Article

Description and validation of a new descriptive and multiparametric numeric rating scale to assess sedation in cats

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Abstract — The objective of this study was to design and assess the validity and reliability of a new feline multiparametric sedation scale (FMSS). A total of 89 household cats were recruited, enabling a total of 534 sedation assessments. Every assessment was performed by 3 blinded observers with varying expertise levels (Level 1: Student; Level 2: RVT; Level 3: ACVAA diplomate or senior resident). For comparison purposes, a visual analogue scale (VAS) and a Simple Qualitative Scale (SQS) were also used concurrently, with the VAS considered the gold standard. The new scale had excellent inter-observer agreement among experience groups with weighted *Kappa* scores of 0.84 (Levels 1 *versus* 2), 0.82 (Levels 2 *versus* 3), and 0.84 (Levels 1 *versus* 3), with $P < 0.0001$ for all comparisons. There was a high degree of association between FMSS and VAS ($r = 0.90$, $P < 0.0001$) and between FMSS and SQS ($r = 0.89$, $P < 0.0001$). Final FMSS numerical values were paired with levels of sedation with None = 0 (0 to 5), Mild = 4 (1 to 7), Moderate = 6 (2 to 10), and Profound = 12 (7 to 12); furthermore, differences were detected between pre- and post-sedation evaluations ($P = 0.001$). This scale demonstrated internal consistency and sensitivity even when evaluating drugs or doses with minimal sedative effects and there was very strong interrater reliability, independent of experience level. Based on this clinical study, we concluded that the use of this sedation scale is appropriate when objective numerical sedation quantification is required, in either a clinical or research setting.

Résumé — Description et validation d'une nouvelle échelle d'évaluation numérique descriptive et multiparamétrique pour évaluer la sédation chez le chat. L'objectif de cette étude était de concevoir et d'évaluer la validité et la fiabilité d'une nouvelle échelle de sédation multiparamétrique féline (FMSS). Un total de 89 chats domestiques a été recruté, permettant un total de 534 évaluations de sédation. Chaque évaluation a été effectuée par trois observateurs en aveugle avec différents niveaux d'expertise (Niveau 1 : étudiant; Niveau 2 : RVT; Niveau 3 : diplomate de l'ACVAA ou résident senior). À des fins de comparaison, une échelle visuelle analogique (VAS) et une échelle qualitative simple (SQS) ont également été utilisées simultanément, VAS étant considérée comme l'étalon. La nouvelle échelle présentait un excellent accord inter-observateurs parmi les groupes d'expérience avec des scores *Kappa* pondérés de 0,84 (niveaux 1 *versus* 2), 0,82 (niveaux 2 *versus* 3) et 0,84 (niveaux 1 *versus* 3), avec $P < 0{,}0001$ pour toutes les comparaisons. Il y avait un degré élevé d'association entre FMSS et VAS ($r = 0{,}90$, $P < 0{,}0001$) et entre FMSS et SQS ($r = 0{,}89$, $P < 0{,}0001$). Les valeurs numériques FMSS finales ont été appariées avec les niveaux de sédation avec Aucun = 0 (0 à 5), Léger = 4 (1 à 7), Modéré = 6 (2 à 10) et Profond = 12 (7 à 12); en outre, des différences ont été détectées entre les évaluations pré- et post-sédation ($P = 0{,}001$). Cette échelle a démontré une cohérence interne et une sensibilité même lors de l'évaluation de médicaments ou de doses avec des effets sédatifs minimes et il y avait une très forte fiabilité inter-évaluateur, indépendamment du niveau d'expérience. Sur la base de cette étude clinique, nous avons conclu que l'utilisation de cette échelle de sédation est appropriée lorsqu'une quantification numérique objective de la sédation est requise, dans un cadre clinique ou de recherche.

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Introduction

Based on recent census data from the Canadian Animal Health Institute (CAHI), cat and dog populations in Canada have risen since 2014 (1). Approximately 38% of households in Canada have a cat, and cats outnumber dogs with 8.8 million cats considered household pets in 2016. The Canadian Veterinary Medical Association, however, estimates that cat owners (46%) are far less likely than dog owners (77%) to have taken their pet to the veterinarian within the last year (2). Resistance to and stress caused by transportation and examination appear to be some of the main factors contributing to cat owners not pursuing regular wellness examinations (3). After the combined stressors of confinement and transportation, cats can be in a state of high arousal or anxiety, increasing the possibility of resistance and aggression. Handling difficult or fractious patients may preclude a thorough examination or lead to increased risk of injury to veterinary staff (4).

Administration of oral or parenteral sedatives is a useful strategy to attempt sedation/anxiolysis prior to hospital visits, facilitate diagnostic or minor procedures such as catheterization before general anesthesia, decrease induction doses, or to facilitate cage rest or exercise restriction post-operatively. Administration of sedatives also aids in reducing stress levels on pets, owners, and staff members. Many studies have described the sedation properties of various drugs in cats (5–9). However, sedation scales for quantifying degree of sedation in domestic cats have not been formally assessed for validity and reliability (9,10). Many of the existing scales vary substantially in their content, with researchers often modifying existing scales used in other species, increasing variability among published results, and hindering comparisons of sedation data (11,12). For example, the scale described by Slingsby et al (13) is a simple descriptive scale that only includes posture and lack of response to sound. This scale has been used and modified by other authors to include a more detailed description of the posture and response to touch and sound (14,15). More descriptive scales have been designed that include various categories to capture more specific signs of sedation in cats. Categories included in these scales vary widely among studies, with some including or excluding variables such as muscle relaxation, response to noise, or restraint, whereas others include more specific signs tailored to the study (16,17).

Determining validation and reliability offers information on whether a sedation scale correctly measures what it is supposed to, and the degree of measurement errors coinciding with the scale of choice. When measuring sedation, verifying evidence for the validity and reliability of the scale is essential to ensuring appropriate scale sensitivity, when assessing various levels of sedation, as well as appropriate inter-rater agreement (12). Moreover, having a reliable scale capable of detecting even mild levels of sedation and one that is easy to use, irrespective of observer experience, should improve reproducibility of future studies and comparisons of results.

The primary objective was to design and assess the validity and reliability of a newly developed sedation scale and determine concordance between raters with varying levels of expertise. We hypothesized that this scale detects differences among various levels of sedation and has acceptable inter-rater reliability when used by multiple raters with varying experience.

Materials and methods

Animals

The study was performed in accordance with an approved Animal Utilization Protocol from the University of Guelph. All feline assessments were completed on client-owned animals at the Ontario Veterinary College Small Animal clinic (OVC-HSC) Canada. Owner consent was obtained for administration of sedatives, either as part of the anesthetic protocol or to facilitate diagnostic procedures. All animals included in the study were cats that required intravenous (IV), or intramuscular (IM) sedation prior to physical examination, general anesthesia, or to perform diagnostic procedures, e.g., radiographs or blood collection. An assessment was completed before and 30 min after drug administration to assess scale performance under pre- and post-sedation for a population of cats with non-homogeneous sedation protocols.

Sedation scale

The feline multiparametric sedation scale (FMSS) is a descriptive multiparametric numeric rating scale designed for the purpose of this study (Appendix 1). Some of the components of this scale were modified from other composite multiparametric scales used for cat sedation studies (14–18). We only included categories considered relevant to all degrees of sedation, excluding end points such as muscle relaxation that are most prominent when using some sedation protocols (18). Before study initiation, this scale was widely trialed and refined by several anesthesia technicians and residents, to ensure clarity and ease of use. For comparison purposes, a visual analogue scale (VAS) and a Simple Qualitative scale (SQS) were also used at the same time points (Appendix 1). Therefore, the sedation assessment sheet had 3 sections.

The first section of the sedation sheet was the FMSS, which allowed observers to rank an animal's posture, behavior, response to sound, and response to restraint, on a scale of 0 to 3. Each numerical choice was accompanied by a descriptor. Posture was assessed by observing the cat in their cage from the other side of the room (distance of approximately 2 m). Behavior was assessed through interacting with the animal by petting its head or body. Response to sound was determined by an animal's reaction to a loud single clap inside the cage while they were not looking at the operator. Lastly, response to restraint was assessed by the animal's reaction to being held for an intramuscular injection or placement of an intravenous catheter. The final resulting scale was a number out of 0 to 12, with 0 and 12 representing no and maximum sedation, respectively. Cats were never scruffed, and all interactions with them were standardized. Restraint for IM injections was always performed by covering the cat with a towel and applying moderate pressure to ensure contact of the cat with the cage floor. For IV catheterization, cats were gently wrapped in a towel, positioned in sternal recumbency, and the restrainer positioning 1 hand under the jaw to control the head while using the other hand to extend the leg to facilitate catheter placement.

Table 1. Drug protocols for sedating cats with FMSS final scores expressed as median (range) and SQS for all 3 observers.

Drug protocol	*n*	FMSS final score[a]	SQS[b]
Pre-sedation			
None	85	1 (0 to 5)	None
Gabapentin (PO)	4	3 (0 to 7)	Mild
Post-sedation			
Opioid (IM or IV)	7	4 (3 to 12)	Moderate
Dexmedetomidine + opioid (IM)	36	11 (2 to 12)	Profound
Dexmedetomidine + opioid + ketamine (IM)	1	10 (10)	Profound
Dexmedetomidine + opioid + alfaxalone (IM)	2	12 (12)	Profound
Gabapentin (PO) + dexmedetomidine + opioid (IM)	1	12 (12)	Profound
Acepromazine + opioid (IM)	25	5 (2 to 12)	Moderate
Acepromazine + opioid + ketamine (IM)	10	11 (5 to 12)	Profound
Gabapentin (PO) + acepromazine + opioid (IM)	3	10 (8 to 11)	Profound
Alfaxalone + opioid	1	4 (4)	Mild

[a] FMSS final score — Range of 0 to 12 with 0 being no sedation and 12 being maximal sedation.
[b] SQS word choice: None, Mild, Moderate, or Profound.

Table 2. Lins concordance correlation analysis testing for agreement between all raters for visual analogue scoring (VAS) and various Spearman's correlations for Level 3 raters for sedating cats.

VAS concordance	Level[a] 2 *versus* Level 3	Level 2 *versus* Level 1	Level 1 *versus* Level 3
Lin's *r*-value	0.94	0.95	0.96
Lower limit	0.92	0.93	0.95
Upper limit	0.96	0.96	0.97
Spearman's correlation	**Final score[b] *versus* VAS[c] (Res)**	**Word choice[d] *versus* VAS (Res)**	**Final score *versus* Word choice (Res)**
r-score[e]	0.90	0.96	0.89
R^2	0.81	0.91	0.80
P-value	< 0.0001*	< 0.0001*	< 0.0001*

* Indicates significant correlation.
[a] Level 1 — Student; Level 2 — RVT; Level 3 — ACVAA resident/boarded.
[b] FMSS final score: Range of 0 to 12 with 0 being no sedation and 12 being maximal sedation.
[c] VAS score: Range of 0 to 100 with 0 being no sedation and 100 being maximal sedation.
[d] Word choices: None, Mild, Moderate, or Profound.
[e] *R* score indicates the correlation. R^2 is the square of the correlation.

The second portion of the assessment was a Simple Qualitative scale (SQS) consisting of a simple word choice. The observer was asked to circle the option that better described the level of sedation: none, mild, moderate, or profound. This assessment is commonly used in multiple practices, including our institution, as part of the pre-medication sedation assessment on the anesthetic record (19). It was included to determine if there was a correlation between final FMSS values and various levels of sedation.

Lastly, the third section was a Visual Analogue Scale (VAS). This scale has been extensively used to assess sedation in multiple species, including cats (20), and it is commonly used in humans as clinimetric measure of wakefulness or sedation (21,22). The VAS used in this study consisted of a straight line measuring from 0 to 100 mm, with observers drawing a point on that line to indicate the level of sedation. The final score, therefore, was a number ranging from 0 to 100 (none and maximal sedation, respectively).

Observers

To assess inter-observer variability, 3 observers independently assessed the animals at each time point. One of the 3 observers was trained and familiar with the scale; they oversaw interactions of cats to ensure standardization. The other 2 observers were not trained and only watched the interactions. To evaluate if clinical experience level affected the use of this new scale, observers were classified into 3 expertise groups, based on their knowledge and experience in the use of sedatives on cats.

- Level 1: Undergraduate DVM students with minimal experience;
- Level 2: Registered veterinary technicians with years of experience in anesthesia; and
- Level 3: Board-certified ACVAA faculty members or ACVAA senior residents considered experts in the field.

Individual observers varied from case to case, but assessments were always performed by 1 member of each group and all observers were blinded to sedation protocol and route of administration.

Statistical methods

To determine if there was a significant difference in VAS score between the 4-word choice categories, a VAS value out of 100 was treated as a visual analog scale variable. A Kruskal-Wallis 1-way analysis of variance (ANOVA) was used to compare the median VAS among the 4-word choice categories.

Pairwise comparisons were based on the Dwass, Steel, Critchlow-Fligner Method (DSCF). The FMSS final score was compared among word choice groups with a Kruskal-Wallis test with pairwise comparisons using DSCF. Lins concordance correlation analysis, including Bland-Altman plots, was used to test for agreements between raters for VAS scoring. A weighted *Kappa* was used to test for agreement between raters for FMSS final scores and SQS. Spearman's correlation was used to test degrees of association between final score, SQS, and VAS scores. To determine if sedation score was sensitive enough to identify differences of sedation between pre- and post-scores for FMSS and VAS among all observer classifications, a Wilcoxon sign-ranked test was used. Significance was set to $\alpha = 0.05$ for all statistical testing.

Results

A total of 89 cats was recruited, enabling 178 individual pre- and post-sedation assessments to be included in the statistical analyses. As each case was assessed by 3 observers, a total of 534 sedation assessments was recorded. The cats were of the following breeds: domestic short hair ($n = 65$), domestic medium

Table 3. Weighted *Kappa* scores for agreement between all levels of raters[a] for FMSS final scores[b] and word choices[c] for sedating cats.

	Levels 1 *versus* 2	Levels 2 *versus* 3	Levels 1 *versus* 3
Final score comparison			
Weighted *Kappa*	0.84	0.82	0.84
Probability (2-sided)	< 0.0001	< 0.0001	< 0.0001
Word choice comparison			
Weighted *Kappa*	0.85	0.84	0.87
Two-sided *P*-value	< 0.0001	< 0.0001	< 0.0001

[a] Level 1 — Student; Level 2 — RVT; Level 3 — ACVAA resident/boarded.
[b] FMSS final score: Range of 0 to 12 with 0 being no sedation and 12 being maximal sedation.
[c] Word choices: None, Mild, Moderate, or Profound.

Table 4. Relationship between word choice and FMSS final score expressed as median (range) for sedating cats.

Word choice[a]	Final score[b]	Hypothesized range
None	0 (0 to 3)	0 to 2
Mild	4 (1 to 5)	3 to 6
Moderate	6 (2 to 10)	7 to 9
Profound	12 (7 to 12)	10 to 12

[a] Word choices: None, Mild, Moderate, or Profound.
[b] FMSS final score: Range of 0 to 12 with 0 being no sedation and 12 being maximal sedation.

hair (n = 7), domestic long hair (n = 6), Bengal (n = 3), Siamese (n = 3), Maine coon (n = 1), ragdoll (n = 2), Scottish fold (n = 1), and Russian blue (n = 1). Mean age was 5.1 ± 3.8 y (range: 7 mo to 16 y). Mean body weight was 5.4 ± 1.1 kg (range: 3.2 to 9.1 kg). Reasons for sedation included premedication for surgery (n = 26), blood donation (n = 27), diagnostic imaging (n = 7), and minor procedures such as nasogastric tube or jugular catheter placement (n = 28).

Nine drug combinations were used (Table 1). Opioids included butorphanol, buprenorphine, hydromorphone, and fentanyl. All drug regimens were approved by a Board-certified ACVAA anesthesiologist. No major complications or side effects were observed in any cats undergoing sedation. Four animals received oral gabapentin at home before the initial assessment.

For all categories of observers and pre-/post-assessments, VAS values had moderate to substantial concordance, with no difference ($P > 0.05$) in VAS scores amongst the 3 experience groups (Table 2). For both FMSS and SQS, weighted *Kappa* scores had good agreement and significant *P*-values, indicating a high level of comparison between all observer groups (Table 3). Based on the high level of concordance and agreement amongst observers, the remaining statistics were completed only on the Level 3 group of experience. A comparison of FMSS and VAS revealed a high *r*-score and significant *P*-value Spearman's correlation, indicating a high degree of association between both scales. Similar values were obtained between SQS and VAS and between SQS and final FMSS (Table 2). The relationship between word choice and FMSS final score expressed as median (range) is reported in Table 4. Multiple comparisons analysis of the differences between the median values of the FMSS scores in the 4 groups of word choice showed all pairwise comparisons where significant at $P < 0.016$ (Table 5). The VAS and FMSS evaluations

Table 5. Pairwise comparisons of final FMSS scores[a] for all sedation levels[b].

Sedation levels	*P*-value
None *versus* Mild	< 0.0001
None *versus* Moderate	< 0.0001
None *versus* Profound	< 0.0001
Mild *versus* Moderate	0.0161
Mild *versus* Profound	< 0.0001
Moderate *versus* Profound	< 0.0001

[a] FMSS final score: Range of 0 to 12 with 0 being no sedation and 12 being maximal sedation.
[b] Word choices: None, Mild, Moderate, or Profound.

for each experience level examiner differed ($P < 0.0001$) for the median difference in pre- *versus* post-sedation scores (Table 6).

Discussion

The main objective was to design and assess the validity and reliability of a newly developed sedation scale and determine concordance between raters with varying levels of expertise. The final goal of this project was to validate a sedation scale specific for cats that could be easily used for research and clinical cases. This numerical descriptive scale, designed using influences from published scales and clinical experience, was described by all observers as being easy or very easy to use.

Since there is no true gold standard in veterinary literature for sedation scores, we selected VAS and SQS for comparison. The former was selected because it has been used in human and animal studies and is considered by some as the gold standard, whereas the latter is commonly used in clinical settings and many veterinarians are familiar with it. Based on the excellent correlations between FMSS and both VAS and SQS, we concluded that there was a strong relationship between levels of sedation and overall score. It is noteworthy that VAS is considered the goal standard in human medicine (23). To the authors' knowledge, no sedation scales have been validated against VAS, but it has proven to be repeatable and valid for use in assessing the degree of pain and lameness in dogs (24) and has been used as comparison for newly developed pain or lameness scales (25,26). Although VAS is an effective scale for measuring sedation and pain in humans, scales that include multiple descriptive parameters perform better and may be easier to use (26,27). Despite the 3 scales performing well in our population, the major advantages of FMSS are a more descriptive nature that facilitates accounting for specific feline behaviors, while also providing a final numerical value for statistical comparisons.

An ideal sedation scale should not only be reliable but also easy to use and require minimal training. Most observers in this study did not receive any training on how to use the scale prior to the study. Our results indicated not only good interindividual agreement, but also near perfect agreement amongst all experience groups tested, eliminating this as source of variability for future studies.

It may be difficult to detect small changes in sedation levels and some scale systems may fail to detect differences, especially between none *versus* mild sedation. This behavioral scale was designed to consider cats with a wide range of personalities,

Table 6. Pre- *versus* Post-FMSS and VAS scores compared with Wilcoxon sign-ranked test.

Score	Experience[a] level	Median pre (range)	Median post (range)	Median difference	Wilcoxon signed-rank *P*-value
FMSS[b]	1	0 (0 to 7)	9 (2 to 12)	7	< 0.0001
FMSS	2	1 (0 to 7)	9 (1 to 12)	7	< 0.0001
FMSS	3	1 (0 to 9)	9 (0 to 12)	7	< 0.0001
VAS[c]	1	0 (0 to 35)	80 (10 to 100)	75	< 0.0001
VAS	2	0 (0 to 65)	80 (15 to 100)	75	< 0.0001
VAS	3	0 (0 to 50)	80 (0 to 00)	75	< 0.0001

[a] Level 1 — Student; Level 2 — RVT; Level 3 — ACVAA resident/boarded.
[b] FMSS final score: Range of 0 to 12 with 0 being no sedation and 12 being maximal sedation.
[c] VAS score: Range of 0 to 100 with 0 being no sedation and 100 being maximal sedation.

and based on our results, it was sensitive enough to detect small changes in awareness. Consequently, FMSS can potentially be used to assess drugs that only cause mild sedation or anxiolysis such as gabapentin or trazodone. This is particularly true if a baseline is obtained on the same animal before drug administration to compute individual personality quirks in the comparison.

As an additional objective, a numerical range was associated with each sedation level and expressed in word format. Based on statistical results, it appears word choice appropriately captured final sedation values. For example, for word choice "none," final scores amounted to zero, whereas for word choice "profound," final scores ranged from 9 to 12. This was demonstrated throughout all word choice selections, and accurately related to final sedation score ranges. The main reason for doing so was to enable the user to easily equate a familiar descriptive word to a specific quantity of sedation, making this sedation score user-friendly. This practice is commonly used in human medicine settings and is known as Simple Descriptive Scoring. Many studies have been compiled that validate the use of words paired with numerical ranges, to quantify pain levels appropriately and accurately in adults and children (27–29). To put our sedation scale into a more clinical context, final sedation scores of 1 to 5 were common in cats with signs of mild sedation that was sufficient to perform non-invasive diagnostic procedures such as radiographs or abdominal ultrasound. Furthermore, final scores of 6 to 9 indicated a degree of sedation that allowed small procedures such as blood collection, catheterization, or fine-needle aspiration with minimal restraint. Scores higher than 9 were often recorded with sedation protocols that included dexmedetomidine or ketamine; this degree of sedation facilitated manipulation of highly aggressive patients or to perform more invasive procedures such as wound debridement or biopsies.

In conclusion, the scale used in this study had excellent internal consistency and very good reliability between multiple untrained raters with varying expertise levels. Therefore, we inferred that we developed a reliable, sensitive, and validated feline sedation scale which is easy to use and universal in terms of application (both observer and drug selection). To our knowledge, there is no validated sedation scale in drug-related veterinary research specifically designed for cats. Therefore, this scale may be a useful tool when testing new drug protocols in cats or when sedation levels need to be quantified. CVJ

Appendix 1 Feline Multiparametric Sedation Score (FMSS).

Posture (observe from far away first)
- 0 Sitting up and/or walking around, no ataxia
- 1 Sternal recumbency head up and/or able to stand with mild ataxia if walking
- 2 Sternal or lateral recumbency with head down, severe ataxia if walking
- 3 Recumbent even when stimulated

Behavior
- 0 Alert, normal interaction with assessor*
- 1 Alert, but slower response than normal to interaction with assessor
- 2 Minimal response to interaction with assessor
- 3 No response to interaction

Response to sound
- 0 Reacts quickly to clapping# or too distracted to react
- 1 Slower or milder response than normal to clapping
- 2 Very mild response to clapping
- 3 No response to clapping

Response to restrain and/or IM injection/IV catheter (if responses to restrain and needle correlate with different numbers, always circle the lowest value)
- 0 Readily resist restrain or very interactive with handler, strong response to needle insertion
- 1 Initial resistance to restrain but gives up, moderate response to needle
- 2 Minimal resistance, easy to restrain, mild response to needle
- 3 No resistance to restrain, no response to needle

Final Score (0–12):

Select one:

None	Mild	Moderate	Profound

* Contact with the assessor includes opening cage door and attempt to pet, record what normal interaction is (friendly vs aggressive behavior). If the cat is showing strong aggressive behaviors (growling, hissing, trying to bite/scratch), assign a 0.
# If cat does not respond to clapping because is actively focusing on something else such as getting out of the cage, assign a 0.

Please include below any other specific behaviors observed such as purring, kneading, rolling exposing abdomen…

Behaviors observed (Notes):

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