come into conflict with humans, their infrastructure, and their pets.

Trauma is a major reason for presentation with motor vehicle collisions, wire fence hits, and attacks by domestic pets being most common. The high incidence of known and presumed motor vehicle collisions is consistent with another study[3] that showed 73% of tawny frogmouth admissions to a wildlife hospital were due to vehicle collisions.[3] The latter may partially be explained by the natural biology of tawny frogmouths. They are nocturnal and live in pairs, usually occupying the same territory for long periods of time.[9] Tawny frogmouths consume mainly invertebrates, such as beetles, moths, spiders, centipedes, and caterpillars (although they have also been known to consume frogs and mice).[10] They use their beaks, rather than their feet, to catch prey. Although they may be ambush predators, waiting for their food to pass by, most actively hunt on the ground, in the trees and whilst flying.[1] The ability to snatch their prey mid-flight allows these birds to exploit man-made lighting (such as streetlights and car headlights) that attract insects such as moths.[1] The potential negative aspect to this hunting behaviour is their tendency to swoop in front of the headlights of oncoming vehicles.

Tawny frogmouths in the present study that were diagnosed with neurological signs likely included some with neuroangiostrongylosis. The latter can only be definitively diagnosed by histopathology,[11,12] a level of investigation not undertaken by the UQVTH or many private veterinary practices. Given the apparently increasing incidence of this disease, further research in this area is warranted.

The comparatively low number of orphans seen in the present study (0.4%), compared to another study (10.8%),[3] may reflect that (in the Lockyer Valley) they may be passed directly to wildlife carers rather than for veterinary attention. The tawny frogmouth breeding season occurs from August to December.[5] Pairs construct flimsy and unstructured nests, preferably in eucalyptus trees.[13] These shallow nests are constructed from thin twigs, lined with leaves and pieces of eggshells and therefore disintegrate easily. Strong winds, heavy rains and even the fledglings' behaviour can dislodge them from the nest with ease.[1] Many fledglings have been sighted roosting on the supporting branches with the nest no longer viable.[7] It is hardly surprising that in such circumstances orphaned nestlings come into care. Although carers (in Queensland) are supposed to present these birds to a veterinarian for assessment,[14] many do not do so (Doneley, personal observation).

The high number of unknown causes for presentation may reflect inadequate record keeping, an issue that all veterinary clinics face when dealing with wildlife. Currently there is no requirement for veterinary practices to report or record the number of wildlife patients admitted to their practices.[15] There is, however, a requirement to keep a medical record on each patient seen. Improved record-keeping by veterinary staff would greatly assist in retrospective data analysis and better quantify the veterinary contribution to wildlife care.

The majority (59%) of tawny frogmouths presented to the UQVTH in the period 2012-2020 were euthanased or died. This number may be an understatement when the numbers of patients with incomplete records are taken into consideration. This finding is consistent with a study that showed 73% of tawny frogmouths admitted to a wildlife hospital were euthanased,[3] and another that showed 56-66% of all wild birds that were admitted died or were euthanased.[6]

There are few large wildlife hospitals in Australia, and they are usually concentrated around major population centres. Private veterinary practices therefore become the frontline in examining, triaging, and treating wildlife. A recent survey[12] of 131 veterinary practices found that 45% of these practices saw <5 wildlife cases/week, 37% saw 5-10 cases/week, 11% saw 10-15 cases/week, 3% saw 15-20 cases/week, and 3% saw >20 cases/week.

The same survey indicated that wildlife cases were only examined immediately upon presentation in 20% of the practices, with 74% reporting they only attended to wildlife whenever they had spare time. The reasons given for this delay in treatment were lack of time (26%), lack of knowledge and skills (26%), cost (17%), and a lack of wildlife-specific equipment and resources (14%). Most of the veterinary practices (90%) reported that they never (or rarely) received reimbursement for their wildlife work.

Given that the present review, and other surveys and reviews,[3,6,12] indicate that the majority of birds were presented for trauma (particularly cars and domestic pets) and that the majority of these birds were euthanased after examination, the development of a triage system may allow veterinary practices to more efficiently and rapidly assess wildlife patients on presentation and decide on treatment options that may reduce the waiting times (and suffering) for wildlife cases presented for veterinary care.

Triage is the process of determining the priority of patients' treatments by the severity of their condition or likelihood of recovery with and without treatment. Good triage determines the order of treatment and is useful when resources are insufficient for all patients to be treated immediately and to a high level. Wildlife cases may be triaged into three categories: 1) those with little or no chance of successful rehabilitation; 2) those that could be rehabilitated and released but will require extended treatment and hospital care; and 3) those who require little or no veterinary care and are likely to be successfully rehabilitated and released (Doneley, personal observation). Those cases falling into Category 1 should be euthanased immediately. Category 2 cases should be assessed with a view to available resources for treatment and if resources are scarce they should also be euthanased immediately. Category 3 patients should be assessed, treated appropriately, and passed on to a wildlife carer the same day.

Using the data obtained in the present review, the authors have developed a flowchart to triage tawny frogmouths (Figure 3), which may be suitable for other species.

## CONCLUSION

Tawny frogmouths are commonly presented during spring and summer when they are most active. A large proportion of these birds have suffered traumatic injuries, usually from cars but also domestic pets and fences. Many of these birds are euthanased as successful rehabilitation and release is unlikely. Knowing these likely outcomes and using a flowchart to assist decision-making may allow clinicians to respond rapidly and appropriately to wildlife cases, thus reducing treatment waiting times and animal suffering.

## CONFLICTS OF INTEREST AND SOURCES OF FUNDING

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# Abdominal ultrasonographic findings and post mortem diagnosis of a haemocholecyst in a case of canine leptospirosis

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**ABSTRACT** A 2-month-old male entire Bichon-Frise cross was referred to an emergency and critical care service in the United Kingdom with a 24-hour history of vomiting, diarrhoea, anorexia and lethargy. Physical examination revealed icteric mucous membranes and hypersalivation but was otherwise unremarkable. Haematology and biochemistry revealed a leucocytosis with neutrophilia, normocytic hypochromic anaemia, thrombocytopenia, hypoproteinemia, hyperkalaemia, hypochloraemia, hypercalcaemia, hyperphosphataemia, azotaemia, and hyperbilirubinaemia. Microbiology and parasitology performed on a faecal sample were unremarkable. Polymerase chain reaction (PCR) performed on a blood sample confirmed leptospirosis. An abdominal ultrasound revealed bilateral nephropathy, retroperitoneal fluid and a marked amount of heterogeneous hyperechoic material within the gallbladder lumen. The patient developed anuria while hospitalised and despite attempting peritoneal dialysis, humane euthanasia was eventually elected. Post-mortem examination revealed moderate diffuse icterus, multifocal petechial haemorrhages and multifocal neutrophilic and lymphoplasmacytic interstitial nephritis with tubular degeneration and necrosis, consistent with leptospirosis. The gallbladder contained a moderate amount of dark red, gelatinous material, consistent with a blood clot (haemocholecyst).

To the authors' knowledge, only one other report has correlated sonographic and post mortem findings of gallbladder haemocholecyst formation in a dog affected by leptospirosis. Haemocholecyst formation may therefore be taken into consideration in the list of ultrasonographic differential diagnoses for intraluminal echogenic, poorly-mobile, non-vascularised and non-shadowing material within the gallbladder lumen, in patients affected by leptospirosis.

**KEYWORDS** dog, haemocholecyst, histopathology, leptospirosis, ultrasonography

**ABBREVIATIONS** DIC, disseminated intravascular coagulation; DNA, deoxyribonucleic acid; EDTA, ethylene diamine tetraacetic acid; PCR, polymerase chain reaction

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Leptospirosis is a worldwide zoonotic bacterial disease caused by spirochaetal bacteria of the genus *Leptospira*.[1] It has been reported in over 150 mammalian species[2] and is considered to be a re-emerging disease both in humans and dogs.[3-8] Approximately 250 different serovars have been identified, of which six to eight are thought to be pathogenic in the dog.[9] Leptospires are shed in the renal tubules of mammalian hosts, and incidental hosts are infected by contact of mucous membranes or abraded skin with infected urine, or contaminated water, soil or bedding.[3] Infection can result in disease of varying severity depending on the strain of bacteria involved and host immune response. While some animals show minimal to no clinical signs, others develop multi-organ disease including acute kidney injury, liver disease, pulmonary disease and, less commonly, a haemorrhagic syndrome.[8,10]

Ultrasound has commonly been used for investigation of abdominal pathology resulting from leptospirosis, and sonographic findings have been described extensively in the literature, in particular relating to the kidneys and liver.[8,11-19] More recently, the abnormal ultrasonographic appearance of the gallbladder has been described in dogs affected by leptospirosis.[13,17-20] The literature describing gallbladder pathology in cases of leptospirosis is scarce, with only a few reports describing acute cholecystitis in human patients,[21,22] or in veterinary patients.[18,20]

The term haemocholecyst refers to the presence of a blood clot within the gallbladder.[23] The pathogenesis of haemocholecyst formation has been described in the human literature,[23-26] although, to the authors' knowledge, no reports describe haemocholecyst formation secondary to leptospiral infection in humans. A histopathological diagnosis of haemorrhagic necrotising cholecystitis secondary to leptospirosis has been described in a single veterinary case report.[18] Although the haemorrhagic potential of leptospirosis is well recognised,[27] the mechanisms of haemorrhage are not yet clearly understood.[10] The present case report attempts to help gain further understanding of the pathology of the gallbladder in leptospiral infections, by describing the ultrasonographic appearance and post mortem findings in the gallbladder of a puppy diagnosed with leptospirosis.

## CLINICAL FEATURES

A two-month-old male entire Bichon-Frise cross dog was referred to an emergency and critical care service in the United Kingdom with a 24-hour history of vomiting, diarrhoea, anorexia and lethargy. The puppy had been in the owner's possession for two weeks prior to presentation, received his first vaccination 11 days earlier, had been wormed by the breeder and was fed an adequate quality commercial puppy food. The puppy was reported to have had not yet interacted with any other animals, although a fox had regularly been seen in the garden.

On presentation, the patient appeared lethargic, although alert and responsive. Physical examination revealed icteric mucous membranes and hypersalivation suggestive of nausea, but was otherwise unremarkable. Body weight was 2.32 kg with a body condition score of 4/9.

Haematology revealed a leucocytosis (20.4 x $10^9$/L; reference interval (RI) 6-17.1), with a mature neutrophilia (17.8 x $10^9$/L; RI 3-11.5). There was a normocytic hypochromic anaemia, with haematocrit 0.23 L/L (RI 0.37-0.55). Platelets were clumped and decreased in number with platelet count 24 x $10^9$/L (RI 150-900).

Biochemistry revealed hypoproteinaemia (46 g/L; RI 54.9-5.3), due to hypoalbuminaemia (22 g/L; RI 26-38), with hyperkalaemia (6.7 mmol/L; RI 3.6-5.6), hypochloraemia

(94 mmol/L; RI 100-116), hypercalcaemia (3.03 mmol/L; RI 2.10-2.79), and hyperphosphataemia (4.8 mmol/L; RI 0.8-1.6). The dog was azotaemic with urea 63.2 mmol/L (RI 3.1-10.1) and creatinine 435 umol/L (RI 20-145). The bladder was empty, and a urine sample could not be obtained. Plasma appeared grossly icteric. Total bilirubin (87.4 umol/L; RI 0.1-4.2) and alkaline phosphatase (668 U/L; RI 0-130) were both increased.

Microbiology and parasitology performed on a faecal sample were unremarkable. A parvovirus antigen assay (SNAP ELISA, IDEXX Laboratories) was negative.

A full abdominal ultrasound performed by a board-certified radiologist (PDD) revealed bilateral nephropathy and retroperitoneal fluid. The gallbladder contained a marked amount of heterogeneous hyperechoic material, which filled most of the lumen. The gallbladder wall was homogenously thin (approximately 1 mm in thickness) and hyperechoic (Figure 1). The material did not appear to be vascularised with power Doppler examination, while multiple small vessels were seen within the gallbladder wall (Figure 2). The spleen was mottled in appearance. The kidneys were bilaterally hyperechoic, with reduction in corticomedullary definition and a moderate amount of retroperitoneal fluid (Figure 3). There was a mild degree of pyelectasia bilaterally (less than 2 mm). The duodenum and jejunum appeared slightly corrugated with reduced motility. The cranial abdominal mesentery was hyperechoic and there was a small amount of anechoic free peritoneal fluid.

DNA extracted from an EDTA blood sample was subjected to PCR amplification using a previously reported leptospira genus-specific protocol, confirming a diagnosis of leptospirosis.[28]

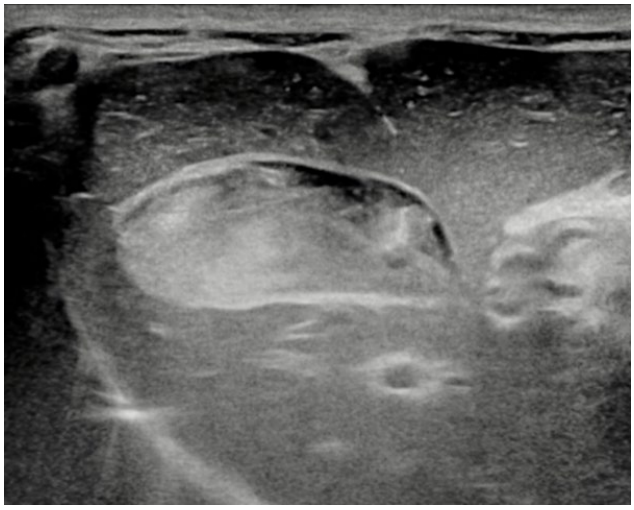

**Figure 1:** Long axis view of the gallbladder in B-mode. Notice the large amount of intraluminal echogenic material occupying most of the lumen of the gallbladder. The gallbladder wall is homogeneously thin (approximately 1 mm in thickness) and hyperechoic.

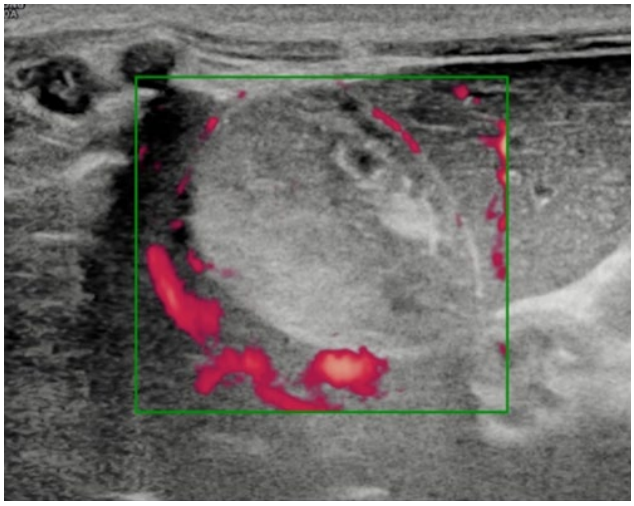

**Figure 2:** Long-axis view of the gallbladder in power Doppler-mode. Notice the gallbladder material does not appear to be vascularised, while multiple small vessels were seen within the gallbladder wall.

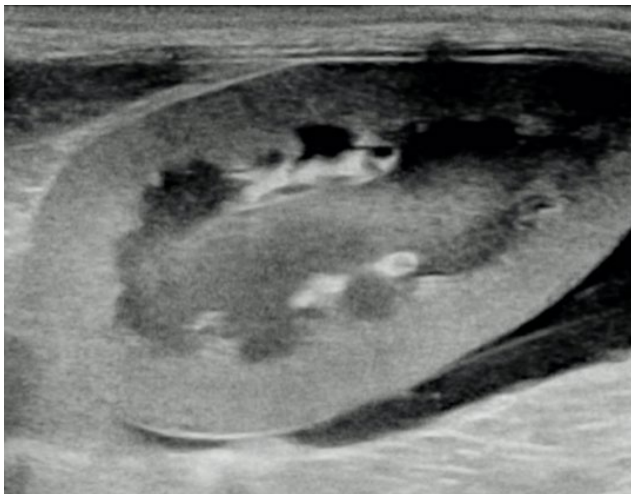

**Figure 3:** Long axis view of the left kidney in B-mode. Notice the hyperechoic cortex and the moderate amount of retroperitoneal fluid.

Supportive medical management was initiated with intravenous fluid therapy, anti-emetics (maropitant, 1mg/kg intravenously every 24 hours) and antibiotics (amoxycillin-clavulanate 20 mg/kg intravenously every 8 hours). Weight, urine output and acid-base balance were closely monitored. Unfortunately, the dog developed anuria while hospitalised, associated with marked hyperkalaemia and thrombocytopenia. Further treatment was attempted with peritoneal dialysis; however, the hyperkalaemia could not be controlled, and humane euthanasia was recommended.

A post mortem examination was performed. Gross examination revealed moderate diffuse icterus, multifocal subcutaneous oedema and multifocal petechial haemorrhages throughout the body, supportive of the clinical suspicion and positive PCR result of leptospirosis. The gallbladder contained a moderate amount of dark red, gelatinous material, consistent with a blood clot (haemocholecyst), and the common bile duct was not patent. Microscopic examination of the kidneys revealed mild, subacute, multifocal, neutrophilic and lymphoplasmacytic interstitial nephritis with tubular degeneration and necrosis (Figure 4). Within the cortical interstitium and perirenal adipose tissue were multifocal acute haemorrhages. There was mild, multifocal myocardial necrosis and haemorrhage in the heart, while the stomach, gallbladder and urinary bladder revealed moderate multifocal vascular congestion and haemorrhage (Figure 5). Microscopic examination of haematoxylin and eosin stained sections of the liver revealed mild to moderate hepatocellular necrosis and haemorrhage, while moderate, multifocal congestion, oedema and haemorrhage with pulmonary mineralisation were observed in the lungs. No spirochetes are observed within additional sections of kidney or liver with Warthin-Starry histochemical staining.

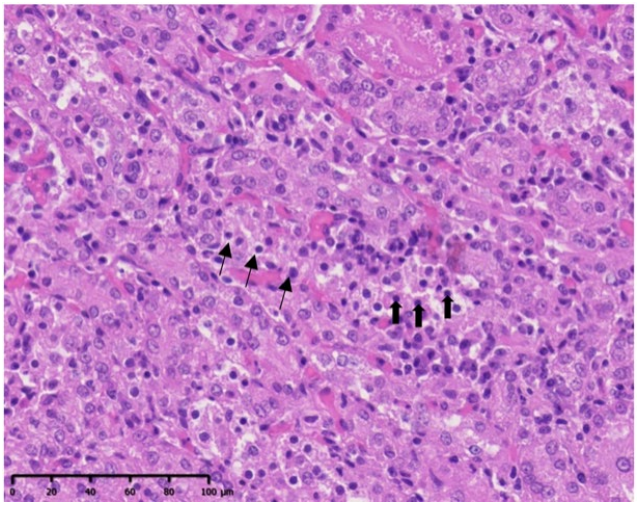


**Figure 4:** Histology of the renal cortex. There is multifocal tubular degeneration and necrosis denoted by cytosolic vacuolation (thin arrow) and pyknotic nuclei (thick arrow) of tubular epithelial cells with infiltrating interstitial lymphocytes, plasma cells, and neutrophils. Haematoxylin & eosin stain.

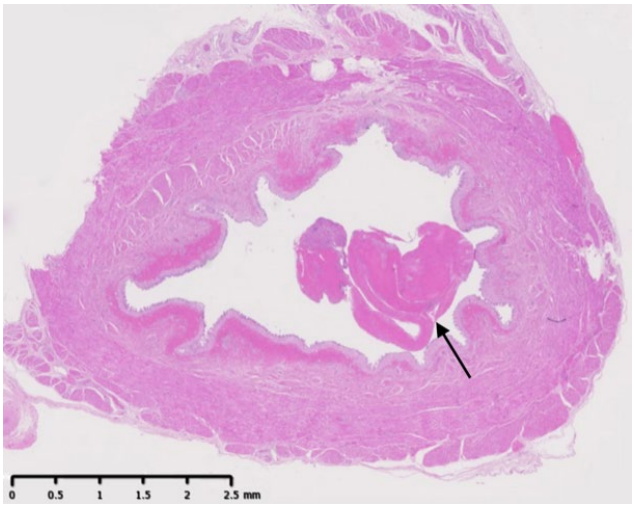


**Figure 5:** Histology of a coagulum of haemorrhage (haemocholecyst, arrow) within the gallbladder lumen. Haematoxylin & eosin stain.

## DISCUSSION

Abdominal ultrasonography is recommended for the investigation of multisystemic disease in all cases with a clinical suspicion for leptospirosis. The presence of at least one ultrasonographic abnormality has been reported to occur in every dog diagnosed with leptospirosis and changes have been noted to affect all organs except for the adrenal glands and organs of the reproductive tract.[8,11-19]

Historically, renal abnormalities have been cited most commonly, including renomegaly, increased cortical echogenicity, perirenal fluid, mild pyelectasia and a hyperechoic medullary band.[8,13,16,17,29,30] Other reported findings have included thickening of the gastric wall and less commonly the intestinal wall,[8,13,16,17] small intestinal corrugation, hyperechogenicity of the mucosa, decreased peristalsis and intussusception,[17] splenomegaly and mottled splenic architecture, mild abdominal lymphadenomegaly,[8,13,16] ascites and hepatomegaly.[13,16] Ultrasonographic appearance suggesting gallbladder disease has been described more recently, including biliary sludge, thickening and hyperechogenicity of the gallbladder wall,[13,17,18] gallbladder mucocoele[17] and an occluded bile duct.[13] Prevalence of gallbladder abnormalities was 60% in a recent paper (46% biliary sludge, 29% wall thickening, 26% mucocoele and 20% hyperechoic wall).[17] Differential diagnoses for echogenic material in the lumen of the gallbladder include biliary sludge, mucocoele, cholelith, neoplasia or haemocholecyst.[24] Echogenic gallbladder contents can be gravity-dependent, such as may be seen more commonly with biliary sludge or cholelithiasis. Biliary sludge is generally defined as variably gravity-dependent, hyperechoic, variably particulate material, without acoustic shadowing.[31-33] Choleliths are often mobile and gravity dependent, markedly echogenic, with acoustic shadowing.[31] Echogenic gallbladder contents can also be non-mobile and non-gravity dependent, such as may be seen more commonly with haemocholecysts, mucocoeles and neoplasia.[31] Neoplasia will generally appear as solid, non-dependent, non-shadowing but vascularised material. Mucocoeles can be recognised by the presence of an echogenic stellate or finely striated bile pattern with a hypoechoic rim, and are non-gravity dependent and do not demonstrate acoustic shadowing.[31,32] Haemocholecysts may be variable in appearance, depending on the severity or duration of the bleed. They should be considered as a differential diagnosis in cases with echogenic, poorly mobile, non-vascularised and non-shadowing material. The use of colour-flow Doppler or contrast-enhanced ultrasound may be useful in differentiating gallbladder debris or blood clots from neoplastic disease. In the present case, the material noted within the gallbladder lumen on ultrasonography was confirmed to represent a blood clot (haemocholecyst)[23-26] on post mortem examination, and was associated with obstruction of the common bile duct.

Pathology affecting the gallbladder as a result of leptospirosis remains poorly understood, though the development of acute cholecystitis has been described both in humans[21,22] and animals.[18,20] The pathogenesis of haemocholecyst formation is also poorly understood. It has been suggested that both the rate of bleeding and bile flow affect the tendency to form a clot, where clot formation is more likely to occur in association with minor bleeding. These clots can lead to cystic duct obstruction, cholecystitis and cholelithiasis when persistent, and even rupture of the gallbladder as a result of thinning and ischaemia of the gallbladder wall.[24,25,31] Their presence often remains silent and so haemocholecysts are often overlooked until complications occur.[24,34]

Direct causes of haemocholecyst formation (at the level of the gallbladder itself) include malignancy, cholecystitis, cholelithiasis, vascular disorders, coagulopathies and the presence of heterotopic gastrointestinal mucosa within the gallbladder.[24,25,35] There are also rare reports in the human literature of haemocholecyst formation as a result of complications of anticoagulant treatment.[34,36] Indirect causes, such as haemobilia, or bleeding of intrahepatic or bile duct origin, are thought to occur due

to iatrogenic or traumatic damage to the liver.[24,25] In one anatomicopathological study on 53 dogs, haemorrhage within the gallbladder (haemocholecyst) was observed on histopathological examination in 5.7% of the cases diagnosed with leptospirosis. Unfortunately, ultrasound findings were not available to correlate with histopathology in those dogs.[37]

While there are multiple reports in the literature of acute cholecystitis in cases of human leptospirosis, none appear to describe haemocholecyst formation. One veterinary paper describes a puppy with confirmed leptospirosis, demonstrating ultrasonographic changes consistent with cholecystitis (including a thickened gallbladder wall, echogenic material (biliary sludge) and a dilated bile duct), and histopathology of the gallbladder demonstrated a haemorrhagic necrotising cholecystitis.[18]

While the haemorrhagic potential of leptospirosis was observed as early as 1886,[27] the pathogenesis of haemorrhage remains poorly understood. One mechanism is likely related to a systemic vasculitis, due to direct invasion of the endothelium by leptospires, as well as secondary immune-mediated inflammation. Thrombocytopenia has been well documented in cases of leptospirosis and may further contribute to bleeding tendencies in the disease. Finally, the development of disseminated intravascular coagulation (DIC), is likely to be a contributing factor in the development of the haemorrhagic syndrome.[8,10,19] In the present case, histopathology confirmed widespread vascular congestion. While the latter can occur agonally, it was likely secondary to cardiogenic shock associated with renal failure and hyperkalaemia in this puppy. In many tissues there were multifocal petechial haemorrhages with bleeding into the bladder and gallbladder lumina, which suggested an underlying haemorrhagic diathesis, secondary to primary infection with leptospirosis or associated with DIC. The documented thrombocytopenia and possible development of DIC in the later stages may have contributed to the bleeding observed. Although Warthin-Starry staining of sections of liver and kidney did not reveal the presence of intralesional spirochetes, these histologic findings are consistent with the positive PCR for leptospira.

The diagnosis of a haemocholecyst remains difficult based on imaging studies alone. More cases are needed, with increased observation of subtle differences in gallbladder ultrasonographic findings in leptospirosis compared to other diseases. While blood clots are visible on ultrasound, these can be mistaken for other luminal echogenic structures of the biliary system. The presence of intraluminal material which is echogenic, poorly mobile, non-vascularised and non-shadowing should alert the clinician to the possibility of a haemocholecyst.[24] It is important that this differential diagnosis is considered early in case management to help prevent the development of complications such as biliary obstruction, cholecystitis, cholelithiasis or gallbladder rupture. Serial ultrasound examinations may be of benefit for monitoring such cases.

## CONCLUSION

To the authors' knowledge, the present report is only the second one to correlate the ultrasonographic and post mortem findings of a gallbladder haemocholecyst in a dog with leptospirosis. Intraluminal haemorrhage and haemocholecyst formation should be taken into consideration in the list of ultrasonographic differential diagnoses for echogenic gallbladder contents in dogs with leptospirosis and haemorrhagic disease.

## CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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# Urinary incontinence due to congenital prostatic urethral dilation in two dogs

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**ABSTRACT** Dilation of the prostatic urethra was found in a 9-month-old neutered male Rottweiler and a 5-month-old entire male German shepherd dog, both of which had a history of urinary incontinence. To the authors' knowledge, there are no detailed reports of surgical or medical management of this structural, and likely congenital, abnormality in the literature. The Rottweiler was treated by surgical resection of the redundant urethra, whilst the German shepherd dog was treated medically. Although both cases showed improvements in continence, neither resolved long-term with these treatments. Incontinence in the Rottweiler initially resolved following urethral reconstruction. Although it gradually recurred, it remained subjectively improved compared to before surgery. The German shepherd dog's continence was improved though not resolved on phenylpropanolamine.

**KEYWORDS** congenital abnormality, dog, prostate, urethra, urinary incontinence, urethral dilation

**ABBREVIATIONS** BID, twice daily; CT, computed tomography; IV, intravenous(ly); PO, per os; SID, once daily; USMI, urethral sphincter mechanism incompetence

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Urinary incontinence occurs uncommonly in male dogs, constituting only 15% of an incontinent population of dogs in one retrospective study.[1] Urethral sphincter mechanism incompetence (USMI) is the most common cause of urinary incontinence in female dogs, however, in male dogs only 26-45% of incontinent patients have USMI.[1,2] The largest case series of male dogs with USMI (published in 1996) included only 54 dogs.[2] Whilst the majority of the cases were in adult dogs and the incontinence was considered acquired, 17 (31%) were juveniles and were therefore thought to be congenital. Interestingly, gross radiographic urinary tract abnormalities were found to occur in 56% (9/16) of the juvenile male dogs diagnosed with USMI.[2] Gross anatomical changes included pelvic urethral dilations and prostatic urethral diverticula. Anatomically, the male urethra is divided into a pelvic part and a penile part and although the pelvic part consists of a preprostatic and a prostatic portion, the preprostatic portion is essentially absent in the dog.[3] Since the study in 1996,[2] anatomical abnormalities tend to be referred to only briefly when discussing USMI in male dogs and treatment recommendations are not given specifically for these, but rather are based on USMI as a whole.

Current treatment recommendations for male dogs with USMI include medical and surgical options, with generally less success than in females. The medical treatment of choice in male dogs is the off-label use

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of phenylpropanolamine, an α-adrenergic agonist which increases the tone of the smooth muscle urethral sphincter.[4] Positive response to this medication has been found in approximately 44% of affected dogs, which is significantly less than for females.[2] Testosterone supplementation has had a low efficacy, whilst oestrogen supplementation is not recommended in male dogs due to the potential for feminization.[2,5,6]

Surgical techniques generally aim to either increase urethral resistance, increase urethral length or to relocate the bladder into an intraabdominal position.[4,5] Vas deferens pexy and prostatopexy have been used in male dogs in attempts to replicate female colposuspension.[4,5,7,8] One study used vas deferens pexy in 7 incontinent male dogs with normal anatomy but which were refractory to medical management.[7] Three dogs had an excellent response, 3 had a good response and one a poor response. Castration (a necessary prerequisite for vas deferens pexy) may have a negative impact on incontinence.[9] Another study used prostatopexy on 9 dogs with severe incontinence and found resolution in one dog, improvement in 4 dogs and no improvement in 4 dogs.[8]

Artificial urethral sphincters have more recently been used in female dogs with USMI and have success rates ranging between 36-90%.[4] Their main limitation is the difficulty in achieving a balance between continence and obstruction. Minor complications include seroma formation, urinary tract infection and slow urination. Major complications (such as stricture formation or severe infection) may require device removal.[4,10–12] There has been one report of their use in 3 adult male dogs.[11]

There are no current treatment recommendations specifically for juvenile male dogs with gross structural abnormalities. The present paper describes two cases of juvenile male dogs with congenital prostatic urethral dilation and urinary incontinence and their response to treatment.

## CLINICAL FEATURES

### Case 1

An 11-month-old male neutered Rottweiler was referred to our hospital for investigation of urinary incontinence, present since being acquired at 16 weeks of age. Urine leakage occurred in large volumes when lying down and intermittently when ambulating. The owners had only witnessed voluntarily urination approximately 5 times prior to presentation. The urine stream subjectively appeared to be of low pressure and of short duration. The dog had been neutered at 7 months of age, with no impact on the incontinence and minimal improvement after treatment with phenylpropanolamine. At 9 months of age, urine culture revealed a heavy growth of *Escherichia coli* and a pneumocystogram revealed pelvic urethral dilation. The incontinence did not improve following treatment with amoxycillin/clavulanic acid at 17 mg/kg per os (PO) twice daily (BID) for 14 days.

Clinical examination, on presentation at our hospital, was unremarkable, except for frequent leakage of clear urine. An excretory phase computed tomography (CT) urogram (Siemens Somatom Sensation Cardiac 64-slice) was performed with a pre-contrast CT study of the abdomen followed by intravenous (IV) administration of iohexol (2 ml/kg; Omnipaque, 350 mg iodine/ml, GE Healthcare). Post-contrast images were acquired using CT protocol involving a gantry rotation time of 1 second, pitch factor 0.75, tube voltage of 120 kV, tube current of 188 mA and field view of 31 cm, slice thickness of 2 mm and convolution/Kernel of B40s (soft tissue algorithm). Images were reformatted and evaluated in Horos™ viewing software (Purview; horosproject.org) and window level and width were adjusted as needed. Images were acquired during the nephrogram phase, pyelogram phase and multiple delayed acquisitions at 3-, 5-, 7- and 10-minutes post-contrast. There was severe, focal dilation of the prostatic urethra with


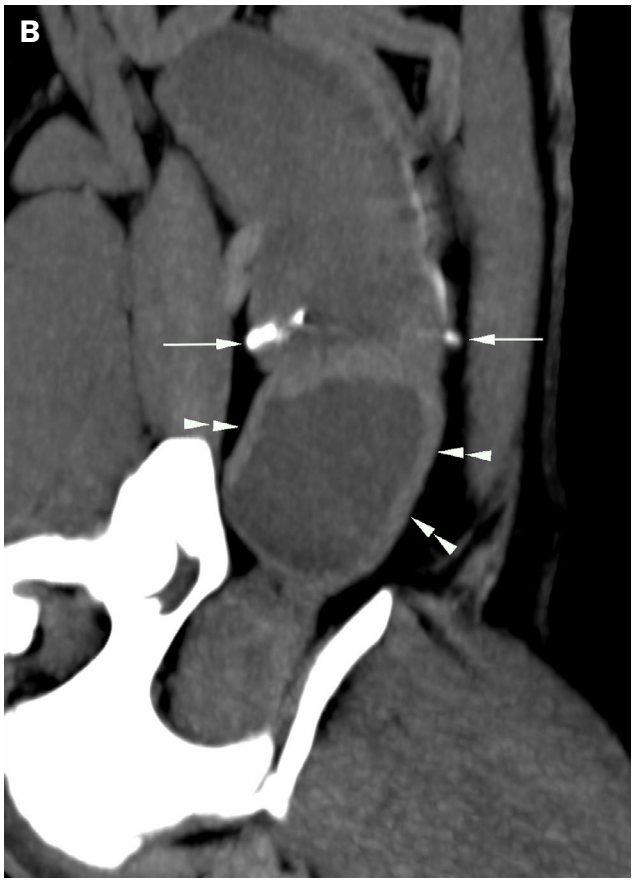


**Figure 1.** Case 1. CT excretory urogram of prostatic urethral dilation (double white arrowheads) in sagittal plane **(A)** and dorsal plane **(B).** Note normal location of ureterovesicular junction (white arrows).

smoothly rounded margins measuring 8.2 cm in length, 6 cm in width and 4.2 cm in height (Figure 1). The proximal urethral orifice was dilated to a diameter of 1.9 cm x 1.7 cm. The ureterovesicular junctions were normal in location, excluding ectopic ureters as a contributing cause. The urethral dilation was thought to be the cause of the urinary incontinence, due to the presumed absence of a functional urethral sphincter. The left kidney was irregular and small with a sagittal length of 6.9 cm and its cortex contained multifocal triangular areas of reduced/absent contrast enhancement, consistent with moderate left chronic nephropathy with multifocal renal cortical infarcts. Left renal dysplasia was considered likely whilst the right kidney was unremarkable. The prostate was not clearly visualised.

Surgical correction of the abnormally dilated pelvic urethra was elected. The patient was premedicated with methadone hydrochloride (0.2 mg/kg, Methadone, Ilium) IV then induced with propofol (4 mg/kg; Propofol--Lipuro, Virbac) IV. Pre- and post-contrast abdominal radiographs with a retrograde urethrogram (3-5 ml/kg of iohexol (Omnipaque, 350 mg iodine/ml) were performed immediately pre-operatively for surgical planning (Figure 2A).

Surgery consisted of reconstruction of the bladder neck and prostatic urethra, vas deferens pexy and cystopexy. The prostate gland was not grossly visible, and the urethral dilation, located cranial to the pubis, appeared to narrow to a more normal diameter at the level of the pelvic brim. A ventral urethrotomy/cystotomy was extended from the bladder apex to the level of normal urethral diameter at the pelvic brim. The ureters appeared normal and were catheterised with 3.5 French Argyle Tomcat catheters (Covidien) for identification. Redundant urethral wall was resected by first dissecting it from surrounding connective tissue, then incrementally incising, resecting and closing with a rigid size 10 French urinary catheter (Portex, Smiths Medical) as a guide, using 3-0 monofilament absorbable suture material (Biosyn, Covidien) in a series of simple continuous patterns interspersed with several simple interrupted sutures. A post-operative retrograde urethrogram study confirmed reduction in urethral diameter (Figure 2B). An indwelling Foley catheter (ClearView Foley Catheter, Smiths Medical) size 10 French 55 cm was placed and maintained until day 5 post-surgery.

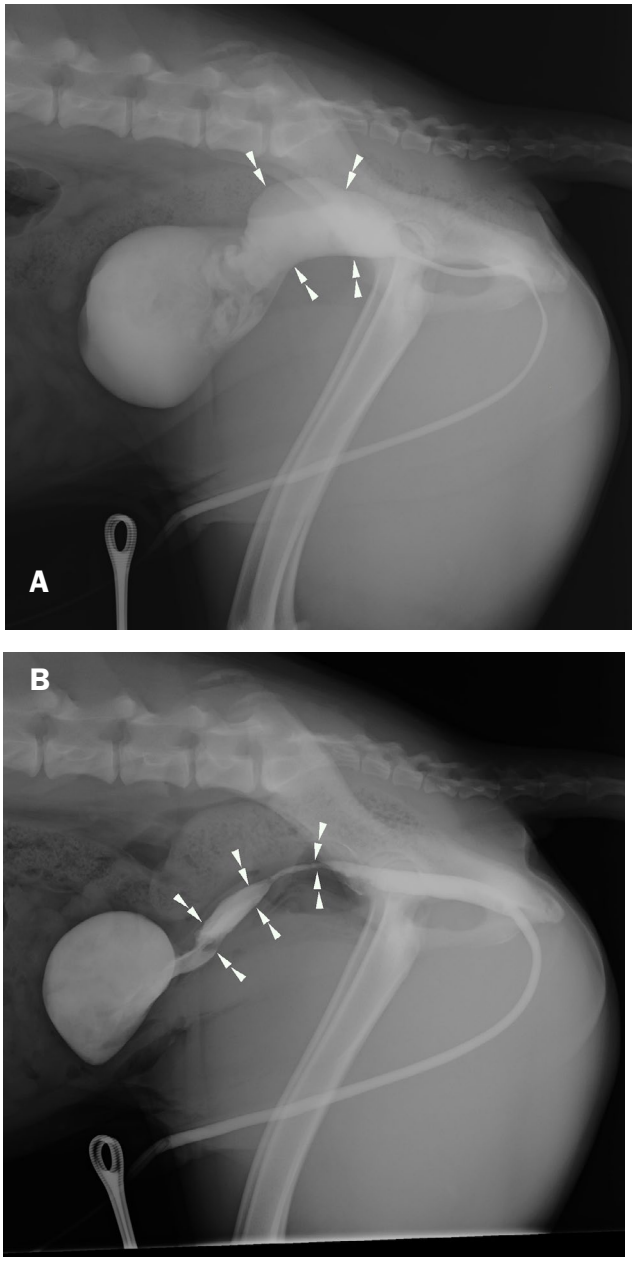


**Figure 2.** Case 1. Retrograde urethrocystogram (lateral projection) of prostatic urethral dilation (double white arrowheads): pre-surgery **(A)** and post-surgery **(B)**.

Cefazolin sodium (22 mg/kg; Cefazolin AFT, AFT Pharmaceuticals) was given IV on induction, then 8-hourly perioperatively until the dog started to eat. It was then changed to amoxycillin/clavulanic acid (20 mg/kg; Amoxyclav 500, Apex Laboratories Pty Ltd) PO BID for 14 days. Omeprazole (1 mg/kg; Losec, AstraZeneca) PO BID was started due to occasional regurgitation post-operatively and continued for 7 days. A single dose of maropitant citrate (1 mg/kg; Cerenia, Zoetis) diluted slow IV was given also. Analgesia was achieved with a fentanyl (DBL Fentanyl Injection USP, Hospira) constant rate infusion (1-2 µg/kg/h) for 36 hours, followed by 0.1-0.2 mg/kg methadone hydrochloride (Methadone) intramuscularly every 4 hours for 48 hours. Robenocoxib (40 mg; Onsior, Elanco) was administered PO once daily (SID) once the patient was eating and regurgitation had resolved and was continued for 10-14 days. Voluntary urination was observed at discharge on day 6.

Histopathology of the resected urethral tissue (using hematoxylin and eosin-stained sections) revealed normal layering of the urethral wall, including urothelium over a fibrous submucosa bordered by distinct smooth muscle layers. There was evidence of poorly developed prostatic tissue within the sections, thereby confirming the dilation of the prostatic urethra. Mild chronic focal lymphocytic and haemorrhagic urethritis was also described.

On day 13 post-surgery, the owner reported that the dog had regularly been posturing to urinate and passing a good stream. The incontinence had also improved significantly with only occasional leakage of urine and a small volume of urine in the bed in the morning. A large seroma associated with the surgical site was present at suture removal and resolved uneventfully.

At 6 weeks post-surgery the patient represented for worsening urinary incontinence, although still significantly improved compared to before surgery. Although still posturing to urinate, there was some leakage whilst lying down and when ambulating. Urine culture was negative. A repeat retrograde urethrocystogram followed by an excretory urogram revealed segmental saccular dilation of the proximal prostatic urethra (up to 6 cm in length x 4 cm in width x 2.6 cm in height) which was more dilated than immediately post-operatively, but still markedly reduced in size compared to the pre-operative study (Figure 3A). Mild mucosal irregularity of the dilated urethra was noted and thought to be possibly due to urethritis. Phenylpropanolamine (Propalin, Vetoquinol) was started at 1.5 mg/kg PO BID. A mild improvement in continence was noted but this remained worse than immediately post-surgery. Changing the dose to 1 mg/kg PO three times a day did not improve continence.

The dog's incontinence remained static on phenylpropanolamine (1.5 mg/kg PO BID). At 8-months post-surgery, a repeat contrast study showed a similar prostatic urethral diameter (2.5 cm height x 4 cm width) compared to the previous study, however, there was evidence of cystic calculi and urethritis (Figure 3B). Urinalysis showed a specific gravity of 1.031. Urinary pH was

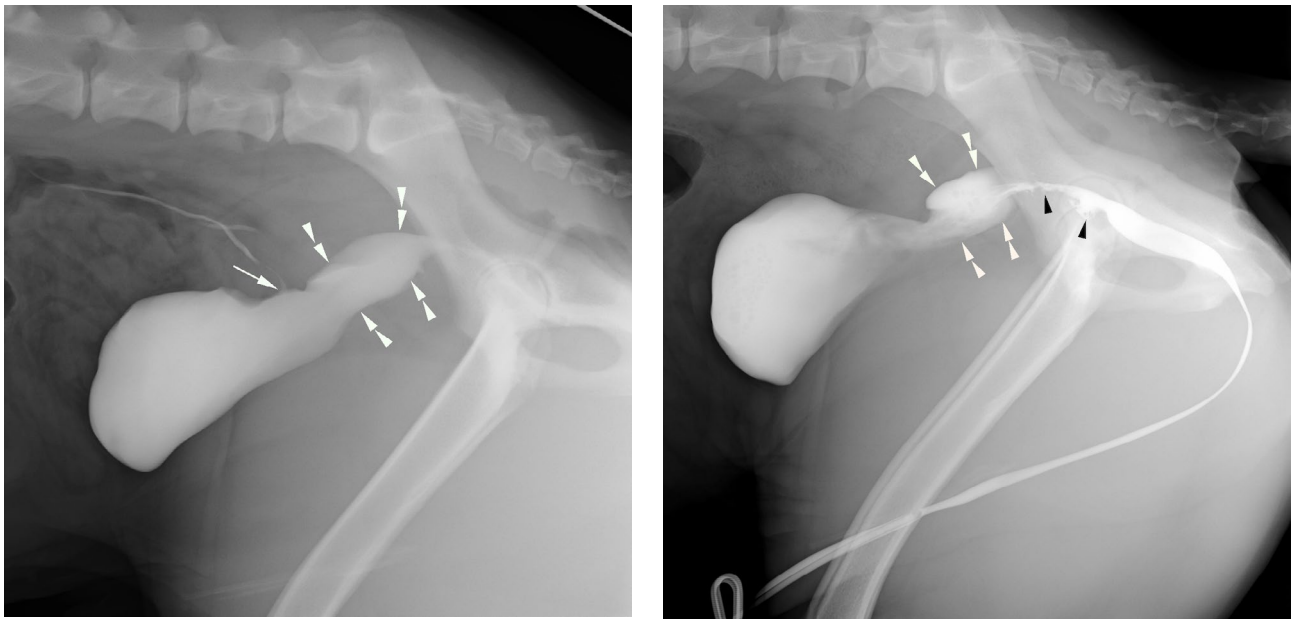

**Figure 3**. Case 1. Repeat retrograde urethrocystogram (lateral projection) 5 weeks post-surgery (**A**) and 8 months post-surgery (**B**). In A, the dilated pelvic urethra (double white arrowheads) had increased in diameter compared with the immediate post-operative study, but remained improved compared to the pre-operative study. White arrow indicates urethrovesicular junction. In B, the dilated pelvic urethra was similar to 5 weeks post-surgery. However, the cranial part of the pelvic urethra had an irregular mucosal margin with a small ventral out pouching (black arrowheads).

8 and there was proteinuria, haematuria, bacteriuria and scant struvite crystals. Urine culture revealed a heavy growth (>108 CFU/L) of *Staphylococcus pseudointermedius* and amoxycillin/clavulanic acid (Amoxyclav 500) was started at 20 mg/kg PO BID for 14 days. The incontinence did not improve. Surgery to remove cystic calculi and to attempt further reduction of the prostatic urethra was discussed, however, euthanasia was elected.

**Case 2**

A 5-month-old, male entire German shepherd dog presented to a private general veterinary practice with lethargy, inappetence, urinary incontinence and a weak urine stream. Unilateral cryptorchidism was noted. A complete blood count and serum biochemistry were unremarkable. An abdominal ultrasound revealed a large amount of debris and numerous small calculi of up to 4 mm in size within the region of the bladder neck. No abnormalities were identified in the bladder wall or kidneys. Urine culture was positive for *Staphylococcus intermedius/ pseudointermedius*. Treatment consisted of amoxycillin/clavulanic acid (12 mg/kg; Amoxyclav 250) PO BID for 14 days and meloxicam (Metacam, Boehringer Ingelheim) 0.2 mg/kg subcutaneously once, then 0.1 mg/kg PO SID until surgery.

Five days later, when the dog returned for cystotomy and castration, his general demeanour had improved and there was a normal urine stream. The patient was premedicated with a combination of acepromazine and methadone and induced with alfaxalone (Alfaxan; Jurox) IV to effect.

A pre-operative radiographic excretory urogram was performed by IV administration of 0.5 ml/kg of iohexol (Omnipaque, 240 mg iodine/ml) given over 15 minutes. Post-contrast images showed that the proximal urethral orifice appeared dilated. This continued into a larger saccular dilation of the prostatic urethra, extending to the level of the pelvic brim where the urethra abruptly appeared to return to normal diameter (Figure 4A). Numerous small round and irregular contrast filling defects were identified, compatible with cystic calculi. A prostate gland was not visible. There was no evidence of ectopic ureters. The kidneys were normal. A retrograde urethrocystogram was then performed by instilling iohexol (240 mg iodine/ml, Omnipaque) via a urinary catheter placed into the distal urethra to assist in defining the abnormal urethral dilation (Figure 4B).

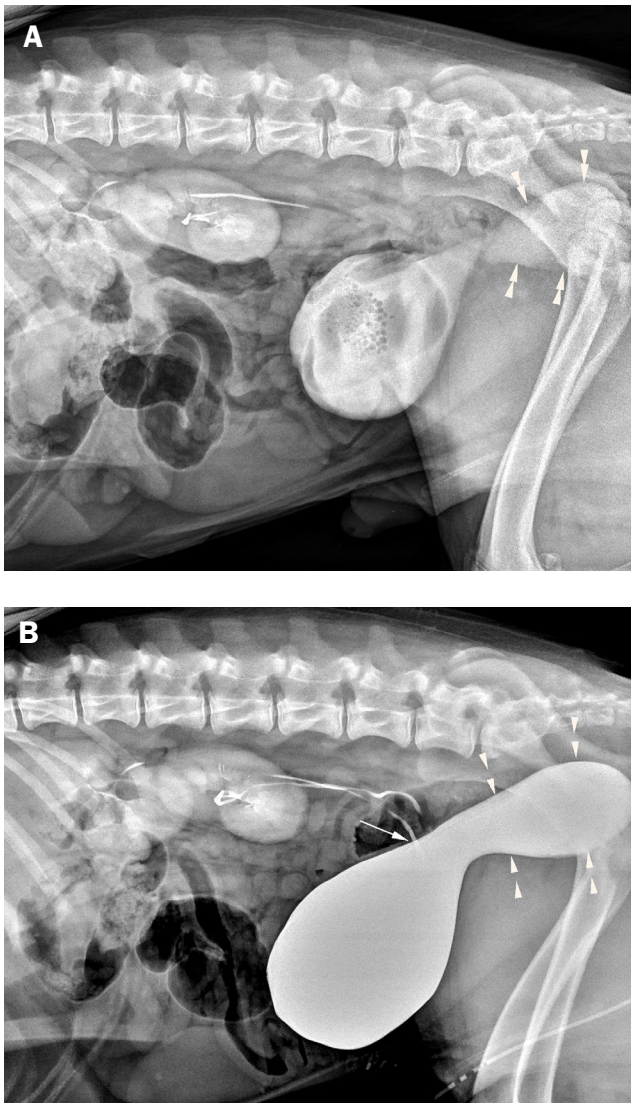


**Figure 4.** Case 2. Retrograde double contrast urethrocystogram **(A)** and retrograde urethrocystogram **(B)**. In both A and B, the pelvic urethra is markedly dilated with smooth margins (double white arrowheads). Note the position of the ureterovesicular junction in image B (white arrow). In A, there were multiple small irregular contrast-filling defects in the bladder, compatible with cystoliths.

A laparoscopic cystotomy allowed removal of a large number of small, rounded calculi. The bladder was closed in two layers with 4-0 monofilament absorbable suture material (PDS, J&J Medical Devices) and the abdomen was closed routinely. The intraabdominal and scrotal testes were removed.

Analgesia was achieved with a fentanyl constant rate infusion (3 ug/kg/h; DBL Fentanyl Injection USP) intra-operatively and post-operatively, as well as meloxicam (0.1 mg/kg; Metacam) subcutaneously once, then PO SID for 4 days and tramadol hydrochloride (2.3 mg/kg; Tramadol, Apex Laboratories Pty Ltd) PO BID for 5 days. Recovery was uneventful and the dog was discharged the following day after urinating with a slow but steady stream. Amoxycillin/clavulanic acid (12.5 mg/kg; Amoxyclav 250) was continued PO BID for another 16 days.

Ten days post-surgery, the patient had a steady urine stream, with no frank blood and minor incontinence. A free-catch urine sample showed mild pyuria and haematuria. The dog was placed on Canine Urinary S/O dry food (Royal Canin).

Three weeks post-surgery, the dog had significantly improved urine stream but was leaking small amounts of urine and frequently licking his prepuce. A urine culture, after finishing the antibiotics, was negative. Calculus analysis revealed struvite calculi. The patient was transitioned back onto large breed puppy food and started on phenylpropanolamine (Propalin) at 1.5 mg/kg PO BID.

Two months post-surgery and one week after discontinuation of phenylpropanolamine, the patient had worsening urinary incontinence and a varied urine stream A free-catch urine sample was unremarkable. Treatment with phenylpropanolamine was resumed at a higher dose of  2 mg/kg PO BID.

There was no recurrence of urinary calculi on repeat ultrasound performed at 4 months post-surgery. Urethral dilation remained unchanged. In-house urinalyses at 4 and 5 months post-surgery were unremarkable. At 7 months post-surgery, a repeat retrograde urethrocystogram study showed no change in the urethral dilation and no evidence of calculi.

Recurrence of a urinary tract infection and cystic/urethral calculi (numerous of 2-3 mm diameter) were diagnosed by culture and ultrasound at 8.5 months post-surgery. Amoxycillin/clavulanic acid (Amoxyclav 500; 18 mg/kg PO BID for 14 days) and Urinary Diet C/D (Hill's Prescription Diet) were commenced. Phenylpropanolamine (Propalin) was also restarted at 1.5 mg/kg PO BID, having been previously discontinued at the owner's discretion. Meloxicam (Metacam; 0.06 mg/kg PO SID) was also restarted for 7 days for presumed cystitis associated with calculi. Conservative management, using the prescription urinary diet and phenylpropanolamine was ongoing at the time of writing, 18 months post-surgery. Although the dog remained incontinent on this medication, continence was improved.

## DISCUSSION

The literature is scant regarding characterisation of prostatic urethral anatomical abnormalities in dogs. A study published in 1996 retrospectively analysed medical records from 54 male dogs diagnosed with USMI.[2] Medium and large breeds were over-represented in the juvenile population (n = 17), including 5 German shepherd dogs and 3 golden retrievers. Of the 17 cases that were juvenile, defined as dogs incontinent at birth or when acquired as a puppy, 9 had gross radiographic abnormalities involving the proximal urethra. Of these 9 dogs, 4 had a dilated pelvic urethra, one had a prostatic urethral diverticulum and 4 had both abnormalities. Information regarding descriptions, treatment and follow-up

was limited. Five of the 9 dogs with gross radiographic abnormalities were either euthanased at the time of initial examination or lost to follow-up. Another case report of a 2-year-old male neutered Australian cattle dog described a suspected urethral diverticulum outpouching from 4-5 cm of the pelvic urethra.[13] No other reports of urethral anatomical abnormalities were found in the literature and no information regarding treatment and prognosis of such abnormalities is available.

Urethral diverticula in humans have been described as focal outpouchings of the urethra into the surrounding periurethral tissues and the communication between the diverticula and the true urethral lumen can be via a narrow or a wide neck.[14] Although the latter definition is consistent with the abnormalities described in the aforementioned case report,[13] it does not describe the two cases in the present report. The 1996 study refers to two categories of gross congenital abnormalities, prostatic urethral diverticula and pelvic urethral dilations.[2] Although specific descriptions were not provided for every case, a selection of contrast study and post-mortem images showed that, despite significant variation in conformation between the cases depicted, the diverticula were distinct from the dilations by the presence of a neck leading to a saccular structure. In contrast, the pelvic urethral dilations appeared comparable to the abnormalities reported in the current cases.

The two cases in the present report are also different to megalourethra, a condition that occurs in humans and involves urethral dilation. However, it is characterised by a deficiency of the corpus spongiosum with or without a deficiency of the corpora cavernosa, so it occurs in the penile urethra.[15]

Histopathology of resected urethral tissue in Case 1 showed evidence of poorly developed prostatic tissue. The significance of this finding is speculative, although in humans the prostatic urethra is reported to be dilated secondary to, or in association, with prostatic aplasia or hypoplasia.[16] We postulate that poorly developed prostatic tissue contributed to a lack of urethral wall support, allowing the dilation to occur. Another study also found an association between bladder neck position and prostate size,[9] and this may be one reason why castrated male dogs may be more prone to USMI than entire animals. The latter authors suggested that prostate size may affect the position of the bladder neck, due to the weight of the gland pulling the bladder neck more cranially, or that a large prostate gland may compress the prostatic urethra, thereby increasing urethral outflow resistance. These factors suggest delaying castration until maturity in incontinent juvenile male dogs may be beneficial. However, it should be noted that these benefits are speculative and hence recommendations regarding castration cannot be provided. Case 2 was not castrated until after the dilation was identified, and the dilation did not appear to change following castration.

There is minimal information regarding recommendations for treatment of prostatic urethral dilations in dogs. There were no reported attempts at surgical correction of urethral dilations found in the literature. In the 1996 study, of the cases not immediately euthanased or lost to follow up, information was limited. The case with both pelvic urethral dilation and prostatic urethral diverticulum had a ‘good’ response to unspecified tablets and improved at sexual maturity. One dog treated with emepronium bromide also had a ‘good’ (albeit undefined) response. Another two cases were later euthanased due to a lack of response to unspecified tablets or no treatment.

In the single case report of canine urethral diverticulum,[13] cystopexy and vasopexy were performed, with 80-90% of the presumed

urethral diverticulum being resected. The surgery was deemed successful, based on improved urinary continence and the ability to produce a normal urine stream and volume (which was not possible prior to surgery). However, the dog still had occasional urinary incontinence 2 years post-surgery.

Case 1 had good results with improved continence for one month following surgery, however, incontinence subsequently recurred to an unacceptable level for the owner. Administration of phenylpropanolamine had a positive impact on incontinence but did not resolve it. Formation of cystic calculi may have contributed to recurrence of incontinence. Surgery to remove the calculi and attempt further reduction of the diameter of the prostatic urethra was proposed. It is likely that, given the unique nature of the case, the first attempt to resect and reduce the urethral diameter was overly cautious. As the owner opted for euthanasia, the effect of a more aggressive prostatic urethroplasty cannot be evaluated. Recurrent urethral dilation due to lack of prostatic support, urethral stricture formation and possible urethral obstruction remained concerns. We hypothesise that some form of external urethral support may be worth considering, such as induced fibroplasia, mesh, or collagen foam.

An artificial urethral sphincter may be an adjunctive treatment option, but if it was used in isolation it would fail to address the entire urethral dilation. Furthermore, placement at the time of surgical reconstruction of the urethra may not be ideal, as there may be an increased risk of fibrosis and stricture formation. However, a staged procedure might be considered, with the placement of an artificial sphincter once the urethra has adequately healed. It is also possible that the urethral tissue may dilate proximal and distal to such a device.

Interestingly, Case 2 initially had significantly improved urinary continence following removal of the cystic calculi and medical management with phenylpropanolamine, despite the urethral dilation remaining. However, over the following 18 months, there was a recurrence of urinary calculi and, although improved on phenylpropanolamine, incontinence remained at the time of writing.

## CONCLUSION

Prostatic urethral dilation is an uncommon disorder in male dogs. A greater understanding of gross urethral abnormalities, their characterisation and their effect on urinary incontinence is needed to better inform treatment options.

## ACKNOWLEDGEMENTS

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# Persistent left cranial vena cava and absent right cranial vena cava in a German shepherd dog with multiple congenital cardiovascular defects

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**ABSTRACT** A 4-month-old male German shepherd dog was referred for investigation of lethargy and exercise intolerance, as well as a grade V/VI systolic murmur. Echocardiography revealed aortic and subaortic stenosis, post-stenotic aortic dilation and aortic insufficiency. The mitral valve was thickened with mild regurgitation. Coronary sinus dilation and an anechoic cystic structure in the region of the right atrium were also noted. Over two months, the dog developed left ventricular hypertrophy, systolic anterior motion of the anterior mitral leaflet, and aortic flow velocity increased. Computed tomography confirmed persistence of the left cranial vena cava and absence of the right cranial vena cava, with the costocervical and azygos veins terminating in the region of the right atrium, producing an atrial aneurysm. The dog has since been evaluated at 3-monthly intervals. Although exercise intolerance partially resolved after atenolol therapy, aortic velocity and pressure gradient have progressively increased, and concentric left ventricular hypertrophy has developed.

This is the first case report of a dog with combined valvular aortic and subaortic stenosis, absent right cranial vena cava, persistent left cranial vena cava, mitral valve dysplasia and right atrial aneurysm. Although congenital cardiac diseases were identified on echocardiography, a contrast computed tomography was needed to clarify the multiple complex cardiovascular abnormalities present.

**KEYWORDS** combined congenital heart malformations; complex congenital heart disease; computed tomography; dog; echocardiography; left ventricular outflow tract obstruction

**ABBREVIATIONS** ARCVC, absent right cranial vena cava; LVOT, left ventricular outflow tract; LVOTO, left ventricular outflow tract obstruction; MVD, mitral valve dysplasia; PG, pressure gradient; PLCVC, persistent left cranial vena cava; RAA, right atrial aneurysm; SAM, systolic anterior motion; SAS, subaortic stenosis; VAS, valvular aortic stenosis

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Congenital defects of the cardiovascular system are a substantial cause of morbidity and mortality in dogs <1 year of age,[1] and are more prevalent in purebred than in crossbred dogs.[2,3] Early recognition is of great importance to direct medical or surgical management, improve outcomes, and provide an accurate prognosis. This article presents clinical findings, electrocardiography, echocardiography, computed tomography and follow-up information from a German shepherd puppy diagnosed with combined valvular aortic stenosis (VAS) and subaortic stenosis (SAS), persistent left cranial vena cava (PLCVC), absent right cranial vena cava (ARCVC), mitral valve dysplasia (MVD) and right atrial aneurysm (RAA).

## CLINICAL FEATURES

A 4-month-old, 4.3-kg, intact male German shepherd puppy was referred to the cardiology section of a veterinary teaching hospital for evaluation of a cardiac murmur. The dog had a history of lethargy and exercise intolerance since birth. A grade V/VI systolic heart murmur was audible over the left heart base and was the only abnormality on physical examination. A ten-lead electrocardiogram documented a sinus rhythm, with a mean heart rate of 135 (range 130-140) beats/min. All electrocardiographic measurements were unremarkable.

Two-dimensional echocardiography revealed increased echogenicity of the aortic valve, fusion of the left coronary and non-coronary leaflets (Figure 1), a hyperechoic ring in the subaortic region, and post-stenotic dilation of the aorta (Figure 2A). Aortic flow was turbulent (Figure 2B) and of high velocity (Table 1) corresponding to an increased pressure gradient (Figure 2C; Table 1). There was severe aortic insufficiency (Figure 2D) (pressure half-time 93 ms). There was mild mitral valvular insufficiency (Figure 3A), and the septal leaflet of the mitral valve was thickened and hyperechoic (Figure 3B). In addition, mitral leaflets did not join the mitral annular plane in diastole, creating a tent-shaped area (Figure 3C), which indicated shortening of the chordae tendineae, therefore pointing to MVD[5] and ruling out a leaflet lesion secondary to aortic flow

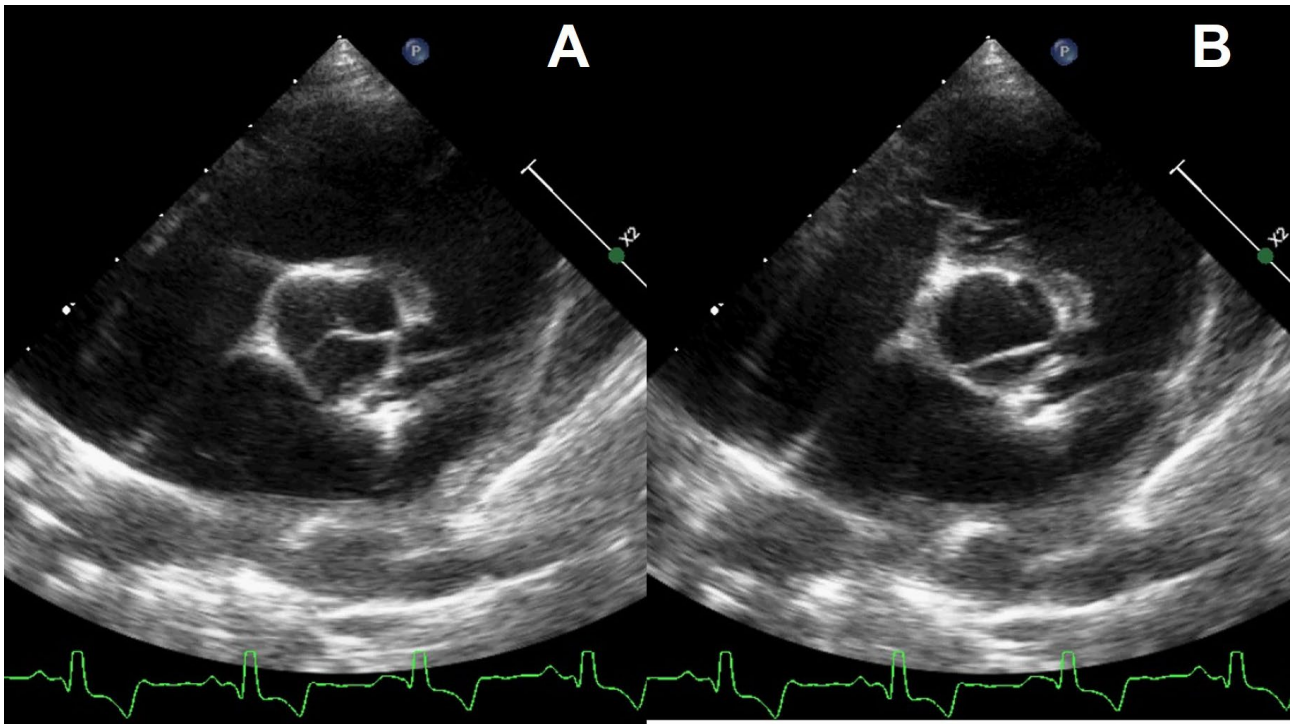


**Figure 1.** Echocardiographic images of the puppy.

**A**. Short axis view of the heart base at the level of the aortic valve. Note closed aortic valve with increased echogenicity of the leaflets.
**B**. Open aortic valve demonstrating fusion of the left coronary and non-coronary leaflets.

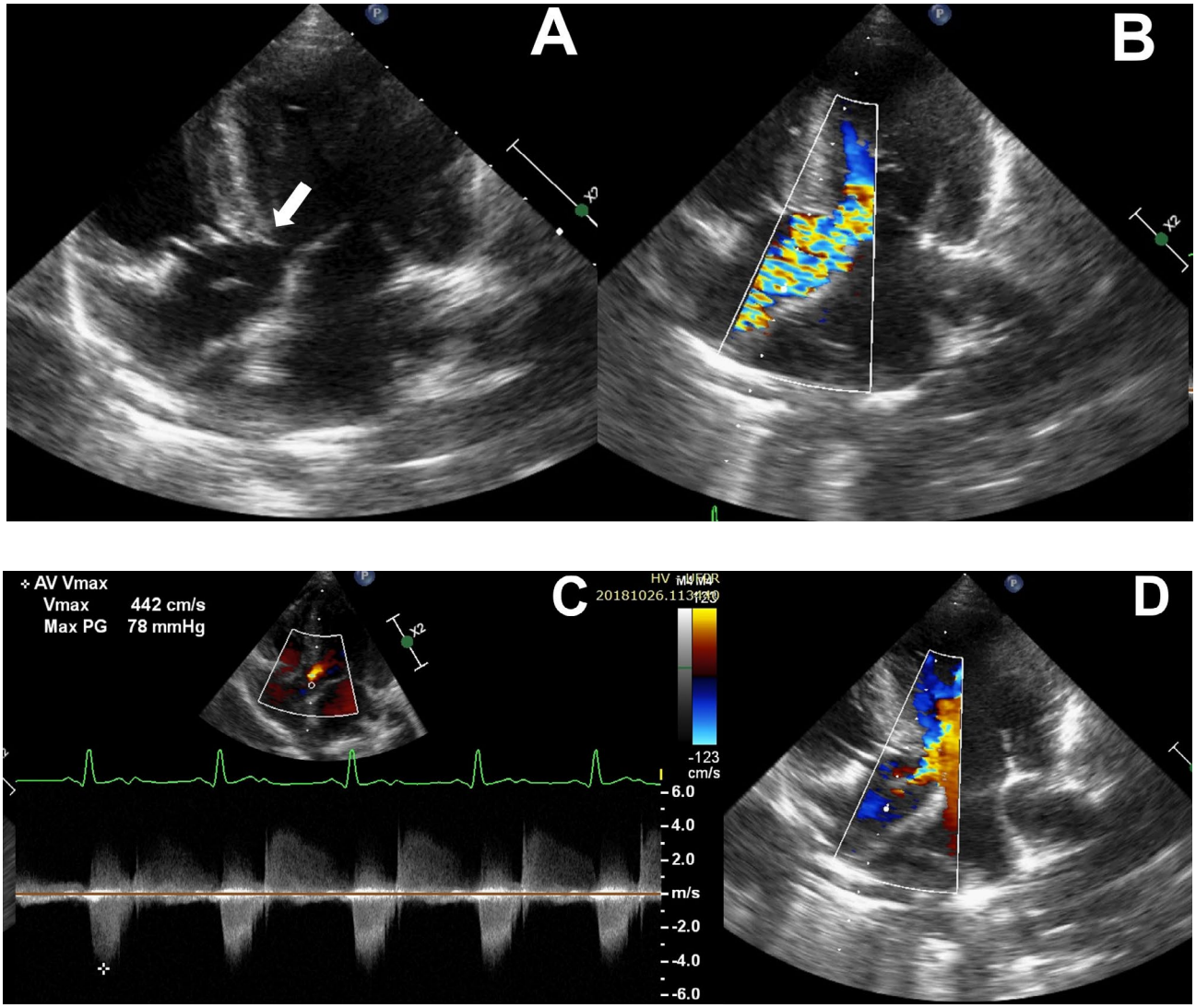


**Figure 2.** Apical five-chamber echocardiographic images of the puppy, demonstrating a hyperechoic ring in the subaortic region (white arrow), in addition to post-stenotic dilation of the aorta **(A)**; systolic aortic flow turbulence **(B)**; high aortic flow velocity and pressure gradient **(C)**; and aortic insufficiency **(D)**.

turbulence. The left ventricular filling pattern was classified as 'pseudonormal', which is characterised as normal transmitral flow velocity ratio and decreased myocardial tissue motion velocity ratio (Table 1), which reflects the second stage of diastolic dysfunction. Left ventricular chamber dimensions were increased in systole and diastole, but the left atrial, and the diastolic interventricular wall and left ventricular free wall thicknesses were otherwise normal (Table 1).

The echocardiogram showed a dilated coronary sinus and a circular chamber apparently located adjacent to the left atrium (Figure 3A). Gentle rotation of the transducer demonstrated that this structure was in fact a projection arising from the right atrium (Figure 3D). A microbubble contrast study showed contrast first filling the coronary sinus, then the RAA and the right atrium (Figure 4). This filling pattern indicated a PLCVC,[7] and ruled out a cor triatriatum sinister, a cardiac anomaly in which the left atrium is divided into two compartments by an anomalous membrane.[8] No medical treatment was recommended. The owner was advised to have the dog re-evaluated regularly.

**Table 1**: Two-dimensional echocardiography measurements from a German shepherd dog with multiple cardiovascular abnormalities

| Parameter* | Units | Reference values | Age | | |
|---|---|---|---|---|---|
| | | | 4 months (at presentation) | 6 months | 13 months |
| Aortic flow velocity[4] | m/s | 0.65-2.65 | 4.42 | 5.56 | 6.7 |
| Aortic pressure gradient[4] | mmHg | 1.69-28.09 | 78 | 124 | 181 |
| Left atrium-to-aorta ratio[7] | mm | 1-1.68 | 1.14 | 1.21 | 1.3 |
| Transmitral flow velocity ratio (E:A)[4] | | 1.18-1.89 | 1.1 | 1.1 | 1.1 |
| Myocardial tissue motion velocity ratio (E':A')[4] | | >1 | 0.7 | 1.5 | 1.6 |
| Left ventricular chamber dimension in systole[4] | mm | 10.4-14.1 | 14.9 | | |
| Left ventricular chamber dimension in diastole[4] | mm | 19.1-24.2 | 28.6 | | |
| Interventricular septum thickness in diastole[4] | mm | 5.7-7.6 | 5.4 | | |
| Left ventricular free wall thickness in diastole[4] | mm | 4.6-6.1 | 5.9 | | |
| Interventricular septum thickness in diastole[4] | mm | 7.4-8.6 | | 10.2 | |
| Left ventricular free wall thickness in diastole[4] | mm | 5.9-6.9 | | 9.56 | |
| Left ventricular chamber in diastole[4] | mm | 26.5-29.9 | | 31.3 | |
| Left ventricle internal diameter in diastole[4] | mm | 36-38.6 | | | 37.6 |
| Interventricular septum thickness in diastole[4] | mm | 9.3-10.3 | | | 21.3 |
| Left ventricular free wall thickness in diastole[4] | mm | 7.5-8.3 | | | 15.3 |
| Left ventricle internal diameter in systole[4] | mm | 22-23.9 | | | 21.3 |

Two months later, there was no change in clinical condition. Electrocardiography showed an increased QRS duration (0.06 s, reference interval[9] ≤0.056 s), left mean electrical axis deviation (+8°, reference range[10] +40° to +100°), and increased T wave amplitude (>25% R wave, reference range[11] <25% R wave) (Figure 5). Echocardiographic re-examination revealed left ventricular hypertrophy with a slightly enlarged left ventricular chamber in diastole and increased aortic flow velocity compared to the first

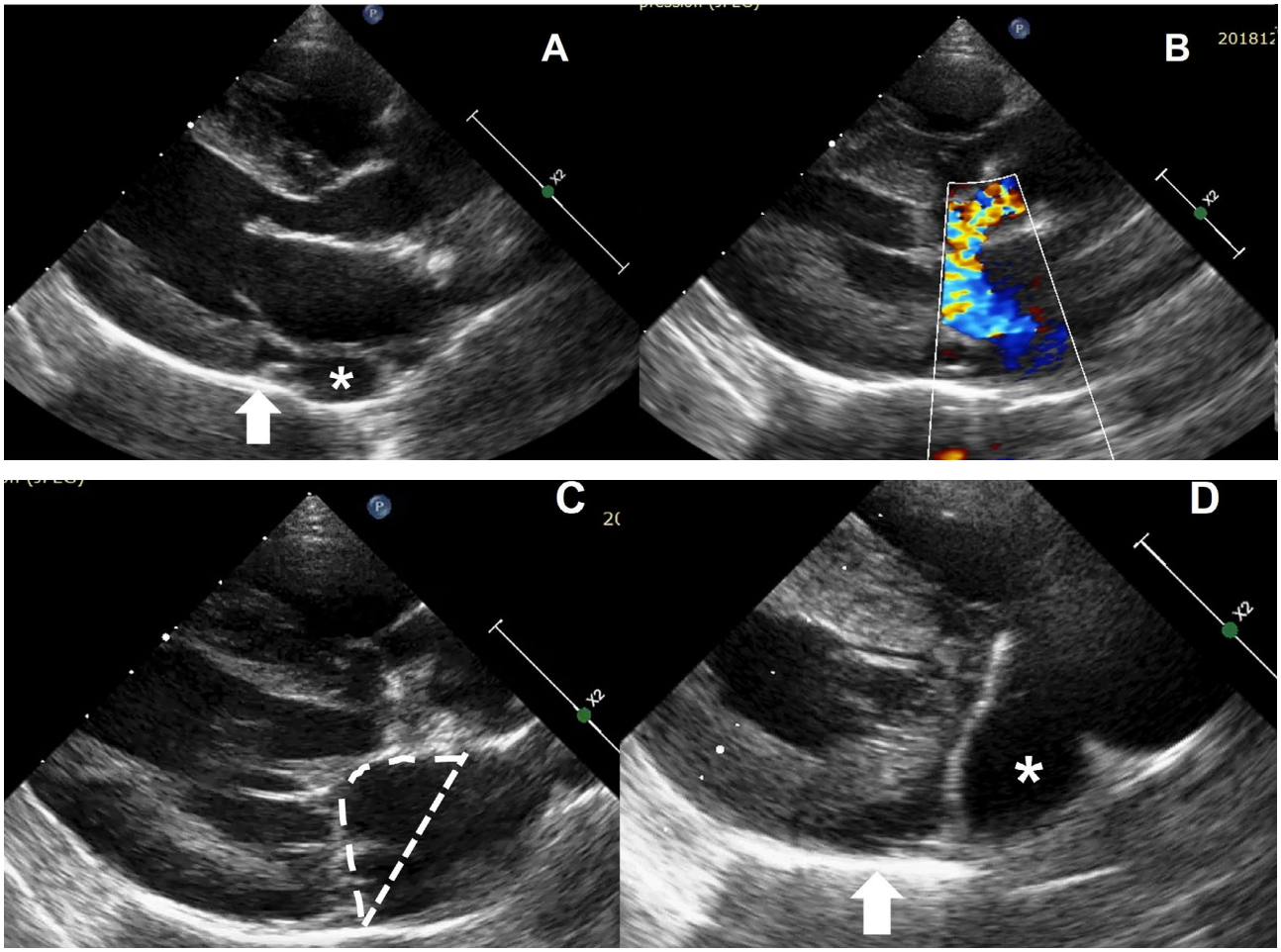


**Figure 3.** Right parasternal long axis left ventricular outflow echocardiographic view of the puppy, showing the thickened mitral valve anterior leaflet with increased echogenicity **(A)**; the mild mitral valve regurgitation **(B)**; and the tent-shaped area of mitral leaflets and mitral annular plane in diastole, indicating shortening of chordae tendineae and MVD **(C)**. The dilated coronary sinus (white arrow) and the RAA (white asterisk) in Image A were better visualised with a gentle rotation of the transducer (Image D).

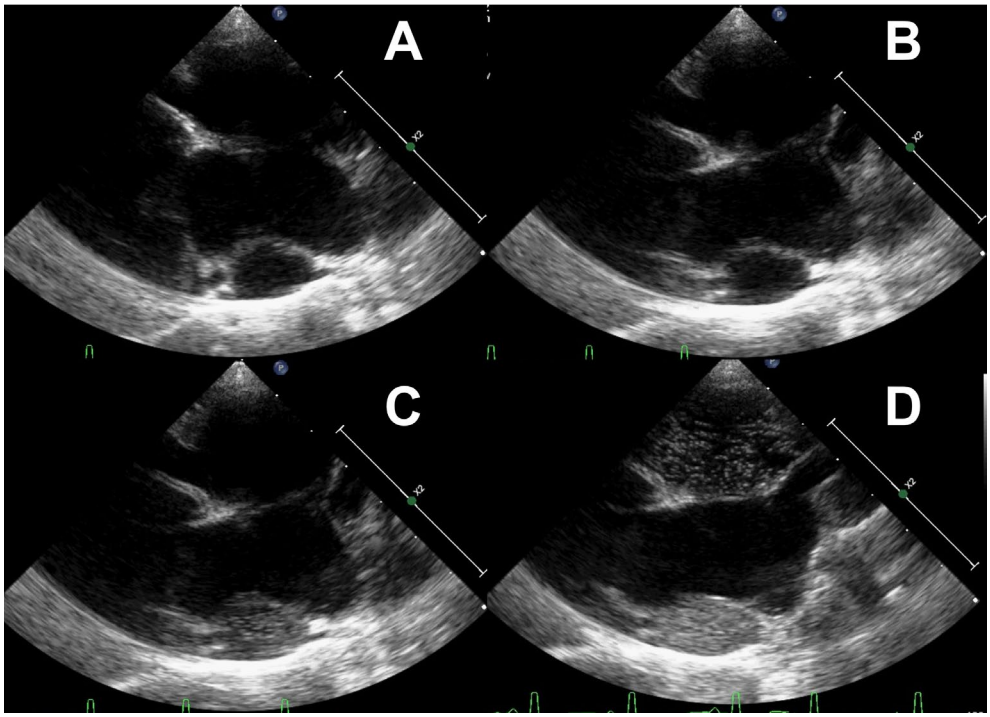


**Figure 4.** Echocardiographic images of the right parasternal long axis four-chamber view of the puppy showing a microbubble contrast study. Baseline **(A)**. Showing contrast filling of the coronary sinus **(B)**, the right atrium aneurysm **(C)** and the right atrium **(D).**

**Figure 5.** Lead II electrocardiographic tracing from the puppy showing an increased QRS duration (0.06 s, reference interval ≤0.056), and increased T wave amplitude (>25% R wave, reference range <25% R wave). Paper speed = 50 mm/s; 1 cm = 1 mV.

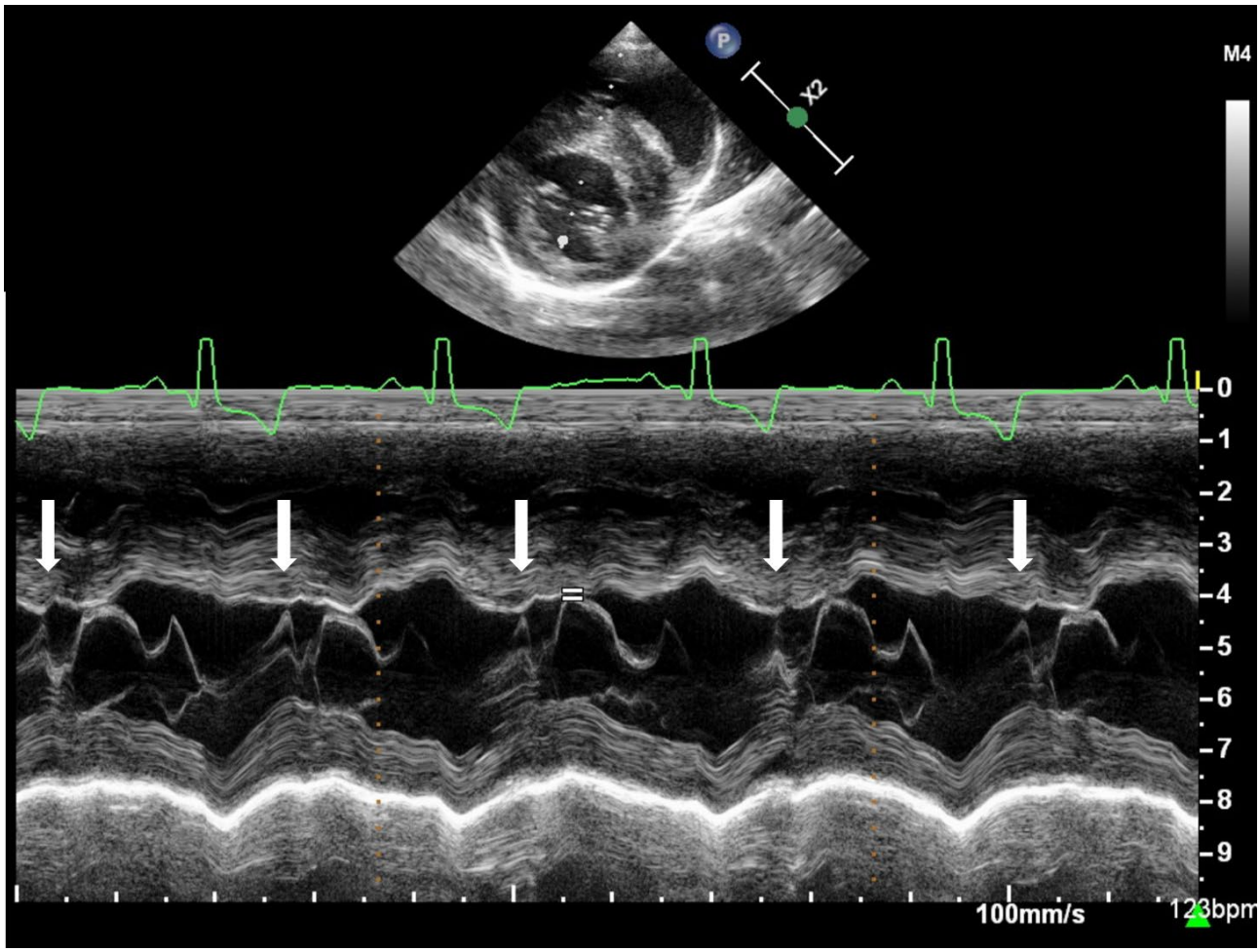


**Figure 6.** M-mode echocardiography confirming systolic anterior motion (white arrows) of the anterior mitral leaflet of the puppy.

examination (Table 1). Systolic anterior motion (SAM) of the anterior mitral leaflet (Figure 6) was also observed. Atenolol (0.25 mg/kg orally q 24h) was prescribed.

Computed tomography was performed to provide detailed characterisation of the vascular anomaly and investigate the projection arising from the right atrium. For this, intramuscular acepromazine (0.05 mg/kg) and methadone (0.2 mg/kg) were used in pre-anaesthesia, followed by anaesthetic induction with a combination of fentanyl (5 mg/kg), ketamine (1 mg/kg) and propofol (1 mg/kg) intravenously, and maintenance with isoflurane. The examination confirmed PLCVC

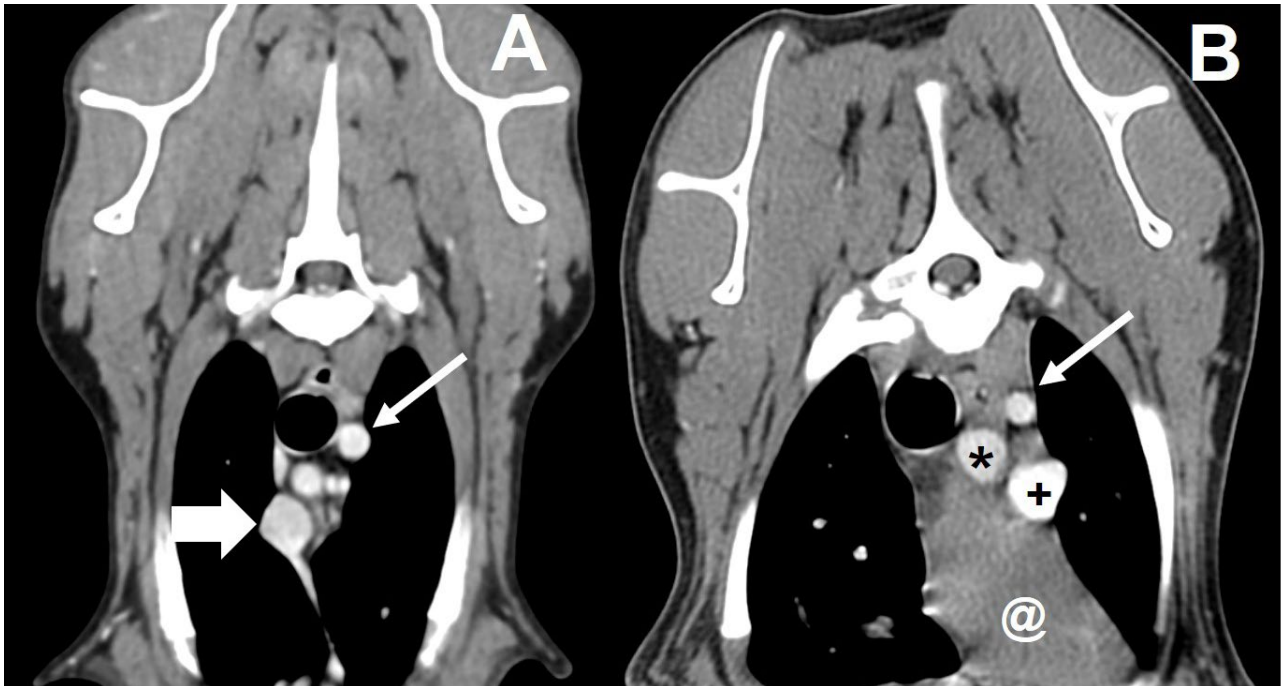


**Figure 7.** Computed tomography transverse thoracic images of a normal adult dog (A) and the puppy (B), showing the right cranial vena cava (thick white arrow), the left cranial vena cava (+), the left subclavian artery (narrow white arrow), brachiocephalic trunk (*) and the thymus (white @).


**Figure 8.** Computed tomography dorsal thoracic images of a normal dog **(A)** and of the puppy **(B** and **C)**, showing the right cranial vena cava (white +). In the puppy, the right cranial vena cava is absent, and the right (black *) and left (black +) brachiocephalic veins drain into the persistent left cranial vena cava (white arrow) **(B)**. A sequence tomographic slice section shows the caudal pathway of the persistent left cranial vena cava that ends within a small dilation (white *) before entering into the right atrium **(C)**.

and demonstrated ARCVC. The right and left brachiocephalic veins drained into the PLCVC, and the PLCVC ended in an aneurysmal cavity (Figures 7-9). The costocervical and azygos veins were also identified and terminated in the region of the right atrium, creating an atrial aneurysm.

The dog was re-evaluated at 3-monthly intervals, with the last follow-up at 13 months of age. Exercise tolerance improved slightly once atenolol therapy was initiated, however, the last echocardiographic examination demonstrated a further increase in aortic flow velocity and development of left ventricular concentric hypertrophy (Table 1). Atrial chamber size (left atrium-to-aorta ratio) remained within the reference range (Table 1).

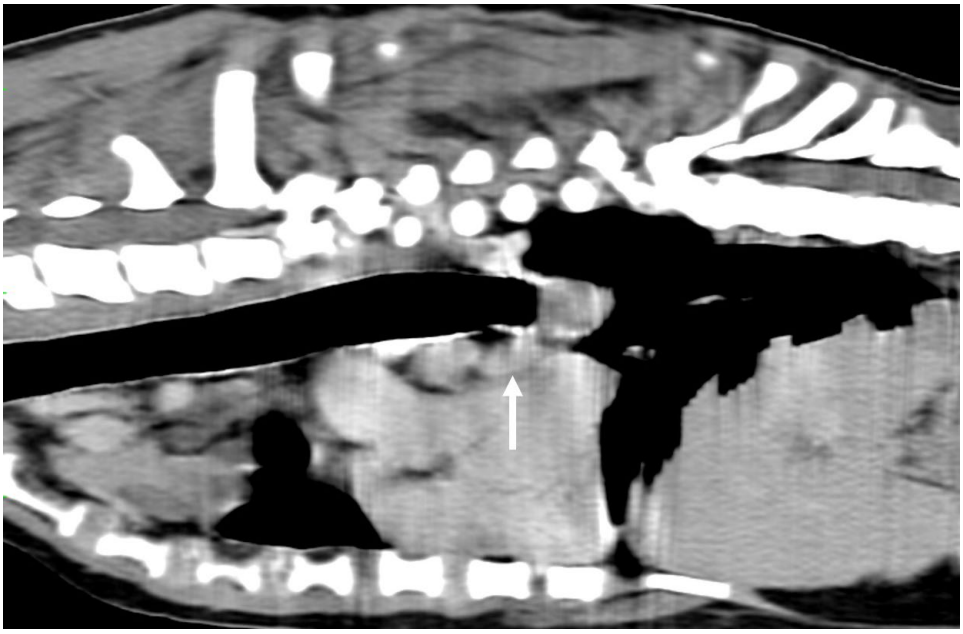

**Figure 9.** Computed tomography sagittal thoracic images of the puppy with multiple congenital heart abnormalities, showing a dilation (white arrow) adjacent to the left atrium.

## DISCUSSION

A combination of multiple congenital heart diseases is less common than isolated forms.[1,2,11,12] There is a lack of information regarding complex congenital heart diseases in the veterinary literature, and their diagnosis is challenging and their prognosis is likely poor. To the authors' knowledge, the current case is the first report in the veterinary literature documenting combined VAS, SAS, MVD, PLCVC, ARCVC and RAA. Only a few human medical reports describe combined VAS, PLCVC, and ARCVC.[13,14,15] An Italian study that included 976 dogs with congenital heart disease reported one dog with concurrent SAS, PLCVC and mitral stenosis, but without VAS, ARCVC or RAA.[11]

Mitral valve dysplasia and left ventricular outflow tract (LVOT) obstruction (LVOTO), including VAS and SAS, are reported among the most common congenital heart diseases in dogs.[11,12,16] Conversely, PLCVC is an uncommon congenital defect, resulting from abnormal development of the left cranial vena cava, which is most often an incidental finding with other congenital malformations.[11] There is a male predisposition for all four diseases,[11,16,17] and German shepherd dogs are predisposed to MVD,[18] SAS[11] and PLCVC.[3]

The presence of a dilated coronary sinus on the echocardiograph should give a high index of suspicion for PLCVC.[7] During fetal life, the right and left cranial cardinal veins are directly fused with the heart. The remainder of the left cranial cardinal vein atrophies caudal to the fusion while the corresponding right-sided vessel enlarges and forms the distal part of the definitive right cranial vena cava.[19] If the caudal portion of the left cranial cardinal vein remains patent, it forms a PLCVC; and with the presence of a normal right cranial vena cava, the patient has a duplicated cranial vena cava.[7] Rarely, in patients with PLCVC, the right anterior cardinal vein atrophies, resulting in ARCVC, and the blood from the right side is carried to the PLCVC and then, in most cases, drains into the right atrium through the coronary sinus.[7] The dilated coronary sinus, as seen in the present puppy, is attributable to the venous drainage from the cranial body in cases with PLCVC and ARCVC.[20] However, although PLCVC is the main cause of coronary sinus dilation,[21] it is not the only one. At least in people, differential diagnoses for dilated coronary sinus include chronic right ventricular dysfunction, right atrial hypertension, and anomalous venous drainage into the coronary sinus.[22-24]

Therefore, other abnormalities such as total anomalous pulmonary venous return, coronary atrioventricular fistula, and anomalous hepatic venous drainage[21,25] should also be excluded. In the present case, other congenital causes of dilated coronary sinus were ruled out by contrast thoracic computed tomography.

RAA is a rare cardiac anomaly that has been previously reported only in nine dogs, eight of which were male.[26-28] This present case is the first to be reported in a German shepherd dog. The suspicion of RAA in this dog arose from the observation of right atrial dilation on echocardiographic examination, which was later confirmed by contrast computed tomography. Because it is rare, RAA may easily be confused with other anomalies that lead to right atrial enlargement, such as Ebstein's anomaly, tricuspid dysplasia, pulmonary hypertension, pulmonic stenosis, and atrial septal defect. These differential diagnoses were excluded by the absence of morphologic and functional cardiac characteristics such as insufficiency, stenosis, malformation or displacement of the tricuspid valve,[29-31] right ventricular hypertrophy or systolic dysfunction, flattening of the interventricular septum, pulmonary artery enlargement,[31] narrowing or obstruction of the right ventricular outflow tract[32] and communication between the two atria.[33] It is also important to differentiate an aneurysm from a diverticulum. An aneurysm is defined as a dilation that involves all layers of the atrial wall (as in the present case), while a diverticulum has an entry (orifice) from the atrium into the cavity.[34]

Atrial aneurysm has previously been proposed to be caused by a congenital or acquired abnormality of the atrial musculature[35,36] or of the pericardial sac, leading to a herniation of the auricle and atrium.[26,37] The dog in the present report had no echocardiographic or computed tomographic evidence of a pericardial sac abnormality, nor of right cardiac chamber disease that might cause an aneurysm. In addition, its young age was more suggestive of a RAA caused by a congenital defect of the right atrial musculature.

The clinical signs in the present case were probably the result of LVOTO and the other malformations may have been clinically silent. In most cases, PLCVC has no haemodynamic significance and is found incidentally during cardiovascular imaging or surgery for other causes.[19,38] RAA is frequently silent in man[39] and in dogs,[28] although weakness, dyspnoea, syncope and sudden death related to supraventricular arrhythmias have been reported in man.[39] However, rhythm disturbances were not observed in the present case. Moreover, the fact that the dog had mild mitral insufficiency and normal atrial chamber size suggests that there were no haemodynamic consequences of the MVD at that time.

Dogs with LVOTO rarely progress to congestive heart failure, however, weakness, syncope, and even sudden death are more frequent in patients with moderate and severe obstruction.[40] If only an isolated form of LVOTO had been documented in the present case, the severity of obstruction would have been classified as severe, according to human VAS and canine SAS guidelines.[32,41] However, the present case had both functional forms of LVOTO combined: two fixed lesions, including VAS (fusion of left coronary and non-coronary leaflets) and SAS type 2 (fibrous ring formation on LVOT); in addition to one dynamic lesion, namely mitral valve SAM.[40] The fact that the present case had several cardiac defects, including three abnormalities (VAS, SAS and SAM) of the LVOT that could each increase aortic flow velocity and PG, makes it hard to assess the severity of each defect quantitatively as all measurements will be affected by the other comorbidities. It is probable that the combined haemodynamic effect produced by the sum of all types of

LVOTO increased afterload, impairing the haemodynamic function of the dog. This is evidenced by the observation of progression from left ventricular enlargement without left ventricular concentric hypertrophy.[4,42]

Balloon valvuloplasty is an option for treating dogs with SAS because it can reduce PG and clinical signs.[43] However, it does not increase the survival time when compared to atenolol therapy.[44] Furthermore, beta blockade does not increase survival time compared to untreated patients.[45] Nonetheless, these treatments are used in dogs with SAS, including the present case, for their negative chronotropic and inotropic effects, in addition to a reduction in myocardial oxygen demand.[46] In human patients with right or left atrial aneurysms, surgical resection is recommended due to complications such as arrhythmia, congestive heart failure, and thromboembolic disease.[35,47] Surgical treatment has also been reported in one dog with left auricular aneurysm related to stage C myxomatous mitral valve disease.[36] Surgical options for severe mitral regurgitation include valve replacement and valve repair. However, in cases of MVD the original mitral valve is difficult to repair, therefore bioprosthetic valve replacement may be more useful.[48] Surgical management was not considered in the present case, as there were no haemodynamic consequences of the RAA and MVD, and due to the complexity of the combined congenital cardiac diseases. In addition, despite improvements in the surgical management in dogs, open heart cardiac valve surgery in veterinary practice is still limited by prohibitive cost and high surgical risk.[48,49]

## CONCLUSION

This is the first case report of a dog with combined VAS, SAS, MVD, PLCVC, ARCVC and RAA. Echocardiography was an excellent tool for identification of the lesions in this dog, however the complexity of multiple uncommon cardiovascular abnormalities demanded the use of a more advanced image technique (computed tomography) to improve the diagnosis. Atenolol therapy partially resolved the dog's exercise intolerance, although haemodynamic complications progressed.

## CONFLICTS OF INTEREST AND SOURCES OF FUNDING

The authors declare no conflicts of interest for the work presented here.

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# Progressive dyspnoea in a kitten 2 days after ovariohysterectomy

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**ABSTRACT** A 6-month-old kitten developed a hoarse, raspy breathing pattern the day after being spayed under a general anaesthetic but without endotracheal intubation. This progressed to dyspnoea and open mouth panting the following day. On presentation, the cat exhibited a harsh, raspy sound on inhalation which could be localised to the larynx on auscultation. Thoracic and abdominal radiographs showed hyperinflation of the lungs and aerophagia. The kitten was treated for presumptive laryngitis and responded rapidly to a high dose of dexamethasone and oxygen therapy. Mild residual clinical signs gradually resolved over 7 days.

This case highlights laryngeal inflammation as an important diagnostic consideration in dyspnoeic cats, especially when airway stertor can be localised to the larynx. A recent history of anaesthesia without intubation suggested the possibility of reflux laryngitis as the cause of the laryngeal dysfunction.

**KEYWORDS** cat, dyspnoea, laryngitis, post-anaesthesia

**ABBREVIATIONS** IV, intravenous(ly)

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Aspiration pneumonia and oesophageal stricture formation secondary to gastroesophageal reflux are well-documented complications associated with general anaesthesia in cats.[1-3] Gastroesophageal reflux is also widely thought to cause laryngitis in humans, termed 'reflux laryngitis',[4] although occurrence in veterinary species is unknown aside from a single case report in a dog.[5]

The present case report describes a kitten that developed progressive dyspnoea 2 days after a general anaesthetic for ovariohysterectomy without endotracheal intubation. Although the possibility of other causes cannot be completely excluded, reflux laryngitis seems the most likely inciting cause considering all available clinical evidence, which is summarised below.

## CLINICAL FEATURES

A 6-month-old domestic medium hair cat (2.3-kg) was presented on a Sunday afternoon for severe dyspnoea. She had been spayed on Friday, 2 days earlier, and at first had made an apparently unremarkable recovery. On Saturday, however, she developed anorexia, lethargy, and a hoarse, raspy breathing pattern. This progressed to dyspnoea, with foaming of saliva around the mouth on the following morning.

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The cat was taken to the referring veterinary practice and thoracic and abdominal radiographs obtained. The diaphragm was flat and extended to the 2nd lumbar vertebrae (Figure 1). The lungs appeared overinflated, with spectacular gaseous dilatation of the stomach and intestines, presumably due to aerophagia. There was also a slight irregularity of the internal lumen of the thoracic trachea. No specific diagnosis was made. The cat was treated symptomatically: she was placed in an oxygen cage, given dexamethasone (0.33 mg/kg intravenously [IV]), amoxicillin/clavulanic acid (12 mg/kg combined) subcutaneously, salbutamol (270 µg) via metred dose inhaler and theophylline (50 mg) orally. She was transported to Animal Referral Hospital Brisbane approximately 6 hours later.

On initial physical examination the cat was quiet, alert, and responsive. The heart rate was 168 beats per minute with a regular rhythm, no murmur, normal pulses, pink and moist mucous membranes, and a capillary refill time of 1-2 seconds. At rest in the examination room, the cat was open-mouth panting with a moderately increased inspiratory effort. Importantly, there was a harsh, raspy sound on inhalation, which was loudest over the larynx. On auscultation of the chest, breath sounds were considered normal in all regions. The cat's abdomen was moderately distended, although soft and comfortable on palpation. There was a small amount of serous ocular discharge, with bilaterally prolapsed nictating membranes. Point-of-care ultrasound examination showed a small number of B-lines in the left cranioventral lung region; the other lung regions appeared normal.

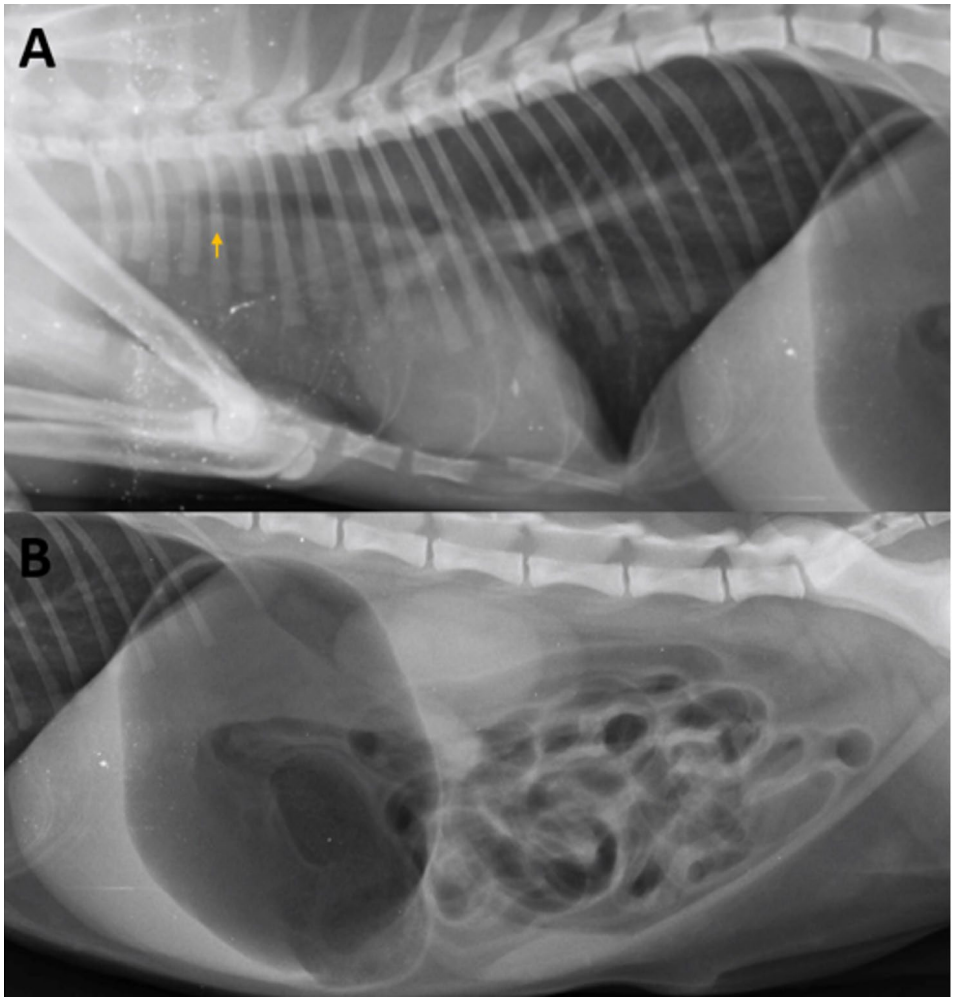


**Figure 1.** Lateral thoracic **(A)** and abdominal **(B)** radiographs taken with the cat in left lateral recumbency on the day of initial presentation. Note the irregularity in the internal tracheal lumen (orange arrow), lung overinflation, flat diaphragm and aerophagia resulting in marked gastric dilatation.

From these findings, it was thought that the cat has inspiratory dyspnoea due to a laryngeal problem. The most likely diagnostic possibilities entertained were laryngeal oedema or inflammation, possibly due to traumatic intubation (or extubation), excessive pressure from an overinflated endotracheal tube cuff, gastroesophageal reflux or coincidental viral laryngitis. As a result of the cat's critical condition, it was decided to treat the cat based on a presumptive diagnosis of laryngeal inflammation or oedema, rather than to investigate the larynx further by direct visualisation under heavy sedation or anaesthesia using a laryngoscope (possibly combined with sampling via a cytology brush), or by laryngeal ultrasonography.[6]

**Figure 2.** Kitten in the oxygen cage before commencement of intravenous fluid therapy. Note the prolapsed nictating membranes.

The cat was treated with an additional 0.55 mg/kg dexamethasone IV, amoxicillin/clavulanic acid (20 mg/kg combined) IV every 12 hours, oxygen supplementation (5L/min) in an oxygen cage (Figure 2), and IV fluid therapy (Hartmann's solution at 2.4 mL/kg/hr).

Approximately 3 hours after commencing treatment, a marked clinical improvement was apparent. The panting respiratory pattern resolved (respiratory rate now 40 breaths per minute), the inspiratory effort was much reduced, the inspiratory stridor was improved (only just discernible) and the cat became bright and playful. Overnight a butorphanol continuous rate infusion (0.2 mg/kg/hr) was used to provide sedation and analgesia. The cat had a single episode of haemorrhagic diarrhoea.

Mild tachypnoea and dyspnoea persisted the following day. Repeat thoracic radiographs showed narrowing of the trachea at the thoracic inlet region and tracheal distention further caudally within the thorax (Figure 3). She was transitioned to amoxicillin/clavulanic acid (15 mg/kg) orally twice daily and oxygen

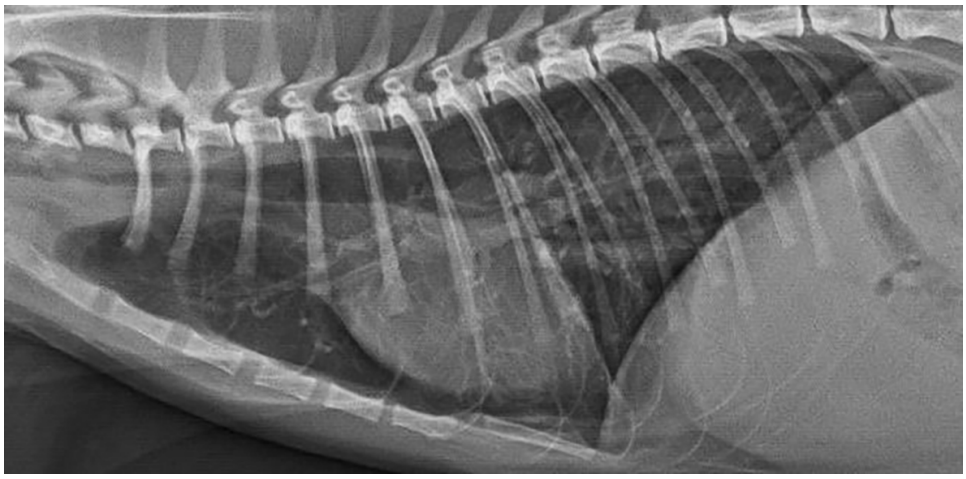

**Figure 3.** Lateral thoracic radiograph taken with the kitten in left lateral recumbency about 24 hours after initial presentation.

therapy was weaned and discontinued overnight. The cat was discharged on prednisolone (1 mg orally once a day) the next morning. Over the subsequent few days, the owners reported intermittent raspy purring, coughing, and snoring exacerbated by eating. These signs gradually resolved over the next week. Prednisolone (1 mg orally once daily) was continued for six days post-discharge, then every other day for a further six days. The owner reported that the cat had remained healthy at 2 months after discharge (Figure 4).

**Figure 4.** Kitten 2 months following discharge

Retrospectively, details of the kitten's anaesthetic were obtained from the referring veterinarian. Ketamine, medetomidine and butorphanol were administered subcutaneously (doses unknown). The patient had been fasted for over 12 hours prior to the procedure. An endotracheal tube was not placed, and no complications were noted in the immediate postoperative period by the attending veterinarian.

## DISCUSSION

The present case is similar in some respects to one described in 1991,[7] even though the events leading up to the clinical presentations were quite different. Common features include the prominent aerophagia and dramatic drooling, presumably due to inability to swallow saliva, possibly exacerbated by increased saliva production due to fear and anxiety. In the earlier case, laryngeal swelling was evident in lateral cervical radiographs and confirmed by direct visualisation during laryngoscopy.[7] However, the chronology of events was different for our case in that the kitten's signs occurred following a recent general anaesthetic. As the kitten was not intubated (thus excluding traumatic laryngitis as a cause), this leaves reflux laryngitis as the likely cause of the problem. However, viral laryngitis could have provided an alternative disease process considering the cat's serous ocular discharge and prolapsed 3rd eyelids at presentation. The earlier case[7] was shown to be due to viral laryngitis based on isolation of feline herpes virus and calicivirus; even though the cat's acute airway obstruction was successfully managed by IV corticosteroid therapy, the cat subsequently developed classic signs of severe viral upper respiratory disease. The latter was not the sequence of events in the cat of the present report.

The radiographic findings in the present case are consistent with aerophagia and pulmonary hyperinflation secondary to upper airway obstruction. Pulmonary hyperinflation is more commonly associated with chronic bronchial disease,[8] although it has also been reported in a dog with a tracheal tumour.[9] It is a shame the lateral radiographs did not extend to the cervical area, as laryngeal swelling might have been evident radiologically. Likewise, the small number of B-lines seen with lung ultrasonography may reflect trivial negative-pressure pulmonary oedema, which is known to occur secondary to upper airway obstruction.[10] We speculate that the slight irregularity of the internal lumen of the thoracic trachea may represent damage caused by gastroesophageal reflux followed by aspiration of gastric acid or ingesta into the proximal trachea. The resulting tracheitis may also have contributed to the coughing observed in the period following discharge. Distention of the trachea within the thoracic cavity seen on subsequent radiographs is likely referable to increased negative pressure

generated by the intercostal muscles and diaphragm to compensate for increased upper airway resistance, although the significance of tracheal narrowing seen at the thoracic inlet is unclear.

The episode of haemorrhagic diarrhoea may have occurred secondary to the stress of dyspnoea or the high dose of corticosteroid administered (dexamethasone 0.88 mg/kg in 12 hours).[11] This underscores the need to taper corticosteroid treatment as soon as possible, especially in very young animals, and particularly if adverse gastrointestinal signs are noted.

The present case highlights laryngeal inflammation as an important diagnostic possibility in cats with dyspnoea, especially when airway stertor can be localised to the laryngeal region. Although the aetiology remains equivocal, reflux laryngitis from exposure of the larynx to gastric fluid containing hydrochloric acid and pepsin seems most likely.[12] The delayed onset of signs is interesting, and it is notable that in a rabbit model of the effect of gastric fluid on the larynx, clinical signs took 3-4 days to manifest.[12] It is possible that progressive inflammation and oedema occurred 48 hours following the inciting insult due to friction between the inflamed supraglottic tissues and increased airflow velocity through the increasingly narrow laryngeal lumen.[13]

How often reflux laryngitis develops post-anaesthetic is unknown, but to our knowledge, there are no prior published reports of such a scenario.[14,15] It is unclear whether pre-operative proton pump inhibitors, gastric prokinetics or shorter fasting times (3-4 hours) may help.[3,16] Cat owners should be advised to monitor for signs of laryngeal disease (dyspnoea, stridor, dysphonia, gagging and coughing) in the days following a general anaesthetic, and veterinarians should always consider the possibility of laryngeal swelling in such patients. Immediate institution of corticosteroid therapy is mandatory to prevent progressive airway obstruction.

## CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

## ACKNOWLEDGEMENTS

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# AVA Centenary Conference Series

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# Abstracts

These Abstracts have been sourced from the following journals: Journal of the American Veterinary Medical Association, Journal of Exotic Pet Medicine, Journal of Feline Medicine and Surgery, Journal of Veterinary Emergency and Critical Care, Journal of Veterinary Internal Medicine, Journal of Small Animal Practice, Veterinary Surgery and New Zealand Veterinary Journal.

These abstracts are arranged under the headings Cats, Cats and Dogs, Dogs, and Exotics, and within those headings by broad subject area.

## GENERAL

### Pet health insurance reduces the likelihood of pre-surgical euthanasia of dogs with gastric dilatation-volvulus in the emergency room of an Australian referral hospital

***Anderson S et al***

**NZ Vet J May 2021; doi: 10.1080/00480169.2021.1920512**

**Aims:** To determine the association between the presence of pet health insurance and the risk of euthanasia at the time of diagnosis for dogs with gastric dilatation-volvulus (GDV).

**Methods:** Insurance status at the time of GDV diagnosis was sought for a cohort of 147 non-referred, confirmed cases of GDV that presented to the emergency department of a university-based veterinary hospital in Australia between 2008 and 2017. Insurance status was obtained from the medical record (n=18) or after contacting the owners by phone using a standardised questionnaire (n=129). Animal, clinical and outcome data was retrospectively compiled in a research database. The primary outcome measure was whether or not the dog was euthanised before surgery. The Mantel-Haenszel procedure was used to quantify the association between the presence of pet health insurance and the risk of euthanasia at the time of diagnosis for dogs with GDV, adjusting for the confounding effect of age at the time of presentation using Bayesian methods.

**Results:** Of the 69 dogs for which insurance information could be obtained, 10 (14%) cases were insured at the time of the GDV event and 59 (86%) cases were not. The majority of non-insured dogs (37/59; 63 (95% CI=50–74)%) were euthanised before surgery, while none (0 (95% CI=0–28)%) of the insured dogs were euthanised at that time ($p<0.001$). Of the 32 insured and non-insured dogs that underwent surgery, four dogs (13 (95% CI=5–28)%) did not survive to hospital discharge. Three dogs (9%) were euthanised during or after surgery and one dog (3%) experienced cardiopulmonary arrest during treatment. The majority of dogs for which insurance status was known did not survive to hospital discharge (41/69; 59%), and 90 (95% CI=7–96)% of deaths were caused by euthanasia prior to surgery. Uninsured dogs were 5.0 (95% credible interval=1.8–26) times more likely to undergo presurgical euthanasia compared with insured dogs.

**Conclusions :** Euthanasia prior to treatment was most common cause of death in non-referred dogs with GDV; such euthanasia was entirely absent in the cohort of dogs that were insured.

**Clinical relevance:** Financial considerations significantly contribute to mortality of dogs with GDV presented to an emergency room. Financial instruments to reduce the out-of-pocket expense for pet owners confronted with unexpected veterinary expenses have potential to reduce pet mortality.

### Compassion satisfaction, burnout, and secondary traumatic stress among full-time veterinarians in the United States (2016-2018)

***Ouedraogo FB et al***

**J Am Vet Med Assoc 258: 1259-1270, 2021; https://doi.org/10.2460/javma.258.11.1259**

**Objective:** To determine prevalences of low compassion satisfaction (CS), high burnout (BO), and high secondary traumatic stress (STS) scores among full-time US veterinarians and estimate effects of selected demographic, employment-related, and education-related factors on those scores.

**Sample:** 5,020 full-time veterinarians who participated in the 2016, 2017, and 2018 AVMA Census of Veterinarians surveys.

**Procedures:** Data were obtained from census surveys regarding demographic, employment-related, and education-related factors, and scores assigned to items from a professional quality-of-life instrument designed to measure CS and compassion fatigue (ie, BO and STS) were compared between and among various demographic and employment groups.

**Results:** Overall, 35.5% of veterinarians were classified as having low CS scores, 50.2% as having high BO scores, and 58.9% as having high STS scores. Controlling for other variables, high educational debt was associated with low CS, high BO, and high STS scores. Veterinarians who spent ≥ 75% of their time working with dogs or cats had higher BO and STS scores than did those who spent < 25% of their time. Veterinarians with more experience and higher annual incomes had higher CS scores and lower BO and STS scores. Women had higher BO and STS scores than did men, but no gender differences were observed in CS scores.

**Conclusions and Clinical Relevance:** Several variables were identified that may put veterinarians at higher risk than others for compassion fatigue and low CS. These findings may be useful in the development of resources and targeted initiatives to support and defend veterinarian well-being.

# CATS

## Aging

### 2021 AAHA/AAFP Feline Life Stage Guidelines

***Quimby J et al***

**J Fel Med Surg 23: 211-233, 2021; https://doi.org/10.1177/1098612X21993657**

**Abstract:** The guidelines, authored by a Task Force of experts in feline clinical medicine, are an update and extension of the AAFP-AAHA Feline Life Stage Guidelines published in 2010. The guidelines are published simultaneously in the Journal of Feline Medicine and Surgery and the Journal of the American Animal Hospital Association. A noteworthy change from the earlier guidelines is the division of the cat's lifespan into a five-stage grouping with four distinct age-related stages (kitten, young adult, mature adult, and senior) as well as an end-of-life stage, instead of the previous six. This simplified grouping is consistent with how pet owners generally perceive their cat's maturation and aging process, and provides a readily understood basis for an evolving, individualized, lifelong feline healthcare strategy. The guidelines include a comprehensive table on the components of a feline wellness visit that provides a framework for systematically implementing an individualized life stage approach to feline healthcare. Included are recommendations for managing the most critical health-related factors in relation to a cat's life stage. These recommendations are further explained in the following categories: behavior and environmental needs; elimination; life stage nutrition and

weight management; oral health; parasite control; vaccination; zoonoses and human safety; and recommended diagnostics based on life stage. A discussion on overcoming barriers to veterinary visits by cat owners offers practical advice on one of the most challenging aspects of delivering regular feline healthcare.

## Cardiorespiratory system

### Feline cardiopulmonary resuscitation: Getting the most out of all nine lives

***Ward MJ et al***

**J Fel Med Surg 23: 447-461, 2021; https://doi.org/10.1177/1098612X211004811**

**Practical Relevance:** Cardiopulmonary arrest (CPA) can occur in any veterinary or animal care setting and is a particular risk in scenarios involving ill, injured or anesthetized patients. Education of all staff on the prevention and recognition of CPA, as well as the performance of cardiopulmonary resuscitation (CPR), is vital to influencing outcome.

**Evidence base:** While there is a plethora of information regarding CPA and CPR in human medicine, there are comparably few studies in the veterinary literature. Many of the current veterinary guidelines are extrapolated from human medicine or studies based on animal models. Ongoing work is needed to tailor guidelines and recommendations to our domestic feline (and canine) patients in a clinical setting.

**Aim:** The aim of this article, which is intended for veterinarians in all areas of small animal practice, is to provide an evidence-based review of CPA and CPR in feline patients. The authors have drawn heavily on detailed recommendations published by the Reassessment Campaign on Veterinary Resuscitation (RECOVER) initiative – one of the few resources specific to the veterinary clinical setting – as well as reviewing the available peer-reviewed literature studies, in constructing this article. Among the topics discussed are recognizing and preventing CPA, staff training and clinic preparedness, basic life support and advanced life support interventions, and appropriate post-cardiac arrest care.

### Effects of pimobendan in cats with hypertrophic cardiomyopathy and recent congestive heart failure: Results of a prospective, double-blind, randomized, nonpivotal, exploratory field study

***Schober KE et al***

**J Vet Intern Med 35:789-800, 2021; https://doi.org/10.1111/jvim.16054**

**Background:** The benefits of pimobendan in the treatment of congestive heart failure (CHF) in cats with hypertrophic cardiomyopathy (HCM) have not been evaluated prospectively.

**Hypothesis/Objectives:** To investigate the effects of pimobendan in cats with HCM and recent CHF and to identify possible endpoints for a pivotal study. We hypothesized that pimobendan would be well-tolerated and associated with improved outcome.

**Animals:** Eighty-three cats with HCM and recently controlled CHF: 30 with and 53 without left ventricular outflow tract obstruction.

**Methods:** Prospective randomized placebo-controlled double-blind multicenter nonpivotal field study. Cats received either pimobendan (0.30 mg/kg q12h, n = 43), placebo (n = 39), or no medication (n = 1) together with furosemide (<10 mg/kg/d) with or without clopidogrel. The primary endpoint was a successful outcome (ie, completing the 180-day study period without a dose escalation of furosemide).

**Results:** The proportion of cats in the full analysis set population with a successful

outcome was not different between treatment groups (P = .75). For nonobstructive cats, the success rate was 32% in pimobendan-treated cats versus 18.2% in the placebo group (odds ratio [OR], 2.12; 95% confidence interval [CI], 0.54-8.34). For obstructive cats, the success rate was 28.6% and 60% in the pimobendan and placebo groups, respectively (OR, 0.27; 95% CI, 0.06-1.26). No difference was found between treatments for the secondary endpoints of time to furosemide dose escalation or death (P = .89). Results were similar in the per-protocol sets. Adverse events in both treatment groups were similar.

**Conclusions and Clinical Importance:** In this study of cats with HCM and recent CHF, no benefit of pimobendan on 180-day outcome was identified.

## Diabetes

### Accuracy of a flash glucose monitoring system in cats and determination of the time lag between blood glucose and interstitial glucose concentrations

***Del Baldo F et al***

**J Vet Intern Med 35: 1279-1287, 2021; https://doi.org/10.1111/jvim.16122**

**Background:** The FreeStyle Libre (Abbott Laboratories) is a flash glucose monitoring system (FGMS) that measures interstitial glucose concentration (IG). The system is factory-calibrated, easy to use, inexpensive, and could be useful for monitoring diabetic cats.

**Objectives:** To evaluate the analytical and clinical accuracy of the FGMS in cats and establish the lag-time between IG and blood glucose concentration (BG).

**Animals:** Twenty client-owned diabetic cats and 7 purpose-bred healthy cats.

**Methods:** Prospective study. Blood glucose concentration was measured using a portable glucose meter validated for use in cats that served as a reference method for IG, as measured by FGMS. In diabetic cats, data were collected for sensor wearing time with different methods of application and accuracy across glycemic ranges. Accuracy was determined by fulfillment of ISO15197:2013 criteria. In healthy cats, lag-time between IG and BG was established after IV administration of exogenous glucose.

**Results:** Good agreement between IG and BG was obtained (r = .93). Analytical accuracy was not achieved, whereas clinical accuracy was demonstrated with 100% of the results in zones A + B of the Parkes consensus error grid analysis. In the immediate 30 minutes after an IV bolus of glucose, when BG was increasing rapidly (approximately 2%/min), IG increased slowly, resulting in a difference of as much as 579 mg/dL, and no positive correlation between BG and IG was found.

**Conclusions and Clinical Importance:** The FGMS did not fulfill ISO requirements but is sufficiently accurate for glucose monitoring in cats, while considering the lag between IG and BG during periods of rapid changes in BG.

## Oncology

### Metastatic feline mammary cancer: prognostic factors, outcome and comparison of different treatment modalities - a retrospective multicentre study

***Petrucci G et al***

**J Fel Med Surg 23: 549-556, 2021; https://doi.org/10.1177/1098612X20964416**

**Objectives:** Although feline mammary carcinomas (FMCs) are highly metastatic, the literature and treatment options pertaining to advanced tumours are scarce. This study aimed to investigate the clinical outcome of metastatic FMC with or without adjuvant treatment.

**Methods:** The medical records of 73 cats with metastatic FMC (stage IV) were reviewed and included in this study. Metastatic disease was detected by distinct imaging techniques (radiography, ultrasound and CT) and confirmed by cytology and/or histopathology. Cats with adjuvant chemotherapy treatment (n = 34) were divided into three groups: group 1 (n = 9) cats receiving maximum tolerated dose chemotherapy; group 2 (n = 15) cats receiving metronomic chemotherapy; and group 3 (n = 10) cats treated with toceranib phosphate. The study endpoints were time to progression (TTP) and tumour-specific survival (TSS). Treatment-related toxicity was evaluated according to the Veterinary Co-operative Oncology Group's Common Terminology Criteria for Adverse Events version 1.1 (VCOG-CTCAE).

**Results:** Overall mean TTP and TSS were 23 and 44 days, respectively. Cats with clinical signs at the time of diagnosis had a lower TSS (14 days) than asymptomatic cats (128 days; P <0.001). Cats with pleural effusion had a lower TSS (16 days) than cats without (P <0.001). Median TSS was 58, 75 and 63 days in groups 1, 2 and 3, respectively (P = 0.197). Toxicity was observed in 66.7%, 20% and 30% of cats in groups 1, 2 and 3, respectively.

**Conclusions and Relevance:** To the best of our knowledge, this study includes the highest number of patients with metastatic FMC assessed. Despite the overall poor prognosis, some cats survived >6 months, indicating that adjuvant treatment may be an option to consider in metastatic disease. More studies are warranted for better understanding and management of stage IV patients.

## Orthopaedics

### Owner evaluation of quality of life and mobility in osteoarthritic cats treated with amantadine or placebo

***Shipley H et al***

***J Fel Med Surg 23: 568-574, 2021; https://doi.org/10.1177/1098612X20967639***

**Objectives:** The aim of the study was to determine if amantadine improves owner-identified mobility impairment and quality of life associated with osteoarthritis in cats.

**Methods:** Using a blinded, placebo-controlled, randomized, crossover design, 13 healthy client-owned cats with clinical and radiographic evidence of osteoarthritis and owner-identified mobility impairment were studied. Cats received 5 mg/kg amantadine or placebo q24h PO for 3 weeks each with no washout period in between. Locomotor activity was continuously assessed with a collar-mounted activity monitor system, and owners chose and rated two mobility-impaired activities using a client-specific outcome measures (CSOM) questionnaire on a weekly basis. Locomotor activity on the third treatment week was analyzed with two-tailed paired t-tests. The CSOM scores were analyzed using a mixed-effect model and the Bonferroni post-hoc test. Owner-perceived changes in quality of life were compared between treatments using the $\chi 2$ test. Statistical significance was set at P <0.05.

**Results:** Mean ± SD activity counts during the third week of each treatment were significantly lower with amantadine (240,537 ± 53,880) compared with placebo (326,032 ± 91,759). CSOM scores assigned by the owners were significantly better with amantadine on the second (3 ± 1) and third (3 ± 1) weeks compared with placebo (5 ± 2 and 5 ± 1, respectively). A significantly greater proportion of owners reported improvement in quality of life with amantadine compared with placebo.

**Conclusions and Relevance:** Amantadine significantly decreased activity, but improved owner-identified impaired mobility and owner-perceived quality of life in cats with osteoarthritis. Amantadine appears to be an option for the symptomatic treatment of osteoarthritis in cats.

## Pancreas

### ACVIM consensus statement on pancreatitis in cats

***Forman MA et al***

**J Vet Intern Med 35 (2): 703-723, 2021; https://doi.org/10.1111/jvim.16053**

Consensus Statements of the American College of Veterinary Internal Medicine (ACVIM) provide the veterinary community with up-to-date information on the pathophysiology, diagnosis, and treatment of clinically important animal diseases.

**Background:** Pancreatitis in cats, although commonly diagnosed, still presents many diagnostic and management challenges.

**Objective:** To summarize the current literature as it relates to etiology, pathogenesis, diagnosis, and management of pancreatitis in cats and to arrive at clinically relevant suggestions for veterinary clinicians that are based on evidence, and where such evidence is lacking, based on consensus of experts in the field.

**Animals:** None.

**Methods:** A panel of 8 experts in the field (5 internists, 1 radiologist, 1 clinical pathologist, and 1 anatomic pathologist), with support from a librarian, was formed to assess and summarize evidence in the peer reviewed literature and complement it with consensus clinical recommendations.

**Results:** There was little literature on the etiology and pathogenesis of spontaneous pancreatitis in cats, but there was much in the literature about the disease in humans, along with some experimental evidence in cats and nonfeline species. Most evidence was in the area of diagnosis of pancreatitis in cats, which was summarized carefully. In contrast, there was little evidence on the management of pancreatitis in cats.

**Conclusions and Clinical Importance:** Pancreatitis is amenable to antemortem diagnosis by integrating all clinical and diagnostic information available, and recognizing that acute pancreatitis is far easier to diagnose than chronic pancreatitis. Although both forms of pancreatitis can be managed successfully in many cats, management measures are far less clearly defined for chronic pancreatitis.

## Reproduction

### Disappearance of signs of heat and induction of ovulation in oestrous queens with gonadorelin: a clinical study

***Ferré-Dolcet L et al***

**J Fel Med Surg 23: 269-277, 2021; https://doi.org/10.1177/1098612X20951284**

**Objectives:** The objective of this study was to assess the efficacy of a single intramuscular administration of gonadorelin to induce ovulation in queens in oestrus.

**Methods:** Twenty-seven queens presented in oestrus for elective ovariectomy were divided into a treatment (n = 19) and a placebo (n = 8) group. Treated queens received a 50 µg dose of gonadorelin, while placebo-treated queens were injected intramuscularly (IM) with an equal amount of saline solution. All treatments were performed between the second and fourth days of heat.

**Results:** Two days later, signs of behavioural heat had disappeared in all gonadorelin-treated queens, while 5/8 placebo-treated queens were still in heat. Following ovariectomy, performed 4 days after drug administration, the ovaries of each queen were evaluated histologically and the number of corpora lutea were counted. Sixteen of 19 (84%) gonadorelin-treated queens had ovulated and developed five (range 2–9) corpora lutea, while 3/8 (37%) placebo-treated queens had ovulated and developed

five (range 3–6) corpora lutea.

**Conclusions and Relevance:** This is the first study to document the efficacy of a 50 µg/cat gonadorelin dose to induce ovulation in oestrous queens when administered IM on days 2–4 following the onset of oestrus.

## Urinary System

### Multicenter evaluation of decompressive cystocentesis in the treatment of cats with urethral obstruction

***Reineke EL et al***

**J Am Vet Med Assoc 258: 483-492, 2021; https://doi.org/10.2460/javma.258.5.483**

**Objective:** To investigate whether decompressive cystocentesis (DC) safely facilitates urethral catheterization (UC) in cats with urethral obstruction (UO).

**Animals:** 88 male cats with UO.

**Procedures:** Cats were randomly assigned to receive DC prior to UC (ie, DC group cats; n = 44) or UC only (ie, UC group cats; 44). Abdominal effusion was monitored by serial ultrasonographic examination of the urinary bladder before DC and UC or before UC (DC and UC group cats, respectively), immediately after UC, and 4 hours after UC. Total abdominal effusion score at each time point ranged from 0 (no effusion) to 16 (extensive effusion). Ease of UC (score, 0 [easy passage] to 4 [unable to pass]), time to place urinary catheter, and adverse events were recorded.

**Results:** No significant difference was found in median time to place the urinary catheter in UC group cats (132 seconds), compared with DC group cats (120 seconds). Median score for ease of UC was not significantly different between UC group cats (score, 1; range, 0 to 3) and DC group cats (score, 1; range, 0 to 4). Median change in total abdominal effusion score from before UC and DC to immediately after UC was 0 and nonsignificant in UC group cats (range, −5 to 12) and DC group cats (range, −4 to 8). Median change in effusion score from immediately after UC to 4 hours after UC was not significantly different between UC group cats (score, −1; range, −9 to 5) and DC group cats (score, −1; range, −7 to 5).

**Conclusions and Clinical Relevance:** DC did not improve time to place the urinary catheter or ease of UC in cats with UO.

# CATS AND DOGS

## Haematology/Haemostasis

### Complications associated with bone marrow sampling in dogs and cats

***Woods GA et al***

**J Small Anim Pract 62: 209-215, 2021; https://doi.org/10.1111/jsap.13274**

**Objectives:** To evaluate the prevalence of complications during bone marrow sampling and associated patient and procedural factors in dogs and cats.

**Materials and Methods:** Retrospective cohort study, records were evaluated to identify dogs and cats that had bone marrow sampling between 2012 and 2019. Data including signalment, the presence of specific clinicopathological findings, anatomical site of bone marrow sampling, number of attempts, diagnostic quality of sampling, analgesia protocol and complications postprocedure were recorded.

**Results:** A total of 131 dogs and 29 cats were included in the study. Complications were recorded in 22 of 160 (14%) of cases. Pain was the most common complication of bone marrow sampling in 20 of 22 (91%) of cases with bruising reported in the remaining patients. A local anaesthetic block was used in 98 of 160 (61%) of patients.

**Clinical Significance:** Excluding pain, complications associated with bone marrow sampling were rare and no clear association were detected between patient or procedural variables. Haemorrhage and infection are rare complications in dogs and cats when thrombocytopenia and neutropenia are present. Peri-procedure analgesia is strongly recommended to minimise complications.

### Special ("Free to Read") Issue on Transfusion Medicine

**J Vet Emerg Crit Care 31 (Issue 2), 2021; https://onlinelibrary.wiley.com/toc/14764431/2021/31/2**

Includes:

Association of Veterinary Hematology and Transfusion Medicine (AVHTM) Transfusion Reaction Small Animal Consensus Statements on: Definitions and clinical signs; Prevention and monitoring; and Diagnosis and treatment.

Review: The role of cryoprecipitate in human and canine transfusion medicine

Studies on:

- The effect of time on packed cell volume following packed red blood cell transfusion in anemic dogs
- Effects of storage and leukocyte reduction on the concentration and procoagulant activity of extracellular vesicles in canine packed red cells
- An in vitro study of canine cryopoor plasma to correct vitamin K–dependent coagulopathy in dogs
- Hemostatic capacity of canine chilled whole blood over time
- The effects of additive solutions on the development of storage lesions in stored canine platelet concentrates
- The effects of two intramuscular sedation protocols on echocardiographic variables in cats following sedation and blood donation
- Indications for use and complications associated with canine plasma products in 170 patients

# DOGS

## Cardiorespiratory System

### Accuracy of history, physical examination, cardiac biomarkers, and biochemical variables in identifying dogs with stage B2 degenerative mitral valve disease

***Wilshaw J et al***

**J Vet Intern Med 35: 755-770, 2021; https://doi.org/10.1111/jvim.16083**

**Background:** Treatment is indicated in dogs with preclinical degenerative mitral valve disease (DMVD) and cardiomegaly (stage B2). This is best diagnosed using echocardiography; however, relying upon this limits access to accurate diagnosis.

**Objectives:** To evaluate whether cardiac biomarker concentrations can be used alongside other clinical data to identify stage B2 dogs.

**Animals:** Client-owned dogs (n = 1887) with preclinical DMVD prospectively sampled in Germany, the United Kingdom, and the United States.

**Methods:** Dogs that met inclusion criteria and were not receiving pimobendan (n = 1245) were used for model development. Explanatory (multivariable logistic regression) and predictive models were developed using clinical observations, biochemistry, and cardiac biomarker concentrations, with echocardiographically confirmed stage B2 disease as the outcome. Receiver operating characteristic curves assessed the ability to identify stage B2 dogs.

**Results:** Age, appetite, serum alanine aminotransferase activity, body condition, serum creatinine concentration, murmur intensity, and plasma N-terminal propeptide of B-type natriuretic peptide (NT-proBNP) concentration were independently associated with the likelihood of being stage B2. The discriminatory ability of this explanatory model (area under curve [AUC], 0.84; 95% confidence interval [CI], 0.82-0.87) was superior to NT-proBNP (AUC, 0.77; 95% CI, 0.74-0.80) or the vertebral heart score alone (AUC, 0.76; 95% CI, 0.69-0.83). A predictive logistic regression model could identify the probability of being stage B2 (AUC test set, 0.86; 95% CI, 0.81-0.91).

**Conclusion and Clinical Importance:** Our findings indicate accessible measurements could be used to screen dogs with preclinical DMVD. Encouraging at-risk dogs to seek further evaluation could result in a greater proportion of cases being appropriately managed.

## Prospective evaluation of plasma lactate parameters for prognosticating dogs with shock

***Blutinger AL et al***

***J Vet Emerg Crit Care 31: 351-359, 2021; https://doi.org/10.1111/vec.13046***

**Objective:** To determine whether admission venous plasma lactate concentration, serially calculated lactate variables, or the Acute Patient Physiologic and Laboratory Evaluation (APPLEfast) score could discriminate hospital survivors from non-survivors in dogs presenting to the emergency department with clinical signs of shock.

**Design:** Prospective case series performed over a 24-month period.

**Setting:** Large urban private teaching hospital.

**Animals:** Seventy-one dogs admitted to the ICU with initial peripheral venous plasma lactate concentration > 2.5 mmol/L and clinical and hemodynamic parameters consistent with shock.

**Interventions:** None.

**Measurements and Main Results:** Heart rate, systolic blood pressure, temperature, initial venous plasma lactate, and APPLEfast score were recorded at admission. Lactate concentrations were serially recorded at predefined time points and used to calculate lactate variables, including lactime (time lactate > 2.5 mmol/L), lactate clearance ([lactateinitial – lactatedelayed]/ lactateinitial × 100), and LACAREA (area under the lactate concentration versus time curve). Primary outcome was survival to discharge. Overall survival rate was 61%. Admission plasma lactate did not differ between groups (P = 0.28). Lactime was shorter in survivors vs non-survivors (P = 0.03). Lactate clearance at hours (h) 1, 4, 10, and 16 was greater in survivors vs non-survivors (P < 0.05). Final plasma lactate clearance differed between groups (P < 0.05). LACAREA at time intervals 1 to 4 hours, 4 to 10 hours, 10 to 16 hours, and 16 to 24 hours was larger in non-survivors vs survivors (P < 0.05). Total LACAREA did not differ between groups (P = 0.51). Admission APPLEfastwas not different between survivors and non-survivors (P = 0.16).

**Conclusions:** While neither single APPLEfast nor admission plasma lactate concentration could discriminate between hospital survivors and non-survivors, measures of lactate clearance can prognosticate survival in dogs with shock.

## Impact of equipment and handling on systolic blood pressure measurements in conscious dogs in an animal hospital environment

***Lyberg M et al***

**J Vet Intern Med 35: 739-746, 2021; https://doi.org/10.1111/jvim.16062**

**Background:** Situational hypertension and differences between devices complicate interpretations of systolic blood pressure (SBP) measurements in dogs.

**Hypothesis/Objectives:** To evaluate if time point of in-clinic SBP measurement, type of oscillometric device, and operator affect SBP measurements in conscious dogs.

**Animals:** Sixty-seven privately owned dogs with or without chronic kidney disease, divided into 2 study samples (A and B).

**Methods:** Cross-sectional diagnostic study. In part A, SBP measurements in dogs were performed using 2 different devices (HDO and petMap) after acclimatization at 3 standardized time points during a clinical visit. In part B, SBP measurements (HDO) were performed in dogs by a trained final year veterinary student and by the owner alone, at the same occasion.

**Results:** For all dogs, there was no difference in mean SBP (mSBP) among the 3 time points for HDO (P = .12) or petMAP (P = .67). However, intraindividual mSBP differences of up to 60 mm Hg between time points were documented. Mean SBP obtained with petMAP was on average 14 (95% CI: 8-20) mm Hg higher than mSBP obtained with HDO, and this difference increased with increasing SBP. Mean SBP measurements obtained by the trained student were 7 (95% CI: 2-11) mm Hg higher than mSBP measurements obtained by the owner.

**Conclusions and Clinical Importance:** According to the results of this study, time point of in-clinic SBP measurement in dogs is of minor importance, and instructing owners to perform measurements might reduce suspected situational hypertension. Differences in mSBP measured with HDO and petMAP underscore the need for validation of BP devices used clinically.

## Surgical management and outcome of dogs with primary spontaneous pneumothorax: 110 cases (2009–2019)

***Dickson R et al***

**J Am Vet Med Assoc 258: 1229-1235, 2021; https://doi.org/10.2460/javma.258.11.1229**

**Objective:** To describe surgical management and associated outcomes for dogs with primary spontaneous pneumothorax.

**Animals:** 110 client-owned dogs with primary spontaneous pneumothorax that underwent surgical management.

**Procedures:** Medical records at 7 veterinary teaching hospitals were reviewed. Data collected included signalment, history, clinical signs, radiographic and CT findings, surgical methods, intraoperative and postoperative complications, outcomes, and histopathologic findings. Follow-up information was obtained by contacting the referring veterinarian or owner.

**Results:** 110 dogs were included, with a median follow-up time of 508 days (range, 3 to 2,377 days). Ninety-nine (90%) dogs underwent median sternotomy, 9 (8%) underwent intercostal thoracotomy, and 2 (2%) underwent thoracoscopy as the sole intervention. Bullous lesions were most commonly found in the left cranial lung lobe (51/156 [33%] lesions) and right cranial lung lobe (37/156 [24%] lesions). Of the 100 dogs followed up for > 30 days, 13 (13%) had a recurrence of pneumothorax, with median time between surgery and recurrence of 9 days. Recurrence was significantly more likely to occur ≤ 30 days after surgery, compared with > 30 days after surgery. Recurrence > 30 days after surgery was rare (3 [3%]). No risk factors for recurrence were identified.

**Conclusions and Clinical Relevance:** Lung lobectomy via median sternotomy resulted in resolution of pneumothorax in most dogs

with primary spontaneous pneumothorax. Recurrence of pneumothorax was most common in the immediate postoperative period, which may have reflected failure to identify lesions during the initial thoracic exploration, rather than development of additional bullae.

## Dermatology

### Transverse sectioning in the evaluation of skin biopsy specimens from alopecic dogs

***Bond R et al***

**J Small Anim Pract 62: 244-252, 2021; https://doi.org/10.1111/jsap.13243**

**Objectives:** Transverse sectioning of skin biopsy specimens has revolutionised assessment of human alopecia by demonstration of every hair in each specimen, allowing quantitative evaluation of follicular activity. Since only vertical sectioning is performed routinely in veterinary laboratories, we aimed to determine whether transverse sectioning was a valuable technique in assessment of canine alopecia.

**Methods:** Paired vertical and transverse sections of biopsy specimens from 31 alopecic dogs were examined independently in triplicate in random order and blinded to previous diagnosis using a standard check-list proforma. Assessments of key features (follicular activity [anagen/telogen], infundibular hyperkeratosis, sebaceous gland abnormalities, pigment clumping, dermal inflammation) by each sectioning method were compared.

**Results:** In the 31 cases, (atrophic [n = 13], dysplastic [n = 12], inflammatory diseases [n = 6]), follicular inactivity scores (median, [lower-upper quartile]) in transverse sections significantly exceeded those in vertical sections (transverse 4 [3-5], vertical 3 [2-4]). Agreement between the two sectioning planes was moderate for infundibular hyperkeratosis (kappa = 0.5210) and dermal inflammation (0.4351), fair for sebaceous gland abnormalities (0.3966) and pigment clumping (0.2197), but slight for follicular activity (0.1041). Vertical sectioning demonstrated diagnostically important epidermal pathology (n = 2) and dermal thinning (n = 3) whereas transverse sectioning enhanced assessment of hair growth phase (n = 11), follicular structure and architecture (n = 11), and focal luminal or mural folliculitides (n = 3).

**Clinical significance:** Transverse sectioning confers significant benefits and complements traditional vertical sectioning in the histological assessment of canine hair follicle diseases, particularly when subtle abnormalities comprise distorted compound follicle architecture, hair cycle arrest or when relatively few adnexal structures are affected.

## Gut/Liver

### Prognostic indicators at presentation for canine parvoviral enteritis: 322 cases (2001-2018)

***Chalifoux NV et al***

**J Vet Emerg Crit Care 31: 402-413, 2021; https://doi.org/10.1111/vec.13052**

**Objective:** To evaluate clinicopathological prognostic indicators associated with survival based on hematology and serum biochemistry profile findings at presentation of dogs with canine parvoviral enteritis (CPE). Secondary objectives were to describe the signalment, history, physical examination findings, and progression of disease while in hospital and correlate them to survival.

**Design:** Retrospective study from medical records of dogs diagnosed with CPE between 2001 and 2018.

**Setting:** University teaching hospital.

**Animals:** Three hundred twenty-two dogs diagnosed with CPE that received in-hospital treatment.

**Interventions:** None.

**Measurements and Main Results:** Of 322 hospitalized dogs, 294 dogs (91%) survived infection with a median hospitalization time of 79 hours. Multivariable analysis showed that glucose (P = 0.04), total magnesium (P = 0.011), and the dichotomized variable of a low HCT (P = 0.033) on presentation were significantly associated with survival. For every 1 mmol/L (18 mg/dL) decrease in glucose concentration, cases had 1.85 lower odds of survival. For every 0.1 mmol/L (0.2 mEq/L) increase in total magnesium concentration, cases had 2.50 lower odds of survival. Cases with a low HCT had 10.69 lower odds of survival. On univariable analyses, non-survivors had a lower median body weight (P = 0.006) and presented more commonly for diarrhea (P = 0.015). At least 1 episode of diarrhea (P = 0.003) and hematochezia or melena (P < 0.001) in hospital were negatively associated with outcome, in addition to the persistence of diarrhea (P = 0.026) and hyporexia (P = 0.018) in hospital for 5 to 6 days.

**Conclusions:** Survival rates of 91% were achieved with in-hospital treatment in this cohort of dogs. Negative biochemical prognostic indicators affecting survival include a low HCT, decreased blood glucose concentrations, and increased total serum magnesium concentrations at presentation.

## Resting and postprandial serum bile acid concentrations in dogs with liver disease

***Pena-Ramos J et al***

**J Vet Intern Med 35: 1333-1341, 2021; https://doi.org/10.1111/jvim.16134**

**Background:** Serum bile acids (SBAs) are frequently measured in dogs. However, there is limited data comparing SBAs in different liver diseases diagnosed according to standardized histological criteria.

**Objectives:** To compare resting and postprandial SBAs, and determine their sensitivity and specificity, for various liver diseases in dogs.

**Animals:** Three hundred and forty-one client-owned dogs with suspected liver disease that had a liver biopsy and SBAs measured.

**Methods:** Multicenter retrospective study. Cases were classified according to standardized histological criteria. The sensitivity and specificity of resting and postprandial SBAs for the diagnosis of each liver disease, and all liver diseases combined, were calculated.

**Results:** The median resting SBAs were highest in dogs with cirrhosis (98.8 µmol/L; range, 6-135) and congenital circulatory anomalies (CCa; 79.45 µmol/L; 0.3-705). The highest median postprandial concentrations were found in CCa (126 µmol/L; 0-726) and chronic hepatitis (CH; 54.3 µmol/L; 0-260). Using the cut-off value of 10 µmol/L, the highest sensitivities of resting SBAs were recorded in dogs with CCa (87.5%; 95% confidence interval, 76.8-94.4) and CH (81.1%; 71.5-88.6). The sensitivities of postprandial SBAs were the highest in cholangitis (100%; 47.8-100.0) and CCa (91.1%; 78.8-97.5). The specificities of resting and postprandial SBAs for all diseases were 49.3% (37.6-61.1) and 29.7% (15.9-47.0), respectively.

**Conclusions and Clinical Importance:** Postprandial SBAs are more sensitive but less specific than resting SBAs for the diagnosis of liver disease. There were dogs in all categories of liver disease with resting SBAs <10 and >90 µmol/L. Therefore, careful interpretation of both normal and elevated values is required.

## The effect of assisted enteral feeding on treatment outcome in dogs with inflammatory protein-losing enteropathy

***Economu L et al***

**J Vet Intern Med 35: 1297-1305, 2021; https://doi.org/10.1111/jvim.16125**

**Background:** The effect of assisted enteral feeding on treatment outcome in dogs with protein-losing enteropathy (PLE) is unknown.

**Objectives:** To determine if dogs with inflammatory PLE that had an enteral feeding tube placed had better outcome vs dogs with inflammatory PLE without a feeding tube.

**Animals:** Fifty-seven dogs with inflammatory PLE.

**Methods:** A retrospective study at a UK referral hospital identified dogs with inflammatory PLE using a standard diagnostic criterion. Positive outcome was defined as survival greater than 6 months or death unrelated to PLE and negative outcome as death related to PLE within 6 months of diagnosis. Several variables were assessed to identify factors for positive outcome using logistic regression.

**Results:** Thirty-five (61%) and 22 (39%) dogs had a positive and negative outcome at 6 months, respectively. Of the 21 dogs that had a feeding tube placed within 5 days of gastrointestinal biopsy, 16 (76%) had a positive outcome and 5 (24%) had a negative outcome. Dogs treated with dietary treatment alone (P = .002) and dogs with an enteral feeding tube (P = .006) were significantly associated with a positive outcome. When stratified by treatment, assisted enteral feeding was significantly associated with a positive outcome in dogs treated with concurrent immunosuppressive treatment (P = .006), but there was insufficient data to evaluate dogs treated with dietary treatment alone.

**Conclusions and Clinical Importance:** Assisted enteral feeding in dogs with inflammatory PLE could be associated with improved treatment outcome, especially in those receiving immunosuppressive treatment, and should be considered in the treatment plan of these dogs.

## Association between biliary tree manipulation and outcome in dogs undergoing cholecystectomy for gallbladder mucocele: A multi-institutional retrospective study

***Piegols HJ et al***

**Vet Surg 50: 767-774, 2021; https://doi.org/10.1111/vsu.13542**

**Objective:** To determine whether catheterization of the common bile duct (CBD) is associated with outcome in dogs undergoing cholecystectomy for gallbladder mucocele and to determine whether this association is modified by the catheterization method.

**Study design:** Multi-institutional retrospective cohort study.

**Animals:** Dogs (n = 252) that underwent cholecystectomy for gallbladder mucocele.

**Methods:** Dogs were identified via electronic medical record review at four veterinary teaching hospitals. Baseline dog characteristics, surgical findings, and methods including normograde vs retrograde CBD catheterization, intraoperative outcomes, and postoperative outcomes and complications were recorded. Variables were compared between dogs with and without catheterization.

**Results:** Catheterized dogs had higher American Society of Anesthesiologists scores (P = .04), higher total bilirubin (P = .01), and were more likely to have dilated CBD at the time of surgery (P < .01). Incidence of major and minor intraoperative complications was

similar between the two groups. Surgical time was longer for the catheterized group (P= .01). The overall incidence of postoperative complications was similar between the groups; however, postoperative pancreatitis was associated with performing CBD catheterization (P = .01). This association was retained as an independent association in a multivariable model that addressed baseline group differences (P = .04). Likelihood of developing postoperative pancreatitis was not different between normograde and retrograde catheterization (P = .57).

**Conclusion:** Catheterization of the CBD was associated with development of postoperative pancreatitis. This was not influenced by the method of catheterization.

**Clinical significance:** The requirement for catheterization of the CBD during open cholecystectomy in dogs should be carefully considered, particularly in dogs without evidence of biliary obstruction because the procedure may induce postoperative pancreatitis.

## Oncology

### Retrospective evaluation of thrombocytopenia and tumor stage as prognostic indicators in dogs with splenic hemangiosarcoma

***Masyr AR et al***

**J Am Vet Med Assoc 258: 630-637, 2021; https://doi.org/10.2460/javma.258.6.630**

**Objective:** To identify physical examination and perioperative CBC variables in dogs with splenic hemangiosarcoma (HSA) that could aid in predicting progression-free interval (PFI) and overall survival time (OST) in affected dogs.

**Animals:** 70 client-owned dogs with splenic HSA treated with splenectomy and chemotherapy between September 2004 and October 2016.

**Procedures:** A retrospective search of the University of Minnesota Veterinary Medical Center medical records database was performed to identify dogs with splenic HSA treated with splenectomy and with evidence in the medical records of intent to treat with chemotherapy. Data collection included dog signalment and body surface area, results from CBCs performed within 6 days before to 2 days after splenectomy, whether dogs had hemoabdomen or received transfusions, and tumor stage. Hematocrit, WBC count, and platelet count were treated as categorical variables (divided into terciles: above, within, or below reference limits) because of variation among reference intervals for the numerous analyzers used. Associations between variables and PFI or OST were investigated with Cox regression analyses, and hazard ratios (HRs) for a shorter PFI or OST were reported. Population Pearson correlation coefficient (ρ) analysis was performed to identify potential associations between variables of interest.

**Results:** Stage 3 HSA was identified as a negative prognostic indicator of PFI (HR, 6.6) and OST (HR, 4.5). Perioperative thrombocytopenia was similarly associated with shorter PFI (HR, 2.2) and OST (HR, 2.0). Results for Hct correlated (ρ = 0.58) with those for platelet count, and although our findings did not indicate a notable association between anemia and shorter PFI, such could not be ruled out.

**Conclusions and Clinical Relevance:** The prognostic value of thrombocytopenia warrants further substantiation to understand causal and mechanistic connections, and the presence of thrombocytopenia ultimately may prove valuable in guiding treatment recommendations for dogs with splenic HSA.

# Orthopaedics

## Canine medial patellar luxation

***Perry KL, Déjardin M***

**J Small Anim Pract 62: 315-335, 2021; https://doi.org/10.1111/jsap.13311**

**Review Paper:** Despite being one of the most commonly diagnosed causes of canine hind limb lameness, the pathogenesis of medial patellar luxation remains incompletely understood. Most cases are considered developmental with anatomical deformities leading to failure of the stifle extensor mechanism. These include coxa vara, coxa valga, reduced anteversion angle, distal external femoral torsion, excessive distal femoral varus, internal proximal tibial torsion, proximal tibial valgus, tibial tuberosity medialisation, patella alta and shallow trochlear groove. The diagnosis of medial patellar luxation is generally easily made during an orthopaedic examination, however, assessment of the associated limb deformities can be challenging. While radiography remains the most common method for assessment of limb deformity in dogs, accurate characterisation of three-dimensional structures from two-dimensional radiographs is limited, particularly for tibial deformities. CT is advantageous in facilitating the precise qualification and quantification of skeletal abnormalities contributing to the luxation. This is critical in planning correction of said deformities and in achieving accurate realignment of the quadriceps mechanism. Dogs presenting with lameness secondary to medial patellar luxation are candidates for surgical intervention. Techniques used to realign the extensor mechanism and improve patellofemoral articulation congruity include femoral trochleoplasty, tibial tuberosity transposition laterally and/or distally, corrective osteotomies of the femur and tibia and soft tissue balancing techniques. Every case should be carefully evaluated to identity all abnormalities and develop a comprehensive plan that addresses each of them. Complication rates following medial patellar luxation surgery vary extensively but can be reduced following accurate measurement of conformational deformities and subsequent tailored corrective surgery.

## Outcomes and prognostic indicators in 59 paraplegic medium to large breed dogs with extensive epidural hemorrhage secondary to thoracolumbar disc extrusion

***Woelfel CW et al***

**Vet Surg 50: 527-536, 2021; https://doi.org/10.1111/vsu.13592**

**Objective:** To evaluate outcomes and prognostic factors after decompressive hemilaminectomy in paraplegic medium to large breed dogs with extensive epidural hemorrhage (DEEH) and thoracolumbar intervertebral disc extrusion (TL-IVDE).

**Study design:** Retrospective, cohort, descriptive study.

**Animals:** Fifty-nine client-owned dogs.

**Methods:** Medical records and advanced imaging were reviewed for paraplegic dogs with DEEH. Ambulatory status 6 months after surgery and postoperative complications were recorded. Multiple logistic regression models were constructed to explore prognostic factors.

**Results:** Records of 22 dogs with and 37 dogs without pelvic limb pain perception at presentation were included. Median age of dogs was 5 years (interquartile range, 4-7), and mean weight was 26.9 kg (SD, ±9.71). Labradors and Labrador mixes were most common (17/59 [28.8%]). Recovery of ambulation occurred in 17 of 22 (77.3%) dogs with and in 14 of 37 (37.8%) dogs without pain perception prior to surgery. Progressive myelomalacia was recorded in three of 59 (5.1%) dogs, one with pain perception and two without pain perception at presentation.

Postoperative complications (14/59 [23.7%]) were common. Factors independently associated with outcome included clinical severity (odds ratio [OR] 0.179, P = .005), number of vertebrae with signal interruption in half Fourier single-shot turbo spin-echo sequences (HASTEi; OR, 0.738; P = .035), and ratio of vertebral sites decompressed to HASTEi (OR, 53.79; P = .03).

**Conclusion:** Paraplegic medium to large breed dogs with DEEH have a less favorable outcome after surgical decompression than paraplegic dogs with TL-IVDE.

**Clinical significance:** Dogs with DEEH can have severe postoperative complications. Loss of pain perception and increased HASTEi are associated with a poor outcome, while more extensive decompression improves outcome.

## Thyroid

### Recombinant human thyrotropin stimulation test in 114 dogs with suspected hypothyroidism: a cross-sectional study

***Corsini A et al***

**J Small Anim Pract 62: 257-264, 2021; https://doi.org/10.1111/jsap.13290**

**Objective:** To evaluate the performance and define cut-offs for the interpretation of a thyroid-stimulating hormone (TSH) stimulation test with a recombinant human TSH dose of 75 µg/dog administered intravenously in dogs with suspected hypothyroidism.

**Materials and Methods:** Cross-sectional study. Medical records of dogs presented for suspected hypothyroidism were retrospectively reviewed. Animals were included if a TSH stimulation test with a recombinant human TSH dose of 75 µg/dog was performed and follow-up was available. Dogs with a post-TSH serum total thyroxine (T4) level of ≥2.2 µg/dL were considered euthyroid. Dogs with a post-TSH T4 level of <2.2 µg/dL were classified as hypothyroid or euthyroid based on follow-up, including response to levothyroxine supplementation. A receiver operating characteristic curve analysis was used to define the performance of the test.

**Results:** One hundred and fourteen dogs were included. Forty were classified as hypothyroid and 74 as euthyroid. Post-TSH T4 cut-offs of 1.3 and 1.7 µg/dL showed sensitivities of 92.5 and 100% and specificities of 97.3 and 93.2%, respectively. Post-TSH T4 levels of >1.7 µg/dL had a negative predictive value of 100%. Post-TSH T4 levels of <1.3 µg/dL showed a positive predictive value of 94.9%. Area under the ROC curve for post-TSH T4 was 0.99.

**Clinical Significance:** A TSH stimulation test performed with a recombinant human TSH dose of 75 µg/dog is highly reliable to discriminate between hypothyroid and euthyroid dogs, even in cases of concurrent non-thyroidal illness or administration of medications. A post-stimulation T4 concentration of >1.7 µg/dL is suggestive of normal thyroid function.

# EXOTICS

## Rabbits

### Comparison of plasma total solids concentration as measured by refractometry and plasma total protein concentration as measured by biuret assay in pet rabbits and ferrets

***Eshar D et al***

**J Am Vet Med Assoc 258: 977-982, 2021; https://doi.org/10.2460/javma.258.9.977**

**Objective:** To determine the agreement between plasma total solids (TS) concentration as measured by refractometry and plasma total protein (TP) concentration as measured by biuret assay in pet rabbits and ferrets.

**Sample:** 253 and 146 blood samples from 146 and 121 ferrets and rabbits, respectively, with results of CBC and plasma biochemical analyses.

**Procedures:** Data were collected from medical records regarding plasma TS and TP concentrations, PCV, plasma biochemical values, plasma appearance, and patient signalment. Agreement was determined between refractometer and biuret assay (reference method) values for plasma TS and TP concentration. Other variables were examined for an impact on this agreement.

**Results:** Mean ± SD plasma TP and TS concentrations were 6.4 ± 0.8 mg/dL and 6.6 ± 0.8 mg/dL, respectively, for rabbits and 6.3 ± 1.2 mg/dL and 6.4 ± 1.1 mg/dL for ferrets. On average, refractometer values overestimated plasma TP concentrations as measured by biuret assay. Plasma cholesterol, glucose, and BUN concentrations and hemolysis and lipemia had significant effects on this bias for ferrets; only BUN concentration had an effect on bias for rabbits given the available data. Other variables had no influence on bias. The limits of agreement were wider than the total allowable analytic error, and > 5% of the data points were outside acceptance limits, indicating that the 2 methods were not in clinical agreement.

**Conclusions and Clinical Relevance:** Refractometer measurements of plasma TS concentration failed to provide a good estimation of biuret assay measurements of plasma TP concentration in rabbits and ferrets, suggesting that these 2 analytic methods and the results they yield cannot be used interchangeably in these species.

## Reptiles

### Complications associated with esophagostomy tube placement in chelonian patients

***Hedley J et al***

**J Exotic Pet Med 37: 24-26, 2021; https://doi.org/10.1053/j.jepm.2021.02.006**

**Abstract:** Esophagostomy tube placement is commonly performed in chelonian patients, either to provide nutritional support during a period of anorexia or for administration of oral medications. Placement is usually a quick and simple procedure performed under a short general anaesthetic or sedation. Studies in mammals indicate that tubes are associated with relatively few major complications and appear well tolerated by patients. The aim of this study was to describe and quantify the complications associated with esophagostomy tube placement in chelonians. Medical records for patients presenting between 2013 and 2018 were reviewed retrospectively at three veterinary practices. All chelonian patients that had an esophagostomy tube placed during this time period were included in the study. Reasons for tube placement, frequency and types of complications were recorded. Complications were noted in 40/98 (40.82%) patients, with tube obstruction and tube displacement by the patient being the two most commonly seen problems. Complications associated with esophagostomy tube placement occur commonly in chelonian patients, but in the majority of cases are minor issues which are easily managed. Major complications are rare but can potentially have fatal consequences.

## Lymphoid leukemia in five bearded dragons (Pogona vitticeps)

***Hepps CM et al***

**J Am Vet Med Assoc 258: 748-757, 2021; https://doi.org/10.2460/javma.258.7.748**

**Case Description:** 2 male and 3 female adult bearded dragons (Pogona vitticeps) were evaluated at the North Carolina State University College of Veterinary Medicine's Exotic Animal Medicine Service between September 2018 and October 2019 because of severe lymphocytosis.

**Clinical Findings:** All 5 bearded dragons had nonspecific clinical signs, including lethargy, poor appetite, ocular discharge, and weight loss. Clinicopathologic testing revealed extremely high lymphocyte counts with morphological findings consistent with lymphocytic leukemia.

**Treatment and Outcome:** All 5 patients were treated with lomustine, prednisolone, and antimicrobials. In addition, 1 or 2 doses of L-asparaginase were administered when the drug was available. Partial remission was achieved in all 5 patients. One patient, after disease progression was documented, was treated with cyclophosphamide and achieved a second partial remission. One of the 5 patients was still alive and continuing to receive chemotherapy at the time of final follow-up 244 days after the initial diagnosis. Survival times (ie, times from initial diagnosis to euthanasia) for the other 4 patients were 57, 157, 330, and 416 days.

**Clinical Relevance:** The present report represented the first description of lomustine as a primary chemotherapeutic agent for the treatment of lymphocytic leukemia in bearded dragons and provided information on response to treatment, adverse effects, and survival times.

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