

Canine Pyometra: A Clinical Review of Pathogenesis, Diagnosis, and Therapeutic Management

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Canine pyometra is one of the most common and life-threatening reproductive disorders affecting intact female dogs. Characterized by bacterial infection of the uterus and accumulation of purulent exudate within the uterine lumen, pyometra represents a true veterinary emergency requiring prompt diagnosis and treatment. The disease typically develops during diestrus under the influence of prolonged progesterone stimulation, which induces cystic endometrial hyperplasia, suppresses uterine immune defenses, and decreases myometrial contractility. Ascending bacterial infection, predominantly caused by *Escherichia coli*, leads to severe local inflammation and may progress to systemic inflammatory response syndrome (SIRS), septic shock, multiple organ dysfunction, and death if untreated (Dow, 1959; Smith, 2006; Hagman, 2018). Clinical manifestations vary depending on whether the cervix remains open or closed. Diagnosis relies on history, physical examination, hematological and biochemical evaluation, diagnostic imaging, and cytological or bacteriological examination when indicated. Ovariohysterectomy remains the treatment of choice for most patients, while medical management is reserved for selected breeding animals. Early recognition and prompt intervention significantly improve prognosis. This review summarizes the current understanding of the epidemiology, pathophysiology, clinical presentation, diagnostic approaches, and therapeutic strategies for canine pyometra.

Keywords: canine pyometra, cystic endometrial hyperplasia, progesterone, *Escherichia coli*, ovariohysterectomy, reproductive disease

Introduction

Pyometra is a hormonally mediated bacterial infection of the uterus occurring predominantly in sexually intact bitches during the luteal phase of the estrous cycle. It is among the most frequently encountered reproductive emergencies in small animal practice and carries substantial morbidity and mortality if left untreated (Smith, 2006). The condition usually develops between four and eight weeks after estrus, when circulating progesterone concentrations remain elevated. During this period, progesterone induces profound physiological alterations within the uterus, including increased glandular secretion, reduced myometrial contractions, closure of the cervix, and suppression of local immune responses. These changes create an ideal environment for bacterial proliferation once microorganisms ascend through the cervix from the vaginal flora (Dow, 1959). Although pyometra may occur in dogs of any breed or age, incidence increases with advancing age and repeated estrous cycles due to cumulative endometrial changes known as cystic endometrial hyperplasia (CEH). The disease frequently presents as a medical emergency because bacterial endotoxins

and inflammatory mediators may induce systemic illness, acute kidney injury, disseminated intravascular coagulation, and septic shock (Hagman, 2018).

Epidemiology

The lifetime incidence of pyometra varies geographically depending upon the prevalence of elective ovariohysterectomy. In countries where routine neutering is uncommon, approximately 20–25% of intact female dogs develop pyometra before ten years of age (Egenvall et al., 2001). The disease predominantly affects middle-aged and older bitches, with the highest incidence reported between six and ten years of age. Nevertheless, pyometra has been documented in young adult females, particularly following administration of exogenous progesterone or estrogen for estrus suppression or mismating therapy (Smith, 2006). Breed predisposition has been reported in several studies. Increased risk has been observed in Rottweilers, Bernese Mountain Dogs, Golden Retrievers, Rough Collies, Cavalier King Charles Spaniels, and Miniature Schnauzers, whereas German Shepherd Dogs and Dachshunds may demonstrate comparatively lower risk in some populations (Jitpean et al., 2014). These variations likely reflect genetic influences on immune function, reproductive physiology, and breeding practices. Seasonality has minimal influence because canine reproduction is non-seasonal; however, disease occurrence closely follows diestrus, emphasizing the importance of endocrine regulation in disease development.

Etiology

Pyometra results from the interaction between hormonal influences and ascending bacterial infection. Neither hormonal stimulation nor bacterial contamination alone is generally sufficient to produce disease; rather, pyometra develops when bacterial invasion occurs within a uterus rendered susceptible by progesterone-mediated alterations (Dow, 1959).

Bacterial Etiology

Escherichia coli accounts for approximately 70–90% of canine pyometra cases and remains the predominant pathogen isolated from uterine exudates (Hagman and Kühn, 2002).

Other microorganisms occasionally isolated include:

- *Staphylococcus pseudintermedius*
- *Streptococcus* spp.
- *Proteus mirabilis*
- *Klebsiella pneumoniae*
- *Pseudomonas aeruginosa*
- *Enterococcus* spp.

Most infecting bacteria originate from the normal vaginal microbiota and ascend through the cervix during estrus when cervical relaxation facilitates bacterial entry. Virulent *E. coli* strains possess adhesins, fimbriae, lipopolysaccharide endotoxin, hemolysins, and iron-acquisition systems that promote colonization, immune evasion, and systemic dissemination (Hagman and Kühn, 2002).

Pathogenesis

The pathogenesis of canine pyometra is multifactorial and involves endocrine, immunological, microbiological, and inflammatory mechanisms.

Hormonal Influence

Progesterone plays the central role in disease development. Following ovulation, progesterone concentrations remain elevated for approximately two months regardless of pregnancy status.

Progesterone exerts several effects that predispose the uterus to infection:

- Stimulates endometrial gland secretion
- Promotes glandular hyperplasia
- Suppresses uterine leukocyte activity
- Inhibits myometrial contractions
- Reduces cervical drainage after cervical closure

These physiological adaptations support embryo survival during pregnancy but simultaneously impair uterine defense mechanisms (Smith, 2006).

Cystic Endometrial Hyperplasia

Repeated exposure to progesterone over successive estrous cycles induces cystic endometrial hyperplasia (CEH), characterized by cystic dilation of endometrial glands, excessive secretion, fibrosis, and altered vascular architecture (Dow, 1959).

Histologically, affected endometrium demonstrates:

- Cystically dilated glands
- Hyperplastic epithelium
- Stromal edema
- Plasma cell infiltration
- Chronic inflammatory changes

Accumulated glandular secretions provide an excellent growth medium for invading bacteria.

Bacterial Colonization

Ascending bacteria colonize the hormonally primed uterus. *Escherichia coli* adheres to endometrial epithelial cells through type-1 fimbriae and P-fimbriae, resisting mechanical clearance and initiating infection.

Bacterial multiplication stimulates recruitment of neutrophils, macrophages, and inflammatory cytokines including:

- Interleukin-1 β
- Interleukin-6
- Tumor necrosis factor- α
- Interleukin-8

These mediators amplify inflammation while simultaneously contributing to systemic illness.

Endotoxemia and Systemic Disease

Gram-negative bacterial lipopolysaccharide (LPS) enters systemic circulation and activates macrophages through Toll-like receptor-4 signaling pathways.

Consequences include:

- Systemic inflammatory response syndrome (SIRS)
- Vasodilation
- Hypotension
- Disseminated intravascular coagulation
- Acute kidney injury
- Multiple organ dysfunction

Renal impairment results from dehydration, endotoxemia, immune complex deposition, and reduced renal perfusion, explaining the common clinical finding of polyuria and polydipsia (Hagman, 2018).

Risk Factors

Several factors increase susceptibility to pyometra:

- Increasing age
- Multiple estrous cycles
- Cystic endometrial hyperplasia
- Administration of progesterone-containing contraceptives
- Exogenous estrogen therapy
- Previous reproductive tract disease
- Nulliparity in some populations
- Genetic predisposition

Routine ovariohysterectomy effectively eliminates the risk.

Clinical Presentation

Clinical signs depend primarily on whether the cervix remains open or closed.

Open-Cervix Pyometra

Patients commonly present with:

- Purulent, hemorrhagic, or mucopurulent vaginal discharge

- Lethargy
- Polyuria and polydipsia
- Decreased appetite
- Weight loss
- Mild fever
- Vomiting in some patients

Because uterine contents are able to drain, systemic illness is often less severe.

Closed-Cervix Pyometra

Closed pyometra is associated with rapid clinical deterioration due to accumulation of purulent material within the uterus.

Clinical findings include:

- Marked abdominal distension
- Severe lethargy
- Complete anorexia
- Persistent vomiting
- Dehydration
- Tachycardia
- Tachypnea
- Weak peripheral pulses
- Hypothermia or hyperthermia
- Septic shock
- Collapse

Closed pyometra carries a substantially higher mortality rate because delayed diagnosis often permits progression to uterine rupture and generalized septic peritonitis (Jitpean et al., 2014).

Diagnosis

Early diagnosis of canine pyometra is essential because the disease can progress rapidly from localized uterine infection to systemic inflammatory response syndrome (SIRS), septic shock, and multiple organ dysfunction. Diagnosis is based on a combination of history, clinical examination, laboratory abnormalities, and diagnostic imaging findings.

Clinical Evaluation

A complete reproductive history is critical in suspected cases. Important information includes:

- Age and reproductive status of the bitch
- Date of the last estrous cycle
- Previous pregnancies or breeding history
- Previous episodes of vaginal discharge
- Use of hormonal contraceptives or estrus-suppressing medications

Most affected dogs develop clinical signs during diestrus, typically 4–8 weeks after estrus, when progesterone concentrations are elevated (Smith, 2006; Hagman, 2018).

Physical examination findings vary depending on the type and severity of pyometra.

Common findings include:

- Depression and lethargy
- Dehydration
- Fever or hypothermia
- Tachycardia
- Abdominal discomfort
- Enlarged uterus detectable by abdominal palpation in some cases
- Vaginal discharge in open-cervix pyometra

Patients with severe disease may show signs of endotoxemia and sepsis, including weak pulses, prolonged capillary refill time, hypotension, altered mentation, and collapse (Jitpean et al., 2014).

Laboratory Diagnosis

Complete Blood Count (CBC)

Hematological abnormalities are common but variable.

Typical findings include:

Leukocytosis

A regenerative neutrophilic leukocytosis with a left shift is frequently observed due to bacterial infection and systemic inflammation.

Leukopenia

Severe cases, particularly those associated with sepsis, may demonstrate leukopenia due to overwhelming inflammatory response and consumption of neutrophils. Leukopenia is considered a negative prognostic indicator (Hagman et al., 2009).

Anemia

Mild to moderate normocytic, normochromic anemia may occur due to chronic inflammation, endotoxemia, and suppression of erythropoiesis.

Serum Biochemical Evaluation

Serum biochemical testing is important for evaluating systemic effects and determining anesthetic risk.

Common abnormalities include:

Azotemia

Increased blood urea nitrogen (BUN) and creatinine concentrations may occur due to:

- Dehydration
- Reduced renal perfusion
- Endotoxin-induced renal injury
- Immune complex-mediated glomerular disease

Some dogs develop acute kidney injury associated with pyometra-associated sepsis (Hagman, 2018).

Increased Liver Enzymes

Mild increases in alanine aminotransferase (ALT) and alkaline phosphatase (ALP) may occur due to inflammatory changes and reduced hepatic perfusion.

Electrolyte Abnormalities

Common alterations include:

- Hyponatremia
- Hypochloremia
- Hypokalemia or hyperkalemia in severe cases

Electrolyte disturbances reflect dehydration, vomiting, renal dysfunction, and systemic inflammatory processes.

Urinalysis

Urinalysis provides valuable information regarding renal involvement and concurrent urinary abnormalities.

Possible findings include:

- Low urine specific gravity due to impaired renal concentrating ability
- Proteinuria associated with glomerular injury
- Pyuria or bacteriuria due to concurrent urinary tract infection

Urine culture may be considered, especially in patients with recurrent infection or suspected antimicrobial resistance.

Diagnostic Imaging**Abdominal Radiography**

Survey abdominal radiography may demonstrate:

- Enlarged tubular soft tissue opacity in the caudal abdomen
- Displacement of abdominal organs
- Increased abdominal density

Radiography is less sensitive than ultrasonography because uterine enlargement may be minimal in some cases, particularly early infection.

Abdominal Ultrasonography

Ultrasonography is the preferred imaging technique for diagnosis of pyometra.

Characteristic findings include:

- Enlarged uterine horns
- Fluid-filled uterine lumen
- Thickened uterine walls
- Hyperechoic or heterogeneous uterine contents
- Cystic changes in the endometrium

Ultrasonography also helps differentiate pyometra from pregnancy, mucometra, hydrometra, and uterine neoplasia (Bigliardi et al., 2004).

Bacterial Culture and Sensitivity Testing

Culture of uterine contents provides valuable information regarding antimicrobial selection. *Escherichia coli* is the predominant organism isolated from canine pyometra cases, although other aerobic and anaerobic bacteria may be involved (Hagman & Kühn, 2002). Antimicrobial susceptibility testing is recommended because increasing antimicrobial resistance has been reported among uterine isolates.

Differential Diagnosis

Diseases that may mimic pyometra include:

- Pregnancy-related uterine changes
- Uterine torsion
- Uterine neoplasia
- Mucometra or hydrometra
- Vaginitis
- Urinary tract infection
- Gastrointestinal disease
- Peritonitis
- Acute kidney disease

A combination of ultrasonography, laboratory findings, and clinical history usually allows definitive diagnosis.

Treatment of Canine Pyometra

Treatment depends on the severity of disease, reproductive value of the animal, type of pyometra, and presence of systemic complications.

The two primary approaches are:

1. Surgical treatment (ovariohysterectomy)
2. Medical treatment

Surgical Treatment

Ovariohysterectomy

Emergency ovariohysterectomy (removal of ovaries and uterus) is considered the gold-standard treatment for canine pyometra.

Advantages include:

- Removal of the infected uterus
- Elimination of the source of bacterial endotoxins
- Prevention of recurrence
- Definitive treatment of the disease

Medical Management

Medical therapy may be considered only in selected cases, particularly valuable breeding females with open-cervix pyometra and stable clinical condition.

Medical treatment aims to:

- Reduce progesterone effects
- Promote uterine evacuation
- Control bacterial infection

Prostaglandin Therapy

Natural prostaglandin F2 α and synthetic analogues stimulate:

- Luteolysis



Fig. 1: Mixed echogenicity of uterine contents (pockets).

- Cervical relaxation
- Myometrial contraction

Progesterone Receptor Antagonists

Drugs such as aglepristone block progesterone receptors and promote:

- Cervical opening
- Reduction of uterine resistance to infection
- Uterine evacuation

Medical therapy is more successful in open pyometra diagnosed early and requires intensive monitoring with repeated ultrasonography.

Prognosis

Prognosis depends on:

- Early diagnosis
- Severity of systemic inflammation
- Presence of septic shock
- Renal function
- Surgical timing

Dogs treated promptly with ovariohysterectomy generally have an excellent prognosis, with survival rates exceeding 90% in uncomplicated cases (Jitpean et al., 2014).

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