FOUR LEG NEWS

OUTCOME MEASURES:

NEUROLOGIC FUNCTION SCALES

NOV-DEC 2020 **VOL 9: ISSUE 6**

From Gait scoring to Functional Scoring… this issue provides you with the information to be objective in evaluating status or progress of your neurologic canine patients! This newsletter is also the last in the Outcome Measures series of newsletters! I hope you have found them all useful. 2020 = Outcome Measures!

Cheers! Laurie Edge-Hughes, BScPT, MAnimSt, CAFCI, CCRT

Table of Contents:

Development of a Scoring System… Page 2
A Modified Neuro Scoring System… Page 4
Finger Painting Method to Quantify Neurologic Gait… Page 5
Another Locomotion Rating Scale… Page 7
Overall Neurologic Function Scoring… Page 11

DEVELOPMENT OF A SCORING SYSTEM

Olby N, De Risio L, Muñana KR, et al. Development of a functional scoring system in dogs with acute spinal cord injuries. Am J Vet Res 2001;62:1624–1628.

Introduction: A sensitive and reliable scoring system for pelvic limb gait is needed for clinical trials to determine the best management of dogs with spinal cord injuries. The study aimed to develop and test a scoring system for the pelvic limb gait of dogs that have suffered acute thoracolumbar spinal cord injuries and score their recoveries. Two different scoring systems were tested for intra- and interobserver variability.

Materials and Methods: Dogs with acute spinal cord injuries due to thoracolumbar intervertebral disk herniations were videotaped from both sides and behind when walking on a non-slippery surface for a minimum of 10 steps per angle.

28 dogs were paraparetic or paraplegic with pelvic limb deep pain sensation and 18 dogs were paraplegic without pelvic limb deep pain sensation at the time of injury.

In the first phase of this study, two observers reviewed videotapes of 10 dogs at different stages of their recovery; which was used to develop a numeric scoring system.

In the second phase, 24 sections of videotape from 16 dogs at various stages of recovery from spinal cord injuries of various severities were scored with 2 different methods; the numeric scoring system developed in the first phase and a visual analog scale. The scale was on a sheet of paper with a 100 mm line, marked at 25, 50, and 75 mm. Observers marked the amount of pelvic limb function and the score was recorded as a percentage.

In the third phase, pelvic limb function of 29 dogs; 12 with paraplegia without deep pain sensation and 17 with nonambulatory paraparesis with deep pain sensation, was scored using the numeric scoring system at 1, 4, and 12 weeks after injury. The mean of the pelvic limb scores at 4 and 12 weeks were used.

To assess and compare the reliability of the scoring methods, the same dogs' gaits were scored on multiple occasions by the same observer and by different observers. Scoring with the visual analog scale was completed first so that the observers were not biased by having completed an evaluation of the tapes with the numeric scoring system.

Appendix

The 5 stages of recovery of use of pelvic limbs in dogs with spinal cord injuries. Each stage is subdivided on the basis of recovery patterns (ie, yielding a scale of 0 to 14). Dogs were considered as weight-bearing when the full weight was born with joints extended for at least 2 steps (ie, standing alone was not considered weight-bearing).

Stage 1
- 0—No pelvic limb movement and no deep pain sensation.
- 1—No pelvic limb movement with deep pain sensation.
- 2—No pelvic limb movement but voluntary tail movement.

Stage 2
- 3—Minimal non–weight-bearing protraction of the pelvic limb (movement of 1 joint).
- 4—Non–weight-bearing protraction of the pelvic limb with $>$ 1 joint involved $<$ 50% of the time.
- 5—Non–weight-bearing protraction of the pelvic limb with $>$ 1 joint involved $>$ 50% of the time.

Stage 3
- 6—Weight-bearing protraction of pelvic limb $<$ 10% of the time.
- 7—Weight-bearing protraction of pelvic limb 10 to 50% of the time.
- 8—Weight-bearing protraction of pelvic limb $>$ 50% of the time.

Stage 4
- 9—Weight-bearing protraction 100% of the time with reduced strength of pelvic limb. Mistakes $>$ 90% of the time (eg, crossing of pelvic limbs, scuffing foot on protraction, standing on dorsum of foot, falling).
- 10—Weight-bearing protraction of pelvic limb 100% of the time with reduced strength. Mistakes 50 to 90% of the time.
- 11—Weight-bearing protraction of pelvic limb 100% of the time with reduced strength. Mistakes $<$ 50% of the time.

Stage 5
- 12—Ataxic pelvic limb gait with normal strength, but mistakes $>$ 50% of the time (eg, lack of coordination with thoracic limb, crossing of pelvic limbs, skipping steps, bunny-hopping, scuffing foot on protraction).
- 13—Ataxic pelvic limb gait with normal strength, but mistakes made $<$ 50% of the time.
- 14—Normal pelvic limb gait.

Results & Discussion: Dogs with acute spinal cord injuries went through 5 stages during recovery; the first stage was paralysis with no voluntary pelvic limb movement, the second was nonweight-bearing voluntary pelvic limb movement, the third was voluntary pelvic limb movements with occasional weight bearing steps, the fourth was weight-bearing movements with decreased motor strength, and the final was normal motor strength with pelvic limb ataxia.

The numeric scoring system required detailed analysis of the gait of the dog, while the visual analog scale was much simpler.

Conclusion: The detailed scoring system for pelvic limb gait developed in this study proved more reliable than the simpler visual analog scale. This scoring system enabled us to accurately quantify the extent of recovery of dogs following spinal cord injuries.

Laurie's thoughts: This is a good start to this newsletter! I'll include this paper on FourLeg.com in the articles section, under Outcome Measures!

MODIFYING THE NEUROLOGIC FUNCTION SCORING SYSTEM

Lee CS, Bentley RT, Weng HY, et al. A preliminary evaluation of the reliability of a modified functional scoring system for assessing neurologic function in ambulatory thoracolumbar myelopathy dogs. BMC Veterinary Research (2015) 11:241.

Introduction: In this study, we modified the observational gait analysis (OGA) scoring system of Olby et al. (2001) in order to evaluate the function of each pelvic limb separately in ambulatory thoracolumbar myelopathy dogs and we assessed the inter-rater agreement between two observers.

Methods: OGAs were performed by using a functional scoring scale modified from a scoring method developed by Olby et al (2001) in order to evaluate each pelvic limb separately. If giving the two limbs equal scores, the observer was instructed to specify which limb was worse.

In the first phase of the study, OGAs were performed by having the patient walk on a non-slip surface until the observers were certain of the score; all dogs were allowed to rest for 10 min if there were signs of fatigue. In the second phase, videotape was obtained from both sides, in front and behind when the patient was walking and continued until good footage was captured. Each observer separately evaluated the same video, with pauses and playbacks allowed until they were certain of the score; and videos were analyzed in batches.

Table 1 The modified functional scoring system used in this study

Each pelvic limb is evaluated individually
1. Non-ambulatory (scores 2–10 indicate the dog is ambulatory and can take at least 4 steps)
2. Weight-bearing protraction of the pelvic limb <10 % of the time
3. Weight-bearing protraction of the pelvic limb 10 to 50 % of the time
4. Weight-bearing protraction of the pelvic limb >50 % of the time
5. Weight-bearing protraction 100 % of the time with reduced strength of the pelvic limb; mistakes >90 % of steps (e.g., scuffing foot on protraction, standing on dorsum of foot)
6. Weight-bearing protraction of the pelvic limb 100 % of the time with reduced strength; mistakes 50 to 90 % of steps
7. Weight-bearing protraction of the pelvic limb 100 % of the time with reduced strength; mistakes <50 % of steps
8. Ataxic pelvic limb gait with normal strength (including ability to rise from a sitting down position); mistakes >90 % of steps (e.g., crossing of pelvic limbs, skipping steps, bunny-hopping, scuffing foot on protraction)
9. Ataxic pelvic limb gait with normal strength; mistakes 50–90 % of steps
10. Almost normal pelvic limb gait with normal strength; mistakes <50 % of steps

Results & Discussion: OGAs were performed on 16 dogs during recheck appointments and one dog was evaluated during a new appointment.

The results of this preliminary study suggest that the evaluated scoring system had a weak inter-observer agreement regarding the score of each pelvic limb and a fair agreement regarding the more severely affected limb with an inconclusive effect of using videotape on OGA scoring.

Conclusions: A separate functional score for each of the pelvic limbs in ambulatory dogs with T3-L3 myelopathies can be recorded by using the modified scoring system with moderate reliability between observers.

Laurie's thoughts: So, while this is interesting, the value of scoring each pelvic limb separately did not result in better agreement. So, stick with the original Olby 2001 scoring system for now. But keep reading, you might find a system you like better!

GOT ANY PAINT?

Song RB, Oldach MS, Basso DM, et al. A simplified method of walking track analysis to assess short-term locomotor recovery after acute spinal cord injury caused by thoracolumbar intervertebral disc extrusion in dogs. Vet J. 2016 April ; 210: 61–67.

Introduction:
Walking track analysis can measure base of support (BS), stride length (SL), inter-limb coordination, regularity of step patterns and paw position, which provides valuable information about the animal's pattern of locomotion in both the thoracic limbs (TL) and pelvic limbs (PL) which may reflect the injury type, severity of injury, and specific spinal tracts affected by the lesion.

The primary goal of this study was to evaluate a simplified 'finger painting' method of walking track analysis to compare footprint parameters between normal dogs and dogs with acute thoracolumbar spinal cord injury (SCI) caused by Intervertebral disc extrusion (IVDE).

Materials and methods:
"Normal" small breed dogs served as the control group. SCI-affected dogs were enrolled if they met the following criteria: clinical localization of a T3-L3 myelopathy caused by acute IVDE as determined by CT or

MRI; intact nociception of both pelvic limbs and tail; small-breed ≤ 20 kg; and behaviorally amenable. All dogs underwent surgical decompression for their IVDE.

To identify the footprint patterns, different colored non-toxic, washable paints were applied to each paw, then dogs walked with a leash at a natural, consistent pace by the same investigator down 3 m of butcher paper.

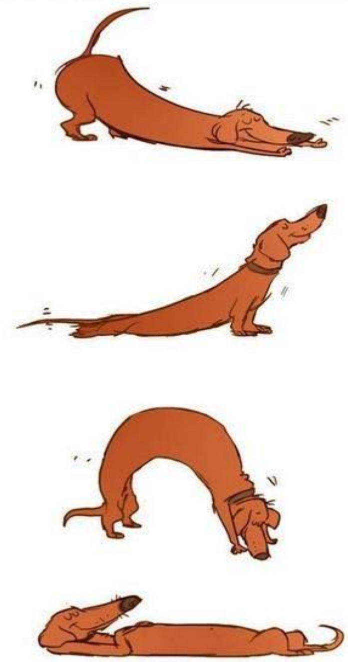
Results & Discussion:
Twenty normal dogs of small breeds were recruited for the study. A total of 27 small breed dogs (12 Dachshunds) with 28 discrete episodes of acute SCI caused by IVDE were enrolled.

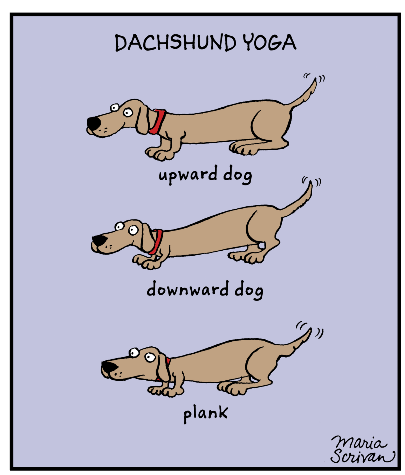
With a 'finger paint' technique, the researchers were able to measure several useful footprint parameters in normal dogs and to compare them with SCI-affected dogs.
They demonstrated that dogs with thoracolumbar SCI have a measurable decrease in SL in all four limbs and a widened BS-TL during the first 30 days of post-operative recovery.
A decrease in SL of the PL is maybe due to loss of supraspinal excitatory input to motor neurons innervating the pelvic limb extensor muscles; leading to paraparesis, decreased weight support in the affected limbs, reduced limb propulsion, and decreased stance or swing duration.

This evaluation technique was also useful for evaluating BS, and revealed a significantly wider BS-TL in SCI-affected dogs, which may reflect attempts to stabilize the trunk cranial to the lesion using a wider center of gravity to compensate for instability and paresis of pelvic limbs.

BS-PL as measured by our method did not differ between normal and SCI-affected dogs. This measurement may increase after SCI, and then gradually decrease with neurologic recovery. However, BS-PL also varies with lesion severity, such that animals with more severe lesions may have decreased BS-PL, while those with milder lesions have increased BS-PL.

Of particular interest to us were the differences in TL gait parameters noted after SCI. Functional reorganization of the sensory and motor cortex occurs after SCI, allowing for increased representation of the trunk and thoracic limbs, and structural reorganization of damaged motor





pathways in the form of increased collateral sprouting of the corticospinal pathway occurs to increase connections in the cervical spinal cord immediately and weeks after injury. The changes in SL and BS detected in the TL of the SCI-affected dogs in our study underscore the importance of the adaptations of the trunk and TL in quadrupedal locomotor recovery from SCI.

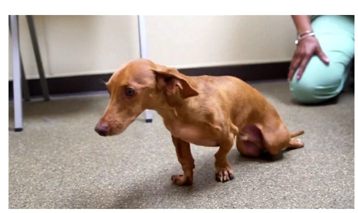
There are some limitations to the use this method as a sole outcome measure of SCI in dogs, mainly that dogs needed to be consistently ambulatory. Therefore, footprint analysis could not be performed in dogs with more severe SCI in the early stages of recovery. This limitation resulted in a significant underestimation of the true differences between normal and SCI-affected groups. Additionally, although significantly cheaper, the current method proved time and labor intensive.

Laurie's thoughts: While I find this study interesting, and it does benefit my knowledge base, I don't think that this is a testing method that will be adopted into clinical practice. Most of what the researchers were able to determine they most likely could have observed visually as well. So, let's put this paper into the category of 'good to know that what you might 'see' in your neurologic dog can be validated by research'.

ANOTHER LOCOMOTION RATING SCALE

Song RB, Basso DM, da Costa RC et al. Adaptation of the Basso–Beattie–Bresnahan locomotor rating scale for use in a clinical model of spinal cord injury in dogs. J Neurosci Methods. 2016 August 1; 268: 117–124.

Introduction:
The current canine locomotor scales tend to have large ceiling effects, vague operational definitions, or use subjective assessments which makes it difficult for comparison. **The Basso–Beattie–Bresnahan (BBB) locomotor rating scale is a 21-point scale developed for rat models of thoracolumbar SCI** that has phases of recovery based on injury severity and/or time after injury. This scale has high sensitivity, intra-rater reliability, strong validity and correlates with histopathologic changes. Although the BBB scale has not been validated for use in dogs, it has been used in several canine SCI studies. The current study aimed to assess the BBB locomotor rating scale for use with dogs recovering from SCI.



Materials and methods:
20 neurologically normal pet dogs and 30 dogs with spontaneously occurring acute thoracolumbar SCI caused by intervertebral disc extrusion (IVDE) were included in this study.

The normal dogs were encouraged to move freely in a 10-ft diameter open field for 4 min to collect locomotor scores, three times on different days for both the left and right hindlimbs. Two raters initially used the 21-point BBB scale to assess the difference between canine and rodent locomotion. The original definitions of stepping, coordination, paw position, trunk stability, and tail position needed modifications; so, a canine BBB (cBBB) locomotor rating scale was developed.

Table 1

The canine locomotor rating scale (cBBB) developed for use in dogs with thoracolumbar spinal cord injury. Notable modifications from the rat scale include acceptance of internal paw rotation as normal, removal of tail assessment, and allowance for mild symmetrical truncal sway. Scores are assigned during a 4 min open field assessment of the dog, conducted in a 10 ft diameter space. Two observers are positioned directly across the open field from each other and verbally communicate observations related to score over the course of the 4 min time period. At the end of four minutes, a score is assigned to each hind limb by consensus of both reviewers based on their collective observations.

Score	Description
0	No observable hind limb (HL) movement
1	Slight movement of one or two joints
2	Extensive movement of one joint, or extensive movement of one joint and slight movement of one other joint
3	Extensive movement of two joints
4	Slight movement of all three joints of the HL
5	Slight movement of two joints and extensive movement of the third
6	Extensive movement of two joints and slight movement of the third
7	Extensive movement of all three joints in the HL
8	Plantar placement of the paw with no weight support
9	Plantar placement of the paw with weight support only when stationary, or occasional, frequent or consistent weight-supported dorsal stepping and no plantar stepping
10	Occasional weight-supported plantar steps; no FL–HL coordination
11	Frequent to consistent weight-supported plantar steps *and* no FL–HL coordination
12	Frequent to consistent weight-supported plantar steps *and* occasional FL–HL coordination
13	Frequent to consistent weight-supported plantar steps *and* frequent FL–HL coordination
14	Consistent weight-supported plantar steps, consistent FL–HL coordination, *and* predominant paw position is *externally rotated* when it makes initial contact as well as just before it is lifted off; or frequent plantar stepping, consistent FL–HL coordination, and occasional dorsal stepping
15	Consistent plantar stepping and consistent FL–HL coordination and *no toe clearance* or *occasional* toe clearance; predominant paw position is *parallel* to the body or *internally rotated* at initial contact
16	Consistent plantar stepping and consistent FL–HL coordination and toe clearance occurs *frequently*; predominant paw position is parallel or internally rotated at initial contact and *externally rotated* at liftoff
17	Consistent plantar stepping and consistent FL–HL coordination and toe clearance occurs *frequently*; predominant paw position is *parallel* or *internal* at initial contact and at liftoff
18	Consistent plantar stepping and consistent FL–HL coordination and toe clearance occurs *consistently*; predominant paw position is parallel or internal at initial contact and at liftoff. *Trunk instability is present*
19	Consistent plantar stepping and consistent FL–HL coordination and toe clearance occurs consistently during forward limb advancement; predominant paw position is parallel or internal at initial contact and at liftoff. *Trunk instability is not observed*

FL = forelimb; HL = hindlimb.

Table 2

Operational definitions applied for locomotor scoring using the canine BBB scale.

Term	Definition
Joint movement	Active flexion of the joint. Assessed separately for three joints (hip, stifle, hock) in each HL. Movement is scored if it occurs one or more times during testing
Slight movement	Movement of a joint through less than or equal to 50% of its normal range of motion
Extensive movement	Movement of a joint through more than 50% of its normal range of motion
Plantar placement	The paw is actively placed with the plantar surface resting on the ground
Weight support	Paw is plantar placed and muscle contraction of the limb causes HL extension and elevation of the hindquarter off the ground
Stepping	Weight support is established, the limb is advanced in the forward direction, and weight support is re-established when the paw contacts the ground. Assessed separately for each HL
Plantar stepping	A step is taken with the paw in plantar placement at both lift off and initial contact
Dorsal stepping	Weight is supported through the dorsal surface of the paw at any point during the step cycle
Occasional stepping	Stepping occurs less than half the time the animal is moving forward
Frequent stepping	Stepping occurs more than half the time but less than 95% of the time the animal is moving forward
Consistent stepping	Stepping occurs 95–100% of the time the animal is moving forward and fewer than 5 dorsal steps are observed
Forelimb–hindlimb (FL–HL) coordination	For every FL step taken, a HL step is also taken and the hind limbs alternate in stepping. This parameter is assessed during forward passes
Forward pass	The animal ambulates in a forward trajectory for a distance equal or greater than 3× its body length
Occasional FL–HL coordination	FL–HL coordination is observed at least once but occurs less than or equal to 50% of the instances the animal performs a forward pass
Frequent FL–HL coordination	FL–HL coordination is observed more than half the instances the animal performs forward passes, but at least one pass was observed to be uncoordinated
Consistent FL–HL coordination	All observed forward passes displayed FL–HL coordination
Paw position	Evaluated at lift off and initial contact for each HL during weight supported plantar stepping
External rotation	The paw is rotated externally for the majority of steps
Internal rotation	The paw is rotated internally for the majority of steps
Parallel	The paw is parallel to the body for the majority of steps
Toe clearance	The toe does not drag or scuff against the floor during forward limb advancement. Assessed separately for each HL by listening for scratching or brushing sounds as the animal walks about the open field
Occasional toe clearance	Toe clearance is achieved occasionally during the open field test, but toe drags are heard for most of the steps
Frequent toe clearance	Toe clearance occurs for more than half of the steps but more than 4 toe drags are recorded during a session
Consistent toe clearance	≤4 HL toe drags are heard during the duration of open field testing
Trunk instability	Lateral weight shifts causing an *asymmetrical* excursion of the trunk to one side, or excursion of the trunk to both sides in a range of motion *greater than one trunk's width*, partial collapse of the trunk on one side. Trunk instability is scored if the animal displays this behavior one or more times during a testing session

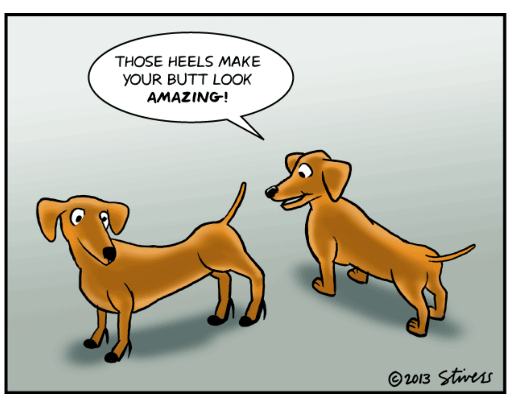
Adapted from Basso et al. (1995).

Discussion:
In this study, several parameters considered abnormal for rodent ambulation were observed frequently in normal dogs, which may be related to conformation of breeds that typically experience spontaneous SCI. The original operational definitions had to be adjusted for dogs so that internal rotation of the paw was scored as normal, and the definition of trunk instability was modified so that this was scored only when there was asymmetry or the sway was larger than the trunk's width. Tail position was removed from the scale due to variation in conformation and behavior.

Conclusion: Once scale parameters of the BBB locomotor scale were adapted, the cBBB was highly responsive to detect locomotor recovery over a 30-day period and correlated well with other assessment tools validated for use in canine models of SCI.

Laurie's thoughts: Now this scoring system shows promise to be a clinically useful tool. I admit that I just deleted all of the data-data from what I'm presenting in this review, because it's the scale itself that I want to highlight. I'll include these two diagrams in the Four Leg Articles Section under Outcome Measures.

Funny Pug and Dachshund Wall Decal *by chuckink* ***Zazzle***



OVERALL NEUROLOGIC MOTOR FUNCTION SCORING

Boström AF, Hyytiäinen HK, Petteri K et al. Development of the Finnish neurological function testing battery for dogs and its intra and inter-rater reliability. Acta Vet Scand (2018) 60:56.

Introduction: To the authors' knowledge, there are no functional testing that evaluate overall motor function of dogs with neurological disease.

The aim of this study was to develop a neurological function testing battery that would measure overall motor function in canine patients independent of neurological disease, and be effective for use in clinics and research.

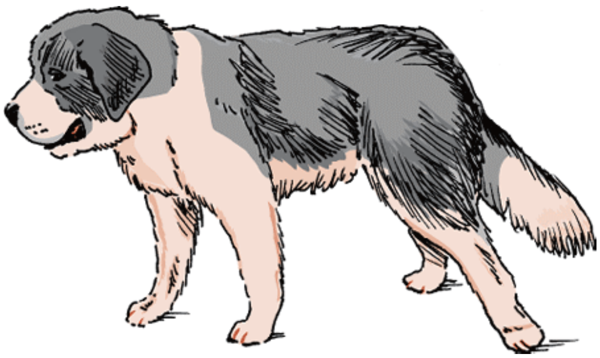
Methods: The Finnish neurological function testing battery for dogs (FINFUN) was designed based on the Motor Assessment Scale for humans, the Basso, Beattie, Bresnahan (BBB) Scale for spinal cord injured rats, the five recovery stages in dogs with acute spinal cord injuries and the clinical experience of the research team.

The FINFUN consists of 11 tasks of progressive difficulty; 'lying', 'standing up from lying', 'sitting', 'standing up from sitting', 'standing', 'proprioceptive positioning in affected limbs', 'start to walk from standing', 'walking', 'running', 'walking turns' and 'walking stairs'. As a dog performs each task, a score from 0 to 4 is given; 0 is unable to perform the task at all and 4 indicates that the dog is able to perform with normal motor function (or at the level prior to injury). Information relevant to the assessment can be recorded in a section set aside for comments; which also makes it possible to determine if the dog is unable to perform a task or is restricted by support, motivation or surgery. The FINFUN criteria also come with general instructions for use, specifying equipment and environment requirements, which allows for standardized scoring. The scoring time is approximately 15 min.

A pilot study with 10 dogs of varying grade of paralysis showed that the FINFUN had excellent intra- and inter-rater reliability. The scoring criteria were further adjusted according to clinical experience and critical reflections with the observers of the pilot study.

In the current study, seven animal physiotherapists, familiar with the tests, volunteered to be observers. Two were considered experienced as they worked with neurological cases daily and the rest were considered novices as they only worked with neurological cases on occasion.

Results & Discussion: This study shows the FINFUN is a valid and reliable functional outcome measure between observers and provides reproducible results. Both human and veterinary outcome measures were used in the development process.



The results show appropriate internal consistency, indicating that the FINFUN measures what it is intended to. In the FINFUN, each task was considered clinically relevant, justifying that all tasks in the testing battery be kept.

The experiences from the pilot study and the training revealed that observers needed to practice the FINFUN at least eight times in order to feel comfortable in the scoring process. Interestingly, the agreement is higher for the FINFUN total score than for the separate tasks, indicating that observers agreed on the dogs' overall function.

It is also recommended that when the FINFUN is used, the dog is allowed to repeat the task and the best performance is recorded.

This study included only dogs with paraparesis or paraplegia, so there was little variation in scoring of 'lying', as might be seen in patients with tetraparesis. The FINFUN does not distinguish between affected limbs although this could be noted subjectively in the comments section. The FINFUN scoring system may not be sensitive enough to evaluate the quality of near-normal movement, so the authors suggest the use of another validated scale focusing on assessment of walking quality along with the FINFUN.

Conclusions: The FINFUN meets the demands of the growing field of physiotherapy and rehabilitation in veterinary medicine as an objective, valid and reliable tool with standardized scoring criteria for evaluation of motor function in dogs recovering from spinal cord injury.

Laurie's thoughts: Brilliant! This is another fabulously clinically useful scoring tool. Thanks to the Fins for creating another great research paper! You can download the test and scoring instructions in the FourLeg.com Articles Section under Outcome Measures. (It's 11 pages altogether!)

AND ANOTER CARTOON JUST FOR FUN!

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