

Findings and prognostic indicators of outcomes for queens with pyometra treated surgically in a nonspecialized hospital setting

Sharon Pailler, PhD^{1*}; Margaret R. Slater, DVM, PhD¹; Sylvia M. Lesnikowski, DVM²; J'mai M. Gayle, DVM²; Camille B. C. A. Duvieusart, DVM²; Eric J. Ledesma, DVM²; Megan L. Lee, DVM²; Jennifer D. Stevens, DVM²; Camille DeClementi, VMD²

¹Department of Strategy and Research, American Society for the Prevention of Cruelty to Animals, New York, NY

²American Society for the Prevention of Cruelty to Animals Animal Hospital, New York, NY

*Corresponding author: Dr. Pailler (Sharon.pailler@aspca.org)

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OBJECTIVE

To describe findings, determine the rate of survival to hospital discharge, and identify prognostic indicators of poor outcomes for female cats (queens) with pyometra treated with ovariohysterectomy (OHE) in a nonspecialized setting.

ANIMALS

134 queens with pyometra diagnosed between January 1, 2017, and December 31, 2019.

PROCEDURES

The medical records were retrospectively searched and data including patient history, clinical signs, blood work results, and outcome (survival to hospital discharge, length of hospitalization, and uterine rupture) were collected from medical records. Logistic regression models were used to assess potential predictors of outcomes.

RESULTS

Dehydration (69% [83/121]) and absolute neutrophilia (83% [52/63]) were commonly reported. The rate of survival to hospital discharge was 100% (126/126; 95% CI, 97% to 100%) for queens treated with OHE; 33% (41/126) were hospitalized ≥ 2 nights, and 4% (5/120) had uterine rupture. Queens with abnormal serum ionized calcium concentration or signs of depressed mentation had greater odds (OR of 4.64 and 2.26, respectively) of ≥ 2 nights' hospitalization. Queens with high rectal temperature, closed pyometra, or heart murmur had greater odds (OR of 35.66, 17.37, or 16.06, respectively) of uterine rupture.

CLINICAL RELEVANCE

Our findings indicated that OHE for pyometra in queens was highly successful even when performed in a nonspecialty hospital with high-quality basic supportive care, and we believe most general practitioners who offer OHE could expect to see similar outcomes. With more general-practice veterinarians comfortable treating pyometra in their clinics, OHE for pyometra will be available to more pets, ultimately saving more lives.

Pyometra, infection of the uterus, can be a life-threatening condition for female cats (queens).¹ Prior research on pyometra has primarily focused on its occurrence in bitches, with few studies documenting the prevalence, characteristics, and prognosis of pyometra in queens.² As such, knowledge of pyometra in queens is largely based on generalizing observations in bitches.² Clinical signs of pyometra in queens are often subtle and difficult to detect.²⁻⁴ Few studies^{2,5,6} address pyometra in queens, and signs most commonly reported include lethargy and anorexia, and to a lesser extent pyrexia, vaginal discharge, dehydration, and abdominal distension. Additionally, queens with pyometra have been

reported to have leukocytosis, leukopenia, anemia, or neutrophilia, alone or in combination.⁵⁻⁷

The reported incidence of pyometra is higher in dogs (> 20% by age 10 years)⁸ than in queens (2% by age 13 years)¹; however, clinical signs of pyometra are nonspecific and may go undetected in queens.^{2,4} Mortality rates are slightly higher among affected queens (6% [19/335]),¹ compared with bitches (4%).⁸ Also, because clinical signs of pyometra in queens are often unnoticed, affected queens may have advanced stages of illness before pyometra is diagnosed.¹ In advanced stages of pyometra, queens may have sepsis, endotoxic shock, or systemic inflammatory response syndrome (SIRS), and

the disease can be fatal.⁹ Pyometra is thus typically treated on an emergent basis.⁹

Although the typical treatment of pyometra is an ovariohysterectomy (OHE), because patients are often treated on an emergency basis, the cost of pyometra surgery can be > 10 times the cost of a routine spay.¹⁰ This financial burden can influence and even preclude surgical treatment of pyometra; therefore, keeping diagnosis and treatment affordable is essential to increase access to veterinary care.¹¹ The high cost of treating a queen with pyometra in an emergency setting could potentially be avoided if general practices were comfortable performing OHEs on queens with pyometra. However, private practice veterinarians may be reluctant to perform emergency OHE in their clinics when an affected patient presents with severe clinical signs.

The goals of the study reported here were 3-fold. Given that little research describes pyometra specifically in queens, one of our goals was to supplement the literature describing the clinical presentation, laboratory findings, and prognosis of pyometra in queens. We also aimed to identify the clinical signs and hematologic indicators associated with poor outcomes following OHE and to demonstrate that surgical treatment with basic, nonspecialized supportive care can be highly successful.

Materials and Methods

This retrospective analysis relied on medical records data from clients seen at the American Society for the Prevention of Cruelty to Animals Animal Hospital (AAH) in New York City. The AAH accepted urgent or emergency patients belonging to economically disadvantaged New York City metro residents and provided financial support for the treatment of eligible patients; as such, patients were often referred to AAH from the area's private veterinary practices for financial reasons. The AAH had guidelines to determine eligibility for financial support for treatments. Patients with poor prognosis and comorbidities, such as cancer or diabetes, were not eligible for financial support but may have been treated at a subsidized cost to the owner or euthanized at no cost. These guidelines were updated as this study progressed, for instance, in June 2018, limits were placed on the number of nights of hospitalization eligible for financial assistance to owners, on the basis of recommendations from preliminary findings of the present study that clinical signs resolve rapidly after surgery.

Animals

Queens of any age with pyometra diagnosed at the AAH between January 1, 2017, and December 31, 2019, were eligible. Diagnosis was made based on patient history, clinical presentation, and findings on physical examination and diagnostic imaging. The AAH did not perform elective spay-neuter services; therefore, animals included did not have incidental pyometra discovered on elective OHE. For queens that had OHE performed, the presence of a fluid-filled

uterus verified the diagnosis of pyometra. Performing fluid analysis or bacterial culture on uterine fluid was not part of the standard treatment protocol at AAH, because findings did not inform postoperative procedures. We therefore could not, with certainty, distinguish among hydrometra, mucometra, or pyometra with information available in the medical records, and the term pyometra was used in the study for any of these disease conditions.

Medical records review and data collection

Presurgical findings—Data extracted from the medical records of queens with pyometra that underwent OHE included whether the animal had been seen by a veterinarian for signs associated with pyometra prior to having been presented to the AAH; duration of clinical signs; whether the pyometra was open versus closed; whether the queen was ambulatory versus nonambulatory; the presence versus absence of depressed demeanor, diarrhea, inappetence, vomiting, polydipsia, polyuria, dehydration, ascites, mammary tumors, or heart murmur; the queen's respiratory rate and effort, rectal temperature, heart rate, age, and body weight; results of serum biochemical analyses or other hematologic assessments when performed; dates of hospital admission (intake), surgery, and hospital discharge; and whether the animal was discharged from the hospital versus euthanized or died in the hospital. On the basis of age, queens were grouped as either ≤ 8 or > 8 years of age for consistency with other work.¹³⁻¹⁵ On the basis of cutoffs for SIRS,¹² queens with rectal temperatures > 39.7 or < 37.8 °C were classified as febrile or hypothermic, respectively; heart rates > 225 or < 140 beats/min were classified as high or low, respectively; and respiratory rates > 40 breaths/min classified as high. Serum biochemical and hematology analyses were performed with point-of-care equipment (i-STAT 1 and i-STAT Alinity, Zoetis Inc) and commercial, offsite laboratories (SA020 [Superchem with CBC], Antech Diagnostics Inc), respectively, with reference limits provided by the manufacturer.¹⁶

Surgery—All OHEs were performed by veterinarians experienced in general surgery. Surgical technique was modified regarding suture selection and ligature choice as needed to provide adequate hemostasis. In general, OHE was performed with a ventral midline approach to the caudal aspect of the abdomen for celiotomy. Abdominal lavage was not standard unless gross contamination of the abdomen was confirmed. Antimicrobials and IV fluids were administered during and after surgery. Transfusions were administered as needed per clinician discretion on the basis of findings (eg, hypotension, tachypnea, tachycardia, or anemia).

Hospitalization—Following OHE, queens were discharged once they were eating appropriately and would tolerate oral administration of medications; antimicrobial and analgesic medications were prescribed at the time of hospital discharge. Because a typical length of hospitalization at AAH following

OHE for pyometra was 1 night, an extended length of stay at the hospital was defined as ≥ 2 nights stay postoperatively. For queens admitted the day before the AAH would be closed and thus could not be discharged for administrative reasons after 1 postoperative night in the hospital (ie, an additional postoperative night in the hospital was attributed to the AAH being closed on Sundays and holidays), we subtracted the additional stay that was not medically necessary from the total length of stay recorded.

Euthanasia or medical treatment—When applicable, we identified and indicated the reason for euthanasia or medical treatment of queens with pyometra that did not undergo OHE. To the extent that clinical signs and bloodwork results were available in the medical records for euthanized queens, we extracted such information from the medical records for comparisons with results for queens with pyometra treated with OHE.

Statistical analysis

For continuous variables, means and SDs were reported for normally distributed data, whereas medians with the first and third quartiles (1Q and 3Q, respectively) of the interquartile (25th to 75th percentile) ranges (IQRs) were reported for data not normally distributed. Normality was assessed with the Shapiro-Wilk test. For each categorical variable, the count, percentage, and 95% CI were reported. The Fisher exact test was used for exploratory univariable analysis between the outcomes of extended length of hospital stay (≥ 2 nights) or uterine rupture and each of the potential prognostic variables of interest to facilitate determining which variables to include in preliminary regressions. Additionally, the Fisher exact test was used for univariable analysis with those same prognostic indicators but with outcomes of euthanasia or OHE.

To identify the most parsimonious models for predicting outcomes, logistic regression models were developed using backward-stepwise selection estimation using the likelihood-ratio test. Prognostic indicator variables documented for $> 95\%$ of queens and with a value of $P < 0.2$ in the exploratory univariable analyses were included in preliminary models as potential predictors of an extended length of hospital stay (≥ 2 nights) or uterine rupture. Because transfusions were administered as needed per clinician discretion on the basis of findings included in the model, receipt of a transfusion was not included as a predictor in logistic regression models. Variance inflation factors were used to identify collinearity between variables. Significance was set at $P < 0.05$. Because preliminary models may have had restricted samples due to missing data for some variables, omitted variables in the initial stepwise process were individually re-entered, tested for significance, and then added back into the model when significant ($P < 0.05$) on a second backward-stepwise process where all variables with a value of $P \geq 0.05$ were removed. McFadden R^2 was used to calculate pseudo R^2 values. The fit of final logistic regression models was assessed with the Hosmer-Lemeshow

goodness-of-fit test. Final models were tested for significant interactions with the use of likelihood-ratio tests. Odds ratios were calculated. Classification tables with estimated sensitivity and specificity of the model and the predictive power of the final models were compiled. Commercially available software (Stata Statistical Software, release 15, StataCorp) was used for all analyses.

Results

Animals

There were 134 queens with pyometra diagnosed at the AAH, of which 126 (94%) were treated with OHE, 6 (4%) were euthanized, and 2 (2%) were treated medically. Median age was 6 years (range, < 1 to 16 years; IQR, 3 to 9 years) for the 126 queens treated with OHE, and all 126 (100%; 95% CI, 97% to 100%) survived to hospital discharge. For these 126 queens, the median number of postoperative nights in the hospital was 1 night (range, 0 to 5 nights; IQR, 1 to 2 nights), with 41 (33%) queens having stayed in the hospital ≥ 2 nights (**Table 1**). The medical records of 119 of these 126 (94%) queens had information regarding whether uterine rupture had occurred; of these 119 queens, 5 (4%) had a ruptured uterus. Additionally, owners commonly reported that their queens had inappetence (74/119 [62%]) or had been examined previously by a veterinarian for the current signs of pyometra (63/126 [50%]). Of queens with clinical signs documented in the medical record, 69% (83/121) were dehydrated.

Bloodwork

Results for serum biochemical analyses (i-Stat, Zoetis Inc [$n = 126$] or Superchem with CBC, Antech Diagnostics Inc [63]) at intake demonstrated that 79% (96/121) of the queens had high total protein concentration and 50% (62/124) had low creatinine concentration. Of the 63 queens for which an automated CBC combined with biochemical analyses was performed at the time of hospital intake (**Supplementary Table S1**), 7 had high serum total protein concentration and only 1 had low serum creatinine concentration on their corresponding biochemical analyses. Additionally, 83% (52/63) of queens had high absolute neutrophil counts (mean, 24,670 cells/ μL ; reference range, 2,500 to 8,500 cells/ μL), 73% (46/63) had a high percentage of neutrophils (mean, 80%; reference range, 35% to 75%), 67% (42/63) had high WBC counts (mean, 30×10^3 WBCs/ μL ; reference range, 3.5×10^3 to 16×10^3 WBCs/ μL), 62% (39/63) had high absolute monocyte counts (mean, 1,573 cells/ μL ; reference range, 0 to 600 cells/ μL), and 56% (35/63) had low platelet counts (mean, 203×10^3 platelets/ μL ; reference range, 200×10^3 to 500×10^3 platelets/ μL). However, the automated CBC test also simultaneously identified platelet counts as adequate for all 35 queens with a platelet count below the lower reference limit.

Table 1—Summary results for various outcomes and potential predictive variables of interest among 126 queens that underwent ovariohysterectomy for treatment of pyometra between January 1, 2017, and December 31, 2019.

Variable	No. of queens with status recorded	No. (%) of queens with finding
Outcomes		
Extended length of hospital stay (≥ 2 nights)	126	41 (33)
Ruptured uterus	120	5 (4)
Potential predictive variables of interest		
Owner-reported patient history		
Age > 8 y	126	44 (35)
Duration of clinical signs > 1 wk	105	44 (42)
Previously evaluated by a veterinarian for the same episode of pyometra	126	63 (50)
Polyuria	102	20 (20)
Polydipsia	103	24 (23)
Diarrhea	110	10 (9)
Inappetence	119	74 (62)
Vomiting	114	36 (32)
Clinical signs		
Signs of depressed mentation	124	45 (36)
Closed pyometra	124	15 (12)
Nonambulatory	110	1 (1)
Increased respiratory effort	124	2 (1)
Tachypnea	108	31 (29)
Hypothermia	108	27 (25)
Febrile	108	9 (8)
Bradycardia	125	2 (2)
Tachycardia	125	24 (19)
Dehydration	121	83 (69)
Laboratory findings on hospital intake		
Hypoproteinemia	121	0 (0)
Hyperproteinemia	121	96 (79)
Hyporcreatininemia	124	62 (50)
Hypercreatininemia	124	7 (6)
Low BUN concentration	124	11 (9)
High BUN concentration	124	22 (18)
Hypoglycemia	124	0 (0)
Hyperglycemia	124	50 (40)
Low PCV	121	9 (7)
High PCV	121	11 (9)
Low serum iCa concentration	123	55 (45)
High serum iCa concentration	123	9 (7)
Hyponatremia	123	33 (27)
Hypernatremia	123	0 (0)
Hypokalemia	123	2 (2)
Hyperkalemia	123	34 (28)
Comorbidities		
Mammary tumor	125	6 (5)
Heart disease	126	14 (11)
Heart murmur	126	13 (10)
Additional surgical findings		
Ascites	119	11 (9)
Transfusion	126	15 (12)

Percentages are rounded to the nearest whole percentage.
iCa = Ionized calcium.

Evaluation for predictive variables

Death was an outcome of interest; however, all queens that underwent OHE survived. Therefore, we could not conduct univariable analysis of predictors of death for queens undergoing OHE for pyometra.

Univariable associations between extended length of hospital stay or uterine rupture and variables of interest for patient history, clinical signs, serum biochemical analyses, and comorbidities were compiled for queens that underwent OHE for

pyometra (**Supplementary Table S2**). Univariable analysis of CBC values was not performed because these data were only available for 63 of the 126 (50%) surgically treated queens.

Results of multivariable analyses were compiled (**Table 2**). Signs of depressed mentation or high or low serum ionized calcium (iCa) concentration were independently associated with greater odds of remaining in the hospital ≥ 2 or more nights. Because the results of the Hosmer-Lemeshow χ^2 tests indicated poor model fit when including variables for high serum iCa

Table 2—Logistic regression models of association between variables for patient history, clinical signs, and laboratory findings and outcomes of length of hospital stay ≥ 2 nights (39/121 animals included in the analysis), ruptured uterus (4/102 animals included in the analysis), or euthanasia (6/116 animals included in the analysis).

Outcome/Variable	OR	SE	95% CI for OR	Wald statistic	P value	McFadden pseudo R^2	P value for Hosmer-Lemeshow χ^2 test	Sensitivity (%)	Specificity (%)
Length of stay ≥ 2 nights						0.12	0.18	46.2	89.0
Abnormal iCa concentration at intake	4.64	2.08	1.93–11.17	3.43	< 0.01				
Signs of depressed mentation	2.26	0.96	0.98–5.22	1.92	0.06				
Ruptured uterus						0.42	0.09	50.0	100
Fever	35.66	52.71	7.97–645.91	2.42	0.02				
Closed pyometra	17.37	23.68	1.20–251.18	2.09	0.04				
Heart murmur	16.06	21.89	1.11–232.21	2.04	0.04				
Euthanasia						0.19	—	33.3	99.1
Nonambulatory	54.50	69.64	—	2.99	< 0.01				

— = Not calculated.
iCa = ionized calcium.

concentration and low iCa concentration separately in the same model, these variables were combined into a single variable, abnormal iCa concentration levels, in the final model and led to an adequate model fit. The outcome of ruptured uterus was predicted by the presence of a high rectal temperature (OR, 35.66; 95% CI, 1.97 to 645.91), closed pyometra (OR, 17.37; 95% CI, 1.20 to 251.18), and heart murmur (OR, 16.06; 95% CI, 1.11 to 232.21). Variance inflation factors were < 1.4 in all final models. Interactions were not significant in any of the models.

Predictive power and model fit

Signs of depressed mentation and abnormal serum iCa concentration correctly predicted extended length of hospital stay for 46% (18/39) of queens that did, in fact, have extended hospital stays and incorrectly predicted an extended length of stay for 11% (9/82) of queens that stayed only 1 night in the hospital. Results of the Hosmer-Lemeshow χ^2 test of the extended length of stay model were not statistically significant, suggesting adequate model fit.

The logistic regression model for uterine rupture correctly predicted the presence of uterine rupture in 2 of the 4 of queens with uterine rupture included in the analysis and correctly predicted the absence of rupture in 100% (98/98) of queens without uterine rupture included in the analysis. Results of the Hosmer-Lemeshow χ^2 test of the model predicting uterine rupture were not statistically significant, suggesting adequate model fit.

Queens with pyometra not treated with OHE

Two of 134 (2%) queens with suspected pyometra were sent home with prescriptions of antimicrobials and analgesics for supportive care. One of the queens was not eligible for surgery due to the presence of metastasized neoplasia. The medical record of the other queen listed financial reasons of the owner for not pursuing OHE, and it was also noted in the medical record that pyometra was not a certain diagnosis.

The remaining 6 of the 134 (4%) queens suspected to have had pyometra were euthanized at the owners' request because of masses in the abdomen (n = 1) or uterus (1), mammary gland tumor (1), concurrent pleural effusion (1), or advanced age (16-year) and concomitant high serum creatinine concentration (1), or because the animal was not a good surgical candidate due to a combination of hypotension, hyponatremia, hypochloremia, hypocalcemia, lethargy, and tremors (1). Mean \pm SD age at euthanasia was 8 ± 5 years (range, < 1 to 16 years). Findings for the 6 queens that were euthanized were compared with those for queens that underwent OHE. Results of exploratory univariable analyses of findings for patient history, clinical signs, serum biochemical analyses, and comorbidities for queens euthanized versus those that underwent OHE were compiled (**Supplementary Table S3**), and results of multivariable analysis (Table 2) indicated that nonambulatory queens were 54 times as likely to have been euthanized. Only 3 of 116 queens with documented ambulatory status were nonambulatory: 2 were euthanized because of comorbidities in addition to pyometra, and 1 survived to hospital discharge. Furthermore, the variable for nonambulation did not correctly predict euthanasia for most queens. The model correctly predicted euthanasia for only 2 of the 6 queens that were euthanized and incorrectly predicted euthanasia for 1 nonambulatory queen that survived to hospital discharge.

Discussion

Although previous reports^{7,17} identify factors that influence mortality rates and prolong hospitalization of surgically treated bitches with pyometra, the present study was the first to our knowledge to focus on such factors in affected queens. Of the 134 queens with pyometra in the present study, 126 underwent surgical treatment (OHE), 2 underwent medical treatment, and 6 were euthanized. None of the queens that underwent OHE for pyometra

at AAH died. The lower limit of the 95% CI for survival to hospital discharge was 97%, which indicated that on a grander scale, the true rate of survival to hospital discharge is likely to be between 97% and 100% for cats with pyometra treated with OHE. The overall mortality rate was 4%, and all queens euthanized were euthanized due to the presence of severe comorbidities in addition to presumed pyometra. This mortality rate was lower than previously reported (5.6% [19/335]¹ to 8% [15/183]),⁵ and lower than that typically found for bitches. In addition, only 33% (41/126) queens stayed ≥ 2 nights in the hospital after surgery, which is lower than the proportion of bitches surgically treated for pyometra at AAH during a similar period (44% [174/394]),¹⁴ and the proportion of dogs with an extended length of stay reported by Jitpean et al.⁷ However, the percentage of queens with uterine rupture in the present study (4% [5/120]) was similar to that reported by Kenney et al.⁵ (4% [7/183]).

Abnormal concentrations of serum iCa and signs of depressed mentation were associated with length of stay in the hospital ≥ 2 nights. These findings may indicate that queens that fit this profile are more likely to need supportive care for longer periods, and this information can be used to make treatment decisions for pyometra at an emergency hospital or general practice. The presence of high rectal temperature (> 39.7 °C), closed pyometra, or heart murmur was associated with greater odds of uterine rupture. However, given that all queens survived to hospital discharge, a ruptured uterus did not seem to increase the risk of death after surgery in the present study.

Our sample of queens with pyometra had mild clinical signs, with anorexia the most frequent followed by signs of depressed mentation and vomiting, which were findings similar to what has been previously reported.^{2,5,6} However, queens seen at AAH for pyometra tended to have documentation of clinical signs more frequently than reported previously. For instance, anorexia was found among 62% (74/119) of the queens that underwent OHE in the present study but was reported in only 40% (73/183) of the animals reported by Kenney et al.⁵ Likewise, vomiting was reported for 32% (36/114) of the queens that underwent OHE in the present study but was reported in only 16% (29/183) by Kenney et al.⁵ The literature specifically notes a lack of observed polyuria and polydipsia in queens versus bitches with pyometra,^{2,5} yet polyuria or polydipsia was documented for 20% (20/102) and 23% (24/103) of queens, respectively, in the present study and for only 9% (17/183) for either polyuria or polydipsia as reported by Kenney et al.⁵

Similarly, blood analysis results for queens of the present study were comparable with the handful of parameters previously described.^{2,3,5} For instance, queens of the present study rarely had serum biochemical analyses values above reference limits, and results for their CBCs demonstrated that neutrophilia and leukocytosis were found in most queens, which were findings similar to those of prior reports.^{2,3,5} The percentage of queens in our study

with hyperproteinemia (79% [96/121]) was higher than that reported by Kenney et al.⁵ (30% [46/150]); however, this could have been attributed to the use of different reference ranges. For the 63 queens in the present study for which automated CBC and biochemical analyses were performed with one device, results for only 7 (11%) indicated hyperproteinemia. In addition, we found monocytosis in 62% (39/63) and thrombocytopenia in 56% (35/63) of the queens for which CBC results were available. These categorical findings were likely influenced by the use of the test's reference ranges, compared with other reference ranges. All queens with platelet counts lower than the lower reference limit ($< 200 \times 10^3$ platelets/ μL) of the point-of-care analyzer concurrently had adequate reports by the analyzer for the given platelet counts.

Despite a greater frequency of reported clinical signs, the mortality rate was 4% (6/134) over the study period for cats in the present study and was substantially lower than the mortality rate of 8% (15/183; 95% CI, 5% to 13%) reported by Kenney et al.⁵ Several descriptions of pyometra^{1,2} have highlighted that mortality rates tend to be higher in queens than bitches and that this could be because clinical signs in queens are subtle and queens are often better at hiding clinical signs from their owners; therefore, pyometra in queens may not be diagnosed until advanced stages.¹ Our data indicated that queens, even those with severe clinical signs, survived when OHE was performed in a general, nonspecialty hospital with high-quality basic supportive care.

Our results suggested that OHE for pyometra may be slightly delayed for many queens without detrimental effects on outcomes; therefore, clients that cannot afford immediate OHE in an emergent setting may be able to be scheduled for a more affordable surgery the following day. Half (63/126) of the queens that underwent OHE in the present study had been seen previously by another veterinarian because of signs of pyometra prior to visiting AAH for treatment, and a substantial portion (44/105 [42%]) had had clinical signs for > 1 week. Despite this, none of these queens died and only 41 of the 126 (33%) surgically treated queens required ≥ 2 nights of hospitalization.

Readily available indicators based on physical examination, history, or simple bloodwork, which help predict pyometra outcomes can enable general-practice veterinarians to make informed decisions about which cases may be appropriate for treatment in their practices, and which cases may require more intensive treatment in a specialty practice setting. Abnormal serum iCa concentration and signs of depressed mentation were associated with a length of stay ≥ 2 nights; therefore, veterinarians can use this information to decide whether they can support this extended hospitalization postoperatively. Likewise, high rectal temperature, a closed pyometra, and heart murmur were associated with uterine rupture, and these clinical signs could indicate a more complicated case that nonspecialist practices may want to refer elsewhere.

The AAH specifically targets the underserved pet-owning population of New York City, providing care to pets of individuals with limited access to veterinary care due to transportational or financial limitations or other barriers. Half (63/126) of the queens that underwent OHE at the AAH for pyometra had visited a veterinarian prior to arriving at the AAH, and in many cases, pet owners initially took their queen to another practice and were subsequently referred to the AAH due to the owner's financial constraints. Therefore, queens in our sample may have had a longer duration of clinical signs, compared with those with standard access to veterinary services. Indeed, our sample demonstrated that clinical signs and hematologic abnormalities were more frequently observed than previously reported.⁵

A limitation of the present study is that some pertinent information was not collected or was not documented in the medical records. Because the AAH did not analyze or perform bacterial culture on uterine fluid, the queens in our study may not have consist exclusively of those with pyometra and may have included those with hydrometra or mucometra. In some cases, information was missing from the medical records for some key clinical findings, and missing data might have influenced the predictive power of the models.

Our findings refuted the common belief that pyometra in queens must be treated on an emergency basis as many of the queens in the present study had either been seen previously at other veterinary clinics or had a protracted duration of clinical signs. These findings additionally demonstrated that OHE for pyometra in queens can be highly successful when performed in a general, nonspecialty hospital with high-quality basic supportive care. Even without highly specialized treatments, such as plasma transfusions, dialysis, and the use of Jackson-Pratt drains, queens that underwent OHE for pyometra in the present study had a 100% (126/126) rate of survival to hospital discharge. As such, most general practitioners that offer OHE could expect to see similar outcomes.

Knowing the potential outcome of pyometra treated with OHE aids veterinarians' decisions regarding which procedures to practice in their clinics. This information also facilitates collaborative treatment decisions between veterinarians and their clients because veterinarians can comprehensively communicate treatment options, risks, and costs. We believe that with more general-practice veterinarians comfortable treating pyometra in their clinics and communicating treatment options with clients, this important procedure will be available to more pets, ultimately saving more lives.

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References

1. Hagman R, Ström Holst B, Möller L, Egenvall A. Incidence of pyometra in Swedish insured cats. *Theriogenology*. 2014;82(1):114–120. doi:10.1016/j.theriogenology.2014.03.007
2. Hollinshead F, Krekeler N. Pyometra in the queen: to spay or not to spay? *J Feline Med Surg*. 2016;18(1):21–33. doi:10.1177/1098612X15623114
3. Hollinshead F, Krekeler N. Pyometra in the queen. *J Feline Med Surg*. 2016;18(1):21–33. doi:10.1177/1098612X15623114
4. Wallace GB, Casal ML. Pyometra. In: Drobatz KJ, Hopper K, Rozanski E, Silverstein DC, eds. *Textbook of Small Animal Emergency Medicine, 1&11*. John Wiley & Sons, Inc.; 2019:75–801.
5. Kenney KJ, Matthiesen DT, Brown NO, Bradley RL. Pyometra in cats: 183 cases (1979–1984). *J Am Vet Med Assoc*. 1987;191(9):1130–1132.
6. Nak D, Misirlioglu D, Nak Y, Keskin A. Clinical laboratory findings, vaginal cytology and pathology in a controlled study of pyometra in cats. *Aust Vet Pract*. 2005;35(1):10–14.
7. Jitpean S, Ström-Holst B, Emanuelson U, et al. Outcome of pyometra in female dogs and predictors of peritonitis and prolonged postoperative hospitalization in surgically treated cases. *BMC Vet Res*. 2014;10(1):6. doi:10.1186/1746-6148-10-6
8. Egenvall A, Hagman R, Bonnett BN, Hedhammar Å, Olson P, Lagerstedt AS. Breed risk of pyometra in insured dogs in Sweden. *J Vet Intern Med*. 2001;15(6):530–538. doi:10.1111/j.1939-1676.2001.tb01587.x
9. Hagman R. Pyometra in small animals. *Vet Clin North Am Small Anim Pract*. 2018;48(4):639–661. doi:10.1016/j.cvsm.2018.03.001
10. McCallin AJ, Hough VA, Kreisler RE. Pyometra management practices in the high quality, high volume spay-neuter environment. *Top Companion Anim Med*. 2021;42:100499. doi:10.1016/j.tcam.2020.100499
11. Farquhar RG. Canine pyometra: assessment to optimise outcomes in first-opinion practice. *Companion Anim*. 2017;22(3):126–131. doi:10.1017/CBO9781107415324.004
12. Brady CA, Otto CM, Van Winkle TJ, King LG. Severe sepsis in cats: 29 cases (1986–1998). *J Am Vet Med Assoc*. 2000;217(4):531–535. doi:10.2460/javma.2000.217.531
13. Cozzi B, Ballarin C, Mantovani R, Rota A. Aging and veterinary care of cats, dogs, and horses through the records of three university veterinary hospitals. *Front Vet Sci*. 2017;4:14. doi:10.3389/fvets.2017.00014
14. Pailler S, Slater M, Lesnikowski S, et al. Findings and prognostic indicators of outcomes for bitches with pyometra treated surgically in a nonspecialized setting. *J Am Vet Med Assoc*. 2022;260(S2):S49–S56.
15. Pailler S, Dolan ED, Slater MR, Gayle JM, Lesnikowski SM, DeClementi C. Owner-reported long-term outcomes, quality of life, and longevity after hospital discharge following surgical treatment of pyometra in bitches and queens. *J Am Vet Med Assoc*. 2022;260(S2):S57–S63.
16. Zoetis. *i-STAT Alinity v Utilization Guide*. Parsippany, NJ, Zoetis Services LLC; 2019.
17. Conti-Patara A, de Araújo Caldeira J, de Mattos-Junior E, et al. Changes in tissue perfusion parameters in dogs with severe sepsis/septic shock in response to goal-directed hemodynamic optimization at admission to ICU and the relation to outcome. *J Vet Emerg Crit Care (San Antonio)*. 2012;22(4):409–418. doi:10.1111/j.1476-4431.2012.00769.x

Supplementary Materials

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