A CLOSER LOOK AT THE HEALTH OF CATS SHOWING URINARY HOUSE SOILING (PERIURIA): A CASE-CONTROL STUDY

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46   **Abstract**

47   *Objective*: Perform a case-control medical evaluation of cats from multi-cat households presenting with

48   inappropriate *latrining* and *spraying* behavior.

49   *Methods:* Owners of 18 *spraying* and 23 *latrining* cats with normal control subjects available from the

50   same households were recruited for a case-control study. Otherwise overtly healthy dyads were brought

51   together to the veterinary hospital of the University of São Paulo, for a medical work-up (i.e. physical

52   examination, complete blood count, biochemical profile, urinalysis and urine culture, abdominal

53   ultrasound of the urinary system and in females, where possible, cystoscopy).

54   *Results:* Medical problems were identified with similar frequency in the "sprayers" (38.9%) "latriners"

55   (39.1%) and controls of the *latrining* group (26.1%) but not the spraying group (5.5%). The difference

56   between cases and controls from spraying households was significant. Common potential health related

57   changes include renal insufficiency, cystitis, bladder lithiasis. Renal calculi, higher creatinine levels

58   (within normal reference range) and "glomerulations" (detected during cystoscopy) were also found in

59   the remaining "sprayers" and "latriners" who were considered healthy. Post-cystoscopy a new form of

60   periuria occurred in two cats (one *"sprayer"* and one *"latriner"*).

61   *Conclusions and Relevance:* These results indicate that *spraying* or *latrining* behaviour in the home, as

62   well as living with a cat who is not using the litter box as a latrine, are all associated with a higher level

63   of urinary tract abnormalities, but not living with a cat who is spraying. The findings also suggest that

64   both forms of periuria might be associated with interstitial cystitis. We therefore conclude that all cats

65   with periuria need to be carefully evaluated medically and that treatment of latrine related problems

66   should consider all cats in the house, whereas spraying may be more focused on the individual

67   displaying the problem.

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69   **Key-words:** marking, spraying, toileting, latrining, disease, feline, cystoscopy

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1. INTRODUCTION

In the clinical context, *spraying* for marking purposes by domestic cats has long been distinguished from inappropriate urinary latrine related behavior (*latrining*) (1,2,3,4,5,6,7,8). *Spraying* commonly involves urine deposited on vertical surfaces (or on significant horizontal spots) with the cat typically in a standing posture (2,4,5). "Sprayer" cats generally keep use of the appropriate latrine for both urination and defecation (2,4,5). By contrast, inappropriate *latrining* is mostly characterized by large amounts of urine, usually on horizontal surfaces with the cat in a squatting posture (2,4,5). "Latriner" cats may give up using the latrine and so both urine and faeces may be found in inappropriate locations (2,4,5).

Successful management of either condition depends on the identification of medical factors which might be contributing to the problem (1,2,3,4,5,6,7,8). The evidence for the significance of medical problems in these cases is inconsistent (9, 10), and largely based on simple case reports and comparisons, with inadequate controls for things like differences in management that might exist (11). Nonetheless, the overall recommendation of adequate medical screening in order to eliminate potential medical factors contributing to the problem, remains sound advice (1,2,3,4,5,6,7,8). Some suggest that the urination behaviour of cats with a urinary problem does not resemble urine marking, and urinalysis does not provide relevant diagnostic information, at least in cases of urine *spraying* (12), but urinalysis may be of value in cases of latrine related problems (12). It is also worth noting that in many cases of periuria (problematic deposition of urine in the home regardless of cause), the medical assessment is often quite superficial, frequently based on only a brief physical exam and possibly urinalysis (12). A more complete evaluation of the urinary system (e.g. via ultrasound or cystoscopy) may reveal further abnormalities (13). Indeed, the frequency and extent to which medical evaluations are made in these cases is not known. Thus it is not possible to say with any confidence, what problems are present in these cases or what their relevance might be. Current practice focuses on the behavioural history, with the precise role of urinary system abnormalities evaluated to a variable extent for their relevance on a case by case basis.

Veterinary behavioural guidelines not only propose diagnostic procedures but also treatment protocols, for both inappropriate *latrining* behaviour and *spraying*. Although these are generally clear and reasonably easy to apply, complete eradication of the problem using only management and environmental change is often unsuccessful (14). There is clearly a proportion of refractory cases in

104 which typical management regimes do not work. This may include those with untreated medical

105 complications, and so it is important to improve our understanding of the potential relationship between

106 and role of urinary tract abnormalities in these cases.

107 Therefore this study aimed to address some of the shortcomings identified in previous reports

108 of the association between urinary tract disease and periuria by performing an in-depth medical

109 evaluation of a series of cats from multi-cat households presenting with inappropriate *latrining* and

110 *spraying* behaviour alongside control subjects drawn from the same household in order to control for

111 management confounds between subjects (15).

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113 **2. MATERIAL AND METHODS**

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115 **2.1. Recruitment and Selection**

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117 Publicity aimed at selecting house soiling cats and matched controls (without periuria) from

118 the same multi-cat households (n=3-9 cats per house) was promoted in several ways: via a poster at the

119 veterinary college at the University of São Paulo (FMVZ/USP) and several veterinary clinics in Sao

120 Paulo and neighboring cities, emails to a list of students of the veterinary college, postings on cat

breeder websites and Internet communities related to pet cats.

121 Cats reported by their owners to manifest periuria were classified into *spraying* or *latrining* groups

122 (together with their respective controls without periuria) on the basis of a careful behaviour analysis

123 made by a veterinary behaviourist considering cat posture and behaviour repertoire when depositing

124 urine outside the litterbox, location, target and amount of urine deposited outside the litterbox, litterbox

125 use, etc. Households where different cats exhibited urine *spraying* and *latrine related behaviour* in the

126 home were not eligible for inclusion. This means that in selected *spraying* households there was no

127 *latrining* behaviour in the home by any of the cats; similarly, in the selected *latrining* households a

128 *spraying* problem was absent.

129 Problem behavior (i.e. spraying or latrining) had been manifested by participant cats from months

130 to years with unsuccessful treatment attempts made by most of the owners previously to the current

131 study. During the study, with the exception of the cases further described in the paper, cats did not

132 receive any treatment for their problem behaviour.

133

134   *2.1.1 Spraying Group*

135   Twenty-one urine *spraying* "case-control" dyads were initially recruited, but in the case of three

136 dyads examinations could not be concluded for various reasons (e.g. cat became sick) and therefore

137 they were excluded from further involvement in the research. The remaining 18 "case-control" dyads

138 were then subjected to medical examinations involving a complete blood count, biochemical profile,

139 urine exam and urine culture and ultrasonic evaluation of the urinary system at the university veterinary

140 hospital (HOVET-USP).

141   Among the 18 "case" cats, there were 3 females and 15 males; 17 mixed-breeds and one

142 Persian, with average age 6.27 years (SD=2.44). "Control" cats were 6 females and 12 males; 17

143 mixed-breeds and one Siamese, with average age 6.43 years old (SD=4.48). On average, there

144 were 6.09 cats per household (range: 3-8 cats). Four of the 18 "case-control" dyads came from

145 two households; there were therefore 16 different households in this Group. *Spraying*

146 households were all houses (as opposed to flats) and half of them offered free outside access to the

147 cats.

148   *2.1.2 Latrining Group*

149   Twenty-nine inappropriate *latrining* "case-control" dyads were initially recruited but for six

150 dyads the examinations could not be concluded (e.g. owner did not fast in the cat or did not prevent the

151 litterbox use and so cat did not have sufficient urine for the exams). The remaining 23 "case-control"

152 dyads were then submitted to similar clinical examinations at the university veterinary hospital

153 (HOVET-USP).

154   Of the selected 23 "case-control" dyads, 18 "case" cats were females and 5 males; 13

155 mixed-breeds, 4 Persians, 4 Maine Coons and 2 Ragdolls. Their average age was 4.46 years

156 (SD=2.19). Among the "control" cats, there were 13 females and 10 males; 16 of mixed-breed, 4

157 Maine Coons and 3 Persian. Their average age was 5.21 years old (SD=3.35). Households in

158 this group had on average 4.6 cats (range: 3-8 cats). Four of the 23 "case-control" dyads came

159 from two households, and so there were 21 different households in the group. Toileting

160 households were evenly split between houses and flats and none of the toileting households offered free

161 outside access to the cats.

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163   **2.2. Medical Exams**

All procedures involved in the medical examination were conducted on both "case" and "control" cats from the household on the same morning, with cats having fasted for between 8 and 12 hours. The collected materials were processed according to standards and techniques established by the Laboratory of Clinical Pathology (HOVET-USP). Ultrasounds were performed in the same room, by a specialist in veterinary ultrasonography; a second veterinary feline specialist carried out all other clinical examinations.

In the 2 hours immediately preceding the exams, owners were instructed to encourage water intake, and to prevent the use of the litterbox in an attempt to promote bladder filling, necessary for the collection of urine, which was done by cystocentesis guided by ultrasound. Blood samples had to be sufficient for at least a complete blood count and biochemistry profile, otherwise the dyad was excluded.

Any abnormality of the lower urinary tract (e.g. bladder urolithiasis, cystitis) or alterations indicative of either systemic disease or organ dysfunction was considered a medical abnormality; the dyad did not then progress further in order to avoid undue stress, following the establishment of a medical problem of concern. However, alterations of the upper urinary tract which, did not appear to interfere with functioning of the urinary system (e.g. renal urolithiasis accompanied by normal urinalysis and renal profile) although considered potentially problematic, did not result in exclusion of the dyad from further analysis.

2.3. Cystoscopy

Second visits to the veterinary hospital were planned for cystoscopies of suitable female cats, subject to owner informed consent, including explanation of the need for a general anaesthetic. Cystoscopies were carried out on selected female "case" cats only (i.e. those exhibiting periuria without medical abnormality of concern in the preliminary exams). This cystoscopy allowed us to investigate abnormalities that may have passed unnoticed in the previous exams (e.g. interstitial cystitis) (13).

Out of the 23 potential "case-control" dyads reaching this stage, 12 (2 from the *Spraying* Group and 10 from the *Latrining* Group 2) included female "case" cats, suitable for cystoscopic examination and 8 owners elected for cystoscopy.

Cystoscopies were performed by the same specialist as the clinical exams following fasting for at least 8 hours (maximum of twelve hours) and withdrawal of water 2 hours before the exam. Cats

were pretreated with acepromazine and meperidine (0.05mg/kg and 4mg/kg, respectively, IM). Anesthesia was then induced with propofol (5-6 mg/kg, IV) and maintained with isoflurane diluted in 100% oxygen at concentrations necessary to maintain the third level of the third stage of Guedel´s classification of depth of anesthesia (16). In the case of three females which appeared to be aggressive, ketamine (2 mg/kg IV) was added to the premedication, which allowed us to safely handle them whilst promoting induction with propofol. In the last four procedures, in order to achieve a better penetration of the endoscope via a deeper urethral relaxation, butorphanol (0.4 mg/kg IV) was added to the protocol.

2.4. Statistical Analysis

A Shapiro-Wilks normality test was first performed for each of the medical variables in both groups ("cases" and "controls" were first tested separately). In the event of a normal distribution for both "cases" and "controls", Student paired t-tests were used for pairwise comparisons, with Wilcoxon signed-rank tests used in the case of non-normally distributed data.

The prevalence of medical alterations in "case" versus "control" cats in both *spraying* and inappropriate *latrining* dyads was compared by either Fisher exact test or Pearson Chi^2 test. Similarly, comparisons of case subjects between groups were also assessed using Pearson Chi^2 test. Statistical analysis was performed using SAS software (9.2 version) with a probability level of 0.05 used to assess significance.

3. RESULTS

3.1. *Spraying* dyads

Medical exams revealed that out of 18 apparent healthy cats exhibiting urine *spraying,* 7 (38.9%) demonstrated medical alterations; but this was found in only one control cat (5.5%). Significantly more "case" than "control" cats (Fisher exact test, p=0.041) therefore had at least one of the following medical conditions: renal insufficiency (2), idiopathic cystitis (2), diabetes insipidus (1), diabetes mellitus (1), ectopic testes (1). The only control cat with a medical alteration presented with bladder lithiasis.

223   The remaining 11 dyads were considered clinically healthy on the basis of the initial health

224   screen, although some medical complications which did not obviously impair either urinary or other

225   system functioning were identified. In 4 "case" and 1 "control" cat, renal lithiasis was identified (these

226   measured about 0.3 cm and in all cases were located in the renal pelvis); a renal cyst was found in a

227   fifth "case" cat. One "case "and one "control" showed renal diverticulum calcification. This meant that

228   12 out of the initial 18 recruited "sprayers" (i.e. 66.7%) and 3 out of 18 (i.e. 16.7%) controls had

229   identifiable deviations from a perfect state of the urinary tract. One of the remaining "case" cats had

230   glycosuria, but blood levels of glucose as well as frutosamine were within normal reference range.

231   Leucocytes count was high (i.e. 19,900 cells/mm^3) and further urinalysis did not reveal glycosuria

232   suggesting the condition was not due to diabetes mellitus.

233   Blood leucocyte counts of "cases" and "controls" (n=11) did not differ significantly (median

234   +/- IQR: "case" cats = 13,700 +/- 3,800 cells/mm^3, controls = 10,700 +/- 13,200 cells/mm^3; p =

235   0.6377). However, serum creatinine levels were significantly higher for *sprayers* in comparison with

236   their "controls" (mean+/-SD: "case" cats = 1.53+/- 0.31mg/dL controls = 1.19+/-0.23mg/dL p=0.005).

237   With regard to blood urea, the difference between "cases" and "controls" approached significance

238   (mean+/-SD: "case" cats = 62.68+/-6.13mg/dL controls = 56.35+/-6.41mg/dL p=0.0597).

239   Cystoscopy performed in one of the two *spraying* female cats revealed several scattered

240   submucosal petechiae ("glomerulations") (Figure 1), oedema and mild bladder haemorrhage, indicative

241   of interstitial cystitis.

242   Follow-up: over the days following cystoscopy, the cat with petechiae showed hematuria,

243   polakiuria and apparently painful urination. A latrine related problem arose with the cat depositing

244   urine containing blood in the bathroom sink (such a behaviour had never been observed before). This

245   lasted a couple of weeks and the owner felt that the problem had been exacerbated by the cystoscopic

246   examination. The cat was successfully treated with amitriptyline (1mg/kg, BID) from the first day after

247   cystoscopy for 60 days; the cat returned to using the litterbox for latrine related urination with the

248   owner reporting only rare occasions of urine *spraying*. Such improvement was sustained for at least 6

249   months when the last contact with the owner occurred.

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251   **Figure 1.** Cystoscopic examination of a female "sprayer" cat. White arrows indicate petechiae (A –

252   normal size; B – 1.5X zoom)**.**

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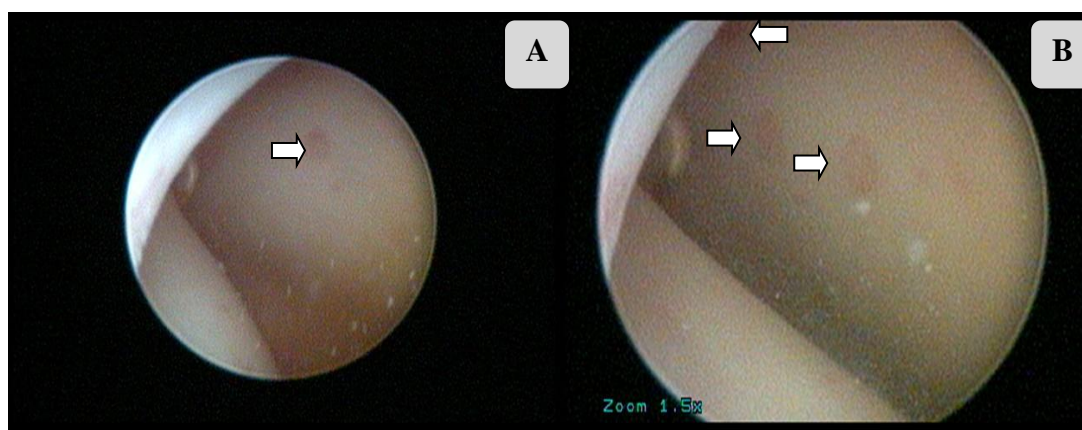
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258   **3.2. *Latrining* dyads**

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260   Medical exams revealed that out of 23 apparently healthy cats exhibiting inappropriate *latrine*

261   behaviour, 9 (39.1%) demonstrated an overt medical concern; this was found in 6 control cats (26.1%).

262   The difference was not significant between "case" and "control" cats (Pearson Chi^2 test, p=0.365).

263   Medical problems found among cases were: renal insufficiency (3), leucocytosis (2), leucocytosis plus

264   bladder plug (1), bladder lithiasis (1), bladder plug (1), hepatic disease (1). "Control" cats had

265   leukaemia (1), bladder diverticulum (1), renal insufficiency (1), bladder lithiasis (1), abdominal liquid

266   (1), hepatic disease plus urinary infection (1).

267   Of the 12 remaining dyads considered healthy on the basis of the initial health screen, there

268   were a range of other conditions identified which were not considered to obviously impair either

269   urinary or other organic system functioning. Four "case" and 4 "control" cats had one of the following

270   alterations in the ultra-sound image of their kidneys: diverticulum calcification, heterogenous texture,

271   decrease cortico-medullary definition, retraction and/or thinning of cortical area leading to loss of

272   kidney definition. This meant that in total 13 out of the initial 23 recruited "latriners" (56.5%) had

273   abnormalities and 10 out of 23 controls (43.5%).

274   One "control" cat had glycosuria, but blood levels of glucose and frutosamine were within

275   normal reference ranges and leucocytes count was high (i.e. 30,100 cells/mm^3). Later further urinalysis

276   did not reveal glycosuria suggesting that the cat did not have diabetes mellitus.

277   Blood leucocyte counts for "cases" and "controls" (n=12) did not significantly differ (mean+/-

278   SD: "case" cats = 10,641.67+/-2,191.91 cells/mm^3, controls = 13,308.33 +/- 7,206.87 cells/mm^3; p =

279   0.229). Serum creatinine as well as urea levels were also not significantly different when "latriners"

280   were compared with their controls (mean+/-SD, creatinine: "case" cats = 1.38+/-0.15mg/dL, controls =

281   1.40+/-0.26mg/dL p=0.848; urea: "case" cats = 60.28+/-15.58mg/dL controls = 60.13+/-12.66mg/dL

282   p=0.968).

283   Cystoscopy was attempted on 6 of the 10 potentially qualifying female cats, but complete

284   bladder visualization was possible in only 3 of them; in the other 3 cats, urethra passage was very

285   difficult and given the risk of injury, the procedure was abandoned. The bladder was healthy in 2 cats,

286   but in the third there were submucosal petechiae ("glomerulations"), ulcerations and haemorrhage

287   (Figure 2) indicative of interstitial cystitis.

288   Follow-up: on the days following cystoscopy the cat diagnosed with interstitial cystitis showed

289   hematuria, polakiuria and painful urination (including high pitch vocalization before entering the litter

290   box). Urine *spraying,* which had never been observed in this cat before as well as a digging behaviour

291   at the front door of the house (followed by urination just there) arose during this time. This cat was

292   treated with amitriptyline (1mg/kg, BID) from the first day after cystoscopy and for 90 days. Within a

293   couple of weeks, the cat returned to its previous pattern of eliminating large amounts of urine on

294   horizontal surfaces in the home without signs of pain. The owner reported, however, a decrease in

295   frequency of inappropriate urination. The problem was still present after 6 months despite inclusion of

296   behaviour therapy to augment treatment.

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299   **Figure 2.** Cystoscopic examination of a female "latriner" cat. Red arrow indicates petechiae and

300   ulceration; white arrow indicates haemorrhage.

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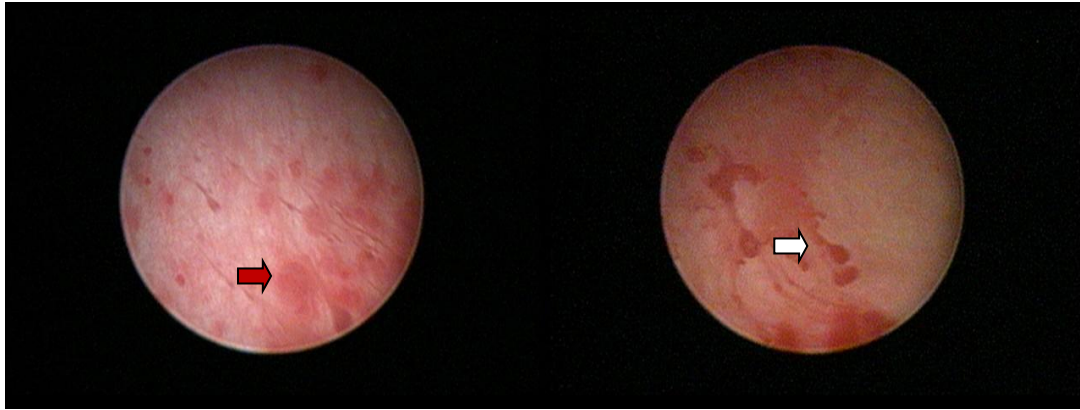
3.3. Comparison between "Sprayers" and "Latriners"

Medical conditions were detected with similar frequency in both apparently healthy "sprayers" and "latriners" (Pearson Chi^2 test, p= 0.639).

4. DISCUSSION

Medical conditions were common in both overtly healthy "sprayers" and "latriners", thus, despite recommendations to focus on ruling out medical problems in cases of inappropriate *latrining* only (12), our findings from the case-control study emphasize that a medical work-up should be undertaken in any case of periuria as previously suggested (10). This finding is supported by two cases who went on to develop periuria one in the form of spraying the other in the form of latrining, following cystoscopy. The prevalence of medical conditions among our selected sprayers is more in agreement with the findings of Frank et al (10), Barcelos et al (11) and Tynes et al (12) than the report of Landsberg and Wilson (17). The differences could be due to which medical conditions are considered as possibly interfering with the act of urine expulsion. In the study reported here, any alteration of the upper urinary system potentially compromising urinary function, any abnormality of the lower urinary tract or altered functioning of the organism in general that was considered as possibly linked to periuria led to a medical concern for the cat; by contrast, other studies have only considered lower urinary tract disorders or the result of a single urinalysis as exclusionary criteria (12,17). In the case of "latriners", the percentage of cats presenting a medical condition (i.e. 32.1%) is consistent with previous research which has indicated a similar lifetime prevalence of urinary tract disease (9,11,18).

Physical alterations in periuric cats are typically described in relation to *lower* urinary tract disorders or other conditions known to be painful (4,5,8,9,12, 18), but alterations in the *upper* urinary

326 tract were seen in both "sprayers" and "latriners" subject to more intense medical evaluation. The

327 significance of this remains unclear. Investigations on the link between renal alterations as early renal

328 disease and different types of urinary act, particularly when urinary function does not seem to be

329 diminished are lacking. Likewise, the potential for renal formations (e.g. calculi within the kidney) to

330 cause pain and as a consequence change urination behaviour has been completely overlooked in the

331 scientific literature. Thus, if such conditions act either as causes or contributors to inappropriate

332 urination (particularly in the *spraying* cases) and have not been detected due to medical exams being

333 focused on the lower urinary tract, this might explain, at least in part, the refractoriness of some cases:

334 since part of the problem has not been recognised and managed. Since the veterinary goal is to provide

335 complete care for the feline patient with a urinary behaviour problem (4,5,8), a detailed medical

336 examination including imaging evaluation of the upper urinary tract should be encouraged, especially

337 in refractory cases. Therapeutic intervention for some conditions (e.g. evidence of CKD-stage 1, renal

338 calculi, renal cyst) may not involve much more than monitoring the condition, since the significance of

339 these features to wider kidney disease progression is still unclear (19); a relapse in periuria correlated

340 with medical progression, or an improvement in association with medical treatment, may help to

341 establish a link between these conditions, and help to explain why a refractory case has not achieved

342 success despite the appropriate behaviour management.

343   In *spraying* households medical conditions were more common in "sprayers" than in "controls"

344 whereas in *latrining* households "latriners" and "controls" were equally affected by medical problems.

345 A 21.4% prevalence of medical problems among "control" cats in the *latrining* group was unexpected;

346 a previous report of 100 apparently clinically healthy cats has indicated that only 6% had medical

347 problems (e.g. hyperthyroidism, urinary infection)*.[1] The current report is the first time medical

348 problems have been identified with such high frequency in cats sharing the same environment as those

349 with a latrine problem. Nonetheless, the relatively high prevalence of abnormalities in control cats from

350 households with a latrine cat, is similar to the general prevalence reported by Tynes et al. (12) and

351 lifetime owner-reported history prevalence or urinary disease reported recently by Barcelos et al. (11).

352 One possible explanation for such a result lies in environmental physical and/or social characteristics

353 (or even ownership style) which may predispose all household cats to diseases in *latrining* households.

354 For example, Barcelos et al. (11) recently reported that cats with a latrine problem were less likely to be

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[1] *Garcia JL, Bruyette DS. American College of Veterinary Internal Medicine Forum poster session. 1998.*

355 described as having a heavy dependence on their owner compared to either spraying cats or non-

356 periuric controls.

357   Spraying households had a higher average number of resident cats than latrining houses. Although

358 this had not reached significance we can hypothesized that cats from spraying houses were more likely

359 to be involved in conflict behaviours and therefore more prone to manifest spraying but not necessarily

360 to develop more diseases. It should also be noted that cats in *latrining* houses did not have outside

361 access whereas half of *spraying* households offered free outside access to the cats, and this has been

362 identified as a risk factor for the condition (11). We hypothesise that a lack of access to diverse external

363 latrines might reduce urinary frequency and thus encourage overdistension of the bladder, predisposing

364 subjects to cystitis. Depending upon combinations of external factors (e.g. decrease in water

365 availability, provision of a low quality diet) and individual predispositions, medical problems

366 interfering with the urinary system may also arise, potentially leading to periuria in some subjects. In

367 other cases, non-urinary illness may develop and likely result in other medical signs which may not be

368 perceived by the owner of multiple-cats, at least in its early stages. Thus, we suggest that there may be

369 several ways in which the care needed for optimal bladder health may not be provided by the owners of

370 participant cats in the *latrining* group. Whether this is a problem of the households in this study only, or

371 if it represents a wider characteristic in cases of latrining cats remains to be explored, although the

372 recent results of Barcelos et al. (11) suggest it may be a much wider problem. In the interests of caution

373 to safeguard cat health and welfare, we therefore suggest clinicians make a broader enquiry into the

374 overall environmental management and general feline urinary health care of households affected by a

375 *latrining* problem. This should emphasise the importance of multiple litter tray sites in all homes, with

376 indoor only cats (regardless of the number of cats in the household), but perhaps for a slightly different

377 reason than is commonly described in behaviour texts (1,2,4,5,6,8); i.e. to maintain bladder health

378 rather than meet the desire of cats not to share a latrine with others. Although issues such as

379 unacceptable cleanliness of the litterbox, inappropriate distribution of the litterboxes etc may play a

380 role (1,2,4,5,6,8), it is worth noting that litter box features were not a risk factor in the recent study of

381 Barcelos et al. (11), although lack of access to outdoor latrines was. Perhaps too much emphasis has

382 been put on hygiene and odour related issues, when it may be more appropriate to focus on choice and

383 opportunity for cats.

384   Cystoscopy provides an accurate way to diagnose cystitis and its use in this study reflects the value

385   of a more multimodal veterinary medical approach to behaviour cases (20,21,22,23,24,25). However,

386   as professionals it is important for veterinarians to offer expert advice which balances the risks with the

387   benefits of any proposed procedure. We do not recommend cystoscopy for all female cases of

388   inappropriate urination. There are risks from anaesthesia, possible complications (including those

389   illustrated here) and cost factors to consider, alongside a recognition that full inspection of the bladder

390   is not possible in all cases (25). It should also be recognised as a highly specialised procedure (26,27).

391   However we do suggest that cystoscopy may be valuable in refractory, atypical and more obscure

392   cases. Before cystoscopy, owners must be made aware of the procedure itself as well as the risk of

393   temporary worsening of the problem or a new form of periuria, as appeared to occur in two cases in this

394   study.

395

396   **5. CONCLUSIONS**

397   In conclusion, our findings emphasise the importance of considering not just bladder health but

398   general urinary tract functioning in all cats with periuria. For those showing a latrine problem in the

399   home, we suggest that attention needs to be paid to the provision of sufficient latrine opportunities as a

400   first line of enquiry. Further work is required to establish the nature of the causal link between urinary

401   tract problems and periuria, and this will likely be accelerated by greater co-operation between internal

402   medicine and behavioural specialists.

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