Monitoring of head trauma in cats: a case study

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ABSTRACT: There is limited data currently in Veterinary Medicine relating to the prognosis, long-term monitoring and outcome in felines suffering from traumatic brain injury. The current main prognostic indicator is the Modified Glasgow Coma Scale, which has limited value after the initial 72 hour survival. It is believed many felines who present with traumatic brain injury may be euthanased in the early stages of recovery due to a lack of data relating to prognosis and outcome. Improvements in clinical condition can persist for over three months after the inciting event and a Standardised Outcome Scale (SOC) would assist clinical decisions relating to these improvements and quality of life. An SOC was designed specifically for felines to monitor the progress of a stray cat who presented with head trauma and severe neurological deficits. The SOC enabled the author to accurately and objectively monitor progress. The SOC demonstrated a consistent improvement in clinical condition, even when the overall clinical presentation was poor. The SOC 's main benefit was the ability to quantitatively monitor condition, which proved a continued and sustained improvement, thereby preventing premature euthanasia. The primary objective of the SOC is the provision of an accurate monitoring tool to facilitate veterinary decision making.

Keywords: head trauma in cats; feline head trauma; traumatic brain injury in cats; modified glasgow coma scale; standardised veterinary outcome scale; post head trauma monitoring

Currently in veterinary medicine there is limited data relating to the prognosis, long-term monitoring and outcome in felines suffering from traumatic brain injury. A recent publication suggests there is no data in veterinary literature relating to the prognosis of felines suffering from a traumatic brain injury (Little, 2015).

At this time the main prognostic indicator after a traumatic brain injury available to veterinary medicine is the Modified Glasgow Coma Scale (MGCS) (Figure 1) (Bush Veterinary Neurology Service, 2020). The MGCS also offers information relating to the anatomical site of injury and whether a neurological lesion is present (Lowrie, 2014). A recent study correlated the use of the MGCS score with the probability of short-term survival in canines with head trauma (Platt et al., 2001). However, there is no known data relating to feline short-term survival, nor any data relating to the long-term survival in either species.

The current Modified Glasgow Coma Scale used in veterinary medicine is limited in its evaluation in relation to a 72-hour survival. There are currently no known standardised progress scales to objectively monitor the degree of recovery of felines following traumatic brain injury. In human medicine, a standardised scale of functional outcome exists in the form of the Glasgow Outcome Scale (GOS). It has been suggested by Silverstein and Hopper (2014) that:

> The Modified Glasgow Coma Scale should be correlated with an outcome scale in veterinary medicine, because this will truly assist with defining a prognosis in small animal patients.

Clinical examinations and assessments are subjective and variable between individuals. A method needs to be developed that enable a score to be initially assigned, which can then be repeated on a regular basis to see if the patient is clinically stable, improving or deteriorating.

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Anecdotally it is believed that many felines who present with traumatic brain injury are euthanased due to the extent of the initial clinical signs, poor prognosis and/or financial limitations. In addition, owner limitations and expectations of quality of life may also influence any decision making. This may correlate with the current lack of data relating to prognosis and outcome.

A standardised assessment of progress and outcome is needed to assist clinical decisions, owner expectations and decision making relating to quality of life. Felines recovering from traumatic brain injury may not make a complete recovery and may suffer from life-long neurological deficits. It is important to note however that improvements in their clinical condition can be seen for at least three months after the initial trauma (Platt, 2005) so clinical decisions should not be based solely on the short-term prognostic indicator of the MGCS. Additionally, in the author's experience, after the initial emergency management to prevent secondary brain injury, the majority of nursing care and rehabilitation can be continued at home, reducing the financial constraints faced by many owners.

A standardised outcome scale has been designed (Figure 2) specifically for felines recovering from a traumatic brain injury. The outcome scale measures the recovery of species-specific neurological, physical and behavioural deficits. Demeanour, vision (distance of vision; vision and seeking behaviour; vision and mobility), mobility, posture, ambulation, exploratory behaviour, toileting ability, feeding ability, responses to touch and play behaviours are all assessed. Each specific response or behaviour is assessed individually so that as well as looking at the overall picture of (hopefully) improving scores, individual

Modified Glasgow Coma Scale	
	Score
Motor activity	
Normal gait, normal spinal reflexes	6
Hemiparesis, tetraparesis, or decerebrate rigidity	5
Recumbent, intermittent extensor rigidity	4
Recumbent, constant extensor rigidity	3
Recumbent, constant extensor rigidity with opisthotonus	2
Recumbent, hypotonia of muscles, depressed or absent spinal reflexes	1
Brainstem reflexes	
Normal PLR and oculocephalic reflexes	6
Slow PLR and normal to reduced oculocephalic reflexes	5
Bilateral unresponsive miosis with normal to reduced oculocephalic reflexes	4
Pinpoint pupils with reduced to absent oculocephalic reflexes	3
Unilateral, unresponsive mydriasis with reduced to absent oculocephalic reflexes	2
Bilateral, unresponsive mydriasis with reduced to absent oculocephalic reflexes	1
Level of consciousness	
Occasional periods of alertness and responsive to environment	6
Depression or delirium, capable of responding, but response may be inappropriate	5
Semicomatose, responsive to visual stimuli	4
Semicomatose, responsive to auditory stimuli	3
Semicomatose, responsive only to repeated noxious stimuli	2
Comatose, unresponsive to repeated noxious stimuli	1
MCGS Score	Score
3-8	Grave
9-14	Guarded
15-18	Good

Figure 1. Modified glasgow coma scale (Bush Veterinary Neurology Service, 2020).

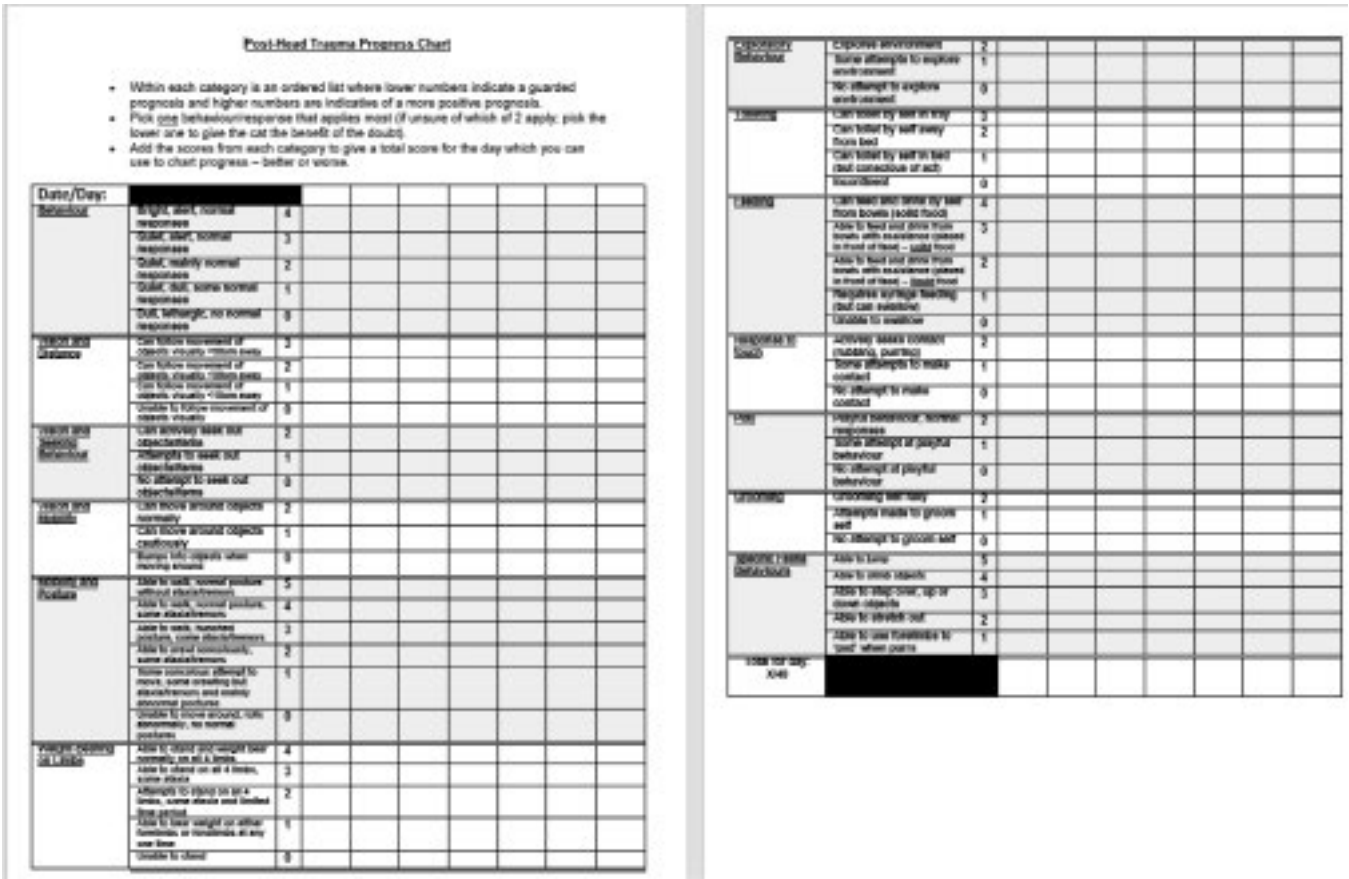

Figure 2. Standardised veterinary outcome scale – post head-trauma progress chart accessed via: https://drive.google.com/file/d/1RZNb7vYk05IgMuuQGuv8jHeDXnWB58_m/view.

behaviours can be identified as stationary where applicable. For example, a cat that has an overall improving score but remains incontinent would need to have consideration and discussions relating to the impact of this on their quality of life. The outcome scale should be performed daily for the most accurate representation of progress or decline. Within each category there is an ordered list, where persistent lower numbers indicate a more guarded prognosis, and higher numbers indicate a more positive outcome. Regardless of the original score, we are looking for a continued pattern of improvement to a level where quality of life is not altered. The standardised veterinary outcome scale allows care givers to objectively monitor progress and allow for more equitable clinical decisions to be made relating to each individuals progress.

Case study: 'Poppy'

Stray, FE, Adult DSH.

Poppy presented with head trauma and a single penetrating wound (5 mm x 5 mm, muscle layer visible) over the hindbrain region. Poppy demonstrated decerebellate posturing when stimulated and had no normal responses to stimulation (Figure 3). She could maintain sternal recumbency when supported and not stimulated (Figure 4). Poppy displayed bilateral nystagmus, absence of a blink reflex in her right eye, reduced pupillary light reflex (PLR) in her right eye, dilated pupils, visual impairment, ataxia and her MGCS was 14 (guarded prognosis).

Decerebellate posturing is due to a rostral cerebellar lesion or damage. The cerebellum is important in motor coordination. It is responsible for the inhibition of the extensor muscles, so a loss of this results in an increase in extensor muscle tone in the limbs. Opisthotonus (Figure 5) is often seen with extension of the forelegs and flexion of the hindlimbs. Although similar to

Figure 3. Decerebellate posturing (Slideshare.net, 2020).

Figure 4. Day 1 – able to maintain sternal recumbency if supported and not roused.

decerebrate posturing (Figure 6), mentation should be unaffected and the patient should be able to be roused. Decerebrate posturing. carries a guarded to good prognosis, depending on the severity of the lesion.

Primary brain injury relates to the inciting incident, whereby secondary brain injury relates to the physiologic response to the initial injury. The ultimate treatment goal is to minimise secondary brain insults and increases in intracranial pressure (Matthews, 2006). Secondary brain injury can be minimised in traumatic brain injury (TBI) cases by aiming to control intracranial pressure (ICP) and achieving normovolaemia in order to maximise oxygen delivery (Vin.com, 2014).

As a stray cat, basic first aid treatment was provided. A radiograph was performed to assess for a potential bullet or exit wound (neither were found) due to the single penetrating wound. If finances had allowed, a CT scan or MRI (if available) would have been recommended as soon as possible after stabilisation to assess for skull fractures, penetrating wounds and foreign objects. Additionally, thoracic radiographs would have been recommended to assess for pulmonary contusions (in which case, fluid therapy would need to be titrated appropriately, managing perfusion while avoiding pulmonary oedema).

Intravenous fluid therapy (IVFT), analgesia and antibiotic therapy were initiated (Table 1). IVFT was initiated to ensure and adequate perfusion. There was an unknown timeline relating to the traumatic injury and presentation. Although not showing any sign of dehydration or hypovolaemic shock on clinical examination, hydration needed to be maintained in absence of her being able to eat or drink by herself. Additionally, neurological deficits cannot be assessed accurately until normovolaemia has been achieved (hypovolaemic shock can cause/mimic neurological deficits).

Pain can increase intracranial pressure so adequate analgesia must be provided. Although opioids can cause respiratory depression, hypotension and vomiting; the benefits outweigh the risks if the dose is titrated to effect. Buprenorphine was administered every six hours initially for the first 24 hours. Meloxicam was avoided for the first 24 hours to ensure adequate perfusion before initiating treatment (Meloxicam is contraindicated in animals with hypovolaemia, hypotension and dehydration). Additionally, vomiting is classed as a typical adverse reaction on the Metacam data sheet (National Office of Animal Health, 2020), without the benefits of being able to titrate to effect as with opioids; and any increases in intracranial pressure (which vomiting would cause) were to be avoided. Buprenorphine therapy was ceased after Meloxicam was started.

Prophylactic antibiotic cover was decided as an appropriate course of action due to the penetrating nature of the head wound, and unknown aetiology (nature and/or age of the injury).

Poppy was placed in a dark ward due to the likelihood of photophobia, and was settled into a padded kennel to minimise further trauma from her abnormal posturing. She was supported with towels and blankets in sternal recumbency to minimise stimulating abnormal responses if in lateral and needing turning every four hours hours (Irish Veterinary Journal, 2017). Her eyes were lubricated every four hours due to the reduced blink response.

Poppy initially showed no normal responses to stimulation, she was unable to toilet or eat by herself. After a few days, she started to show signs of improvement, with efforts to move and eat, but still toileting on her bed, unable to eat without heavy assistance and extremely ataxic, so mobility was compromised. Although showing signs of improvement, at the stray-standard seven day period, no owner had claimed her and she was not fit for rehoming. She was fostered by the author and taken home to continue her recovery.

Daily physiotherapy sessions and manipulation of her limbs took place to reduce cachexia (TVP, 2020). Poppy was placed onto the authors knee and gentle massage of the limbs was interspaced with standard stroking to improve blood flow.

Figure 5. Opisthotonus posturing (NEUROPETVET, 2020).

Figure 6. Decerebrate posturing (Slideshare.net, 2020).

Passive range of movement exercises of the limbs were performed twice daily; (see Adamson Veterinary Services, 2020 for similar exercises).

Although having to be syringe fed initially, after three days Poppy was able to eat out of the bowl when it was placed directly under her face. Syringe feeding in cats can be contraindicated due to the risk of aspiration pneumonia. Naso-oesophageal (NO) tubes are contraindicated in head trauma (TVP, 2020) due to the increase of intracranial pressure with the stimulation of the gag reflex and irritation of the nasal cavity (likely to cause sneezing). On a risk-benefit basis, an oesophagostomy (O) tube would have been the most beneficial option. However, an O tube was not able to be placed in Poppy due to financial limitations and the need for a general anaesthetic for placement (of which Poppy was not deemed stable enough during the first five days). With a need to provide some calorific support to reduce the catabolic process, syringe feeding was deemed the most appropriate option, in spite of the risks associated. Syringe feeding was carried out slowly, using small amounts and ensuring adequate gag reflex and swallowing (Vet Times, 2011). On day ten, as her vision improved, she was able to seek out the food bowl herself and feed independently (Figure 5). Once Poppy was less ataxic and able to eat independently, the author began to place her food bowl at height (Figure 8) to encourage upward movement and strengthen her limbs.

Table 1. Initial medication and intravenous fluid therapy for Poppy (weight of 2.4 kg on admission).

Medication	Strength	Dose	Dose (mls)	Frequency
Buprenorphine	0.3 mg/ml	20µg/kg	0.16 ml	Q 6 hours
Meloxicam injection	2mg/ml	0.2 mg/kg	0.24 ml	Once only
Meloxicam Oral	0.5 mg/ml	0.05 mg/kg	0.12 mg	Q 24 hours
Clavulanic Acid/ Amoxicillin	35mg/ml/140 mg/ml	8.75 mg/kg	0.12 ml	Q 24 hours
Lubrithal Eye Lubricant Gel	N/A	N/A	Both Eyes	Q 2 hours
Compound Sodium Lactate Fluid	Sodium Chloride Ph Eur 0.60% w/v; Potassium Chloride Ph Eur 0.04% w/v; Calcium Chloride Dihydrate Ph Eur 0.027% w/v; Sodium Lactate 0.32% w/v	2ml/kg/hr	5ml/hr	N/A

Poppy was initially incontinent and would toilet where she was laid. After three days, once she was more responsive and a little more mobile, she became aware of the act of toileting, but would still toilet in her bed. Few attempts were made to approach the litter tray. A shallow sided tray was used to facilitate approach. As Poppy had an unknown history and no known owner, it was highly plausible that she was an outdoor cat with no knowledge of using a litter tray. Litter tray training became a big part of her rehabilitation. A variety of substrates were used, including soil, in case this was more familiar to her; all of which were unsuccessful. As Poppy had been toileting in her bed (a high sided bed for support, with a towel over the top to prevent soiling of the actual bed), the author considered the prospect of a learned substrate preference to the towel. Towels were then placed into the litter tray

Table 2. Post head trauma progress scale, data collection, poppy.

Post Head Trauma Progress Scale Daily and Weekly Data Collection - Case ID: 'Poppy 1'												
Week	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Week Total /280	Weekly average /40	Total Point I/D	Weekly Total % I/D	% of Total Points Reached
1	0	3	6	7	12	13	15	56	8	X	X	20.00%
2	18	20	22	23	26	26	26	161	23	105	65.21%	57.50%
3	26	28	28	28	29	28	29	196	28	35	17.85%	70.00%
4	30	30	30	30	30	30	30	210	30	14	6.67%	75.00%
5	29	30	30	31	31	31	31	213	30.4	3	1.41%	76.07%
6	31	31	31	32	32	32	32	221	31.6	8	3.62%	78.93%
7	32	32	32	32	32	32	32	224	32	3	1.34%	80.00%
8	32	32	32	32	32	32	32	224	32	0	0%	80.00%
9	32	32	32	32	32	32	32	224	32	0	0%	80.00%
10	32	32	32	32	32	32	32	224	32	0	0%	80.00%
11	32	32	32	32	32	32	32	224	32	0	0%	80.00%
12	32	32	32	32	32	32	32	224	32	0	0%	80.00%
13	32	32	32	32	32	32	32	224	32	0	0%	80.00%
14	36	36	36	36	36	36	36	252	36	28	11.11%	90.00%
15	37	37	37	37	37	38	38	261	37.3	9	3.45%	93.21%
16	39	39	39	39	39	39	39	273	39	12	7.69%	97.50%
Key: I/D = Increase/Decrease			Head Trauma Progress Scale: Daily points out of a total of 40 Weekly points out of a total of 280						MGCS score: Day 1 – 14 Day 2 – 15.5 Day 3 – 15.5		MGCS suggested prognosis: 9-14 - Guard 15 – 18 - Good	

and Poppy began to use the tray on day 16. Once Poppy was reliably using her tray, the author started to add in small amounts of cat litter to the tray, on top of the towel. A scented variety showed the most promise while her vision and mobility were still impaired, and potentially helped to speed up the association between the towel, tray and toileting. Over the following week, more substrate was added until there were normal amounts in the litter tray and the towel could be removed.

Grooming was carried out by the author daily until Poppy was able to perform this herself. Poppy started to make attempts to groom herself on day 11 (Figure 9) and was able to groom herself fully (without falling over or requiring stability support) after approximately four months post injury.

Poppy's initial score on the Outcome Scale was 0/40, she had no normal responses, no attempts were made to play or groom herself. She was incontinent, unable to swallow, had severe visual impairment, severe ataxia and was predominantly recumbent. By the end of her first week her score was 15/40. She had progressed to having some normal responses, attempting to make contact with the author, being aware of the act of toileting, able to feed herself with solid food when the bowl was placed in front of her, able to move around objects cautiously, able to walk with some ataxia and able to stand for limited time periods. Although still considerably impaired, there was a significant improvement demonstrated by the Outcome Scale (Table 2), as an overall score, but also on specific individual behaviours. Although 15/40 was still a low score, the Outcome Scale demonstrated a vast improvement which was encouraging for her continued recovery. By week eight, Poppy's improvement began to plateau for the ensuing five weeks. By this point, her quality of life was not in question and it was suspected that by this point (week 13), Poppy had recovered to her maximum level. Poppy was happy and able to demonstrate the majority of species-specific behaviours (Figure 9). She was unable to climb objects or jump and was still demonstrating some ataxia, tremors and a lowered posture. After a prolonged period of stable scores, the author determined Poppy was ready for rehoming. An adult-only household without other pets was required, ideally on one level due to Poppy's inability to be able to climb or jump and therefore remove herself from stress or danger. During the next three weeks of trying to find her a new home, Poppy started to show further signs of improvement in her behaviours. At the time of rehoming on week 16 (Figure 10), her score was 39/40 and her only limiting factor was that she was unable to climb (this subsequently resolved in her new home).

Figure 7. Day 10 – able to eat independently.

Figure 8. Feeding from height to encourage muscular strength and movement.

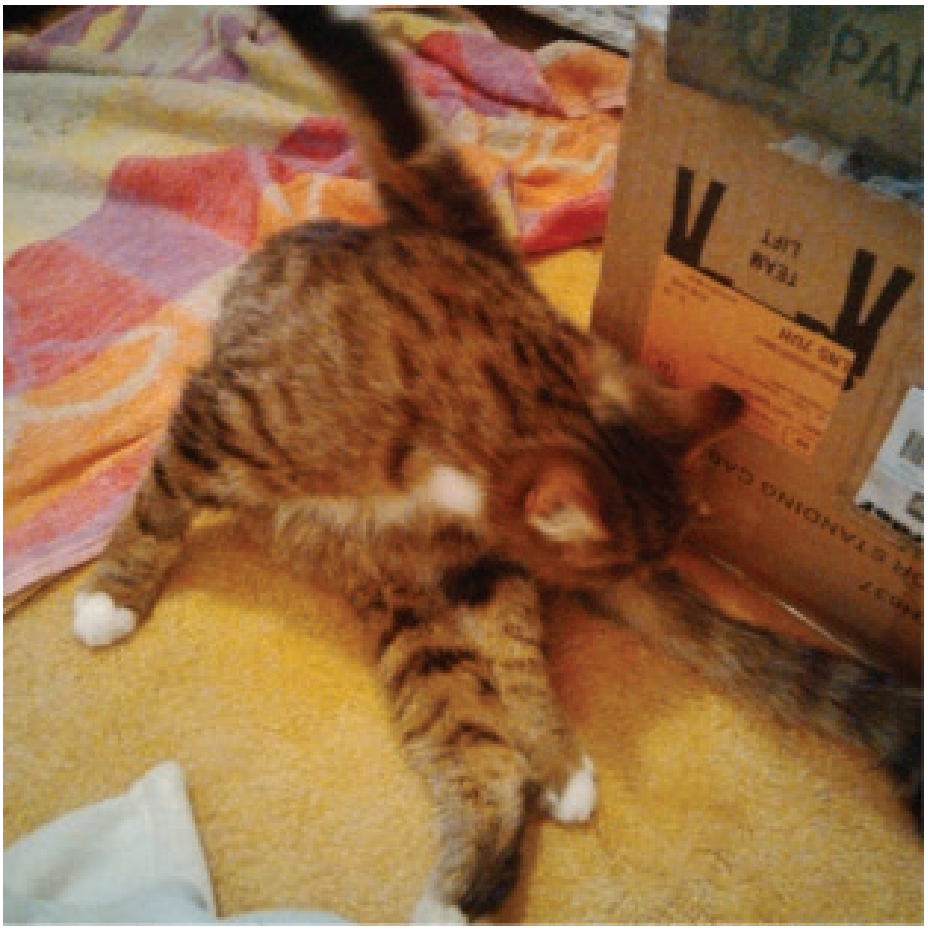

Figure 9. Attempts to groom self.

Figure 10. Settling into her new home.

It was 16 weeks post traumatic incident for recovery to a level of that of any other healthy, ambulatory cat. The Outcome Scale enabled the author to perform subjective assessments daily and review her clinical condition on a weekly basis to ensure quality of life and welfare were not compromised.

Conclusion

The primary objective of this outcome scale is to provide a useful monitoring tool to aid in clinical decision making. Secondary objectives in the future could be to correlate the outcome scale with the MGCS; to determine whether the outcome scale could be used as a prognostic indicator for future cases of feline traumatic brain injury and to collate data relating to feline survival rates post traumatic brain injuries.

Time and patience are the main take-away messages from Poppy's case study. Improvements in condition do not happen overnight, but they do happen with sufficient time and nursing care. Providing there are no secondary insults or deterioration in condition, time to allow sufficient recovery should be recommended and advised. Managing owner expectations with a realistic time frame is paramount. Providing the owner with an Outcome Scale to complete at home can provide valuable insight into trends and reduce the risk of a lack of continuity of care if different clinicians re-examine the case.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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