Published in final edited form as:

J Am Vet Med Assoc. 2011 January 1; 238(1): . doi:10.2460/javma.238.1.67.

Sickness behaviors in response to unusual external events in healthy cats and cats with feline interstitial cystitis

Judi L. Stella, BS, **Linda K. Lord, DVM, PhD**, and **C. A. Tony Buffington, DVM, PhD**
Departments of Veterinary Clinical Sciences (Stella, Buffington) and Veterinary Preventive Medicine (Lord), College of Veterinary Medicine, The Ohio State University, Columbus, OH 43210

Abstract

Objective—To compare sickness behaviors (SB) in response to unusual external events (UEE) in healthy cats with those of cats with feline interstitial cystitis (FIC).

Design—Prospective observational study.

Animals—12 healthy cats and 20 donated cats with FIC.

Procedures—Cats were housed in a vivarium. Sickness behaviors referable to the gastrointestinal and urinary tracts, the skin, and behavior problems were recorded by a single observer for 77 weeks. Instances of UEE (eg, changes in caretakers, vivarium routine, and lack of interaction with the investigator) were identified during 11 of the 77 weeks. No instances of UEE were identified during the remaining 66 weeks, which were considered control weeks.

Results—An increase in age and exposure to UEE, but not disease status, significantly increased total number of SB when results were controlled for other factors. Evaluation of individual SB revealed a protective effect of food intake for healthy males. An increase in age conferred a small increase in relative risk (RR) for upper gastrointestinal tract signs (RR, 1.2) and avoidance behavior (1.7). Exposure to UEE significantly increased the RR for decreases in food intake (RR, 9.3) and for no eliminations in 24 hours (6.4). Exposure to UEE significantly increased the RR for defecation (RR, 9.8) and urination (1.6) outside the litter box.

Conclusions and Clinical Relevance—SB, including some of the most commonly observed abnormalities in client-owned cats, were observed after exposure to UEE in both groups. Because healthy cats and cats with FIC were comparably affected by UEE, clinicians should consider the possibility of exposure to UEE in cats evaluated for these signs.

Millions of cats are euthanized or relinquished to shelters in the United States each year because of inappropriate elimination behaviors that are objectionable to owners, making this a problem of major veterinary importance.[1,2] The most common of these behaviors are referable to the lower urinary tract. Clinical signs of lower urinary tract disease reportedly occur in approximately 1.5% of client-owned domestic cats.[3] The most common cause of LUTS is idiopathic cystitis, a generic description for LUTS of unknown cause after appropriate clinical evaluation.[4] The term FIC has been used to describe the condition in cats that have chronic or recurrent LUTS and characteristic findings during cystoscopic examination of the urinary bladder.[5]

Recent evidence suggests that LUTS may be the urinary bladder manifestation of a systemic disorder in some cats with FIC, as well as in humans with interstitial cystitis[6] and other

Address correspondence to Dr. Buffington (buffington.1@osu.edu)..

chronic multisymptom illnesses.[7] Research has found that comorbid disorders commonly occur in cats with idiopathic cystitis.[8,9] For example, in a recent case-control study[8] of 238 healthy cats, 157 cats with LUTS, and 70 cats with other nonurological diseases, the cats with LUTS had significantly more comorbid disorders, including greater owner-observed gastrointestinal tract signs, self-scratching, and fearful, nervous, and aggressive behaviors than did cats in the comparison groups. A subsequent study[10] evaluated client-reported recurrence of LUTS and clinical signs of comorbid disorders in cats with idiopathic cystitis after institution of multimodal environmental modification. Clients reported reductions in LUTS, fearfulness, nervousness, and clinical signs referable to the respiratory tract.

Cats without LUTS have similar SB. For example, a survey[11] of 550 owners of 1,177 healthy cats found that 644 (54.7%) of the cats had 1 or more behavior problems. Two of the most often mentioned were states of anxiety (16.7%) and feeding problems (10.9%), which included refusal of specialized diets, increased food intake with or without vomiting, and decreased food intake. The majority (59%) of the cats had been treated by a veterinarian, most frequently for gastrointestinal and respiratory tract signs. Additionally, a recent retrospective study[12] of cats referred to veterinary behaviorists reported that more than 75% of all cats referred were diagnosed with house soiling (both urination and defecation outside the litter box) and that 36.4% were diagnosed with aggression toward both the owner and other cats in the household. Males were found to be overrepresented in the house soiling category.

Veterinary clinical scientists and clinicians have reported exacerbations of LUTS in response to external environmental challenges in laboratory studies of cats with FIC[9] and in client-owned cats with idiopathic cystitis.[13,14] External environmental events that activate the hypothalamic stress response system may be termed stressors.[15] For cats, these events may consist of sudden movements, unknown or loud noises, novel and unfamiliar places and objects, and the approach of strangers. Inadequate perception of control and predictability also can activate the stress response system in animals as a result of interference with attempts to cope with their environments.[16] Depending on the frequency, intensity, and duration, chronic activation of the stress response system can overtax homeostatic regulatory systems, resulting in diminished welfare,[17] abnormal conduct, and SB.[18,19]

Sickness behaviors refer to a group of nonspecific clinical and behavioral signs that include variable combinations of vomiting, diarrhea, anorexia or decreased food and water intake, fever, lethargy, somnolence, enhanced pain-like behaviors, and decreased general activity, body-care activities (grooming), and social interactions.[20] Sickness behaviors are thought to reflect a change in motivation of the organism to one that promotes recovery by inhibiting metabolically expensive activities (eg, foraging) and favoring those that contribute to recovery. These behaviors are well-documented physiologic and behavioral responses to infection found in all animal species studied and also have been found to occur in response to aversive environmental events.[21] Psychological stressors recently have been linked to immune activation and proinflammatory cytokine release[22] as well as to changes in mood and pathological pain.[19,23] Thus, SB can result both from peripheral (eg, infection) and central (eg, psychological) pathways.

We have observed a variety of SB in donated cats with FIC and in healthy cats housed in our colony. The purpose of the study reported here was to compare SB in response to UEE in healthy cats with those of cats with FIC. On the basis of our colony experience[9] and review of the literature,[24,25] UEE were defined as events that may activate the stress response system and result in SB. These events occurred during routine operation of the colony and were comparable to events that occur in other research institutions, shelters, veterinary hospitals, and boarding facilities as well as in the homes of client-owned cats.

Materials and Methods

Subjects

Twelve healthy neutered cats (6 males and 6 females) between 1 and 6 years of age and 20 neutered cats with FIC (9 males and 11 females) between 1 and 8 years of age were studied. All cats were housed in individual stainless steel cages measuring 70 × 78 × 75 cm in The Ohio State University Veterinary Medical Center vivarium. A 12-hour light-dark schedule and a mean ± SD room temperature of 22 ± 2°C (72 ± 4°F) were maintained throughout the vivarium. The Animal Care and Use Committee of The Ohio State University approved all experimental procedures used in this study.

Cats with FIC were received as donations from veterinary clients throughout the United States because of a history of severe, irresolvable, recurrent LUTS and transferred to The Ohio State University Veterinary Medical Center for confirmation of a diagnosis of FIC and absence of other diseases. The diagnostic evaluation consisted of a complete physical examination, CBC, serum biochemical analysis, urinalysis, urine bacteriologic culture, and cystoscopy. The diagnosis of FIC was made on the basis of variable combinations of owner-reported chronic dysuria, stranguria, and pollakiuria; hematuria or proteinuria identified in the urinalysis; and, in most cats, cystoscopic identification of glomerulations (submucosal petechial hemorrhages).[4] All donated cats were quarantined for 1 month, then allowed to acclimate to the colony and free-play time for another month. Data on SB were collected from the day of arrival into the colony, but were not used in this study until after week 12 to ensure the cat was fully acclimated to the colony.

Healthy cats were obtained from licensed vendors. Cats were determined to be free of identifiable disease on the basis of history, physical examination findings, and results of CBC, serum biochemical analysis, and urinalysis that were within established reference ranges. Because cats with FIC invariably were neutered, the healthy cats were neutered within 4 weeks of arrival to the colony and at least 36 weeks prior to data collection, except for 2 healthy males that were neutered 4 days after arrival and 3 weeks prior to onset of data collection. As a follow-up to previous findings,[9,26] cats of the study reported here were also included in noninvasive studies to determine the effects of stress and enrichment on behavioral and physiologic variables.

Study design

External environmental events and SB in the colony were monitored and recorded by 1 author (JLS) for 145 weeks. The UEE included, but were not limited to, failure of light timers and temperature regulation, changes in caretaker personnel, introduction of dogs into nearby areas, other loud unpredictable noises, introduction of new cats into the colony, and movement of cats between rooms and cages. At the beginning of the data collection period, animal husbandry practices were not standardized; care occurred at varying times throughout the day by different caretakers, cage-cleaning procedures and placement of food, water, and litter containers within the cages were not consistent, frequent human traffic in and out of the colony occurred throughout the day, cage floors consisted of slatted stainless steel, and enrichments were not provided to the cats.

Behaviors determined to be SB were based on review of the literature[9,10,20,24,25] and our observations of the cats during the first 68 weeks of the study. Sickness behaviors observed and recorded for the study included signs referable to the upper gastrointestinal tract (expulsion of hair, food, or bile from the mouth) and lower gastrointestinal tract (diarrhea, soft feces, or constipation), LUTS (stranguria, hematuria, or pollakiuria), and skin (epilation, skin lesions, or chin acne); anorexia or decreased food and water intake; avoidance behaviors (lethargy, somnolence, withdrawal, guarding, reduced activity level, and decreased social interactions with conspecifics and caretakers); and aggressive, hypervigilant, and hiding behaviors. Urination and defecation outside the litter box were recorded separately from other signs referable to the lower urinary and gastrointestinal tracts in an attempt to differentiate behavioral responses from organ dysfunction.

Improvements in the husbandry practices and the colony environment were implemented on the basis of published recommendations[24,25,27] during weeks 1 to 68. The animal care staff was trained to care for the cats at regular times and carefully observe for the presence of SB; details of cage setup, enrichment, time out of the cage, and data collection were standardized. The SB data collected during the first 68 weeks were not included in the present study because of refinements in care and enrichment protocols that occurred during this period.

Colony plan

The cat housing rooms at The Ohio State University College of Veterinary Medicine vivarium consist of 6 rooms off a main hallway, 3 per side, each with its own door that was kept open. The entrance doors are at 1 end of the main corridor, and a sink with a counter is at the opposite end. Other than stainless steel work and examination tables, a chair, and a supply cabinet in the main hallway, no other furnishings were present in the colony. Each cat-housing room contained 2 banks of stainless steel cages that housed 4 cats each. Five of the rooms housed cats; the sixth room was used to store supplies.

Diet and feeding

All cats were fed 1 of 2 commercial cat foods,[a],[b] and water was provided ad libitum. The cats were fed a measured amount of food once a day in the morning during routine husbandry procedures. The amount and type of food were chosen according to the body condition and feeding habits of the individual. Each cat was weighed monthly by 1 author (JLS), and the amount fed was adjusted as needed to maintain a moderate body condition. If it was determined that the diet needed to be changed because of changes in body condition, the cat was offered both the old and new diet in separate bowls, slowly decreasing the amount of old diet and increasing the amount of new diet over 7 days until the cat was eating only the new food. No cat in the study was observed to have an adverse reaction to this procedure.

Husbandry modifications

The husbandry schedule was standardized by employing 1 caretaker Monday through Friday and a second caretaker on the weekends to provide consistent daily care between 7:00 AM and 10:00 AM. The care staff was instructed to maintain quiet in the colony and to restrict human traffic to the minimum required for animal care. An observation sheet was attached to each cat's cage to facilitate recording of food and water intake, urinations, defecations, vomiting, and any SB noticed by the care staff each day before cleaning and feeding in the morning and by 1 author (JLS) each afternoon between 3:00 PM and 5:00 PM. The cats were fed a measured amount and generally consumed it prior to the next feeding, which facilitated observation of changes in food intake. Food and water intake was estimated from the total provided as less than one-fourth, one-fourth, one-half, three-fourths, or all. The staff was trained to recognize abnormal urinations (urination outside the litter box, hematuria, polyuria, pollakiuria, or dysuria), abnormal defecations (defecation outside the litter box, hematochezia, diarrhea, soft stool, or dyschezia), and vomiting (hair, food, and bile). The

[a]Iam's Original with Chicken, P&G Pet Care, Dayton, Ohio.

[b]Royal Canin Veterinary Diet Feline Calorie Control CC, Royal Canin USA Inc, St Charles, Mo.

author inspected the colony each morning to monitor the care staff and cats and to discuss with the caretaker any changes in behavior that were observed.

The care staff also was trained to standardize the location of cage furnishings and resources. All cages contained identical furnishings, which were consistently placed in the same location within each cage. A rubber[c] mat covered the front half of the cage floor, which was made of slatted stainless steel with a slide-out tray underneath. A plastic litter pan (32 × 22 × 8 cm) was placed in the inside back corner of each cage. The pan contained litter[d] (3 cm in thickness, pine wood shavings), which was emptied twice daily on weekdays and once daily on weekends and holidays. A cardboard hiding box (approx 15 × 10 × 15 cm; hospital supply shipping boxes of variable sizes were used) was placed in the back outside corner of the cage on its side (flaps hanging down) so the top of the box opening faced the cage door. A cage pad (84 × 74 cm) was folded and placed inside the box for use as bedding. Each cage also contained a resting board (68 × 15 cm) that hung on the outside wall roughly 42 cm from the cage floor. All cats were provided with various commercial cat toys (eg, mice and plastic balls) that were replaced weekly, and an additional plastic toy was hung on the cage door. Food and water were provided in 0.6-L (20-oz) stainless steel bowls that were hung on the door of the cage.

Cage maintenance also was standardized. Cages were cleaned daily, hiding boxes were changed as often as needed (depending on wear and tear), and bedding was changed every week or whenever it became soiled. All bedding was washed with the same laundry detergent, fabric softener, and bleach throughout the study.[e] Litter pans were sterilized weekly; bowls were sterilized twice each month. The same cage plan was used throughout the study, except that new toys were not provided during times of environmental enrichment withdrawal.

Environmental enrichment

Routine husbandry was conducted daily from 7:00 AM to 10:00 AM. During this time, 1 author (JLS) opened each cage and interacted with each cat for 2 to 3 minutes. Interactions included petting, playing, and talking to the cat. Classical music[f] was played for 1 to 2 hours each day after completion of morning husbandry activities. The cats were released from their cages for 60 to 90 minutes each afternoon (Monday through Friday only) between 3:00 PM and 5:00 PM. The author released each cat from its cage in a consistent, sequential order, after which she emptied and refilled its litter pan, spot cleaned the cage, and recorded any additional observations on the cat’s observation sheet. Cats were provided additional enrichment in the cage (eg, cat nip, food treats, canned food, and a new toy).

Release of the cats from their individual cages into the colony during the afternoon period of observation was introduced gradually. First, the 8 cats housed in each housing room were released into the room together. The cats in each room had been housed next to each other for months, could see and hear each other, and often played and interacted through the cage doors with the cats located closest to them. Toys were provided in the room that also contained furniture that provided scratching and climbing opportunities. Play items were cleaned as needed with soap and water. One author (JLS) stayed in the room with the cats and interacted with them. Cats were then slowly introduced to groups from other rooms until all cats that chose to had complete access to the colony. No cat was required to leave its

[c]3M Products, Saint Paul, Minn.
[d]Sani Chips, PJ Murphy Forest Products Corp, Montville, NJ.
[e]Downey Simple Pleasures Vanilla and Lavender laundry detergent and fabric softener, P&G, Cincinnati, Ohio.
[f]The Best of Vivaldi CD, MVD Music & Video, Munich, Germany.

cage; access to other areas of the colony during these times was offered as a choice. Music[f] was played during this period and for 1 hour after cats were returned to their cages.

Three female cats with FIC stayed in their cages with the door open, and 3 stayed in a small group in one of the housing rooms. The time taken for introduction to the play sessions depended on each individual cat; some were gregarious, playful, and quick to acclimate, whereas others took much longer. The cats were always monitored by 1 author (JLS) while in play groups and were allowed to interact or not as they chose. Aside from occasional hissing, no displays of intercat aggression were observed, and SB were not associated with the release of cats at any time during the study. Litter pans were not provided because of the short duration of playtime, and all cage doors were closed so that cats did not have access to any other cats' food or litter pan. During times of environmental enrichment withdrawal or when the author was absent, release from cages was discontinued.

Data collection

Sickness behavior data for this study were collected for 77 weeks, from week 69 to week 145. Data from weeks 1 through 68 were collected but not included in the final analysis because of the changes in caging, husbandry, and environmental enrichment that were implemented during this period. Four UEE of at least 1 week's duration, which occurred during 11 of the 77 weeks, were identified. These UEE included the following: discontinuation of contact or interactions with the first author (JLS; during a 1-week absence [week 70]); a study on the effects of unpredictability and chronic mild stress that included changes in time of day of routine husbandry, unfamiliar caretakers, feeding delays (fed after 12:00 PM noon) or food removal (removed at 5:00 PM), restraint stress, anesthesia, and withdrawal of playtime and music and additional cage enrichment (3-week duration [week 92 through 94]); a delay of 3 hours in feeding time (1-week duration [week 118]) for a study on feeding choice; and an absence of the usual weekday caretaker, whose duties were assumed by multiple caretakers unknown to the cats (6-week duration [weeks 128 to 133]). No UEE of at least 1 week's duration were identified during the remaining 66 weeks, so these remaining weeks were considered control weeks.

Statistical analysis

Descriptive statistics and initial comparisons between groups were calculated by use of standard statistical software[g]; results are presented as mean ± SD. A random-effects overdispersion model was used to model the count data and allow for multiple observations per cat to determine risk factors associated with an increased incidence rate for SB. The primary outcome of interest was total number of SB. Covariates screened for inclusion in the models included age (years), sex, FIC status (cat with FIC or healthy cat), stressfulness of week (UEE or control), and relevant interactions between covariates. Separate models for individual SB also were constructed by use of the same screening covariates. Variables with values of $P \leq 0.25$ in univariate analyses were subsequently included in multivariate analyses. Variables were removed from the multivariate model on the basis of results of the Wald test. For total SB analysis, values of $P \leq 0.05$ were considered significant. For individual SB analyses, a value of $P < 0.005$ was used to compensate for multiple comparisons. Standard statistical software was used.[h]

[g]GraphPad Prism, version 5.00 for Windows, GraphPad Software Inc, San Diego, Calif.
[h]Stata, version 10.0, StataCorp, College Station, Tex.

Results

The mean number of SB during control weeks was 0.4 ± 0.4 for healthy cats and 0.7 ± 0.6 for cats with FIC; no significant ($P = 0.06$) difference between these mean values was identified. The distribution of SB during control weeks was similar between groups (Figure 1). Three SB (ie, upper gastrointestinal signs, urination outside the litter box, and decreased food intake) accounted for 88% and 78% of all SB in healthy cats and cats with FIC, respectively, during control weeks.

During weeks with UEE, mean number of SB was 1.9 ± 0.9 for healthy cats and 2.0 ± 1.2 for cats with FIC; no significant ($P = 0.74$) difference between these mean values was identified. Exposure to UEE resulted in a significant risk for an increase in total number of SB, compared with that in control weeks, and was associated with a 3.2-fold increase in risk for SB, irrespective of group (Table 1). An increase in age was associated with a modest 1.2-fold increase in risk for SB irrespective of group, although the healthy cats were significantly ($P = 0.01$) younger (2.8 ± 1.4 years old; range, 1 to 6 years old) than the cats with FIC (4.9 ± 2.2 years old; range, 1 to 8 years old).

Evaluation of the separate models for individual SB revealed that exposure to UEE resulted in large increases in risks for defecation outside the litter box (RR, 9.8), decreased food intake (RR, 9.3), and no eliminations in 24 hours (RR, 6.4); a smaller increase in risk for urination outside the litter box (RR, 1.6) also was identified. Additionally, a protective effect on food intake was identified for healthy males only, and age conferred a small increased risk for upper gastrointestinal tract signs (RR, 1.2) and avoidance behavior (RR, 1.7).

Discussion

This study has 4 noteworthy findings. First, no difference in mean number of SB was identified between healthy cats and cats with FIC under the enriched housing conditions implemented in the colony. This is despite the fact that all the cats with FIC had been donated to the colony as an alternative to euthanasia because of severe LUTS, and previous efforts to enrich the home environment had failed. For example, of the 9 male cats with FIC in this study, 4 had at least 1 episode of urethral obstruction prior to donation, whereas no occurrences of obstruction or signs referable to the lower urinary tract were observed after entry into the colony. These results suggest that the husbandry and enrichment conditions present in the colony were associated with a decrease in SB in the cats with FIC, compared with the amount observed in healthy cats. This change also occurred during feeding of commercial dry diets, demonstrating that implementation of therapeutic diets or increasing the moisture content of the cat’s diet is not necessary to affect recovery from FIC when other environmental factors are addressed. Beneficial effects of environmental enrichment on occurrence of SB in cats with FIC also have been identified in clinical studies.[10]

Second, exposure to UEE significantly increased the risk for an increase in the total number of SB in both groups of cats, suggesting that SB were more closely associated with UEE than with disease status. Features of the external environment that can activate stress responses leading to SB in animals include intrinsic un-pleasantness (cold ambient temperatures, barren cage, or loud noise), unfamiliarity (unknown caretakers or new environment), discrepancy from expectation (change in feeding or husbandry schedule or rearrangement of cage furnishings), and decreased capacity for control (lack of hiding, lack of perching opportunity, or abrupt change in diet).[24,25,27] In other species, SB have been found to be induced by proinflammatory cytokines, which can affect behavior by activation of sensory neurons or propagation of immune signals from phagocytic cells in the circumventricular organs and choroid plexus into the brain.[18] These pathways may be activated peripherally in response to infectious agents[20] or centrally by external events,[19,21] although the initial inciting cause may be difficult to determine in clinical patients.

Third, the most common SB associated with exposure to UEE, which included decreases in food intake and elimination behaviors (ie, none in 24-hour period) and increases in defecation and urination outside the litter box for cats that did eliminate, also are quite common in cats in other captive housing environments including kennels, zoos, shelters, and owner's homes.[2,12] Interestingly, the most common SB we observed, both during control weeks and in association with UEE, included those frequently identified in client-owned cats brought to veterinarians for evaluation, objectionable elimination behaviors referable to the upper and lower gastrointestinal tract and lower urinary tract, and inappetence (which could be interpreted as finicky eating by owners).[11] This information suggests that when a cat is evaluated clinically for presence of these clinical signs, the possibility that the clinical signs resulted from external as well as internal events should be considered.[28] These behaviors are not unique to cats; similar behaviors have been reported for other species in response to UEE.[15,29]

Fourth, an increase in age conferred a significant risk for an increase in total number of SB and for an increase in upper gastrointestinal signs and avoidance behaviors. The effect of age was somewhat surprising; although increases in SB have been reported for aged mice,[30] no cat in this study was older than 8 years of age. Although the mean age of the cats with FIC was somewhat older than that of the healthy cats, no significant differences in the effect of age on SB were identified between these groups.

The present study extends previous research[9,26] that reported substantial increases in activity of the stress response system of cats with FIC, compared with that of healthy cats, in response to an 8-day moderate stress protocol, and normalization of circulating catecholamine concentrations, urinary bladder permeability, and cardiac function; reduced responses to acoustic startle; and decreased frequency of SB in cats with FIC in response to environmental enrichment. These results suggest that SB were initiated by the brain, in accord with the hypotheses termed chronic multisymptom illness by Clauw and Williams,[31] central sensitivity syndrome by Yunus,[32] allostatic load by McEwen,[33] and cognitive activation theory of stress by Ursin and Eriksen,[16] all of which suggest that the chronic wear and tear of cerebral activation of neural, endocrine, and immune responses to environmental triggers can lead to organ dysfunction and SB.

One limitation of the study reported here was the lack of a so called usual-care control group. In our study, all cats were housed in enriched environments and lived to the extent possible in identical conditions. Based on our previous clinical[10] and laboratory studies,[9] however, we concluded that an unenriched control group was not consistent with modern concepts of welfare for laboratory-housed cats. Also, unambiguous determination of external events that activate the stress response system can be subjective, depending as activation does on the individual's history, the context of the occurrence of the event, and the animal's expectation of future events on the basis of current perceptions.[33] Moreover, the sensorium of domestic cats differs from that of humans in many respects, so it always is possible that events outside our perception were responsible for the observed SB. Indeed, we have observed SB in individual cats in the absence of any UEE perceived by humans caring for the cats. And although identification of SB immediately after induced events suggests an association between them, it cannot permit identification of the particular perceptions that led to the SB or determine whether the perceptions were the same in all animals. Additionally, individual cats were observed to react to seemingly benign events with expression of SB. For example, 1 healthy male persistently urinated outside of his litter box after 1 particular caregiver entered the room, and upper gastrointestinal tract signs and hiding and freezing behaviors were observed in 1 female cat with FIC whenever a stranger entered the colony. Another limitation concerns extrapolation of the present results to other situations, including client-owned cats. Although such extrapolations always must be undertaken with caution, confidence of their applicability to other populations is reinforced by the observations that the cats with FIC had engaged in similar SB when owned, that similar SB have been observed by us and others in studies[8,13] of client-owned cats, and that we and others have observed reductions in similar SB in client-owned cats in response to environmental enrichment.[10,34]

Along with measures such as normalization of species-typical behaviors and the minimization of stereotypies, monitoring SB may be an additional useful way of assessing welfare in both caged and client-owned cats.[9,10] The results of our study also provide compelling evidence that cats may engage in objectionable elimination behaviors in the presence of clean, well-tended litter boxes. Because environmental enrichment may reduce these and other SB,[10] we recommend that external as well as internal events leading to clinical signs should be considered in the evaluation of affected cats. Because both healthy cats and cats with FIC were comparably affected by exposure to UEE, we recommend that all clients with cats be provided assistance with environmental enrichment to improve the health and welfare of their cats.[35]

Acknowledgments

Supported by National Institute of Diabetes and Digestive and Kidney Diseases grants P50 DK64539 and DK057284.

Abbreviations

FIC	Feline interstitial cystitis
LUTS	Clinical signs of lower urinary tract disease
RR	Relative risk
SB	Sickness behaviors
UEE	Unusual external events

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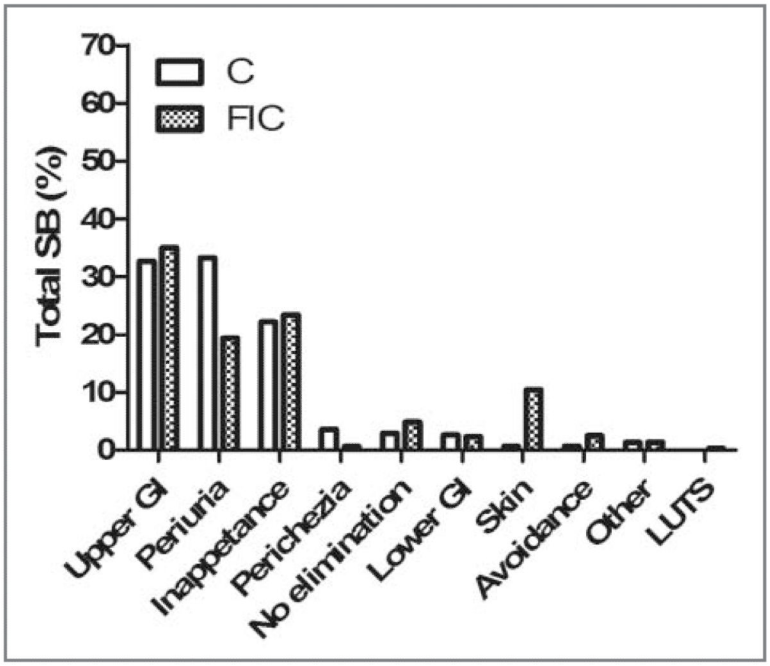

Figure 1.

Distribution of SB during control weeks in healthy cats (C; n = 12) and cats with FIC (FIC; 20). Avoidance = Behaviors of lethargy, somnolence, withdrawal, guarding, reduced activity, and decreased social interactions with conspecifics and caretakers. Inappetence = Anorexia or decreased food or water intake. Lower GI = Signs referable to the lower gastrointestinal tract (diarrhea, soft feces, or constipation). LUTS = Stranguria, hematuria, and pollakiuria. No elimination = No elimination behavior within a 24-hour period. Other = Aggressive, hypervigilant, and hiding behaviors. Perichezia = Defecation outside the litter box. Periuria = Urination outside litter box. Skin = Epilation, skin lesions, and chin acne. Upper GI = Signs referable to the upper gastrointestinal tract (expulsion of hair, food, or bile from the mouth).

Table 1

Regression models for the effect of sex, age, health status, and exposure to UEE on the RR of SB in healthy cats (n = 12; 6 neutered males and 6 neutered females) and cats with FIC (20; 9 neutered males and 11 neutered females).

Models	SB	Variable	RR	95% CI	*P* value
Total SB model	NA	Control week	1.0	Referent	NA
		UEE week	3.2	2.8–3.6	< 0.001
		Age	1.2	1.1–1.3	< 0.001
Individual SB models					
	Perichezia	Control week	1.0	Referent	NA
		UEE week	9.8	5.0–19.2	< 0.001
	Inappetence	Control week	1.0	Referent	NA
		UEE week	9.3	7.4–11.6	< 0.001
	Health status × sex	Healthy female	1.0	Referent	NA
		Healthy male	0.1	0.1–0.3	< 0.001
		Female with FIC	1.5	0.9–2.4	0.15
		Male with FIC	0.8	0.4–1.3	0.3
	No elimination	Control week	1.0	Referent	NA
		UEE week	6.4	4.0–10.2	< 0.001
	Periuria	Control week	1.0	Referent	NA
		UEE week	1.6	1.1–2.2	0.005
	Avoidance	Age	1.7	1.2–1.3	0.001
	Upper GI	Age	1.2	1.1–1.4	0.002

Avoidance = Behaviors of lethargy, somnolence, withdrawal, guarding, reduced activity, and decreased social interactions with conspecifics and caretakers. CI = Confidence interval. Inappetence = Anorexia or decreased food or water intake. NA = Not applicable. No elimination = No eliminations within a 24-hour period. Perichezia = Defecation outside the litter box. Periuria = Urination outside litter box. Upper GI = Signs referable to the upper gastrointestinal tract (expulsion of hair, food, or bile from the mouth).