2024
UPDATE

TICK PARALYSIS OF DOGS AND CATS

An Updated Guide to Diagnosis, Management, Treatment and Prevention

Developed by the Australian Paralysis Tick Advisory Panel, 2024

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STATEMENT BY THE AUSTRALIAN PARALYSIS TICK ADVISORY PANEL

Tick paralysis is a medical emergency that requires immediate tick removal and tick antiserum (TAS) administration. Prompt administration of TAS is crucial to neutralise unbound toxin and improve survival rates. Any delay can result in rapid deterioration of the patient due to further toxin secretion and neuromuscular junction binding, resulting in greater clinical severity and prolonged recovery. On patient admission, swiftly locate and remove all ticks to prevent further toxin release, which dramatically increases as the tick's salivary glands mature.

Effective client communication is essential. Educate clients on using a reliable tick prevention product, conducting daily tick searches, and seeking urgent veterinary attention if a tick is found or if signs of tick paralysis appear.

The aim of the present guidelines is to provide a concise, evidenced based, readily accessible, and up-to-date guide for the diagnosis, management, treatment and prevention of tick paralysis in dogs and cats in Australia.

CONTENTS

ABBREVIATIONS
ACP – Acepromazine; BW – Body Weight; CRI – Continuous Rate Infusion; CRP – C-Reactive Protein; CRT – Capillary Refill Time; ET – Endotracheal; $ETCO_2$ – End-Tidal Carbon Dioxide; FiO_2 – Fraction of Inspired Oxygen; GA – General Anaesthesia; IM – Intramuscular; IV – Intravenous; IVDD – Intervertebral Disc Disease; LMN – Lower Motor Neuron; MSTS – Minimum Standards for Tick Search; NMJ – Neuromuscular Junction; PaO_2 – Arterial Partial Pressure of Oxygen; PCO_2 – Partial Pressure of Carbon Dioxide (venous or arterial); POCUS – Point of care ultrasound; PRN – as needed; SC – Subcutaneous.

INTRODUCTION

The Australian Paralysis Tick Advisory Panel is an initiative supported by Boehringer Ingelheim Animal Health Australia. The Panel first came together in April 2016 with an objective to establish guidelines for the diagnostic approach, treatment, management and prevention of tick paralysis of dogs and cats. The outcome was a document consisting of information sourced from peer-reviewed publications, reported experiences and expert opinions. The Panel reconvened in 2019 and again in 2023 to review and reassess the Guidelines and associated materials, and to update using information published since the previous edition.

Throughout the document you will see the following icon: appear in different areas. Where you see this icon, this indicates there is related video footage or additional resources linked to this information.

To view the videos or linked resources, you can scan the QR code at the bottom of this page and it will take you to the Boehringer Ingelheim Animal Health Academy. You will need to be registered to access the resources on the Academy. If you haven't already registered please go to **www.animalhealthacademy.com.au**. During registration, enter the access code **myAcademy** when prompted.

It is anticipated that these guidelines will:

1. Provide a foundation for consistent management of tick paralysis of dogs and cats
2. Deliver better outcomes for patients and their owners
3. Assist veterinarians who are unfamiliar with treating tick paralysis
4. Establish 'best practice' when managing tick paralysis
5. Upgrade practice standards where applicable and appropriate

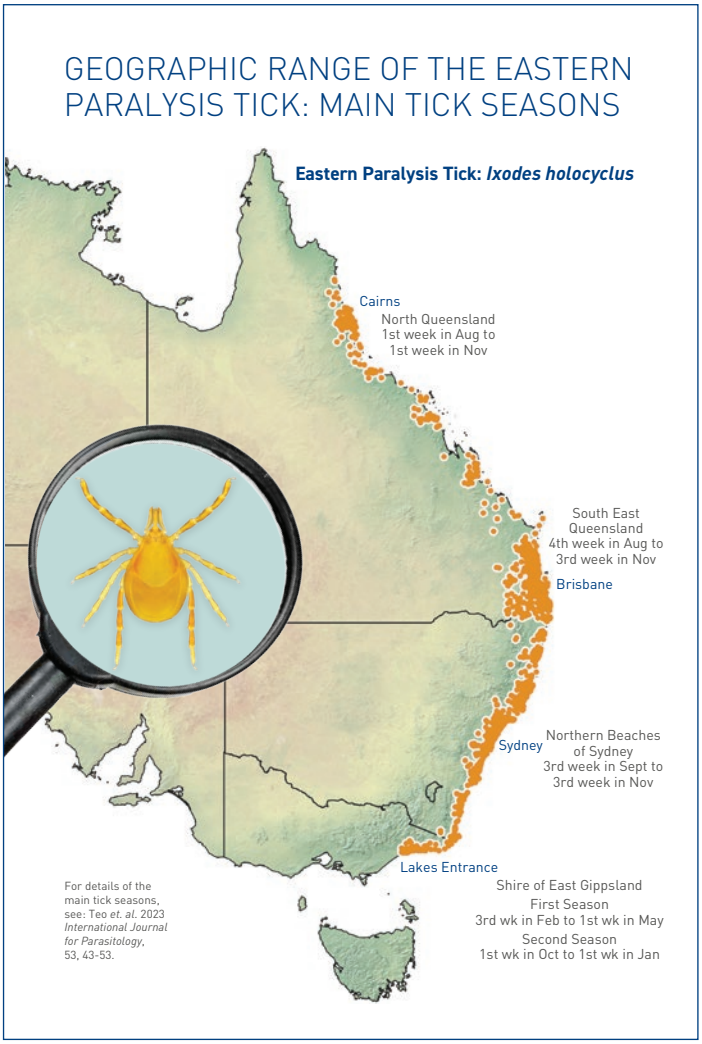
BOEHRINGER INGELHEIM
ANIMAL HEALTH ACADEMY

SETTING THE SCENE

Two species of Ixodes tick; *Ixodes holocyclus* (the eastern paralysis tick) and to a lesser extent, *Ixodes cornuatus* (the southern paralysis tick), are known to cause tick paralysis in dogs and cats in Australia.[1-3] *Ixodes holocyclus* is found within a narrow coastal band on the east coast of Australia that extends from Shipton's flats in northern Queensland to Lakes Entrance in southern Victoria. *Ixodes cornuatus* is found in central and eastern Victoria, south eastern New South Wales, the ACT and also exclusively in Tasmania.[1-3] *Ixodes holocyclus* may also occur from time to time in some years in the Greater Melbourne Area of Victoria and in non-endemic locations as a consequence of transport of ticks by humans, animals or fomites from endemic areas (the "hitch hiker" hypothesis).[4]

Cases of tick paralysis can present all year round. Incidence is often related to times of high humidity. For this reason, *Ixodes holocyclus* generally has a spring to early summer seasonal pattern in New South Wales and Queensland with earlier occurrence at more northerly latitudes. However, cases will occur even in cold winter climates if there are rains followed by days warm enough to increase humidity. In southern NSW and northern VIC, there is often a lesser 'peak' of incidence in late summer/ autumn when there are periods of moderate rainfall in between bouts of warm weather, such that a bimodal autumnal and vernal seasonality occurs. Tick case numbers have been seen to decrease in times of extensive drought when humidity is at a minimum.

Since the first recorded cases in the peer reviewed literature by Horsley in dogs in 1846[5] and Bancroft in cats in 1884,[6] tick paralysis continues to be a significant cause of morbidity and mortality in companion animals. Despite the use of tick antiserum, advances in intensive care, availability of mechanical ventilation at many specialist centres and the recent introduction of highly effective topically and orally administered isoxazoline acaricides[7], the diagnosis, treatment and management of tick paralysis in dogs and cats continues to be a significant clinical challenge for veterinarians. Once clinical signs are evident, cases can rapidly deteriorate within hours, such that assessment and treatment needs to be rapid, efficient and prioritised.



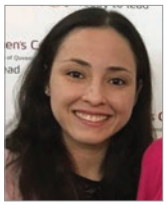
AUSTRALIAN PARALYSIS TICK ADVISORY PANEL MEMBERS 2023

PROF RICK ATWELL

Rick graduated with first class honours in 1973, worked in general practice and then accepted a lectureship at the school of Veterinary Science, University of Queensland. He proceeded to do a PhD in pulmonary hypertension, using canine heartworm disease as the model. He has been the Director of the University of Queensland Clinic and Hospital, and has had various roles within the Veterinary School, including Professorship and Head of the Medicine Department. His clinical speciality training was a Fellowship in Thoracic Medicine with the Australian College of Veterinary Scientists. Most of his clinical research work has been in dirofilariosis and holocyclotoxicosis and he has published over 200 papers and received several veterinary awards.

PROF STEPHEN BARKER

Stephen is a Professor of Parasitology in the Department of Parasitology, Faculty of Science, University of Queensland. Stephen has been studying ticks and other ectoparasites at the University of Queensland for over 30 years. Recent activities include: (i) a monograph with his wife, Dayana Barker, "*Ticks of Australasia: 125 species of ticks in and around Australia*". (2023, Magnolia Press - Zootaxa, 5253, 670 pp.); (ii) research on the paralysis ticks of Australia, *Ixodes holocyclus* (eastern paralysis tick) and *Ixodes cornuatus* (southern paralysis tick); and (iii) research on the evolution of the *Boophilus* ticks and the other hard ticks. Supported by Boehringer Ingelheim, Stephen and Dayana offer a free tick-identification service to veterinarians in Australia.



DR DAYANA BARKER

Dayana is parasitologist with a PhD from the University of Queensland, with much experience in tick taxonomy in Australasia. Her work has been published in national and international journals. Recent activities include: (i) a monograph with her husband Stephen Barker, "*Ticks of Australasia: 125 species of ticks in and around Australia*".; (ii) research on the paralysis ticks of Australia, *Ixodes holocyclus* (eastern paralysis tick) and *Ixodes cornuatus* (southern paralysis tick); and (iii) the discovery of a new species of tick from Far North Queensland, *Ixodes barkeri*, which she named after her husband, Stephen Barker. Dayana has been helping veterinarians to identify ticks for over 10 years.

DR JUSTIN DANIEL

Justin graduated from Murdoch University in 1998. He worked in mixed animal practice in South Australia from 1999–2004, interrupted by a stint in the United Kingdom doing locum work in 2002. Justin moved to the New South Wales South Coast in 2005 to continue in rural mixed practice in a place where the ocean, national parks, snowy mountains and a hobby farm provide healthy outlets for work/life balance. Justin and his wife Lindy became the owners of Eden, Pambula and Merimbula Vet Clinics. These clinics see a significant number of animals (large and small) with tick paralysis each year.

DR CHRISTOPHER HOLLAND

Christopher graduated with honours from the University of Sydney (1982) with BVSc, BSc(Vet). After four years in small animal practice he undertook a PhD in neurophysiology at the University of Sydney (1991) and continued postdoctoral research in this field at the universities of Cambridge (United Kingdom) and Newcastle (New South Wales). He has an interest in small animal neurology, particularly disorders of movement, cranial nerves and the autonomic nervous system, and has published numerous peer-reviewed papers in this field.

DR TERRY KING

Terry graduated from the University of Queensland in 1975 (BVSc). In 1996, Terry became a Member of the Australian and New Zealand College of Veterinary Scientists in Emergency and Critical Medicine. Terry spent 18 years in general practice, mostly small animal and three years in emergency practice before taking a position as Medical Clinician at the University of Queensland Veterinary Teaching Hospital in 1995. Since 2002 Terry has worked at Veterinary Specialist Services in South East Queensland looking after referral cases in small animal medicine and critical care.

DR ELLIE LEISTER

Ellie started working as an Intensive Care Unit (ICU) veterinarian at Veterinary Specialist Services and Animal Emergency Service in 2012, where she has since treated and mechanically ventilated many cases with severe tick paralysis. Ellie's special interests lie in managing tick and snake envenomation and she pursued several lines of research on these topics whilst she completed her Veterinary Emergency and Critical Care residency program between 2015 and 2017. In 2019, Ellie became a Fellow of the Australian and New Zealand College of Veterinary Scientists. She has produced numerous publications, including the largest ever feline tick paralysis case series to date in the Journal of Feline Medicine and Surgery. Ellie is the Hospital Director of The Pet ICU in Brisbane – one of the foremost veterinary critical care centres in the country.

DR ANDREW PADULA

Andrew is a 1993 University of Melbourne veterinary graduate. After four years in mixed veterinary practice he returned to complete a PhD, then worked in the UK as lecturer in farm animal sciences at the University of Bristol, returning in 2005 to manage projects for the Australian dairy industry. Andrew then moved back to Gippsland where he owned and ran a mixed veterinary practice for 10 years whilst undertaking venom and antivenom research with the University of Melbourne. He is an Honorary Research Fellow in the Australian Venom Research Unit, Department of Pharmacology & Therapeutics, University of Melbourne and has published multiple papers on venom and antivenom topics in animals. Recently he started a biotech company producing and researching antivenom products for animals.

DR HEATHER RUSSELL

Heather graduated with honours from the University of Sydney in 2002. She spent the first part of her career in the United Kingdom in small animal general practice where she completed a General Practitioner Certificate in Small Animal Medicine through the European School of Postgraduate Veterinary Studies. In 2011, she began working for Northside Emergency Vet Service (NEVS), and became Clinical Manager in mid-2015. NEVS is located on Sydney's Northern Beaches and treats over 1,000 tick paralysis patients per year. On average, this practice mechanically ventilates over 40 patients per tick season.

DR ROB WEBSTER

Rob is a registered veterinary specialist in Emergency Medicine and Critical Care and a Director of the Animal Emergency Service. The practice has four hospitals in tick areas of South East Queensland, and treats over 2,000 cases of tick paralysis annually. He developed an interest in managing severe tick paralysis early on in his career due to the high numbers of patients that tended to die despite 'appropriate' treatment. Rob has done clinical research into patients with tick paralysis and has several publications on the subject.

DIAGNOSTIC APPROACH

HAS A TICK OR TICK CRATER BEEN FOUND ON THE ANIMAL?‡

NO: Search for ticks and tick craters (refer to Minimum Standards for Tick Search below)

YES: Remove ticks via a tick removal device, tweezers[9] or with fingers in a twist and pluck action. Advise owner to retain ticks for identification in clinic if required

‡It has been documented that paralysis can occur after attachment of juvenile tick stages.[8]

IS THE ANIMAL SHOWING ANY CLINICAL SIGNS?

Phone Advice to Client

NO: Review of case details by veterinarian to decide approach, for example observation by owner as an outpatient versus consultation at clinic

YES: Seek veterinary attention urgently.
In the meantime to manage the pet, advise client to:
- Withhold food and water
- Keep quiet, minimising stress and excitement
- Keep in a temperature controlled environment

Initial Approach

OBTAIN CLINICAL HISTORY

- Presence and time of onset of clinical signs
- Previous history of clinical tick paralysis and TAS treatment
- Details of tick preventative used and date of last dose
- Any concurrent disease(s)
- Exposure to tick habitats

PERFORM PHYSICAL AND NEUROLOGICAL EXAMINATIONS

- Take precautions to minimise stress at all times
- Respiratory examination to include auscultation of upper and lower respiratory tracts and careful assessment of the pharynx and larynx for dysfunction
- Assess gait and, if necessary, movements requiring increased neuromuscular effort[10,11] (e.g., jumping up, hopping, figure of eight or climbing stairs)
- Assess for asymmetrical focal neurological deficits[12] (e.g., anisocoria, reduced palpebral reflex, unilateral facial paralysis)
- Perform corneal fluorescein staining[13]

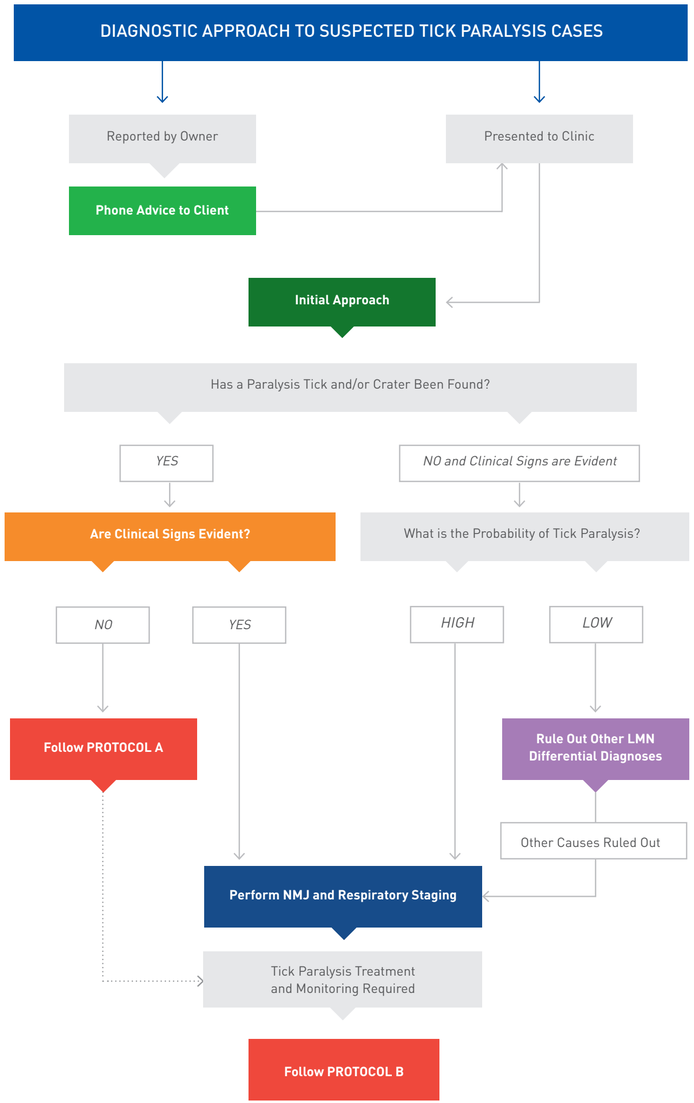
MINIMUM STANDARDS FOR TICK SEARCH (MSTS)

- Search for ticks and tick craters[10]
- Be systematic with the search pattern:
  - Use the finger walking method[14]
  - Search the entire animal focussing on the head and neck[10,14,15]
  - Ticks can be difficult to locate[14] so remember to:
    - Search ear canals, lip margins, gums, hard palate, under collar, prepuce/vulva, rectum, tail tip, interdigital spaces and under dressings
    - Look for asymmetric focal neurological deficits[12]
  - Initially, multiple searches (minimum of three) need to be performed, ideally by different staff members
- Full body clip to enhance retrieval of the entire tick burden[16]
  - Seek owner permission
  - Include the face, ears, paws and tail
  - Be aware that the stress of clipping can exacerbate respiratory dysfunction, even under sedation
  - Sedate if necessary
    - Acepromazine (ACP) at 0.01-0.05 mg/kg IV, IM or SC; or
    - Butorphanol at 0.1-0.3 mg/kg IV, IM or SC; or
    - Dexmedetomidine* at 0.5-2.0 µg/kg IV, IM or SC
    - Note: ACP or dexmedetomidine can be used alone, or in combination with butorphanol. When using drugs in combination, use the lower end of dose ranges.
- If ticks are found, remove immediately[10,17,18]
  - Use a tick removal device, tweezers[9] or fingers in a twist and pluck[10] action
  - Identify the ticks
- Always complete the full body search as multiple ticks can be attached[17,18]
- During hospitalisation, and if not causing undue stress, perform tick searches[10] every 6-12 hours, for at least 48 hours after initial presentation

* Medetomidine and dexmedetomidine can be used interchangeably if unable to access dexmedetomidine. However, dexmedetomidine is preferred as medetomidine results in greater cardiovascular depression than dexmedetomidine.

PREVENTION

The Australian Paralysis Tick Advisory Panel recommends the year-round use of isoxazoline based acaricides for all dogs and cats that are living in, or travelling to known paralysis tick regions.



Clinical Signs

- Hind limb incoordination[10] and paresis, progressing to paralysis[18]
- Dyspnoea[10]
- Inspiratory stridor (may not be present with hypoventilation[19]) **Note: hypoventilation in dogs may present with a normal to low respiratory rate.**
- Change or loss of voice[10]
- Gagging, grunting or coughing[10]
- Inappetence[18]
- Vomiting or regurgitation[10]
- Pupillary dilation[10]
- Reduced palpebral reflex (may present with corneal ulcers)[12]
- Anisocoria[12]
- Unilateral facial paralysis[12]
- Unilateral reduced cutaneous trunci reflex[12]

LMN Differential Diagnosis

- Snake envenomation[10]
- Botulism[10]
- Tetrodotoxin or ciguatoxin toxicity[10]
- Polyneuropathy[10]
- Acute polyradiculoneuritis
- Chronic organophosphate toxicity
- Lasalocid/monensin (ionophore) toxicity
- Recreational drugs, e.g., THC
- Prescription drug toxicity
- Canine neural angiostrongylosis
- Diffuse myopathy/polymyopathy
- Myasthenia gravis
- Metabolic disorders
- Fibrocartilaginous embolism
- Spinal disorders including IVDD

NMJ and Respiratory Staging

NMJ SCORE[20]

1	Mild weakness
2	Can stand but not walk
3	Cannot stand, but can right itself and maintain sternal recumbency
4	Unable to right itself, cannot maintain sternal recumbency

RESPIRATORY VISUAL ANALOG SCALE (VAS) SCORE

Clinical assessment of any respiratory dysfunction scored subjectively on a numerical rating scale between 0 and 100[21]

VAS scores are then allocated into quartiles:
A = 0<25 , **B** = 25<50, **C** = 50<75, **D** = 75<100

0 *No Respiratory Dysfunction*

100 *Most Severe Respiratory Dysfunction*

TREATMENT PROTOCOLS

PROTOCOL A: NO CLINICAL SIGNS OF TICK PARALYSIS WITH EVIDENCE OF A TICK OR TICK CRATER

To be used in conjunction with *Diagnostic Approach*.

Treatment Considerations – A Risk-Benefit Approach

- Potential welfare, ethical and legal considerations include:
  - History and signalment
  - Likelihood of disease progression
  - Access to veterinary attention
  - Adverse systemic reactions to TAS
- Clinical signs usually appear:[14]
  - From 72 hours after attachment
  - With a tick size of 4 mm wide on the 4th day of attachment

Please note: There have been rare anecdotal reports of ticks of <4 mm causing clinical signs of tick paralysis, but equally of large ticks not causing disease.

Treatment Options

Attention to tick paralysis patients needs to be prioritised (triaged as URGENT)

- Hospitalise for 24 hours for observation and tick search as per MSTS; or
- TAS treatment if:
  - High risk patient due to comorbidity or age
  - Owner request
  - It is not feasible to admit the pet for monitoring or for the owner to return if clinical signs develop; or
- Close observation of patient by owner at home, with instructions to contact the veterinary clinic immediately if clinical signs develop
- Please note: If a cat does not present with clinical signs it is recommended to remove the tick and monitor closely for progression of clinical signs. Administration of TAS to cats who have previously been sensitised to TAS has an increased risk of anaphylaxis[22]

Preventative Treatment

- Administer acaricide to patient immediately if indicated
- Discuss ongoing prophylaxis for patient and all other at risk pets
- Considerations for prophylaxis selection:
  - Acaricidal label claims and speed of kill for *Ixodes holocyclus* vary with active ingredients
  - Follow label instructions
  - Likelihood of owner compliance

Owner Vigilance

- Convey that signs of tick paralysis could still develop despite tick removal[10]
- Ongoing monitoring for clinical signs is necessary
- Keep quiet, minimise stress and excitement and consider confinement in a temperature controlled environment
- Perform tick searches (as per MSTS) every 6-12 hours for at least the following 72 hours
- Under veterinary direction, withhold food and/or water for 12-24 hours

General Advice

- Treatment of any tick paralysis patient or potential tick intoxication patient should be prioritised from the initial presentation or even phone consultation due to the likelihood of rapid onset and progression of paralysis symptoms
- Advise importance of routine daily tick searches[17] (as per MSTS), particularly if in a known tick area and during higher risk periods
- If ticks are found on people, seek medical advice

PROTOCOL B: CLINICAL SIGNS OF TICK PARALYSIS WITH OR WITHOUT EVIDENCE OF A TICK OR TICK CRATER

To be used in conjunction with *Diagnostic Approach* and *Management of the Complicated Patient*

Ensure the prognosis, cost and expectations are clearly communicated to, and understood by, the owner.

Clinical signs linked with a guarded prognosis in dogs[21]

- Presence of inspiratory dyspnoea and/or crackles
- Progression to expiratory dyspnoea and an audible expiratory wheeze within 24 hours of hospital admission
- Retching and/or vomiting

With all cases of tick paralysis, despite appropriate treatment, the outcome can still be unpredictable.

TREATMENT

- **Tick antiserum (TAS) – administer as soon as possible[10,23]**
  - It is advised to follow the label recommendations of the relevant TAS product in use
  - The dose rate of TAS remains controversial and panel members vary in their preference for dose rates*

Factors to Consider

- In deciding a dose rate, consider the extent of unbound, circulating toxin available for TAS neutralisation, versus tissue-bound toxin which is therapeutically unavailable.[10,23] This may be determined by the size, stage and number of ticks together with the severity of clinical signs of tick paralysis based on respiratory VAS and NMJ scores[10]
- A 2013 study in Sydney, NSW, showed none of the systems for calculating a dose rate of TAS (mL/kg, mL/tick, mL/animal) had any significant effect on the period from presentation to discharge, in either dogs or cats.[18] In this study, doses ranged from 0.30-3.18 mL/kg for dogs and 0.45-1.79 mL/kg for cats with a median dose of 1 mL/kg for both dogs and cats[18]
- A 2010 study in dogs showed that increasing the dose above 0.1 mL/kg (range 0.1- 8.0 mL/kg) did not alter mortality rate or time to recovery[17]

- **IV administration of TAS is recommended**
  - Administer over >20 minutes[10,24] in dogs and over >60 minutes in cats *(E Leister 2024, pers. comm., 22 July)*
    - Can be diluted in 0.9% NaCl
    - Adverse reaction rate very low with slow infusion in dogs
    - It has been reported that cats have a higher risk of acute severe reactions, especially on repeat administration.[22] **Refer to feline specific case management on page 18**
  - Monitor mental alertness, mucous membranes, capillary refill time, respiratory rate, heart rate, pulse quality and blood pressure.[24] **If monitoring induces stress, consider visual assessment only**
  - If IV administration is not possible, for example in critically stressed cats and small dogs, consider intra-peritoneal administration[10]

*Please see page 33 for a peer-suggested guide on dosage regimens for TAS. Reported methods used for dose rate calculation include: a standard dose rate in millilitres per kilogram; a standard volume per tick; or a standard volume per animal based on the assumption that only one tick, which inoculates a standard amount of toxin, is likely to be present.[18]

Adverse Systemic Reactions to TAS

Although rare in dogs, can be lethal and present as either[25]

Tachycardia, injected mucous membranes, anxiety, piloerection, swelling of the lips, cutaneous wheals, erythema, vomiting, diarrhoea, coughing and dyspnoea (anaphylactic reaction)

Treatment

- Discontinue TAS infusion and abort administration
- Administer adrenaline at 0.01 mg/kg IV every 5 to 15 minutes (see Table 1 below)
- If shock has already developed, give adrenaline CRI at 0.05 µg/kg/min (see Table 1 below)
- Supportive care including IV fluids and oxygen therapy
- There is no evidence to suggest that ancillary treatments (H1 and H2 antihistamines, corticosteroids, bronchodilators) are of benefit and should not be used as a substitute for adrenaline
- If the dog has recovered from the reaction, TAS can be restarted at a slower rate. **N.B. TAS should NOT be restarted in feline patients**

Bradycardia, pale mucous membranes, hypotension, weakness, depression and reduced heart sounds (referred to as the Bezold-Jarisch Reflex)

Treatment

- Discontinue TAS infusion
- Administer atropine increments at 0.01-0.04 mg/kg (total doses as high as 0.1-0.2 mg/kg may be necessary)
- Supportive care including rapid IV fluids for volume expansion and oxygen therapy
- Reassess cardiorespiratory parameters
- If improved, restart TAS infusion at a slower rate in dogs only (DO NOT restart TAS in cats)

Table 1: Adrenaline Dosage Cheat Sheet

Patient Weight (kg)	**Bolus Dose IV (mL) 1 mg/mL (1:1,000) solution^** ^dose rate 0.01 mg/kg	**Bolus Dose IV (mL) 0.1 mg/mL (1:10,000) solution*^** *add 1 mL of 1 mg/mL adrenaline to 9 mL of crystalloid fluid ^dose rate 0.01 mg/kg	**CRI Dose IV (mL/h) 1 µg/mL solution#+ 0.05 µg/kg/min** #add 1 mL of 1 mg/mL adrenaline to 1000 mL of crystalloid fluid, mix well +dose rate 3 mL/kg/h
2.5	0.025	0.25	7.5
5	0.05	0.5	15
10	0.1	1	30
20	0.2	2	60
40	0.4	4	120
60	0.6	6	180

Currently there is no evidence to support the use of premedication including atropine, adrenaline or corticosteroids to prevent adverse systemic reactions to TAS[24], and there is no evidence to support the use of acepromazine or atropine to reduce time to recovery.[18]

PROTOCOL B CONTINUED

- **Stress reduction**
  - Sedation to be used on a case-by-case basis
    Single dose PRN:
    – Butorphanol at 0.1-0.3 mg/kg IV, IM or SC; or
    – ACP at 0.01-0.05 mg/kg IV, IM or SC; and/or butorphanol at 0.1-0.3 mg/kg IV, IM or SC#; or
    – Dexmedetomidine* at 0.5-2.0 µg/kg IV, IM or SC; and/or butorphanol 0.1-0.3 mg/kg IV, IM or SC#
    CRI:
    – Butorphanol CRI at 0.1-0.3 mg/kg/h (titrate to effect); and/or
    – Dexmedetomidine* CRI at 0.5-2.0 µg/kg/h (titrate to effect)#

    * Medetomidine could be used instead of dexmedetomidine, but medetomidine results in greater cardiovascular depression than dexmedetomidine

    # When using drugs in combination, use the lower end of dose ranges
  - Over-sedation of the animal may impact clinical assessment and increase risk of aspiration
  - Environmental
    – Quiet area with dimmed lighting
    – Consider pheromone diffusers (Adaptil® or Feliway®)[26]
- **Full body clip**
  - As per the MSTS
  - Ensure adequate sedation or GA to reduce stress-induced respiratory compromise
- **Administer an acaricide registered to treat and control *Ixodes holocyclus*[10]**
- **Use clinical judgement in deciding whether parenteral anti-emetics and antacids are indicated for increased patient comfort**
  - There is currently no evidence available that these medications affect outcome
- **Assess and treat for aspiration pneumonia if indicated**

Aspiration Pneumonia

If aspiration pneumonia is suspected, ideally confirm diagnostically by:

- Thoracic radiography[10,19,27] – serial radiographs may assist in monitoring progress
- Point-of-care ultrasound (POCUS) examination of left and right lung fields (best done standing or in sternal recumbency) for the detection of ultrasound lung rockets (B lines) and/or "shred" or "tissue sign" indicative of interstitial fluid ('wet lung') that may occur with acute pneumonia and pulmonary oedema – serial POCUS may assist in monitoring progress[28]
- Haematology (complete blood count and differential)
- If the patient is anaesthetised and intubated, broncho-alveolar lavage (BAL) or endotracheal aspirate[29] should be considered to obtain samples for culture and sensitivity

Other considerations where aspiration pneumonia is suspected:

- If diagnostic procedures are not possible due to stress-induced respiratory compromise and/or while awaiting culture results; broad-spectrum antibiotics (penicillins IV, cephalosporins IV, or trimethoprim-sulfonamide IV or SC) should be initiated, and escalated only if indicated by culture and sensitivity results
- **Take into consideration the contraindications for each of these antibiotics as well as protocols for antimicrobial stewardship**
- Oxygen supplementation
- Nebulisation
- IV fluid therapy to ensure adequate hydration – as per the recommendations in the Critical Care section on pages 24-27
- For animals going home on antibiotics, recheck 5-7 days later. If the animal is still showing respiratory signs, consider a transtracheal/endotracheal wash or BAL

In any severely affected dog, consider aspiration pneumonia very likely.[20,27] Early, aggressive treatment in these cases is critical.

The following is quoted from Tso, S.S.K., et al (2022)[29]

"Clinicians should have an index of suspicion for the development of bacterial pneumonia in dogs and cats undergoing mechanical ventilation for tick paralysis. Empirical antimicrobials appropriate for the likely organisms and based on illness severity should be commenced pending culture and susceptibility testing, after which antimicrobial escalation or deescalation is indicated to optimise outcomes while adhering to principals of antimicrobial stewardship."

DIAGNOSTICS

Perform a risk-benefit assessment for each test and consider the potential relative oxygen cost to the patient if stress is induced[10]

Any intervention that raises stress levels will increase oxygen demands. In tick paralysis patients, diagnostic intervention should be carefully considered and avoided if the outcome of the test is unlikely to result in a modification to the treatment plan.

- **Pulse oximetry**[10]
- **Blood gas analysis (if available)**[10]
- **Packed cell volume, total protein and electrolytes**[10]
- **Serial measurement of serum CRP**: C-reactive protein (CRP) is a biomarker of systemic inflammation which may assist in the diagnosis and monitoring of aspiration pneumonia patients with tick paralysis

Scan the QR code to read a summary on CRP by Dr Terry King

- **Thoracic radiographs, if respiratory compromise present**[10,19,27]
- **POCUS examination of left and right lung fields** (refer to notes under Aspiration Pneumonia on page 12)[28]
- **Corneal fluorescein staining**[13]
- **Full body clip (as per MSTS)**
- **Airway cultures**

PROTOCOL B CONTINUED

SUPPORTIVE CARE

Requirements should be tailored on an individual basis

- **As a minimum requirement, place an IV catheter aseptically (and maintain patency)**[13]
- **IV fluid therapy**
  Turn to the Critical Care section on page 24 for more information on fluid requirements, types and rates
- **Oxygen supplementation**[13,19]
  - Methods include:
    - Nasal oxygen
    - Trans/intra-tracheal
    - Oxygen chamber/cage
    - Flow-by/face mask
    - Tube Tracheostomy, Tube Cricothyrotomy

    Turn to page 28 in the Critical Care section of this document for a summary of the indications, advantages, disadvantages, and practical tips for each technique
  - Essential in all cases with dyspnoea
  - Humidification is helpful
- **Ocular care**
  - Lubrication:
    - Cellulose-containing drops[13] (e.g., Ocunovis®, Hylo-Forte®, Viscotears® or Celluvisc®) every 1-4 hours
    - Lubricating eye ointment containing paraffin (e.g., VitA-POS®, Poly Visc®), every 2-4 hours
  - Corneal examination +/- fluorescein staining at least once daily[13]
    - Add appropriate antibiotic topically if indicated
  - Consider a partial temporary tarsorrhaphy or bandage contact lenses if complete lack of the palpebral reflex
- **Soft bedding**
  - Place in sternal recumbency[10] with head up and re-position slightly every 4-6 hours
- **Apply physiotherapy principles for recumbent patients**
- **Express the bladder every 4-6 hours if indicated**[13]
  - Consider placing a urinary Foley catheter with a closed collection system
- **Nil per os**
  - A significant number of dogs with tick paralysis are found to have evidence of megaoesophagus[27,30]
- **Airway care**
  - Ensure patency
  - Suction pharyngeal secretions as needed on a case-by-case basis (avoid causing undue stress)[10]
  - Clear oesophagus by suctioning (achieved by passing a long soft, nasal feeding tube)[10]
- **IV catheter care at least once daily to monitor for any signs of phlebitis and iatrogenic infection**[13]
- **Ensure environment is temperature controlled**

ROUTINE MONITORING

With consideration not to cause undue stress[10]

- **Respiratory rate, effort and pattern every 4-6 hours**
- **Respiratory function (SpO_2 and/or blood gases if available) every 4-6 hours**

When monitoring respiratory parameters, these timelines should be only be used as a guide. More frequent checks should be carried out if required.

Respiratory Concerns

1. Upper airway obstruction: laryngeal dysfunction, mucus plug
2. Pulmonary parenchymal disease: aspiration pneumonia, pulmonary oedema
3. Unsustainable respiratory effort
4. Hypoxaemia
5. Hypoventilation

- **Check body temperature every 4-6 hours to ensure adequately maintained**
- **Check heart rate and rhythm every 4-6 hours**
- **Neurological examination every 12-24 hours to ascertain case progression, with restaging as necessary**
  - Consider serial videos for objective comparison
- **Tick search regularly[10] as per MSTS**
- **Electrolytes (and/or packed cell volume) every 24 hours or more frequently as indicated**
- **Biochemistry if indicated**
- **Measure bodyweight every 24 hours**
  - Consider measuring fluid inputs and outputs

Ensure thorough history taking, physical examination and further work-up, if indicated, to assess for comorbidities/underlying disease

MANAGEMENT OF THE COMPLICATED PATIENT

APPROACH TO ONGOING MONITORING OF TICK PARALYSIS CASES

Guarded Prognostic Indicators

- Vomiting or Regurgitation[21] (d,c)
- Dyspnoea*[10] (d)
- Hypoxaemia (d)
- Hypercapnoea (d)
- High Respiratory VAS Score[10,17,18,20,21,31] (d,c)
- High NMJ Score[10,17,18,21,31] (d,c)
- Comorbidities (d)
- Age (<6 months old or >6 years old) [10,17,21,32] (d)
- Hypothermia at Presentation[31] (c)
- TAS Reaction[31] (c)

d = dog, c = cat

Monitor Parameters and Consider Referral

Respiratory Rate, Effort and Pattern

Is the Work of Breathing Unsustainable?

When the oxygen cost associated with the animal's increased breathing effort is greater than the ventilation and oxygenation benefits obtained.

This may present as:

- Asynchronous abdominal movements[19]
- Head and neck extension[19]
- Open mouth breathing[19] (+/- at commencement of each breath, lateral commissures of lips are pulled back in an exaggerated movement. More common in advanced NMJ score patients)
- Apnoea[19]
- Focused, fatigued, anxious or non-responsive, glazed eyes[21]
- Respiratory VAS Score D

If Respiratory Rate < 16 with NMJ Score ≥ 3

Hypoventilation

Blood Gases

If PCO_2 > 60 mmHg
Severe hypercapnia

If PaO_2 < 80 mmHg

Hypoxaemia

Pulse Oximetry^

If SpO_2 < 93%

If SpO_2 = 93-95%

Interpret with Other Parameters and Monitor Closely

Thoracic Auscultation

If Abnormalities Detected

Thoracic Radiographs

Assess for lower airway, pulmonary parenchymal and cardiac changes and megaoesophagus [10,19,27,30]

Aspiration Pneumonia

Refer to Treatment – Protocol B

Oxygen Supplementation[19]

If SpO_2 > 90%

Is work of breathing sustainable?

NO

YES

Continue Oxygen Supplementation. Monitor closely

If SpO_2 < 90%
or
PaO_2 < 60 mmHg
or
PCO_2 > 60 mmHg

GA and ET Intubation
Assess upper airway for obstruction

Patient Airway Secured

Requires Mechanical Ventilation

If SpO_2 < 90%
or
PaO_2 < 60 mmHg
or
PCO_2 > 60 mmHg
or
$ETCO_2$ > 50 mmHg†

If SpO_2 90-95% maintain intubation but consider pulmonary parenchymal disease. Continue monitoring and if SpO_2 drops to <90%

If SpO_2 > 95%
Upper airway obstruction suspected

Maintain GA, Monitor and Reassess Ongoing Need for Oxygen Supplementation

Consider Temporary Tracheostomy or Temporary Cricothyrotomy[34]

* Dyspnoea (inspiratory and/or expiratory) always requires oxygen supplementation

^ Does not evaluate hypoventilation, variable accuracy in conscious patients

† Care with interpretation of capnograph if patient is hypoventilating due to low tidal volume – needs mechanical ventilation[13]

FELINE PATIENTS: THE DIFFERENCES

The following outlines specific considerations for feline tick paralysis patients and is designed to be read as an adjunct to the *Diagnostic Approach*, *Protocol A*, *Protocol B* and *Management of the Complicated Patient.*

Risk Factors associated with a higher mortality rate[31]	Factors that reduce the risk of mortality[31]
• Advanced respiratory scores • Advanced gait scores • Hypothermia at presentation • TAS reaction	• Coat clipping • TAS administration • Mechanical ventilation (in cats with respiratory failure)
Cats who have previously had TAS or canine blood products are at a higher risk of anaphylaxis to repeat TAS administration[22]	

Initial Clinical Presentation

- More likely to be stressed and anxious[16] compared to dogs

Please note, care should be taken when handling feline patients as upper airway obstruction can be acute and life threatening when exacerbated by stress

- Pronounced changes in phonation
- Hypoventilation in cats may present with a normal to low respiratory rate
- LMN paresis[16]
- Tail may be unaffected[16]
- Bladder voiding dysfunction[16]

Treatment

- It is paramount to minimise stress at all times
  - Ensure adequate sedation and treat in a quiet, dark, temperature controlled environment[16]
  - Handle away from dogs to reduce stress[13]
- Cats are more likely to have an anaphylactic reaction to TAS than dogs[25]
  - TAS reactions have been reported in 9% of cats treated with TAS[31]

  To reduce the risk of anaphylaxis associated with canine tick antiserum administration to cats, an APVMA approved purified tick antiserum (PTAS) manufactured by Padula Serums (padulaserums.com.au) is available from veterinary wholesalers or direct in bulk lots. PTAS has been shown to reduce the risk of acute reactions in cats and is efficacious for treatment of tick paralysis[22]

  Purified Tick Antiserum for Cats APVMA Permit No. 129984/90764.
- Supplement oxygen if indicated using an oxygen cage[13]

Nursing Care

- Minimise handling of cats[13,16]
- Consider the use of Feliway®[26] (e.g., spray towels, use diffuser)
- Due to laryngeal sensitivity, care should be taken with procedures involving the pharyngeal/laryngeal region (e.g., suctioning)

Anaesthesia and Sedation

- Ensure the provision of adequate sedation for feline tick paralysis patients
- Similar sedation protocols can be used in cats as for dogs
- If anaesthesia is required, monitor the depth closely as total intravenous anaesthesia drugs may be cumulative

Refer to pages 30-31 in the Critical Care section for suggested sedation/anaesthesia protocols

Relevant Considerations

- Cats rarely develop aspiration pneumonia[13] (however it can occur)
- Hypoventilation is the more common cause of respiratory failure[13]
- Megaoesophagus is not seen as in dogs[27]
- The reported survival rate for mechanical ventilation in cats with tick paralysis is 83.3%[33]
- The reported mortality rate of cats with tick paralysis is lower than in dogs (2%[31] and 6.9%[21] respectively)
- In cats, multiple ticks and a higher NMJ score are associated with a longer time to recovery[18]

Prevention

- Application of a registered acaricide for control of *Ixodes holocyclus* in cats
- Follow label instructions
- Tick search as per MSTS
  - The pattern of distribution is as for dogs and includes the head, neck, under the chin, hard palate, between the shoulder blades, caudal to the elbow, chest/belly, flank/back, legs, external anus, inside the anus and the tail[12,16]

TIPS FOR TRANSPORTATION OF TICK PARALYSIS CASES TO REFERRAL CENTRES

Refer Early

- See *Management of the Complicated Patient*
- Things to consider:
  - Ideally critical patients with tick paralysis should be transported anaesthetised, endotracheally intubated and have positive pressure ventilation provided manually (Ambu-bag) or via a transport ventilator with an oxygen supply
  - For cases that aren't anaesthetised, they should be heavily sedated on oxygen insufflation via nasal line(s) or oxygen cage

Resuscitation drugs, laryngoscope, endotracheal tubes, Ambu-bag and anaesthetic agents should be readily available

- Advise referral centre of arrival time

If patient is anaesthetised

- Vet and/or vet nurse recommended to travel with patient to maintain airway and monitor general anaesthesia
- Owner assistance not recommended

Legal considerations

- Oxygen tank storage during transportation

TIPS FOR BRACHYCEPHALIC BREEDS

- Assessment and maintenance of airway patency is vital
- Consider existing or previous upper airway disease
- Avoid over-sedating brachycephalic patients as it can further compromise upper airway patency
- Consider general anaesthesia and endotracheal intubation +/- mechanical ventilation early in the course of the disease
- A temporary tracheostomy or temporary cricothyrotomy[34] may be required in cases with upper airway obstruction, or to facilitate a less complicated recovery post general anaesthetic and endotracheal tube placement
- Patients with a temporary tracheostomy or temporary cricothyrotomy need constant monitoring
- Monitor body temperature for early detection and correction of hyperthermia or hypothermia
- Keep in a temperature controlled environment
- Manage owner expectations with regards to increased risk of morbidity

MANAGING HYPOVENTILATION WITH MINIMAL FACILITIES

Any animal that is engaging its abdominal muscles with respiration, has its head extended or has an increase in depth and work rate of respiration is likely to be suffering hypoventilation.

- **Oxygen supplementation** is critical for these patients, regardless of whether their pulse oximetry levels are normal. There is a high incidence of patients who will deteriorate into a state of exhaustion and hypoxaemia with these clinical signs, increasing the risk of death.
- **General anaesthesia, with intermittent manual positive pressure ventilation**, will help reduce respiratory muscle fatigue. Patients can often be maintained on 0.25-1% isoflurane with appropriate oxygen flow rates according to weight. Active warming with temperature monitoring is essential to prevent hypothermia.
- Maintain the patient in a **sternal position** and **remove or reduce the levels of sedation** that may be contributing to hypoventilation.
- See section on the next page Intensive Care of the Anaesthetised and Intubated Patient for additional supportive measures.
- **Maintain anaesthesia for as long as it takes for respiratory effort to be decreased.** Patients must be monitored carefully on extubation and stepped down to an alternative form of oxygen supplementation in recovery from anaesthesia. Refer to pages 28-29 for the various forms of oxygen supplementation.
- **In the absence of access to a ventilator, monitored general anaesthesia** is the most effective way of supplementing oxygen, reducing stress and decreasing fatigue/exhaustion and increasing survival rates.
- **If a patient cannot be maintained in general anaesthesia** overnight due to lack of after hours staffing for monitoring, then choose the form of **oxygen supplementation on pages 28-29** that is achievable with your skill set and facilities that is going to achieve the highest Fraction of Inspired Oxygen (FiO_2).
- **Balance sedation to reduce panic/stress of patient** with the cardiovascular depressing effects of the sedative agent for non-anaesthetised patients with hypoventilation (see page 30 for drug choices).

INTENSIVE CARE OF THE ANAESTHETISED AND INTUBATED PATIENT

- Active warming with temperature monitoring is essential to prevent hypothermia
- Ocular care (refer to *Supportive Care – Protocol B*)
- Oral care[13]
  - Consider using intravenous giving set tubing as ET tube ties
  - Keep the mouth slightly open with small mouth gags to reduce pressure on the tongue. Care in cats as prolonged forced opening of the jaw may cause central blindness[35]
  - Rinse the mouth 4 hourly. Use dilute chlorhexidine (0.05% solution) first, then continue with sterile saline
  - Gentle brushing of teeth with an extra soft toothbrush may be beneficial
  - Apply glycerine to keep the tongue moist or wrap the tongue in moist swabs
  - Re-position the pulse oximeter probe every 2-4 hours to prevent pressure necrosis
- Change the ET tube as necessary
  - The frequency depends on the quantity of secretions and risk of ET tube obstruction
  - Use a new or sterile ET tube placed aseptically
- Monitor electrolytes, packed cell volume/total protein and blood glucose every 12 hours
- Assess blood gases when necessary (or ideally, every 6 hours)
- Consider performing a complete blood count and biochemistry panel every 24 hours
- Measure fluid inputs and outputs
- Measure bodyweight every 12-24 hours

CRITICAL CARE

FLUID THERAPY

HYDRATION STATUS

This is an estimate of the percentage reduction in extracellular fluid using clinical and laboratory parameters. The clinical signs of dehydration do not result in linear changes in the parameters described due to patient variance (e.g., an obese patient will have less skin tent than a cachectic patient).

Table 2: Physical Findings Associated with Inadequate Tissue Perfusion (From Mathews, K. (2012)[36])	
Assessment	**Confounding Factors**
Mucous Membranes	
Pale pink	Vasoconstriction caused by pain or anxiety Anaemia
Pale	Volume loss overestimated because of vasoconstriction caused by pain or anxiety
Dark pink or red	Vasodilatation and may be interpreted as normal volume Haemoconcentration may be interpreted as normal volume
Capillary Refill Time	
	<1 sec may be considered adequate perfusion Difficult to interpret if peripherally vasoconstricted because of pain or anxiety

Table 3: Confounding Factors of Physical Findings Associated With Dehydration (From Mathews, K. (2012)[36])	
Assessment	**Confounding Factors**
Skin turgor ("tent")	Young animals with subcutaneous fat Obese animals with subcutaneous fat Cachectic animals Geriatric animals with loss of tissue elasticity
Mucous Membranes	
Dry	Panting, tachypnoea, dyspnoea
Moist	Nauseated, vomiting, drinking
Position of the globe	Cachexia
Perfusion status	Affected by rate of fluid loss; chronic loss may not affect perfusion parameters until a large volume is lost

Table 4: Physical Signs Associated With Dehydration (From Mathews, K. (2012)[36])	
Percent Dehydration	**Physical Signs**
<5	Not detectable
5-6	Mild loss of skin elasticity
6-8	Definite loss of skin elasticity May have dry mucous membranes May have depressed globes within orbits
8-10	Persistent skin tent with slow return because of loss of skin elasticity
10-12	Persistent skin tent with slow return because of loss of skin elasticity Depressed globes within orbits Dry mucous membranes Signs of perfusion deficits (CRT >2 sec, tachycardia)
12-15	Signs of shock Death
Note: The association between percent dehydration and circulatory compromise must also be considered with rate of fluid loss. Chronic fluid loss may result in severe dehydration, but perfusion may be adequate; however, fluid loss occuring acutely will result in circulatory collapse at an estimated lower level of hydration. Therefore perfusion status cannot consistently be used to assess hydration status.	

ELECTROLYTE AND ACID-BASE STATUS

Comprehensive patient assessment for fluid therapy also requires evaluation of electrolyte and acid-base status. This evaluation is beyond the scope of the tick guidelines and the interested reader is referred to the chapter "Daily Fluid Therapy" in the textbook by Silverstein and Hopper: *Small Animal Critical Care Medicine* 2nd ed.[37]

FLUID THERAPY CONTINUED

FLUID THERAPY KEY POINTS

- Assess hydration status and correct for any deficits with a tailored rehydration plan
- Maintenance fluid therapy is indicated for all patients affected by tick paralysis because nil by mouth is anticipated for at least 24 hours
- Fluids should be administered cautiously in patients with tick paralysis because of the known incidence of pulmonary oedema in dogs[20]
- For maintenance fluid requirements:

  2.5 mL/kg/h is a reasonable maintenance rate for balanced crystalloid fluids in patients affected by tick paralysis

  The specific maintenance calculation is Fluid rate (mL/h) = ((BW x 30) + 70) / 24

  Fluid therapy should be tailored to individual patient needs

- **Fluid Plan** = Maintenance + replacement volume administered over 24 hours if >7.5% dehydrated*
- **Fluid Choice**

  Replacement crystalloids recommended:

  Compound Sodium Lactate (Hartmann's Solution)^
  Plasma-Lyte 148
  Normal Saline (0.9% NaCl)

*This plan differs from typical veterinary patients because ongoing losses are not added to the calculation. The replacement volume is administered at the same rate over 24 hours. Only when the dehydration is clearly above 7.5% are replacement components added. Patients without clinical signs of dehydration administer maintenance fluids only.

^Preferred choice for most patients with tick paralysis is compound sodium lactate (Hartmann's solution). It has a buffer, contains some potassium, and has a more physiological chloride concentration than normal saline.

- **Additives**

  Potassium supplementation is warranted in most patients due to reduced intake and increased losses through vomiting/regurgitation. Use the following table as a guide.

Table 5: Guidelines for Routine Intravenous Supplementation of Potassium in Dogs and Cats (Adapted from DiBartola, S.P. (2012)[38])

Serum Potassium Concentration (mEq/L)	mEq KCl to Add to 250 mL Fluid	mEq KCl to Add to 1 L Fluid	Maximal Fluid Infusion Rate* (mL/kg/h)
<2.0	20	80	6
2.1-2.5	15	60	8
2.6-3.0	10	40	12
3.1-3.5	7	28	18
3.6-5.0	5	20	25

**So as not to exceed 0.5 mEq/kg/h*

MONITORING FLUID THERAPY REQUIREMENTS

- Fluid requirement needs to be calculated for individual patients, and will be affected by age and concurrent disease. The most important component of fluid therapy is to monitor the response of the patient to the fluid being administered and to readjust the strategy as necessary
- Repeat physical examination every 12 hours

  Measure bodyweight every 12 hours

  Repeat PCV/TP and electrolytes as required
- Reduce fluid rate if there are signs of the following:
  - Weight increase > than % dehydration. For example, if a patient is 10% dehydrated and their weight increases by more than 10%, then this could indicate overhydration/positive fluid balance
  - Overhydration - oedema or 'jelly like' presence subcutaneously
  - Tachypnoea and signs of pulmonary oedema

OXYGEN SUPPLEMENTATION

Table 6: Indications, Advantages, and Disadvantages of different methods for Oxygen Supplementation					
Technique	**Indication**	**FiO_2**	**Advantages**	**Disadvantages**	**Procedure**
Tube Cricothyrotomy (CTT) Tube Tracheostomy (TT)	Long-term therapy Described for use in laryngeal paralysis causing upper airway obstruction May be used post ventilator weaning	50-100%	High FiO_2 achieved with minimal flow rate Can be tolerated for extended period, usually with some chemical restraint Anaesthesia may be weaned to sedation and then ceased in many cases CTT has advantages over TT • Larger diameter tubes can be accommodated • Simpler technique • Fewer complications reported	May require general anaesthesia to place – awake CTT has been described Frequent tube suctioning may be necessary due to accumulation of airway secretions	Various cricothyrotomy kits available – all-in-one device, seldinger technique, open surgical technique Cricothyroid membrane landmarks the insertion of CTT
High-Flow Oxygen Therapy (HFOT) • A novel method of oxygenation • Hasn't yet had clinical trials with tick paralysis cases	Long-term therapy where conventional oxygen therapy has failed or where mechanical ventilation (MV) is unavailable Potential bridge between traditional oxygen therapy and MV	50-100% Warm, humidified O_2 delivered at high flow rates	Ease of set-up to patient with nasal prongs High volumes of oxygen (4-60 L/min) provides oxygen-rich air in the upper airways, displacing CO_2, optimising FiO_2 to alveoli Less invasive & less expensive than MV Provides positive end-expiratory pressure (PEEP) (3-5 cm H_2O)	Specialised equipment necessary Tolerance is enhanced with sedation/ anaesthesia O_2 toxicity is possible with long-term use	Nasal prongs placed and secured (diameter <50% of nares diameter to aid ventilation) FiO_2 setting (up to 100%) is chosen T° is set between 34°C and 38°C Flow Rate is set, starting low (range 0.5-2 L/min) and titrating upwards based on response
Trans-tracheal Intra-tracheal	Long-term therapy	50-100%	High FiO_2 achieved with minimal flow rate Can be tolerated for extended period	Trans-tracheal O_2 requires catheterisation of the trachea Intra-tracheal O_2 can only be delivered when an ET tube is placed (patient anaesthetised)	Trans-tracheal: Place large bore (14g) IV catheter into the trachea then feed a 3 Fr rubber feeding tube through the catheter and into the trachea. Remove catheter, place tape wing and suture to skin to secure Intra-tracheal: Place soft rubber tube down the ET tube to the level of the distal trachea and administer oxygen at 50 mL/kg/min titrated to effect

Table 6: Indications, Advantages, and Disadvantages of different methods for Oxygen Supplementation					
Technique	**Indication**	**FiO_2**	**Advantages**	**Disadvantages**	**Procedure**
Oxygen chamber	Long term therapy	40-90%	Very effective and non-invasive. Technique of choice in cats	Larger patients can overheat in cage Oxygen concentration returns to 21% when door opened Difficult to monitor patient other than visual observations	Can buy commercial cage. Concentrate oxygen using high flow into a relatively sealed cage or container and measure internal FiO_2
Nasal oxygen	Short and long term therapy	50-70% increases with flow rate	Good all round technique in dogs. Patients will tolerate for extended periods, high FiO_2 achieved	Less effective in brachycephalic dogs and all cats. Some patients will not tolerate	Place 5-10 Fr soft rubber tube into nasopharynx via the nasal cavity by directing the tube medially and ventrally. Spray a small amount of local anaesthetic in nare first to desensitise. Flow rate starts at 100 mL/kg/min and titrated to effect and patient comfort
Flow-by	Short term therapy only	40%	Quick, non-invasive	Low FiO_2 achieved Patient may not tolerate procedure High flow oxygen required	Hold high flow oxygen line 5 cm from nares and concentrate with a loosely fitting face mask if patient will tolerate

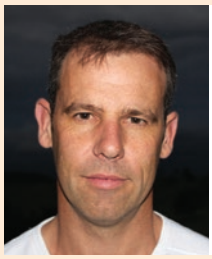
ADDITIONAL CONSIDERATIONS

General Anaesthesia is the most effective way of supplementing oxygen.

Humidified Oxygen:

The use of a humidifier, i.e., an oxygen humidifier bottle bubbler for oxygen lines, or air humidifiers in oxygen chambers, helps prevent drying of airways and reportedly aids alveolar oxygen transfer.
For example:

- https://easyoxygen.com.au/products/humidifier-bottle



TOP TIP FROM DR JUSTIN DANIEL

"Even putting a humidifier in a cage with a towel over the front of the cage can improve oxygen stats in tick patients that aren't needing more 'hands on' oxygen supplementation techniques, or when finances are restricted."

SEDATION AND ANAESTHESIA

SEDATION

Choices of which sedative to use include: **(drugs in bold are considered first-line)**

- **Acepromazine 0.01–0.05 mg/kg IV or SC** (maximum of 2 mg total dose, take into account patient's age and health status, administer slowly IV if possible)
- **Butorphanol 0.1–0.3 mg/kg IV or SC**, CRI at 0.1-0.3 mg/kg/h
- **Dexmedetomidine* 0.5-2.0 µg/kg IV, IM or SC,** CRI at 0.5-2.0 µg/kg/h, can be combined with a benzodiazepine +/- an opioid (lower doses used in combinations)
- Methadone 0.1–0.3 mg/kg IV, IM or SC
- Buprenorphine 10-30 µg/kg IV or SC, mainly for cats, use with ACP or diazepam, takes about 30 minutes to take effect
- Diazepam 0.1-0.2 mg/kg IV or IM, use with an opioid
- Midazolam 0.1-0.3 mg/kg/hr, use with a butorphanol CRI, can result in profound sedation/stage 1 anaesthesia. Make up to 1 mg/mL (50 mg vial up to 50 mL, 15 mg vial up to 15 mL)
- Medetomidine 0.5-2.0 µg/kg IV, CRI 0.5-2.0 µg/kg/h, can be combined with a benzodiazepine +/- an opioid (lower doses used in combinations)

* Medetomidine can be used instead of dexmedetomidine if dexmedetomidine is not available. However, medetomidine results in greater cardiovascular depression than dexmedetomidine

Table 7: Butorphanol Bolus and CRI Doses

Patient Weight (kg)	**Bolus Dose IV (mL) 10 mg/mL solution^** ^dose rate 0.1 mg/kg	**CRI Dose IV (mL/h) 0.2 mg/mL solution*†** *10 mg butorphanol made up to 50 mL using crystalloid solution †dose rate 0.25-1.5 mL/kg/h	**CRI Dose IV (mL/h) 0.1 mg/mL solution#+** #10 mg butorphanol into 100 mL 0.9% NaCl bag +Dose rate 0.5-3.0 mL/kg/h
2.5	0.025	0.625-3.75	1.25-7.5
5	0.05	1.25-7.5	2.5-15
10	0.1	2.5-15	5-30
20	0.2	5-30	10-60
40	0.4	10-60	20-120
60	0.6	15-90	30-180

Choose a concentration of butorphanol CRI suitable for available fluid pumps and take into consideration total fluid rate for patient.
2.5 mL/kg/h is a reasonable maintenance rate for balanced crystalloid fluids in patients affected by tick paralysis.
The specific maintenance calculation is:
Fluid rate (mL/h) = ((BW X 30) + 70) / 24
The temperament, age, and clinical status of the patient should also be considered when choosing a dose rate.

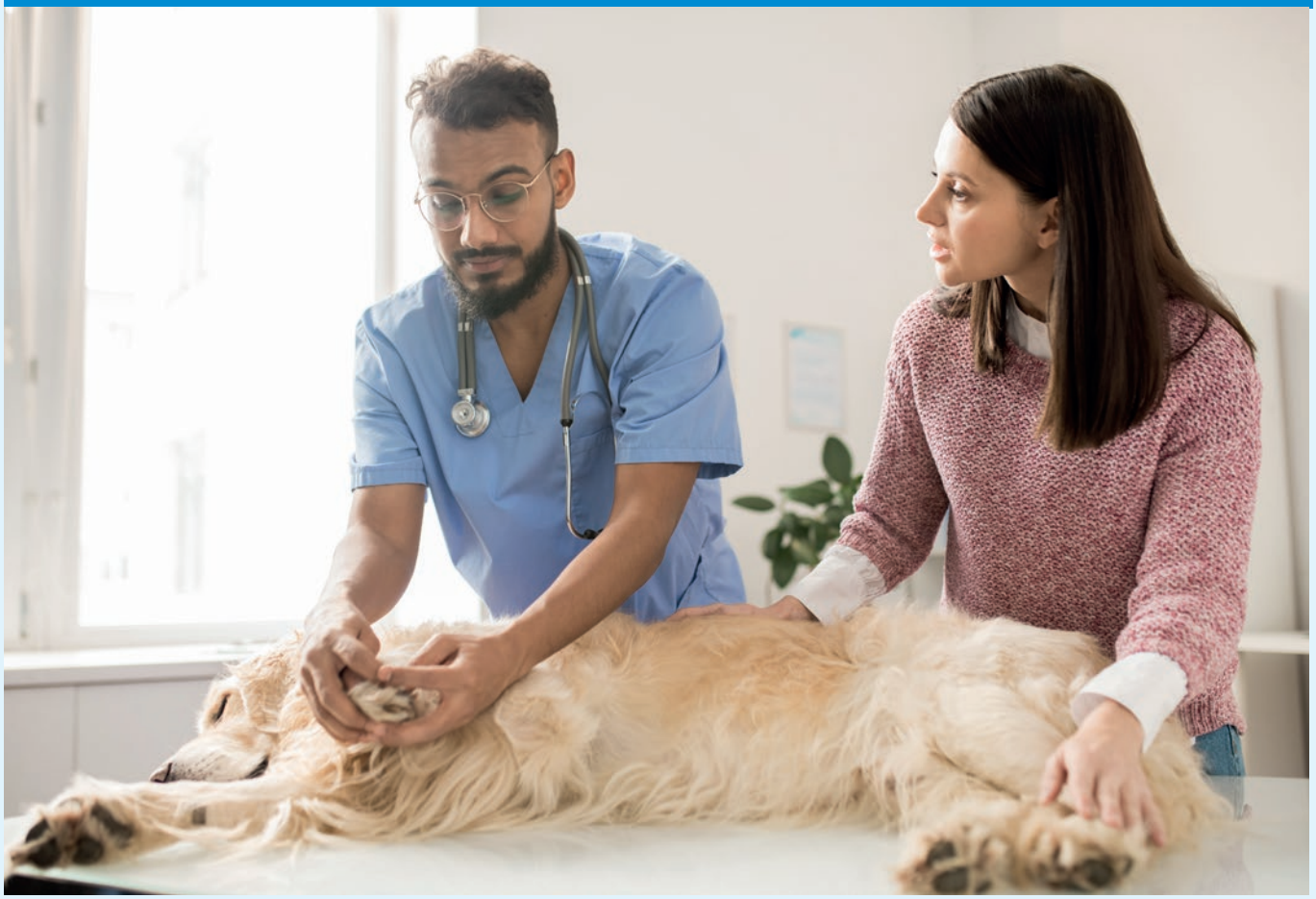
ANAESTHESIA

Anaesthetic options for patients requiring mechanical ventilation include:

- **Propofol 0.05 – 0.6 mg/kg/min with midazolam +/- butorphanol**. Start at about 0.1 mg/kg. Often when used in combination with an opioid and benzodiazepine only small amounts are needed making it moderately cost effective. A practical starting rate is 0.5 mL/kg/h of propofol 1% which can be titrated up or down. Watch for the cumulative effect +/- Heinz bodies in cats, and high doses will cause significant lipaemia. For this reason, alfaxalone is the preferred drug in cats
- **Alfaxalone 2-4 mg/kg/h** (lower dose than stated on current label)
- Fentanyl 4-20 µg/kg/h when used in combination with midazolam. Cardiovascularly stable and can be titrated, but is expensive

PANEL CONSENSUS ON TAS

Although the pathophysiology of tick paralysis and the action of tick antiserum are not fully defined, it is thought, as is the case with other neuromuscular junctionopathies like botulism, the action of TAS is limited to circulating available unbound toxin. **For maximum TAS effectiveness, TAS should be administered as soon as possible**, as once progressive clinical signs are apparent the "effectiveness" of TAS is proportionally reduced. Historically, there has been much discussion on the optimal TAS dosing regimen. **The panel considers reducing time to dosage of "some TAS" the critical aspect of TAS treatment protocols in affected patients, rather than focusing on the specific dose,** as previous studies have shown a wide range of TAS doses to be effective, including those lower than the registered label dose.



TAS DOSES USED BY PANEL MEMBERS

There is currently insufficient evidence to support a consensus panel recommendation for dosing TAS. In the absence of a panel recommendation, the doses on this page represent the current opinion of a number of individual panel members.

PROF. RICK ATWELL

How I think about TAS

- TAS therapy must be instigated immediately to have its maximum effect on unbound toxin about to attach.
- There may be a small window of opportunity (after admission) where maximum TAS effectiveness can be achieved on intra-vascular toxin and probably the interstitial space, but this is determined by capillary pore types and antibody size and complexity.
- Much lower TAS doses have been proved to be just as effective as the registered dosages.
- Extra TAS (in various applications) has no effect on outcome.
- Earlier TAS could also alter (more quickly) the concentration gradient of toxin between vascular and inter-cellular compartments and between neurones and the inter-cellular space. This could facilitate (reversible) detachment (via several different mechanisms) from receptors on voltage-gated electrolyte channels (Na^+, K^+, Ca^{++}).
- The later TAS is given, the more likely that unbound toxin will have attached, resulting in more severe clinical disease and a longer recovery period.
- A 2024 publication of 506 tick paralysis cases found that the only proven factors to reduce mortality were TAS and antibiotic use (note that critical care was not assessed in the analysis).[21]

JUSTIN DANIEL

Cats: 12 mL for all cats

Dogs:

0-5 kg	12 mL
5-10 kg	20 mL
11-15 kg	2 mL per kg
16-25 kg	1.5 mL per kg
>25 kg	1 mL per kg

If there is >1 tick, then I'll quite often give 1.5 x the doses listed above.

HEATHER RUSSELL

Cats: 10 mL diluted to 30 mL with saline (10 mL TAS + 20 mL saline) administered over 3 hours at 10 mL/hr. We start slowly and increase gradually for the first 30 minutes if no reactions.

Dogs: minimum of 10 mL, maximum of 25 mL. (1 mL/kg in the middle) Consider increasing total volume if two or more ticks. We dilute 50:50 with saline and give over 30-60 minutes.

ROB WEBSTER

I approach it on a case-by-case basis. My general rule of thumb is to treat to excess: Most dogs receive 20 mL per dog, or 1 mL/kg whichever is larger. Small dogs <7.5 kg get 10 mL.

Cats receive 5-10 mL.

If the patient is in congestive heart failure and the TAS volume is potentially harmful I reduce the dose further.

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Disclaimer: *This document aims to provide guidance to veterinarians managing tick paralysis cases of dogs and cats and should not replace the attending veterinarian's clinical judgement of individual cases. Drugs and dosages represent the opinions of the panel members and are correct at the time of publication.*

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