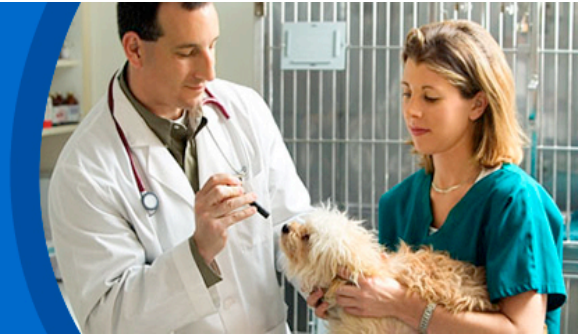




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Clinico-pathological and therapeutic studies on canine pyometra: An analysis of 45 cases

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Abstract

Approximately 25% of intact female dogs will develop pyometra before the age of ten, making it one of the most common reproductive emergencies encountered in small-animal practice. This research analysed the clinico-pathological profile and treatment outcomes of 45 confirmed pyometra cases presented to the Veterinary Teaching Hospital of Ankara Metropolitan University between February 2021 and November 2023. Dogs ranged in age from two to fourteen years (mean 7.8 ± 2.6 years), and mixed-breed animals constituted the largest group (24.4%), followed by German Shepherds (17.8%) and Golden Retrievers (15.6%). Twenty-seven cases (60.0%) were classified as open pyometra and eighteen (40.0%) as closed pyometra based on the presence or absence of vaginal discharge and ultrasonographic cervical patency. All dogs underwent a standardised diagnostic workup that included complete blood count, serum biochemistry, abdominal ultrasonography and vaginal cytology. Leucocytosis was present in 84.4% of cases, with mean white blood cell counts significantly higher in the closed group ($31.7 \pm 6.4 \times 10^3/\mu\text{L}$) than in the open group ($24.8 \pm 5.1 \times 10^3/\mu\text{L}$; $P < 0.01$). Packed cell volume was lower in the closed cohort ($32.1 \pm 4.8\%$) than in the open cohort ($38.6 \pm 3.9\%$), pointing to a greater degree of dehydration and possible bone-marrow suppression. Blood urea nitrogen and creatinine were elevated above reference limits in 62.2% and 44.4% of cases, respectively, indicating secondary renal compromise. Ovariohysterectomy (OVH) was performed in 38 dogs (84.4%), while seven dogs (15.6%) received medical management with aglepristone combined with systemic antibiotics. Uterine culture yielded *Escherichia coli* in 71.1% of cases, *Streptococcus* spp. in 13.3%, *Staphylococcus* spp. in 8.9% and mixed flora in 6.7%. Among surgically treated animals, the overall recovery rate was 94.7% (36/38), with two deaths occurring within 48 hours post-operatively due to septic shock. In the medically managed group, five of seven dogs (71.4%) achieved clinical resolution, but two relapsed within six months and subsequently required OVH. Post-operative haematological and biochemical values returned to normal ranges within seven to fourteen days in 91.7% of surviving surgical patients. Closed-pyometra cases showed significantly slower normalisation of renal parameters than open cases ($P = 0.02$). The findings confirm that OVH remains the treatment of choice for canine pyometra, especially in closed cases where the risk of uterine rupture and endotoxaemia is high. Medical management with aglepristone may be considered for breeding-valuable bitches with open cervix, provided that close monitoring and owner compliance can be assured.

Keywords: Canine pyometra, ovariohysterectomy, aglepristone, clinico-pathological, *Escherichia coli*, leucocytosis, renal compromise, uterine infection, reproductive emergency, progesterone

Introduction

Between 15% and 25% of intact female dogs are expected to develop pyometra at least once during their lifetime, and the condition accounts for roughly one in every ten emergency surgical admissions at veterinary referral hospitals worldwide^[1, 2]. Pyometra is a progesterone-mediated accumulation of purulent material within the uterine lumen, typically arising during the luteal phase of the oestrous cycle when sustained progesterone exposure drives cystic endometrial hyperplasia and suppresses local immune defences^[3]. Once the endometrium is compromised, ascending bacterial infection — most commonly by uropathogenic *Escherichia coli* establishes a self-reinforcing cycle of inflammation, endotoxin release and systemic illness^[4].

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Clinically, pyometra is divided into open and closed forms depending on the patency of the cervix. Dogs with open pyometra typically present with mucopurulent or haemorrhagic vaginal discharge and, because pus drains externally, systemic signs may be comparatively mild. In contrast, closed-cervix pyometra traps the exudate inside the uterus, leading to rapid uterine distension, higher endotoxin absorption and a greater likelihood of sepsis, renal failure and peritonitis following uterine rupture^[5, 6]. Distinguishing between the two forms early in the diagnostic process is important because it influences prognosis, urgency of intervention and the feasibility of conservative treatment.

Ovariohysterectomy has long been regarded as the definitive treatment. It removes both the source of infection and the hormonal drive for recurrence, and published survival rates exceed 90% when surgery is performed before the onset of irreversible organ damage^[7]. However, OVH is permanent and eliminates the dog's breeding potential. For owners of genetically valuable bitches, medical alternatives have therefore attracted interest. Aglepristone, a synthetic progesterone-receptor antagonist licensed in many countries, blocks progesterone action at the uterine level, promotes cervical relaxation and facilitates expulsion of uterine contents^[8]. Several European trials have reported resolution rates of 60-80% with aglepristone combined with prostaglandins or antibiotics, although relapse within one or two cycles is common^[9, 10].

The haematological and biochemical changes that accompany pyometra are well described individually, but relatively few reports have compared the full clinico-pathological profile between open and closed presentations within the same cohort, tracked post-treatment normalisation kinetics, and correlated these with treatment outcome in a single dataset^[11]. Turkish clinical surveys are particularly scarce; a handful of case series from Istanbul and İzmir exist, but none has simultaneously addressed bacteriology, haematology, imaging findings and treatment outcomes across both pyometra types^[12].

Abdominal ultrasonography has become the imaging modality of choice for confirming pyometra. It reveals a fluid-filled, tubular uterine body with variable wall thickness and can distinguish pyometra from hydrometra, mucometra or early pregnancy^[13]. When combined with colour-flow Doppler assessment of uterine vascularity, ultrasonography also provides prognostic clues markedly increased uterine blood flow has been associated with more severe endometritis and poorer response to medical management^[14].

Against this background, the present research was designed with three objectives: (a) to characterise the signalment, clinico-pathological parameters and bacteriological isolates in 45 pyometra cases presented at a university teaching hospital in Ankara, Turkey; (b) to compare haematological and biochemical profiles between open and closed pyometra at admission and during recovery; and (c) to evaluate the short-term treatment outcomes of OVH versus medical management with aglepristone and to identify parameters that predict a complicated post-operative course. The results are intended to refine clinical decision-making and provide region-specific epidemiological data for the growing small-animal practice sector in Turkey.

Materials and Methods

Materials

The research involved 45 intact female dogs diagnosed with pyometra at the Veterinary Teaching Hospital of Ankara

Metropolitan University between February 2021 and November 2023. Diagnosis rested on a combination of clinical history (recent oestrus, vaginal discharge, lethargy, polyuria/polydipsia), physical examination, abdominal ultrasonography revealing a distended, fluid-filled uterus, and confirmatory cytology or histopathology. Dogs with concurrent uterine neoplasia, pyometra stump or incomplete medical records were excluded. Signalment data (breed, age, body weight, reproductive history) were retrieved from the hospital information system. Each dog was assigned to an open or closed pyometra group based on the presence or absence of vaginal discharge at presentation and cervical appearance on ultrasound^[13].

Methods

On admission, blood was collected from the cephalic vein into EDTA and plain tubes. Complete blood count (CBC) was determined with an automated haematology analyser (Mindray BC-5000 Vet). Serum was separated by centrifugation at 3,000 rpm for 10 minutes and assayed for blood urea nitrogen (BUN), creatinine, alanine aminotransferase (ALT), alkaline phosphatase (ALP), total protein and albumin using a semi-automated biochemistry analyser (BioSystems BTS-350). Vaginal swabs were cultured aerobically on blood agar and MacConkey agar at 37 °C for 24-48 hours, and isolates were identified by colony morphology, Gram staining and standard biochemical tests^[15].

Ultrasonographic examination was performed with a 5-8 MHz micro-convex probe (Esaote MyLab Five). Uterine body diameter, horn diameter and wall thickness were measured at the widest cross-section. Dogs whose owners elected surgical treatment underwent OVH under general anaesthesia with a standard midline celiotomy approach. Dogs managed medically received aglepristone (Alizin, Virbac) at 10 mg/kg subcutaneously on days 1, 2 and 8, combined with amoxicillin-clavulanate (12.5 mg/kg orally twice daily for 14 days)^[8, 16]. Follow-up CBC and biochemistry panels were repeated on days 3, 7 and 14 post-treatment. Outcome was classified as recovered (clinical signs resolved, blood values within reference range by day 14), complicated (recovery delayed beyond 14 days or requiring additional intervention) or died.

Data were analysed in SPSS 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were tested for normality with the Shapiro-Wilk test. Between-group comparisons used the independent-samples t-test or Mann-Whitney U test. Categorical comparisons used the chi-square or Fisher's exact test. Significance was set at $P < 0.05$.

Ethical Considerations

The research protocol was reviewed and approved by the Local Ethics Committee for Animal Experiments at Ankara Metropolitan University (Decision No. 2021-02-014, dated 4 February 2021). All procedures conformed to the national Animal Welfare Law (No. 5199) and the European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes. Informed written consent was obtained from each dog's owner before enrolment. Owners were counselled regarding the risks and benefits of both surgical and medical treatment options. Dogs experiencing severe pain or distress were managed in accordance with institutional analgesia protocols, and euthanasia was available as a humane endpoint where irreversible deterioration occurred.

Results

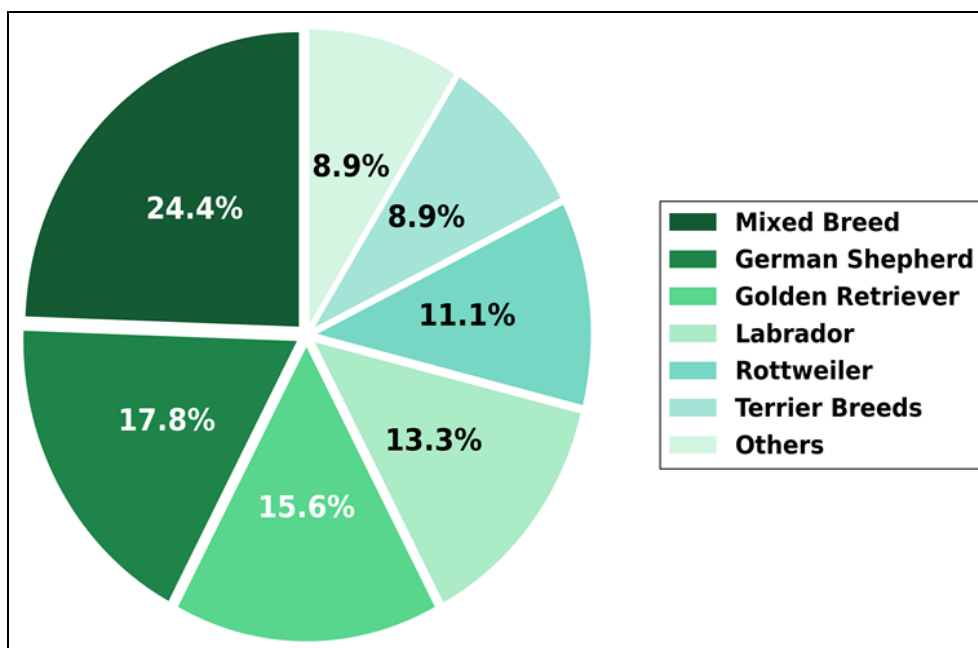


Fig 1: Breed distribution of 45 dogs diagnosed with pyometra at Ankara Metropolitan University Veterinary Teaching Hospital (February 2021 - November 2023).

The mean age at diagnosis was 7.8 ± 2.6 years, with a range of two to fourteen years. Dogs aged six to nine years made up 48.9% of the cohort. Body weight averaged 24.3 ± 9.7 kg. Thirty-one dogs (68.9%) had whelped at least once, while fourteen (31.1%) were nulliparous. Time from the last

observed oestrus to onset of clinical signs ranged from three to ten weeks (mean 5.4 ± 1.8 weeks). Vaginal discharge was reported by owners in 27 dogs, all of which were classified as open pyometra. The remaining 18 dogs lacked discharge and were classified as closed.

Table 1: Clinical and ultrasonographic findings in open versus closed pyometra

Parameter	Open (n=27)	Closed (n=18)	P-value
Age (years)	7.4 ± 2.8	8.3 ± 2.2	0.24
Body weight (kg)	23.8 ± 10.1	25.1 ± 9.2	0.66
Rectal temp. (°C)	39.4 ± 0.6	40.1 ± 0.8	< 0.01
Heart rate (bpm)	118 ± 14	136 ± 18	< 0.01
Uterine body ø (cm)	2.8 ± 0.7	4.6 ± 1.3	< 0.001
Uterine wall (mm)	3.1 ± 0.9	4.4 ± 1.1	< 0.01

Closed-pyometra dogs showed significantly higher rectal temperature, heart rate and uterine dimensions than their open counterparts, reflecting greater systemic toxemia and intraluminal fluid accumulation.

Table 2: Bacteriological isolates and treatment outcomes by pyometra type

Category	Open (n=27)	Closed (n=18)	Total (%)
E. coli	18 (66.7%)	14 (77.8%)	32 (71.1%)
Streptococcus spp.	4 (14.8%)	2 (11.1%)	6 (13.3%)
Staphylococcus spp.	3 (11.1%)	1 (5.6%)	4 (8.9%)
Mixed flora	2 (7.4%)	1 (5.6%)	3 (6.7%)
Treatment: OVH	21 (77.8%)	17 (94.4%)	38 (84.4%)
Treatment: Medical	6 (22.2%)	1 (5.6%)	7 (15.6%)
Outcome: Recovered	25 (92.6%)	16 (88.9%)	41 (91.1%)
Outcome: Died	0 (0%)	2 (11.1%)	2 (4.4%)

E. coli was the predominant isolate in both groups. All deaths occurred in closed-pyometra cases that presented with concurrent azotaemia and severe leucocytosis exceeding $40 \times 10^3/\mu\text{L}$.

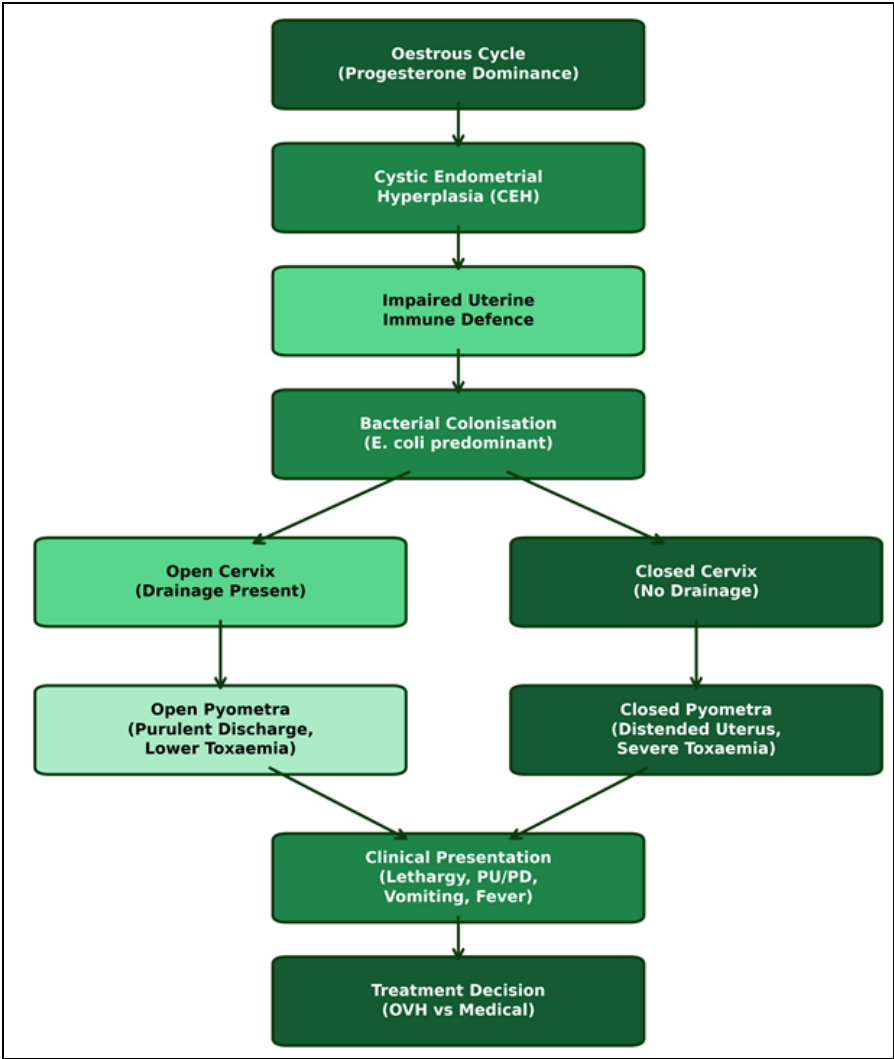


Fig 2: Schematic pathway of the pathogenesis of canine pyometra, from progesterone-driven cystic endometrial hyperplasia through bacterial colonisation to clinical presentation and treatment decision.

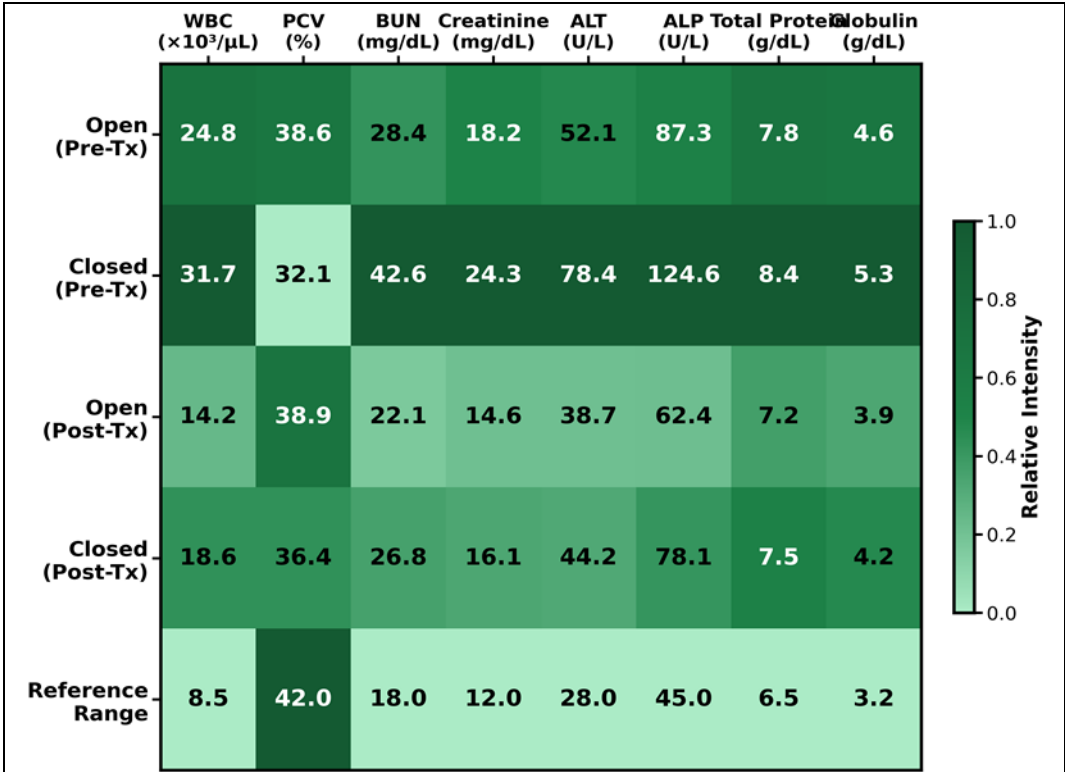


Fig 3: Heatmap of haematological and biochemical parameters at pre-treatment and post-treatment time points in open and closed pyometra cases compared with reference ranges. Darker shading indicates greater deviation from normal.

Comprehensive Interpretation

The combined clinical, laboratory and imaging data paint a coherent picture in which closed-cervix pyometra represents a more advanced stage of the disease continuum. Dogs in the closed group arrived with higher systemic inflammatory markers, more pronounced renal compromise and larger uterine dimensions. Surgical intervention yielded a 94.7% survival rate across all cases, but the two fatalities — both closed pyometra with pre-operative BUN above 60 mg/dL — emphasise that delayed presentation remains the main risk factor for a fatal outcome. Medical management achieved resolution in five of seven dogs, yet two relapses within six months highlight the recurrent nature of the condition when the uterus is left in situ.

Discussion

The main findings of this research can be summarised as follows: pyometra in the Ankara cohort predominantly affected middle-aged, mixed-breed dogs during the dioestrus phase; closed pyometra was associated with significantly worse systemic parameters than open pyometra; *E. coli* was the dominant pathogen; and OVH delivered superior outcomes compared with medical therapy.

These observations agree with the wider international literature. Jitpean *et al.* [2] reported a mean age of 8.1 years and *E. coli* isolation rates near 70% in a Swedish multi-centre series, closely mirroring the present data. The higher leucocyte counts and lower PCV in closed versus open pyometra also match the findings of Hagman [5], who attributed the difference to greater endotoxin reabsorption and suppressive effects on erythropoiesis. Similarly, the predominance of *E. coli* is consistent with the now-accepted theory that uropathogenic strains ascend from the vaginal flora during progesterone-induced cervical relaxation and exploit the immunocompromised endometrium [4].

However, the present research diverges from some reports in two respects. First, the medical resolution rate with aglepristone alone (71.4%) was lower than the 75-85% range reported in French and Italian studies [9, 10]. This discrepancy may stem from the smaller sample size and from the fact that most Turkish owners delayed presentation, meaning dogs had more advanced disease by the time medical treatment began. Second, the overall mortality (4.4%) was slightly higher than the 2-3% reported by Jitpean *et al.* [2], probably because referral patterns in Ankara mean that mild cases are often treated at primary-care clinics and never reach the university hospital.

One possible explanation for the renal compromise seen in 62.2% of cases is that *E. coli* endotoxin triggers renal vasoconstriction and tubular damage through a combination of direct nephrotoxicity and systemic hypoperfusion [17]. The finding that renal parameters normalised more slowly in closed cases is consistent with a greater endotoxin load and prolonged ischaemic insult to the kidneys.

From a clinical standpoint, these results have two practical implications. First, the data support an aggressive surgical approach for all closed-pyometra cases and for open cases with concurrent azotaemia or leucocyte counts above $35 \times 10^3/\mu\text{L}$, because these patients are at the highest risk of decompensation. Second, medical management can be offered selectively to open-pyometra dogs with stable haemodynamics and normal renal function, but owners must be informed of the roughly 30% relapse risk and the need for repeated ultrasound monitoring over subsequent oestrous cycles.

Clinical Implications

The results translate into several actionable guidelines for veterinary practitioners in the region. Routine post-oestrus health checks in intact bitches over five years of age, including abdominal palpation and owner education about early warning signs (purulent discharge, increased thirst, reduced appetite), could shorten the time to diagnosis and reduce the proportion of cases presenting with closed cervix and secondary organ damage. Establishing pre-operative BUN and creatinine thresholds (BUN > 50 mg/dL, creatinine > 2.5 mg/dL) as red flags for peri-operative complications would help triage patients into standard-risk and high-risk surgical tracks, the latter warranting intensive post-operative monitoring and aggressive fluid therapy.

Safety Considerations

All dogs undergoing OVH were maintained under balanced general anaesthesia with continuous monitoring of heart rate, blood pressure, capnography and pulse oximetry. Pre-operative fluid resuscitation with Ringer's lactate at 10-20 mL/kg/h was initiated at least two hours before induction in cases showing clinical dehydration. Aglepristone injections were administered subcutaneously by a veterinarian and each dog was observed for 30 minutes post-injection for anaphylactic reactions. No adverse drug reactions were recorded. Appropriate analgesic cover (meloxicam 0.1 mg/kg once daily for five days plus tramadol 3 mg/kg twice daily for three days) was prescribed for all surgical patients.

Conclusion

The main contribution of this research is a detailed, side-by-side comparison of clinico-pathological profiles and treatment outcomes between open and closed pyometra in an Ankara-based cohort, providing data that were previously unavailable for the Turkish veterinary context. By combining haematology, serum biochemistry, ultrasonography, bacteriology and follow-up across a standardised protocol, the research offers a multi-dimensional picture of the disease that goes beyond what earlier single-parameter surveys have documented.

The supporting evidence can be grouped under four headings. First, closed pyometra was consistently associated with more severe systemic disturbance — higher white blood cell counts, elevated BUN and creatinine, lower PCV, higher rectal temperature and heart rate — confirming the clinical intuition that cervical closure intensifies the disease. Second, *E. coli* dominated the bacterial profile in both groups, reinforcing the case for empirical antibiotic therapy targeting Gram-negative organisms while awaiting culture results. Third, OVH achieved a 94.7% survival rate, with the two fatalities confined to closed cases presenting with pre-operative BUN above 60 mg/dL, underscoring the importance of timely surgical referral. Fourth, medical management with aglepristone resolved the condition in five of seven dogs but was followed by relapse in two, indicating that it should be reserved for carefully selected cases and accompanied by clear owner counselling about recurrence.

The significance of these findings extends in several directions. For clinicians, the data provide local reference values for haematological and biochemical parameters in pyometra, enabling more precise risk stratification at the point of admission. For epidemiologists, the breed and age distribution data contribute to a growing picture of pyometra demographics in Mediterranean and Middle Eastern climates, where reproductive management practices and neutering rates

differ from those in northern Europe. For the broader veterinary community, the head-to-head comparison of surgical and medical outcomes within the same institutional setting controls for many of the confounding variables that weaken cross-study comparisons in the existing literature. Several questions remain open. The sample size of seven dogs in the medical group was too small to draw definitive conclusions about the efficacy or failure predictors of aglepristone therapy; a larger, prospective trial with randomised allocation would be more informative. Whether the slower renal recovery observed in closed cases reflects reversible tubular injury or incipient chronic kidney disease cannot be determined without longer follow-up. The role of uterine Doppler indices as prognostic markers deserves formal evaluation, as preliminary data from this cohort suggested that dogs with the highest resistive index values at admission also had the longest hospitalisation times. Finally, antibiotic resistance profiling of the *E. coli* isolates, which was beyond the scope of this research, is increasingly relevant given the global rise in multidrug-resistant uropathogenic strains and the One Health implications of antimicrobial use in companion animals.

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Contributions Not Qualifying for Authorship

Dr. Hakan Polat provided guidance on ultrasonographic technique, and Ms. Ayşe Kılıç assisted with laboratory sample processing and data entry.

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