

Peer Reviewed

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# Managing the *E coli* UTI



## PROFILE

### Definition

A urinary tract infection (UTI) occurs when a bacterium, such as uropathogenic *Escherichia coli*, overcomes host defenses and adheres to, multiplies, and persists in the urinary tract.

#### ● Simple UTI

- These infections involve the bladder and are typically initial infections with no concurrent disease or underlying structural or functional abnormality (ie, no compromise of host defense mechanisms).

#### ● Complicated UTI

- These infections are associated with pyelonephritis, prostatitis, concurrent systemic diseases (diabetes mellitus, hyperadrenocorticism), and either systemic (corticosteroid use) or local (indwelling urinary catheter, uroliths, neoplasia) alterations in immunity through compromised host defense mechanisms.

### Incidence/Prevalence

- *E coli* is the most common bacterium isolated in canine and feline UTIs.<sup>1,2</sup>
- Approximately 14% of dogs have UTI during their lifetime, but young, healthy cats have an innate resistance and rarely develop UTI.<sup>3</sup>

### Signalment

- **Age**
  - Dogs may have UTI at any age.
  - Cats older than 10 years of age are predisposed and usually have concurrent illness.
- **Sex**
  - Female dogs are at increased risk for UTI due to easier ascension of bacteria through a shorter urethra. In male dogs, UTI is generally classified as complicated.

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CONTINUES

UTI = urinary tract infection

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**Causes**

- *E coli*, a gram-negative bacterium, has been isolated in 44% of all canine UTIs and in as many as 67% of feline UTIs.<sup>1,4</sup> Other bacteria associated with UTI include *Staphylococcus*, *Streptococcus*, *Enterococcus*, *Proteus*, and *Klebsiella* species.

**Risk Factors**

- UTI is associated with alterations in the host’s systemic or local immunity, such as immunosuppression, diabetes, hyperadrenocorticism, anatomic abnormalities (polyps/tumors, recessed vulva), indwelling catheters, uroliths, or urethral sphincter mechanism incompetence.
- In cats, risk factors include diabetes mellitus, hyperthyroidism, and renal disease.<sup>2</sup>

**Pathophysiology**

- *E coli* is considered a normal component of gastrointestinal and distal urogenital flora, but it can ascend the urethra and gain entrance to the urinary tract. Hematogenous spread is uncommon.
- Specific virulence factors found in *E coli* allow it to adhere to and invade host cells, produce toxins, utilize host nutrients, and evade the host’s immune system.

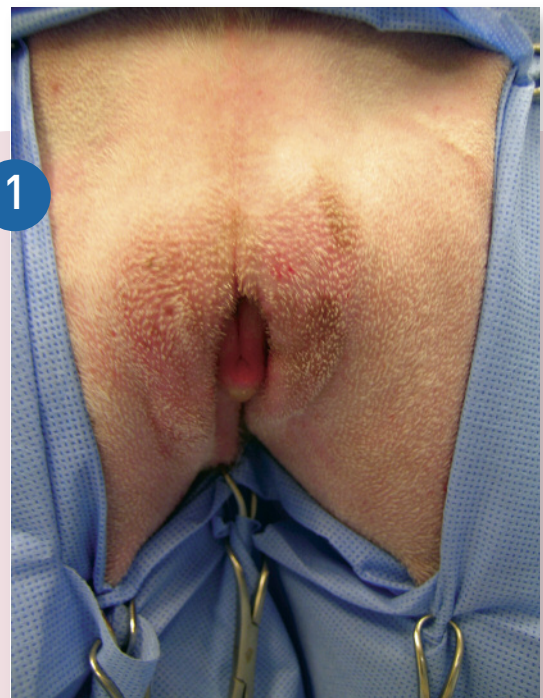
**Signs**

● **History**

- ▶ Thorough medical history, including details of previous UTI, current or recent medications, and response to treatment, is essential.
- ▶ Patient history for UTI typically includes changes in urination (amount, frequency, color, straining). Pollakiuria, stranguria, hematuria, and malodorous urine may indicate cystitis. Dogs with pyelonephritis or prostatitis may have polyuria/polydipsia and signs of systemic illness, such as lethargy, anorexia, and vomiting.
- ▶ Some dogs have silent UTIs with no urinary signs, although they may have evidence or history of concurrent disease.

● **Physical Examination**

- ▶ Findings on physical examination may be normal in simple UTI.
- ▶ Thorough examination for complicated UTI should include abdominal palpation for hepatomegaly, renal pain, thickened bladder wall, and cysturoliths; rectal palpation for prostatomegaly, urethral uroliths, and thickened urethra; and external examination for recessed vulva (Figure 1).



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A 1-year-old golden retriever with recessed vulva and evidence of skinfold pyoderma is prepared for episioplasty.

Courtesy of Emily Klocke, DVM, Diplomate ACVS

MIC = minimum inhibitory concentration, UTI = urinary tract infection





## DIAGNOSIS

### Definitive

- Urine culture and susceptibility testing, preferably on a sample obtained by cystocentesis or urinary catheter, are definitive for UTI. Other methods of collection require a quantitative culture to rule out contamination.

### Differential

- While infection with *E coli* is most common, many bacteria, including *Staphylococcus*, *Streptococcus*, *Enterococcus*, *Proteus*, and *Klebsiella* species, may be responsible. Fungal organisms can also cause UTI.

### Laboratory Findings

- Complete blood count will be within the reference intervals and is not required for diagnosis of simple UTI. However, an increase in white blood cells may be present with pyelonephritis or prostatitis.
- Serum biochemical profile will show abnormalities consistent with the underlying disease (chronic kidney disease, hyperadrenocorticism) in complicated UTI.
- Pyuria, bacteriuria (Figure 2), hematuria, or proteinuria may be noted on urinalysis.
  - Gram's staining and measurement of urine pH may help narrow the differential diagnosis while culture is pending (Table 1).



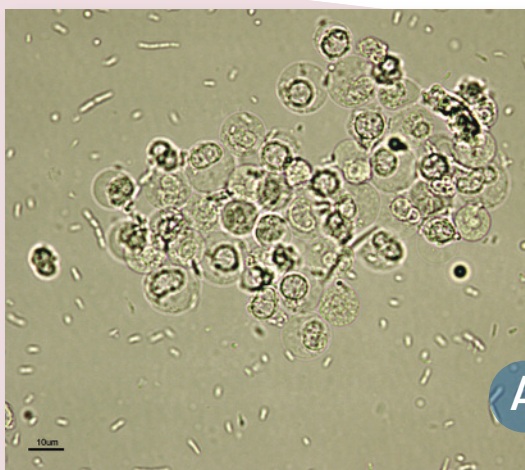
**Table 1. Urinalysis Findings That May Assist with Bacterial Identification and Antimicrobial Selection**

Bacterium	Gram's Stain	Urine pH	Shape
<i>Escherichia coli</i>	Negative	Acidic	Rod
<i>Klebsiella</i> species	Negative	Acidic	Rod
<i>Proteus</i> species	Negative	Alkaline	Rod
<i>Enterococcus</i> species	Positive	Acidic	Coccus
<i>Staphylococcus</i> species	Positive	Alkaline	Coccus
<i>Streptococcus</i> species	Positive	Acidic	Coccus

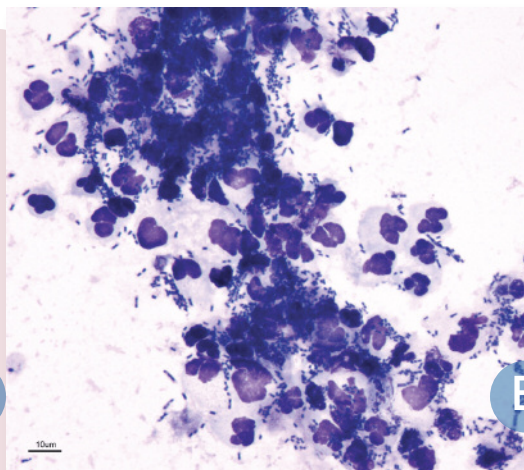
However, urine pH may be affected by other factors (fasting versus postprandial, diet, renal disease, vomiting, drugs).

- Not all cases of UTI have active urine sediment; immunosuppression can block the local inflammatory response.
- Minimum inhibitory concentrations (MICs) should be requested for culture and susceptibility testing of urine.
- Evaluation of endocrine function is indicated if suggested by clinical presentation (measurement of serum thyroxine concentration in a cat with polyphagia, weight loss, and palpable thyroid nodule).

CONTINUES



A



B

2

Canine urine sediment prepared as an unstained wet mount (A) and with modified Wright's stain (B) showing numerous bacilli and leukocytes (40× magnification).

Courtesy of Don Peterson, DVM

Prevalence studies have shown that between 8% and 17% of dog-owner pairs share fecal *E coli* with urovirulence traits.

### Imaging

- For complicated UTI, radiography and ultrasonography are indicated for assessment of uroliths, pyelonephritis (**Figure 3**), prostatitis, adrenomegaly, or other complicating factors. Contrast studies or cystoscopy may be indicated to investigate anatomic defects.

### **Tx** TREATMENT

- Simple versus complicated infections, location of infection, susceptibility of strain, adverse effects of antimicrobial agents, and client compliance issues should be evaluated prior to treatment for *E coli* infections.
- Most patients are treated as outpatients, but patients with pyelonephritis or prostatitis due to infection with *E coli* may benefit from hospitalization and supportive care.
  - ▶ Most infections can be effectively managed or cured with appropriate antimicrobial treatment, but episoplasty may be indicated in female dogs with a recessed vulva. Surgery or lithotripsy for uroliths or surgical resection of polyps/tumors should be performed when possible.
- Concurrent conditions should be identified and managed appropriately to minimize risk for UTI recurrence.

### Antimicrobials

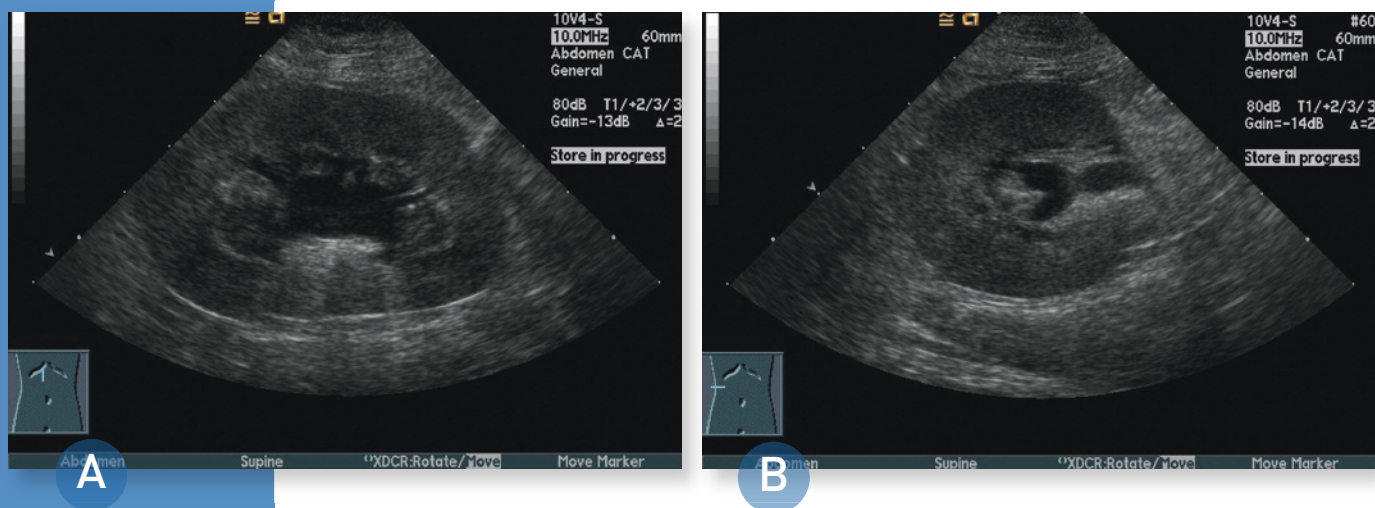
- Complete 10- to 14-day course for simple UTI or 4 to 6 weeks for complicated UTI.
  - ▶ Empirical antimicrobial selection can be based on urinalysis findings for simple UTI. Most *E coli* strains are susceptible to amoxicillin, amoxicillin-clavulanic acid, or cephalexin. Enrofloxacin should be avoided as first-line treatment because of resistance.<sup>5</sup>
  - ▶ Antimicrobial choice for complicated UTI should be based on culture and susceptibility testing and the ability of the drug to achieve more than 4 times the reported MIC in urine.
  - ▶ A lipid-soluble antimicrobial agent that can cross the blood-prostate barrier, such as enrofloxacin, chloramphenicol, or trimethoprim-sulfamethoxazole, is recommended for prostatitis. Castration should be performed after acute inflammation resolves.

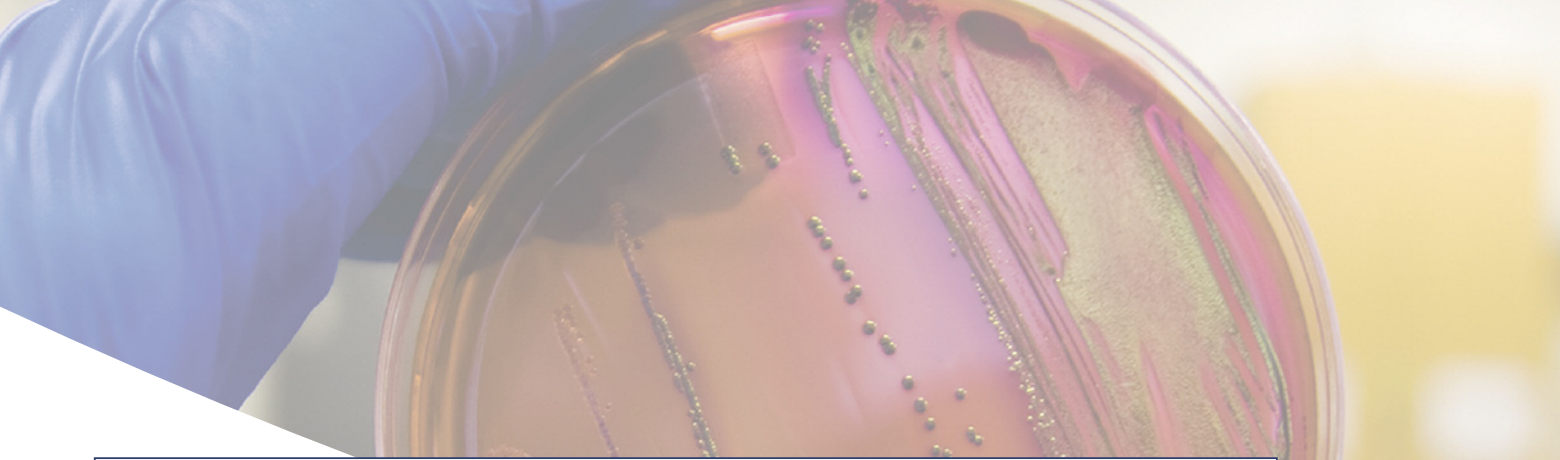
### Supportive Treatment

- Some supportive treatments prescribed in conjunction with appropriate antimicrobial treatment and monitoring (**Table 2**) may be suitable for patients with recurrent *E coli* UTI.
- **Note:** Further research is required to determine efficacy, safety, and optimal dosing profiles for these treatments in companion animals.

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Longitudinal (A) and transverse (B) renal ultrasound images of an 8-year-old female domestic shorthaired cat with pyelonephritis. These images show dilation of the renal pelvis, which is characteristic of pyelonephritis.





**Table 2. Proposed Doses for Supportive Treatment of Recurrent *E coli* UTI<sup>12-13</sup>**

Treatment	Suggested Dose
Methenamine hippurate	500 mg PO Q 12 H (dog) 250 mg PO Q 12 H (cat)
Methenamine mandelate	10-20 mg/kg PO Q 6-12 H (dogs)
Cranberry (dried extract)	20 mg/kg/day PO
Cranberry (juice)	1 mL/kg/day PO, low-sugar, high-concentrate juice
Cranberry (proanthocyanidin equivalent) <sup>a</sup>	1 mg/kg/day PO
D-mannose	250-1000 mg PO Q 12 H
<i>Coleus forskohlii</i> (whole dried herb)	50-500 mg/kg/day PO

<sup>a</sup> Cranadin, Nutramax Laboratories, Inc (nutramaxlabs.com)

- Methenamine* is a urinary antiseptic that is converted to formaldehyde and can have bactericidal activity against *E coli*.<sup>6</sup> Methenamine is often administered with a urinary acidifier; however it is contraindicated in dogs with metabolic acidosis (chronic kidney disease, diabetic ketoacidosis) and is not well tolerated by cats.
- Proanthocyanidins* (found in cranberries) can prevent *E coli* adhesion to the uroepithelium.<sup>7</sup> Preliminary research suggests cranberry extract has antiadhesive effects in canine urine.<sup>8,9</sup>
- D-mannose* is a sugar that competitively binds to mannose-sensitive fimbriae on *E coli*, which can inhibit adhesion to or displace adhered *E coli* from the uroepithelium.<sup>10</sup>
- Forskolin* is the main active ingredient in the Asiatic herb *Coleus forskohlii* and may stimulate exocytosis of *E coli* from the urinary bladder wall.<sup>11</sup> It may be useful in relapsed UTI with suspected poor antimicrobial penetration.



**FOLLOW-UP**

**Patient Monitoring**

- Optimal monitoring for complicated and recurrent UTI includes urine culture 3 to 5 days after initiation of treatment.

  - No growth on culture suggests effective treatment.
  - Growth on culture suggests ineffective treatment, and antimicrobial choice should be reconsidered.
- Bacterial culture should be negative *prior to* discontinuation of treatment and again 5 to 7 days following discontinuation of antimicrobial treatment.

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**There's More!**

Go to [cliniciansbrief.com/journal](http://cliniciansbrief.com/journal) for the related article **Nutritional Management of Urolithiasis** by Sally Perea (September 2009).

MIC = minimum inhibitory concentration, UTI = urinary tract infection



**Recurrence and Resistance**

- Recurrence of UTI with the same organism warrants further investigation of potential problems with antimicrobial treatment and/or reevaluation for a source of the infection (uroliths or neoplasia).
- Recurrence of UTI with a different organism warrants further investigation for a cause of immunosuppression.
- Preventive low-dose antimicrobial treatment (eg, nitrofurantoin 4 mg/kg PO once at bedtime instead of Q 8 H) may be indicated for recurrent *E coli* UTI with an identifiable underlying cause. Low-dose treatment should be initiated after the current infection is properly controlled (following 4–6 weeks of antimicrobial treatment at the therapeutic dose and a negative urine culture).



**IN GENERAL**

**Relative Cost**

- **Simple UTI**
  - The cost for a physical exam, urinalysis, +/- urine culture & susceptibility, and cost of antimicrobial treatment: \$-\$\$
- **Complicated UTI**
  - The total expense for initial extensive diagnostic testing, antimicrobial treatment, and multiple follow-up cultures can be costly: \$\$\$-\$\$\$\$

**Cost Key**

\$ = up to \$100	\$\$\$\$ = \$501-\$1000
\$\$ = \$101-\$250	\$\$\$\$\$ = more than \$1000
\$\$\$ = \$251-\$500	



**Public Health Considerations**

- Uropathogenic *E coli* is considered to be zoonotic based on studies documenting sharing of the organism within a household.<sup>14-17</sup>
- Prevalence studies have shown that between 8% and 17% of dog-owner pairs share fecal *E coli* with urovirulence traits.<sup>14-17</sup> The route and direction of transmission between species are not fully understood.
- Prompt identification and appropriate treatment of *E coli* UTI, as well as maintenance of good hygiene, may reduce risk for transmission of uropathogenic *E coli* between pets and owners.

See Aids & Resources, back page, for references & suggested reading.

UTI = urinary tract infection