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Comparison of stress exhibited by cats examined in a clinic versus a home setting

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ABSTRACT

Serum cortisol levels, physiological parameters and behavior were used to assess stress experienced by cats examined using equivalent low stress handling techniques in two different environments: their home and an idealized veterinary clinic setting.

Healthy cats ($n = 18$) were examined in a randomized cross-over study design: 10 were examined in a clinic setting first and eight in the home first with standardization of the examination procedure including personnel and duration between examinations. All procedures were captured on video for behavioral analysis.

Serum cortisol was not significantly different between the two examination environments. However, cortisol was lower on their second visit regardless of examination environment ($P < 0.01$). There was a significant difference for blood glucose between the clinic and home with blood glucose being higher in the clinic ($P < 0.01$). The behavioral analyses revealed that cats were more likely to hide in the clinic ($P < 0.05$).

In the context of this study, where low stress handling techniques were employed throughout both environments, familiarity with the veterinary examiner and procedure were associated with decreased stress experienced by the cat. Higher blood glucose and more hiding behavior in the clinic support the hypothesis that the clinic is more stressful than the home. In the clinic setting, familiarity with the veterinary examiner and the use of low stress handling techniques potentially masked other physiological parameters associated with stress. Also, the use of low stress handling and the lack of marked extremes of fear or aggression in the cats, made the estimation of stress based on behavioral cues challenging.

1. Introduction

Regular wellness veterinary examinations, for prophylactic care and early in the course of illnesses could improve quality and quantity of life of our pets (Volk et al., 2011). However, pet cats are less likely to be seen by veterinarians than dogs (Lue et al., 2008). In one study, 40% of cats had not been to a veterinarian in the last year compared to 15% of dogs (Volk et al., 2011). Clients report reluctance to bring cats to the veterinarian due to the stress experienced by both the owner and cat during transport of the cat to and from the veterinary clinic and at the veterinary clinic (Volk et al., 2011). The concept that cats are more stressed in the veterinary clinic than home is supported by the finding of higher physiological parameters (temperature, pulse, respiration and blood pressure) in cats examined in a veterinary clinic compared to their home (Quimby et al., 2011). However, in the study by Quimby et al. (2011), all cats were seen in the home first and then the clinic, with the

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clinic examination on the same day, potentially biasing the results. In addition, the handling techniques, which also could have influenced the results, are not described and no behavioral data were included, leaving open the question if cats are more or less stressed in the clinic compared to the home environment.

In addition to altering some of the physiological parameters assessed in the physical examination, behavioral manifestations of stress may negatively impact the veterinarian's ability to perform a physical examination both in regards to its thoroughness and accuracy, and, if the cat becomes aggressive, may lead to injury of the veterinary team. Catecholamine and glucocorticoid release in response to stress can also impact clinical pathology data and complicate its interpretation by causing an increased blood glucose concentration and a stress leukogram (a pattern of increases and decreases in the neutrophils, monocytes, eosinophils and lymphocytes) (Greco, 1991). Potential benefits of reduced stress during examination include increased frequency with which cats are examined (i.e., resulting in more regular, consistent routine veterinary care and earlier detection of clinical illness), increased accuracy of the examination findings, and better overall welfare of the cat.

Means of assessing cat stress include physiological parameters (e.g., temperature, pulse and respiratory rates, blood pressure and serum cortisol) and behavior. Serum cortisol is a frequently used standard in stress research and has been correlated to several physiological parameters (Graham and Brown, 1996; Brien, 1980). Feline behavior and body posture can be indicative of stress and have been used to assess the calmness, or lack thereof, of cats (American Association of Feline Practitioners, 2004).

Methods recommended to reduce stress experienced by cats include: environmental modifications such as minimizing exposure to other cats or dogs; using low stress handling techniques (e.g., limited restraint and use of food rewards/distractions); and performing examinations in an environment familiar to the cat (e.g., the cat's home) (Yin, 2009; Rodan et al., 2011; AAFP, 2004). Cat-only clinics and clinics certified as a Cat Friendly Practice® (American Association of Feline Practitioners) are promoted to decrease cat stress by creating a more cat-friendly environment. Low stress handling guidelines based on knowledge of feline behavior have been published and are intended to maintain safety of the veterinary team while minimizing fear and pain experienced by cats during the veterinary examination (Rodan, 2010; Yin, 2009). Examination in the home is promoted to avoid stress associated with transportation and limit stress associated with a novel environment (American Association of Housecall Veterinarians, 2014). While the impact of stress on physiological parameters and clinical pathology has been well studied in many species, with some data available for cats, few data are available to demonstrate the impact of methods used to reduce cat stress on these parameters (Brien, 1980; Greco, 1991; Oka et al., 2001).

Objectives of this study were to (a) compare the stress experienced by cats that were being examined using low stress handling techniques in two different environments (their home and an idealized veterinary clinic setting) using a number of physiological and behavioral indicators; (b) compare the level of stress revealed by serum cortisol with physiological parameters to better understand the impact of stress on these parameters; and (c) compare the level of stress revealed by serum cortisol with behavioral indicators. Results from these analyses will contribute to the discussion of whether home visits are a viable alternative to the veterinary clinic for feline examination and add to the literature on low stress handling techniques for cats in clinical veterinary practice.

2. Materials and methods

This study was conducted using a randomized crossover design and with approval from the Ross University School of Veterinary Medicine (RUSVM) Institutional Animal Care and Use Committee. The study population consisted of 21 cats recruited from the RUSVM community with 18 cats completing the study. Three cats were excluded as their examinations ran over time (>25 min). Two of these cats were difficult to handle leading to a protracted time line. With the third cat, challenges with operation of the Doppler unit, used to measure blood pressure, led to a protracted time line. All three of these cats were being evaluated in the home environment first. The 18 cats included in the study were domestic short hair cats and ranged in age from 6 months to 8 years (mean 2.5 years ± 2.7). Seven were males and 11 females, and all were spayed or neutered. Many of the cats came from feral colonies from which they were removed when greater than 12 weeks of age (six out of 18) and two of the 18 cats were removed from the queen prior to normal weaning age and were hand reared. Fifteen of the cats were from multiple cat households with an average of 3.2 cats per household (±0.84). All of the cats were considered healthy based on history and physical examination; body condition scores were 3–5 on a 5-point scale where 1 was emaciated, 3 was ideal and 5 was obese (mean 3.3 ± 0.6) and body weights were 1.4–7.1 kg (mean 4.0 kg ± 1.5).

Ten of the cats had a routine physical examination performed in the clinic first and then in their homes, while eight of the cats had a routine physical examination performed in their homes first and then in the clinic. The two examinations were completed 7 days apart. A spike in serum cortisol can continue to impact physiological parameters, e.g., glucose, for up to 72 h; to ensure a complete washout, two times this period was selected and rounded to 7 days for convenience (Greco, 1991). All examinations were between 9:00 h and 17:00 h; for each individual cat, both examinations were performed at the same time of day (e.g., 9:00 h) to ensure that cortisol levels were not impacted by diurnal rhythms.

Each examination was conducted using the same methods and in the same order of procedures. Handler bias was minimized by using the same veterinarian for all examinations. The same technical support team and the video camera operator also were used for both examinations of an individual cat. To ensure uniformity of handling, the duration of confinement preceding each exam was limited. Owners were to contain the cat in a carrier for transport to the clinic for no less than 30 min and no more than 1 h. For examinations in the home environment, cats were to be confined to a room for no less than 30 min and no more than 1 h. Veterinary clinic visits were conducted such that cats were transported directly into an examination room in a facility that did not have any other animals present, to ensure no confounding stress from seeing or hearing other animals. However, in the case of multiple cat households, cats were permitted to remain together in the clinic and be confined together in the home. In the clinic, the cat carrier was opened and the cat allowed 5 min to acclimate to the exam room prior to the examination. Cats for whom all procedures could not be completed within 25 min or who were found to have systemic illness based on history or physical examination were not included in the study. Three cats were excluded due to being unable to complete the examination with 25 min and no cats were excluded due to illness.

During all examinations (in the clinic and at home), cats were provided with a freshly laundered towel on the exam table that had been sprayed with Feliway® facial pheromone (Ceva: Lenexa, KS, USA) 5 min prior to use. The examiner and technical support moved slowly and used quiet voices throughout. During the procedures minimal restraint was applied and, where necessary, the towel was used to create a collar (three times) or to wrap the cat like a "burrito" (all other occasions) as described by Yin (2009). The owner remained with the cat throughout the examination and a veterinary nurse held the cat only during the rectal temperature measurement and phlebotomy. Cat treats were offered to all cats upon initiation and completion of the procedure. Weight was obtained using a contoured infant scale. During the examination, blood pressure was assessed as the average of a minimum of five Doppler unit (Model 811-B, Parks Medical Electronics; Las Vegas, NV, USA) readings obtained from the forelimb or tail using a pediatric cuff with a diameter of approximately 40% of the limb or tail circumference. The location and cuff size was the same for an individual cat on each examination. The final step was peripheral blood sampling (1–3 mL) via the jugular or medial saphenous vein.

A patient side glucometer OneTouch® Ultra®2 (Johnson and Johnson, Milpitas, CA, USA) was used to measure blood glucose. Serum was separated from cells by pipette after centrifugation and complete blood counts as well as blood smear preparations were performed within 4 h of sample collection. Complete blood counts and cytology were reviewed by a board certified clinical pathologist for evidence of a stress leukogram. Serum was stored at −20 °C and serum cortisol was measured by a commercial laboratory (Abaxis; Union City, CA) with a validated chemiluminescent immunoassay (Reimers et al., 1996).

The video recordings (Flip Ultra U1120B: Cisco, Irvine, CA, USA) were obtained from approximately 3 feet distance from the cat with a focus on the head. The video recording for an individual cat (home and clinic) was evaluated by the same trained observer. Two types of behavioral data were documented: "all events" data throughout each visit and "snapshot" sampling to record cat's behavior every 15 s. The ethogram used to score behavior from video recordings is presented in Table 1.

3. Statistical analysis

Serum cortisol served as the reference point for assessment of stress (Brien, 1980). Paired *t*-tests were used to compare cortisol, temperature, pulse, respiration, blood glucose, lymphocyte count and blood pressure for each cat between the two environments and (in order to assess possible influence of familiarity with the examination procedure and examiner on the cats) between the first and second visits. Pearson correlations between each physiological parameter and cortisol levels measured during the examination were calculated. Pearson correlations between each behavioral indicator (rate of head scans, etc.) and cortisol levels measured during the examination were also calculated.

As much of the behavioral data were non-normal, and given small sample sizes, Wilcoxon signed-rank tests were used for the "all events" data to compare behaviors (number/min) during the home vs. clinic examination, and during the first vs. second examination, for each cat. (Wilcoxon, 1945). For the snapshot data, a Wilcoxon signed-rank test was used to compare mean scores (ear position, pupil dilation, and eye movement) for each cat, between home and clinic and between first and second visit. Correlations between mean scores and cortisol levels for the snapshot data were also calculated. For all statistical analyses, $\alpha = 0.05$.

4. Results

For the 18 cats that completed the study, examination time of day was consistent between an individual cat's first and second examinations. Confinement prior to examination was within the outlined parameters of 30–60 min in 20 of 36 events, with a range of 10–90 min for confinement preceding the clinic examination (mean 45 ± 23 min standard deviation) and a range of 0–120 min for confinement preceding the home examination (mean 66 ± 33 min standard deviation). Confinement was longer than planned due to the number of multiple cat households that were included in the study (15 multiple cat households versus three single cat households). In these multiple cat households, all of the cats were confined at the same time in the home environment or transported to the clinic at the same time. Therefore, the second, third, etc., cat in a household had a longer confinement period. When three cats were eliminated from the study during their first examinations, all of which were in the home environment, their housemates (seven cats from two households) experienced a shorter wait on their second examination (in the clinic). This affected the average confinement preceding examination such that there was a significant difference in confinement time between the two environments ($t = 3.27$, $P = 0.005$) with the clinic visit having a shorter confinement period.

Not all physiological parameters, shown in Table 2, could be measured for all cats during each examination (e.g., respiration was not measured for several cats due to purring and/or sniffing at the time scheduled). This decreased the sample size from 18 to 11 for some parameters. For blood glucose, one cat's measurement was not

Table 1
Behavioral ethogram used to score behavior from video recordings.

Behavior	Description
All events data: number of occurrences per 15 s interval recorded	
Head scan	Purposeful movement of the head, looking side-to-side or up-and-down
Escape attempt	Attempt by the cat to struggle while restrained, or move purposefully and rapidly away from the handler at any time
Hiding	Placing head or body away from view, e.g., under a towel, into handler's clothing
Vocalization	Growl (low-pitched rumbling sound)
	Hiss (open mouth, forces burst of air out with a hissing sound)
	Purr (repetitive, buzz-like sound)
	Chirp (high-pitched vocalization <1 s)
	Meow (high-pitched vocalization >1 s)
Snapshot data: observed behavior every 15 s	
Ear position	1 = relaxed/alert ears (upright, oriented forward)
	2 = ears upright but turned to sides
	3 = downward facing ears
	4 = ears pressed flat back against the head
	5 = ears moderately flattened, top of ears rotated forward
Pupil dilation	1 = relaxed eyes (pupils not dilated)
	2 = slightly dilated pupils
	3 = moderately dilated pupils
	4 = pupils very dilated
	5 = slit pupils
Eye movement	0 = eyes not visible
	1 = steady/fixed gaze
	2 = scanning (frequent changes in eye direction)

included due to potentially being pre-diabetic and one cat had a small volume of blood obtained during sampling that was reserved for serum cortisol measurement (so, glucose was not measured), decreasing the sample size to 16.

There were no significant differences in physiological parameters between the home and clinic visit with the exception of blood glucose ($P = 0.003$). Each cat was more likely to have a lower blood glucose in their home compared to the blood glucose reading in the clinic; either 21.4% lower if the clinic was the location of their first visit or 29.5% lower if the home was the location of their first visit (Fig. 1). Cortisol values were not significantly different between home and clinic environments, but were different between the first visit and the second visit ($P = 0.002$). The serum cortisol was consistently lower in each cat's second examination environment (16 out of 18 cats had a lower serum cortisol on their second visit). The drop in cortisol from first to second visit was more marked when cats were examined in the clinic first (a drop of 218% when the clinic was the first examination environment versus a drop of 110% when the home was the first environment) (Fig. 2). No significant differences were seen in the other physiological variables between the first and second examinations. A stress leukogram was not identified at any time in any

Table 2
Mean (S.D.) and range of physiologic parameters from 18 cats in the home/clinic environment and during visit 1/visit 2.

Parameter	Home	Clinic	Visit 1	Visit 2
Temperature (°C)	38.7 (±0.4) (37.9–39.6) $N = 18$	38.8 (±0.6) (37.7–40.0) $N = 18$	38.7 (±0.4) (38.0–39.5) $N = 18$	38.8 (±0.6) (37.7–40.0) $N = 18$
Pulse (bpm)	182 (±32) (110–220) $N = 18$	190 (±20) (160–220) $N = 18$	192 (±19) (160–220) $N = 18$	180 (±33) (110–220) $N = 18$
Respiration[a] (breaths/min)	56 (±17) (20–90) $N = 16$	46 (±17) (20–70) $N = 11$	49 (±18) (20–80) $N = 13$	55 (±17) (20–90) $N = 14$
Blood pressure[a] (mmHg)	150 (±27) (109–200) $N = 16$	163 (±31) (114–226) $N = 18$	155 (±33) (109–226) $N = 17$	158 (±26) (116–203) $N = 17$
Cortisol (μg/dL)	3.7 (±3.0) (0.5–9.6) $N = 18$	4.3 (±3.6) (1.0–12.9) $N = 18$	5.2* (±3.6) (1.0–12.9) $N = 18$	2.8* (±2.5) (0.5–9.6) $N = 18$
Blood glucose[b] (mg/dL)	57.3* (±7.8) (43.0–69.0) $N = 17$	71.8* (±15.8) (46.0–112.0) $N = 16$	64.3 (±11.7) (43.0–87.0) $N = 17$	64.4 (±16.8) (46.0–112.0) $N = 16$
Absolute leukocyte count ($\times 10^9$/L)	5.3 (±3.6) (1.5–16.8) $N = 17$	4.8 (±2.6) (2.1–10.6) $N = 16$	4.8 (±2.6) (1.5–10.6) $N = 17$	5.4 (±3.7) (2.0–16.8) $N = 16$

* $P < 0.005$ comparing home to clinic or visit 1 to visit 2.
[a] Respiration rate not recorded for all cats due to purring/sniffing. Blood pressure not obtained for two cats in the home environment.
[b] Blood glucose: one cat eliminated due to suspected pre-diabetic state; one cat eliminated due to inability to collect adequate sample in the clinic.

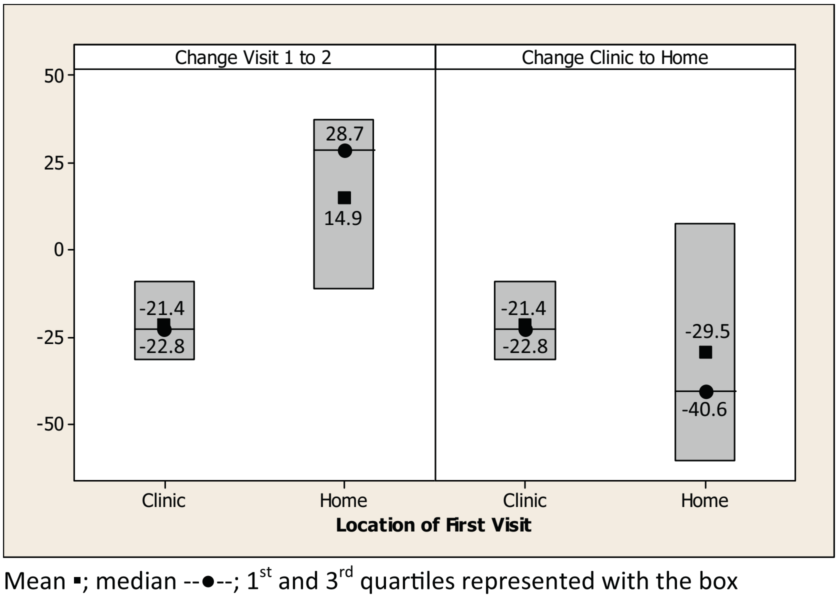

Fig. 1. Percent change in glucose by location of first visit.

of the cats. There were no significant correlations between serum cortisol and the physiological parameters.

For the behavioral event analysis, only hiding behavior differed significantly between home and clinic environments ($V = 100$, $P < 0.03$), with cats being more likely to exhibit hiding behaviors in the clinic environment (clinic: mean ± *sd* $1.13 \pm 1.89\,\text{min}^{-1}$; home: $0.46 \pm 0.97\,\text{min}^{-1}$). Though there initially seemed to be more head scanning in the clinic and escape attempts at home, the results were not significant: head scanning (clinic: mean $9.03 \pm 7.02\,\text{min}^{-1}$; home: $7.07 \pm 4.90\,\text{min}^{-1}$; $P = 0.082$), and escape attempts (clinic: mean $1.42 \pm 1.22\,\text{min}^{-1}$; home: $2.28 \pm 1.76\,\text{min}^{-1}$; $P = 0.11$). There were no significant differences between behaviors recorded in the first versus second visits. Only two of the correlations between cortisol and behavior rates were suggestive, although not statistically significant; cortisol was negatively correlated with escape attempts ($r = -3.19$; $P = 0.058$) and positively correlated with hiding behavior ($r = 0.309$; $P = 0.067$). For the snapshot behavioral data, only ear position differed significantly between clinic and home environments ($P < 0.02$), with higher scores recorded in the home environment; mean ear position scores were low in both locations (clinic: mean 1.57 ± 0.32, home: mean 1.72 ± 0.33; with 1 = relaxed/forward facing

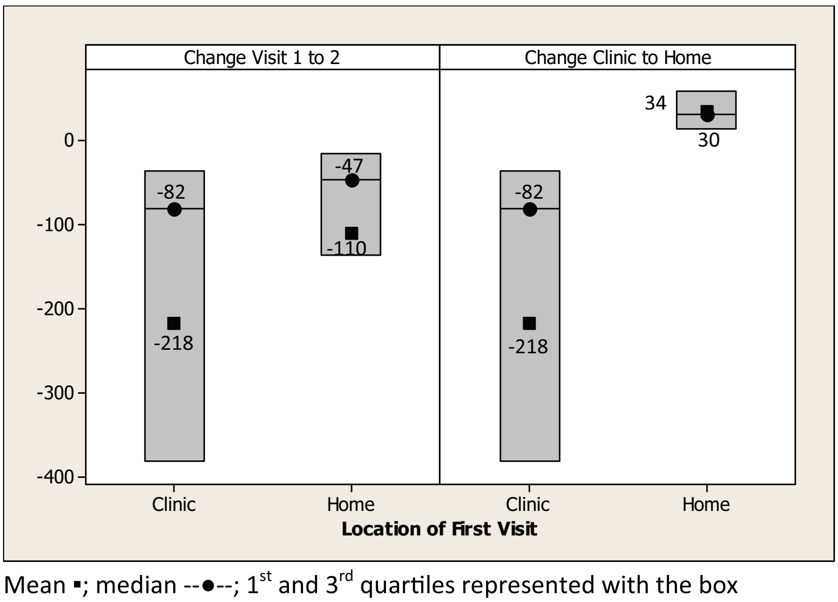

Fig. 2. Percent change in cortisol by location of first visit.

ear and 2 = ear turned slightly sideways). There were no significant differences in snapshot data between the first and second visits. Only pupil dilation and eye movement were significantly correlated ($r = 0.331$; $P < 0.05$); a slight negative correlation between cortisol and eye movement was noted, but was not statistically significant ($r = -0.282$; $P = 0.096$).

5. Discussion

Our study supports that low-stress handling, performed by familiar veterinary personnel, results in a cat that experiences less stress. From a practical standpoint, this means cats should be scheduled to see the same veterinarian and technical support staff whenever possible. The hypothesis was that in the home environment there would be fewer physiological and behavioral indicators of stress in cats. However, serum cortisol to which all other parameters were subsequently compared, was not significantly different between the clinic and home environments. Serum cortisol was, instead, lower on the second visit compared to the first visit. This decrease in cortisol on the second visit becomes the major finding of this study and was attributed to familiarity with the veterinary examiner, handler(s) and handling method, particularly under conditions of low stress handling, as were utilized in this study.

Our rationale for why cortisol was not significantly different between the two environments is due to a confounding variable, familiarity. We believe the stronger influence of familiarity with the examiner and process was masking the influence of the familiar home versus clinic environment. Evidence that cortisol may actually be lower in the home environment comes from examining the magnitude of cortisol decrease seen when the cat was examined in the clinic environment first versus when the cat was examined in the home environment first. Those cats that became familiar with the procedures and handler(s)/handling in the clinic, and were subsequently examined in their home, had a much greater decrease in cortisol (218%). Those that became familiar with the procedures and handler(s)/handling in their home and were subsequently examined in the veterinary clinic, had a much smaller decrease in cortisol (110%). Based on this observation, there appeared to be an interaction effect between familiarity with the personnel/procedures and familiarity of location, with the degree of change in cortisol (home versus clinic) influenced by order of visits (greater change when home was second visit). This suggests that cortisol in the home is in reality lower, which would support the hypothesis that the home environment is less stressful than the clinic environment. Further to this point, the inadvertent but significantly longer confinement time experienced at home is expected to have increased cortisol levels in the home, which would mask evidence of the home being less stressful. It is important to note that longer confinement in the home does not explain the significant drop in cortisol noted on the second visit of cats examined first in the clinic and then in the home. The cortisol decrease for this group of cats (examined in the clinic first) was greater than those cats that were examined in the home first and clinic second (with a significantly shorter confinement preceding their clinic visit in this “home first” group of cats). Diurnal rhythms of cortisol are not expected to have had any impact on the data as only the change in cortisol was examined (not the cortisol concentration), and because each cat was examined at the same time of day in the clinic and home environments.

The hypothesis that the clinic is more stressful than the home environment was supported by the findings of higher blood glucose and more hiding behavior in the clinic. Elevated blood glucose levels occur in stressed animals due to the hormones released during stress (e.g., epinephrine and cortisol), that are counter-regulatory to insulin (Greco, 1991). The clinical relevance of the significantly higher glucose in the clinic is that in this environment, determining if hyperglycemia (blood glucose above the normal range) is physiologic or pathologic could be more challenging. When a cat is found to have hyperglycemia, the veterinarian must make an interpretation: is this likely a physiologic change (related to release of stress hormones) or a pathologic change (as in diabetes mellitus)? In this study, on one occasion, a cat was hyperglycemic (in the clinic, her glucose reading was 178 mg/dL); the cats were normal in the home environment. As this cat had other risk factors for diabetes mellitus (obesity), her glucose data were not included in the data analysis so as not to bias the results of the study. That we could not clearly determine if the change was physiologic or pathologic highlights the importance of minimizing stress experienced by cats during an examination in order to maximize accuracy and minimize the possibility of wrongful interpretation or the need for further testing.

The observation that cats were more likely to hide in the clinic environment, supports that they were more stressed in that environment, as cats subjected to stressors will often attempt to hide (Carlstead et al., 1993). From a clinical standpoint, this increased tendency to hide in the clinic supports the use of towel wrap techniques or allowing the cat to remain in the lower portion of its carrier during examination, as both allow the cat to hide more readily (Yin, 2009; Rodan et al., 2011; AAFP, 2004).

The masking effect of familiarity used to explain the lack of differences in cortisol between the home and clinic would also have influenced the other physiologic and behavioral measures where no difference was detected. In particular, it is thought to have masked finding a significant difference in blood pressure, head scans and escape behaviors between the two environments where a pattern of mean values suggested a difference. Blood pressure was higher in the clinic in 14 of the 18 cats with a mean of 150 mmHg ± 27 at home and a mean of 163 mmHg ± 31 in the clinic but the difference was not significant. If blood pressure had been shown to be statistically significant, this would have supported the hypothesis that cats experience more stress in the clinic environment. The “white coat” effect (related to anxiety and fear associated with seeing veterinary personnel in white lab coats) on blood pressure is to increase the readings related to physiologic stress and complicates the interpretation of blood pressure assessment (Belew et al., 1999). The behavioral analyses were complex and possibly complicated by sample size in addition to the interaction between visit location and visit order (familiarity). Head scanning, though not significantly different, was observed with more frequency in the clinic. We surmise that cats may head scan more in the clinic as a reflection of the cat's unfamiliarity with and attempts to become more familiar with the environment. However, the study likely lacked power (due to our small sample size) to show a significant difference in head scanning. Similarly, escape attempts, though not significantly different, were observed more frequently in the home (clinic: mean 1.42 min^{-1}; home: 2.28 min^{-1}; $P = 0.11$). The idea that in the familiar environment of the home, cats are more likely to make escape attempts is plausible as they are likely to know the location of the best escape routes and hiding places (without the need to perform more head scans). Therefore a lack of power may, once again, have precluded obtaining a significant difference in frequency of escape attempts. Quimby et al. (2011), though behavioral data were not collected in that study, also made note that some cats showed more struggling and apparent agitation during exams done in the home versus the clinic. Few such escape routes are known or visibly available in the clinic environment. This explanation is supported by the tendency seen in the cortisol data toward a positive relationship between higher cortisol levels and more attempts to hide (both variables may reflect stress associated with the clinic environment) and between lower cortisol and more escape attempts (where both variables may reflect the home environment). The negative correlation between cortisol levels and ear position is initially counterintuitive, given that higher ratings of ear position in our study were associated with fearful or aggressive body language. However, in our examinations, conducted using low stress handling techniques, we did not see ear positions reflecting extreme fear and aggression; the majority of observations were scored at 1 (forward facing/relaxed/alert) or 2 (slightly to the side). What this may indicate is that it is not advisable to assume, based solely on forward facing, relaxed/alert ears, that the cat is calm, as the cortisol results in our study indicate that this may not be the case. Many cats may become withdrawn when stressed (Casey and Bradshaw, 2007), making the more subtle body language less indicative of true emotional state, particularly if context is not taken fully into account. Alternately, it is possible that our methodology of recording ear position from video was not precise enough to detect either subtle differences in ear position, or quick or temporary changes in ear position, particularly given the lack of high scoring behavioral events (i.e., body language suggesting extreme stress). We observed some similar quick changes in pupil dilation during some exams that were difficult to capture in the data. Based on our analyses, however, we suggest that some of the more subtle behavioral indicators may be more reflective of the cats' perception of their environment, than of underlying physiological stress levels.

An objective of the study that we were not able to achieve was to identify particular physiological and behavioral variables that were strongly correlated with cortisol and that might readily alert the clinician to a change in the level of stress a cat is experiencing. We were not able to show any significant correlation between cortisol and physiological or behavioral parameters. It seems unlikely that our inability to link cortisol to any other physiologic or behavioral changes is because there is no correlation. Rather, interference from the confounding variable, familiarity, in addition to a lack of power in the study are thought to be causative in disrupting the ability to detect a correlation. Future studies with a larger sample size as well as controlling for the impact of familiarity are still needed to identify physiological or behavioral parameters that could be used by the veterinarian during examinations.

Low-stress handling techniques were found to be highly successful as we were able to complete the majority of exams with minimal difficulty. Despite minimal restraint, no personnel were injured by the cats in this study and all procedures could be completed in the specified time in the majority of cats examined. Further improvement in low-stress handling should be a common goal of all who pursue such strategies and we suggest that our handling in this study could have been improved by use of headphones during Doppler blood pressure measurement and avoiding use of alcohol to wet the fur for phlebotomy. We did not attempt to measure which aspects of low-stress handling had the largest impact (such as comparing the impact of facial pheromone with impact of avoidance of the sight and sound of unknown dogs or cats). Such questions would be central to identifying best practices in feline low-stress handling.

Our results indicate that there is a marked benefit in building a veterinarian–patient relationship in addition to the traditionally discussed veterinarian–client relationship, provided low stress handling techniques are employed. This relationship is anticipated to translate into increased visits and increased thoroughness and accuracy of examination findings, leading to improved medical outcomes for the cat. We suggest that practices take this finding into account and try to maintain, wherever possible, consistency with regards to which veterinarian a cat is scheduled to see for an examination. Furthermore, the other personnel involved as well as procedures and environment should be kept as predictable as possible as this study indicates that predictability or familiarity are significantly associated with a less stressful visit.

Examination in the home environment may still be an important tool in increasing frequency with which cats are seen by a veterinarian. Handling techniques may require some alteration in this environment given the cat's increased desire to escape to known hiding places. A question for future studies might include determining if there is a decrease in escape attempts when examination in the home is repeated (i.e., due to the benefit of familiarity with the examiner and procedures), provided low-stress handling is used. Another important question raised by this study is whether the benefits of familiarity are seen when low-stress handling methods are not utilized.

6. Conclusion

When using the same techniques and same staff, cats appeared to experience less stress, as measured by serum cortisol, on repeated examinations. This supports a business management strategy that aims for consistency in personnel and handling of cats. While this could be challenging to achieve, the resulting decrease in cat stress could increase client satisfaction, number of visits and cat welfare. Subtle behavioral displays in cats that are being examined with low stress techniques may not accurately predict the stress being experienced by the cat. The trends in the study support that home examination is a viable option to increase quality and quantity of veterinary examination of cats.

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