

# Envenomation: Tick Paralysis

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## Introduction

Professor Rick Atwell describes tick paralysis is “an acute, progressive, ascending motor paralysis caused by salivary neurotoxin(s) produced by certain species of ticks”.<sup>1</sup> What he cannot describe well in a scientific paper is the anguish and emotion that is released when the diagnosis is missed or a patient dies because it was presented in an advanced stage of toxicosis.

Of the approximately 70 tick species found in Australia, the focus is mainly on one species – *Ixodes holocyclus*, the commonly named paralysis tick.<sup>2</sup> This tick species regularly attaches to domestic animals including dogs, cats, cattle, and horses, and occasionally to humans.<sup>3</sup>

In the area I live and work (Illawarra, East coast of Australia just South of Sydney) the tick species *Ixodes holocyclus* is endemic, supported by the natural host – bandicoots. These bandicoots are rarely affected, presumably acquiring immunity at an early age.<sup>1</sup> Interestingly, if the bandicoots are deprived of exposure to the toxin they also become susceptible to its effects.<sup>1</sup>

Using diagrams and images to assist clients in identifying ticks and understanding their life cycle can be a useful addition to your consultation room wall<sup>7,8</sup>.

## Factors contributing to envenomation

### Host Factors<sup>1</sup>

- Species affected
- Sensitivity to toxin
- Age of animal affected
- Concurrent work factors
- Reaction to environmental factors
- Skin reactivity
- Population density

### Tick Factors<sup>1</sup>

- Toxin absorption and circulation dynamics
- Virulence
- Paralysis-inducing capability
- Sexual activity
- Rate of infestation
- Frequency of the sucking stage

Many of these factors are unknown when an individual animal presents so predicting the outcome is only for the very brave or extremely foolish. Toxicity does not relate directly to tick size or duration of attachment.<sup>1</sup>

Ticks are usually reported as being maximally active mainly in Spring and early Summer.<sup>1</sup> In my experience, the female ticks are more active and more eggs appear to hatch whenever there is a short bout of rain (to cause a rise in humidity), followed by

warm weather. The ticks are easily killed by extremes of temperature and wet conditions.<sup>1</sup>

A tick needs to form a blood pool to suck blood effectively, hence the formation of a crater<sup>4</sup>. Most dogs become ill on day 4 of tick attachment<sup>4</sup>.

Paralysis usually occurs during the period of rapid engorgement by the adult female *Ixodes*, but there have been reports of it also being caused by large numbers of larval or nymphal ticks.<sup>1</sup> It is presumed that the toxin travels from the attachment site to the systemic circulation via the lymph system.<sup>1</sup>

The main cause of death in severe cases is primary hypoventilation<sup>1</sup>. The toxin also causes myocardial depression and diastolic failure which leads to cardiogenic pulmonary oedema and signs of congestive heart failure<sup>1</sup>.

Throughout Australia, mortality and morbidity is the same but clinical signs vary from area to area.

### **Clinical Findings**

Clinical signs are usually seen within 3-5 days of attachment ( in rare cases it can be up to 18 days)<sup>1</sup>. Progression of clinical signs is rapid over 24-48 hours<sup>1</sup>. Removal of the attached tick does not stop progression of clinical signs but many animals will deteriorate over the subsequent 24 hrs.

Early signs include<sup>1</sup>:

- Dysphonia or loss of voice (laryngeal paresis)
- Hindlimb incoordination and weakness
- Change in breathing rhythm, rate, depth and effort
- Gaging, grunting or coughing
- Regurgitation or vomiting
- Dilated pupils

Assessment of the respiratory tract is also important. Bronchoconstriction, fatigue of respiratory muscles and eventually aspiration of oesophageal/gastric secretions can lead to aspiration pneumonia<sup>1</sup>. In many cases the poor airflow interferes with auscultation of crackles, so pneumonic changes are undetected until they are severe<sup>1</sup>. Radiography may reveal extensive pulmonary opacity in dyspnoeic dogs with minimal clinical signs. These cases are often terminal.

Upper respiratory tract obstruction in dogs may be seen as a marked expiratory stridor with head and forelegs extended to maximise air flow<sup>1</sup>. Palpation at or just below the larynx may reveal a thrill secondary to the obstruction and stridor<sup>1</sup>.

Affected dogs lose their thermoregulatory capacity (secondary to airway compromise and loss of shivering reflex with paresis), so body temperature should be monitored for both hyperthermia and hypothermia, varying with the ambient environmental factors<sup>1</sup>.

Pulmonary oedema, secondary to congestive heart failure, can occur with diastolic myocardial dysfunction and some dogs may develop a ventricular arrhythmia that is lethal<sup>1</sup>.

Cats that are affected may develop significant anxiety<sup>1</sup>. It is important to handle these animals minimally as they may die suddenly (from dyspnoea, hypoxaemia, acidosis and hypercapnoea) if stressed<sup>1</sup>.

The airway constriction seen with cats that are mildly paretic may be easily misdiagnosed as asthma as the signs they display are similar: expiratory wheeze on auscultation; forced abdominal respiratory effort; and easily induced<sup>1</sup>.

Atwell has developed a 4-stage classification for Neuromuscular and Respiratory signs in the dog<sup>1</sup>:

#### Neuromuscular Score

Stage 1	Dysphonia (noticed retrospectively), weakness and incoordination but can still stand and walk. Best assessed walking up stairs
Stage 2	Can stand but unable to walk (obvious ataxia/paresis)
Stage 3	Cannot stand but can right itself
Stage 4	Cannot right itself

Any dog in stage 3 or 4 has a guarded prognosis<sup>1</sup>.

#### Respiratory Score

A	Normal - No clinical respiratory compromise
B	Mild compromise - increased HR & RR
C	Cannot stand but can right itself Moderate Compromise - restrictive breathing, gagging, retching
D	Cannot right itself Severe compromise - expiratory grunt, dyspnoea, cyanosis

These combined neuromuscular and respiratory scores (1A to 4D) are particularly useful when more than one person will be assessing the cases each day, to maintain consistency and assess if there is improvement or not.

Below are 2 tables that I add to the patient's file on our computer to assist in being thorough when I am examining a tick case. It also helps someone who may be assessing it later as comparisons may be made more easily:

**Tick Assessment:**

No. Ticks	Location:		
Observations as below: (circle or fill in appropriate data)			
HR=	RR=		
Breathing Pattern:	Normal		
	Obstructive (slow, deep)		
	forced exp effort, exp stridore, wheeze, grunt		
	Restrictive (Shallow, fast, crackles)		
Coughing?	Gagging?	Increased Anxiety level?	Regurgitation/Vomiting?

**Assessment of Signs:**

	<b>Mild</b>	<b>Moderate</b>	<b>Severe</b>
Score NM	1	2	3-4
Score Respiratory	AB	C	D
Mucosae	NAD	Bright Pink	Dark Red/Cyanotic
Heart Sounds	NAD	softened	Barely audible
Pulse Amplitude	NAD	Low	Barely palpable
Blood PCV %	< 45	45-55	>55
TPP	< 65	65-75	>75
ECG QT (50mm/sec)	< 280	280-300	>300
T wave inversion (lead 2)	NO		YES
U/sound FS%	>30	<30	<20

**Diagnosis**

Diagnosis can be frustrating as a tick may be difficult to locate or may no longer be attached and you are searching for a small crater. A tick must be part of the differential diagnosis when there are signs of lower motor neuron or neuromuscular disease. In a known tick area this is easier as it is an endemic problem. The more difficult cases are outside the traditional tick areas. For these cases, a history of recent possible exposure by either a visit to the coast or a tick being transported onto the property (another animal has been to a tick endemic area or turf has been recently placed on the property and it came from a tick endemic area).

Differential Diagnoses<sup>1</sup>:

- Botulism
- Snakebite
- Polyradiculoneuritis
- Hypokalemia
- Acute peripheral neuropathies
- Toadfish or ciguatera toxicity

Include tick paralysis in any presentation of megaesophagus, unexplained vomiting, acute left –sided congestive heart failure in dogs, or asthma in cats<sup>1</sup>.

Increased PCV with normal serum protein, indicates a fluid shift into the lungs and a more guarded prognosis<sup>1</sup>.

### **Treatment**

To initiate treatment, you must locate the tick(s). I usually sedate the animal with acepromazine (0.03mg/kg SC) and allow it to become calm before embarking on this procedure. The best method is to pick up the skin and allow it to run through your fingers, feeling for a mass the size of a crater or tick. The majority of ticks are found cranial to the forelimbs and so initially this is where we concentrate our attention. Over the years I have experienced that they can be attached anywhere so for severe cases or where a tick cannot be found, we will recommend a full clip of the fur. This has to be balanced against any stress it may cause and so should be approached gently and slowly. Unlike humans, it is safe to pluck a tick once it is located and it will not cause anaphylaxis<sup>1,4</sup>. An alternative to clipping is to apply an effective acaricide to the dog. This should kill the tick, ensuring the toxin production ceases. Unfortunately, if the acaricide does not reach the tick (e.g. deep in ear canal, nasal cavity or rectum) toxin production continues. The situation is similar when more than one tick is present on the dog and a search fails to locate the second or third tick - the dog will initially improve and then deteriorate, toxin is still being produced and injected by the remaining tick/s.

Once the tick is removed or the crater located treatment can begin with confidence. There are many myths surrounding tick removal, most of them are incorrect e.g. Squeezing the tick during removal does NOT increase the toxicity<sup>9</sup>.

Treatment has to address all the signs found in your examination and so treatment of each individual will vary:

### **Medications:**

- **Tick Antiserum (TAS)** – to neutralize the toxin
  - Dose calculation is more an art than a certainty as there are so many variables<sup>1,4,9</sup>.
  - Give as early as possible as the TAS can only neutralize toxin in the circulatory system. The molecules of the TAS cannot penetrate the wall of the blood vessels and so cannot reach toxin that has passed into the tissues and become bound<sup>1,4</sup>.
  - You cannot remove toxin once it is bound to tissue sites, this helps to explain why top up TAS is not useful and also why it is less useful in severe clinical cases – the toxin has left the circulation and is bound to tissue sites.
  - Minimum dose is 0.5-1.0ml/kg delivered slowly IV or IP. Rapid IV delivery can cause reactions in over 80% of dogs<sup>1,4</sup>. The best delivery route in cats is IP<sup>4</sup>.
  - In dogs, deliver TAS by slow IV injection(over 15-20 minutes) and there will be no side effects<sup>9</sup>. Mortality from TAS is around 0.01%<sup>4</sup>.

- **Sedation:**
  - Acepromazine: (0.03mg/kg) is often useful prior to any medication, but high doses should be avoided in animals that are depressed, hypotensive or hypothermic.<sup>1,4</sup>.
  - An alternative used by some is Domitor (Pfizer, Medetomidine hydrochloride, 1.0 mg/mL, 0.1ml-0.25ml/10kg)
  - Opiates can be used as an alternative (eg, methadone (0.3-0.5mg/kg), and Butorphanol (10mg/ml, 0.1ml/10kg), SC or IM<sup>1</sup>.
- **General anaesthesia:** in animals that are severely dyspnoeic, pentobarbitone IV will reduce dyspnea and enable muscle rest to assist in overcoming primary muscle fatigue and general exhaustion<sup>1,4</sup>. Periods of 6-8 hours are best, with reassessment after each period<sup>1</sup>.
- **Atropine:** use a low dose (0.05mg/kg IM), repeat each 6 hours, for control of excess respiratory and gastrointestinal secretions<sup>1</sup>. However it may also reduce tear production (corneal ulcers may be more likely when the actions of atropine is combined with poor blink reflex from the tick toxin) and also affect heart rate and rhythm<sup>1</sup>.
- **Antiemetic** therapy may be required for animals that are vomiting.
  - Metoclopramide 0.5-1mg/kg IV or IM
  - Maropitant (Cerenia) 1.0 mg/kg equal to 1.0 mL/10 kg SC once daily for up to 5 consecutive days. For dogs only as not registered for cats.
  - If the animal is regurgitating it is better to aspirate the oesophagus of secretions that are pooling because of megaesophagus<sup>1</sup>. Place the animal in the correct drainage positioning to assist in avoiding aspiration<sup>1,4</sup>.
- **Broad-spectrum antibiotics** are probably indicated in all tick cases as the best treatment for even mild aspiration that can lead to pneumonia<sup>1,4</sup>.
- **Diuretic** (eg, furosemide up to 8.0mg/kg aggressively IV q1hr until pulmonary oedema resolved – especially in dogs) with or without oxygen therapy is indicated for cases of congestive heart failure<sup>1,4</sup>. Pulse oximetry is useful to assess an animal's ability to oxygenate.

### Supportive Techniques:

- **Hospitalisation**
  - Most animals will continue to deteriorate over the first 24 hours from tick removal
  - Regular monitoring and nursing care is essential to address problems as they appear
  - Place the animal in a quiet dark and comfortable part of the hospital. This is essential with cats as they stress easily<sup>1,4</sup>.
- **Correct Drainage Positioning**
  - Place the animal on its sternum to maximize lung function<sup>1</sup>
  - If the animal is unable to maintain sternal recumbency, place in lateral recumbency, left side down with the shoulder at the highest point – not the neck or pharynx and with the head slightly down<sup>1</sup>.

- Do not rotate the animal unless it can be done every 1-2 hours, 24 hours a day<sup>1</sup>.
- **Monitor body temperature**
  - Take temperature at least twice daily initially. Hypothermia and hyperthermia may suddenly occur and must be treated accordingly.
  - Heating – hot water bottles, blankets and hot air-flow blankets such as Bair-Hugger<sup>1</sup>.
    - Toxin may have caused arteriovenous shunts to shut and host's vasoconstriction responses to hypothermia may interfere with peripheral heat absorption<sup>1</sup>.
    - Warmed IV fluids or rectal fluids may be required in animals that present with a temperature lower than 32°C<sup>1</sup>.
    - Cooling – wet towels, direct fan flow, high rate air changes, air-conditioning<sup>1</sup>. Cooled rectal fluids may also assist<sup>1</sup>.
  - Hypothermia is better than hyperthermia because animal requires less oxygen when hypothermic.
- **Oxygen therapy**
  - Nasal Oxygen supplementation ( not > 200ml/kg/min)
  - Trans-tracheal Oxygen supplementation: 12g teflon catheter passed between ventral mid tracheal rings. Then pass 5-6F infant feeding tube through this to tracheal bifurcation. Remove catheter and place IV drip line onto feeding tube. Bandage apparatus to neck and supply low flow rate O<sub>2</sub> (approx 1L/min/20kg).
  - Tracheostomy and supplemental oxygen supply is better than ventilation as long term ventilation patients have a low recovery rate (less than 25%)<sup>1,4</sup>.
- **Eye protectants**
  - Tick toxin causes eyelid paresis, loss of blink reflex and corneal drying<sup>1,4</sup>. This can be exacerbated by medication with atropine.
  - Use artificial tears or drops as required to maintain hydration of the cornea.
- **Stress reduction**
  - Cats particularly become dyspnoeic with any stress and may resemble asthma with even mild restraint<sup>1</sup>.
- **Monitor urination**
  - Some animal may not be able to evacuate the urinary bladder and may require catheterization and the bladder being expressed at least twice daily<sup>1</sup>.
- **Repeated tick searches**
  - Never assume there is only a single tick present once it has been removed. We routinely have at least 2 people search an animal in the first 24 hours. If the animal does not stabilize in the first 24 hours we routinely clip them with the least stress can achieve.
  - Application of an effective acaricide is recommended.
    - Frontline Plus<sup>®</sup> Spray is recommended by Rick Atwell as being effective in his studies<sup>4</sup>.

- We have also used Permaxin Spray<sup>®</sup> on dogs and found it effective – it must not be used in cats.

The dog's ability to bark is the last toxicity sign to recover, so when it can bark all other systems should be back to normal<sup>4</sup>.

### **Tick Home instructions**

Below are the printed instructions we send home with each animal.

***Dog:*** Avoid all excitement for 2 weeks. Feed 2-3 small meals a day for next 4 days. Precede each meal with a small volume of water to check swallowing is normal. If any gagging or spluttering with the water, do not give any food until the next meal is due, and try water first again. Check daily for Ticks. Avoid walking near creeks and areas with long grass. For all dogs on the property, consider using Frontline Top Spot or Advantix on the back of the neck each 2 weeks or preferably Frontline spray over whole body every 3 weeks to assist in preventing ticks, or alternately, they should be rinsed thoroughly every 7 days with Permaxin Rinse. Do NOT use Permaxin on cats. Use daily inspections for ticks to ensure good control. Take care with prolonged exposure to sun and subsequent sunburn now that coat is so short.

***Cat:*** Avoid all excitement for 2 weeks. Feed 2-3 small meals a day for next 4 days. Precede each meal with a small volume of water to check swallowing is normal. If any gagging or spluttering with the water, do not give any food until the next meal is due, and try water first again. Check daily for Ticks. You may need to keep your cat indoors to avoid areas near creeks and areas with long grass for at least 2 weeks. Consider using Frontline Top Spot or Advantage on the back of the neck each 2 weeks or preferably Frontline spray over whole body every 3 weeks to assist in preventing ticks.

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