Bacterial urinary tract infections

Author: CATHERINE F LE BARS

Categories: Vets

Date: February 11, 2008

CATHERINE F LE BARS discusses ways to treat this common illness and how to find the tell-tale signs associated with it.

BACTERIAL urinary tract infections (UTIs) occur commonly in dogs, affecting up to 14 per cent of all canines at some point during their life.

It appears to be more prevalent in females and dogs less than two years old or more than six years old. Failure to recognise and treat the condition may lead to serious consequences, such as pyelonephritis, infertility, septicaemia, discospondylitis and struvite urolithiasis. This article will examine the causes, diagnosis and treatment options for this condition.

The canine urinary tract can be divided into an upper or proximal portion (kidneys and ureters) and a lower or distal portion (bladder, urethra and prostate). Excluding the distal urethra, the urinary tract is usually sterile. In general, pathogens ascend proximally via the external urethral orifice, although they may also spread by the haematogenous route, extension from the prostate or as a result of iatrogenic introduction.

Classification and pathogenesis of UTI

UTIs are often caused by the ascending migration of microflora that inhabit the lower genitourinary and alimentary tracts. Bacteria may colonise a single site (as in urethritis, cystitis and pyelonephritis), a combination of sites or be restricted to the urine (bacteriuria).

UTIs are often classified according to the specific location of infection. However, it should be
recognised that all parts of the urinary tract are vulnerable to subsequent invasion once colonisation has taken place.

The risk of infection is dependent on three factors: the presence of microbial pathogens, large numbers of pathogens and diminished host resistance.

Poor or abnormal host defence should be considered whenever recurrent or persistent UTI is present.

Uncomplicated or simple UTI is diagnosed when there are no evident underlying structural, neurological or functional abnormalities. This may occur when a large number of pathogens overwhelm normal host defences. However, it occurs more commonly when there is a transient defect in those defences – the cause of which may not be immediately apparent. In general, simple UTIs hold a good prognosis.

Complicated UTIs occur secondarily to an identifiable disorder that interferes with host defences. Predisposing causes include anatomical defects, impaired immunocompetence, alterations in the uroepithelium and mucosal defences, disorders in voiding frequency and alterations in urine chemistry. Failure to address the underlying problem may lead to recurrent UTIs. Because of the low prevalence of UTIs in male dogs, many experts consider all UTIs in this population to be complicated and assume prostatic involvement.

Recurrent UTIs can be divided into three groups: relapses, reinfections and superinfections. Accurate classification relies on the use of urine cultures.

Relapsing or persistent infections are caused by the same species and serologic strain of bacteria within the days or weeks following the cessation of treatment. These treatment failures may occur as a result of one or more causes and represent a failure to completely eliminate pathogens before treatment is withdrawn.

Reinfections involve the recurrent invasion of the urinary tract by different pathogens and tend to occur at longer intervals post treatment than relapsing infections. They are associated with a variety of causes, including iatrogenic infection, and appear to occur more commonly in female dogs.

Superinfections occur when a new pathogen invades the urinary tract during a course of treatment. They are often associated with indwelling catheters and may develop as sequelae to urinary diversion procedures, such as tube cystotomies and antepubic urethrostomies.

**Clinical signs of UTI**

Clinical signs are dependent on the location of infection within the urinary tract. They include:
• excessive thirst (polydipsia);
• increased volume of voided urine (polyuria);
• increased frequency of urination (pollakiuria);
• reluctance to urinate;
• painful or difficult urination (dysuria);
• abnormal odour or colour of voided urine;
• incontinence or inappropriate urination;
• presence in urine of blood (haematuria), pus (pyuria) or crystals (crystalluria);
• abdominal discomfort;
• pyrexia; and
• toxaemia.

The history, signalment and presence of the above signs may be indicative of bacterial UTI. However, additional investigation is always required to rule out other disease states.

**Diagnosis**

Reliance on the presence of suspicious clinical signs and the use of in-house dipsticks may result in the under or over-diagnosis of bacterial UTIs, leading to inappropriate treatment regimens and subsequent treatment failure. It is important to note that even if a bacterial UTI is present, the variety of bacterial species capable of causing disease makes it difficult to predict the causative pathogen and formulate an effective empirical therapy. The examination of sediment will allow the clinician to determine the involvement of gram-positive, gram-negative or mixed populations, enabling a more educated approach to treatment. However, urine culture remains the most effective means of correctly diagnosing bacterial UTIs and identifying the pathogens involved.

Urine cultures should be performed whenever clinical signs fail to improve with empirical treatment, or when UTIs recur.

To avoid misdiagnosis and treatment failure, appropriate sampling techniques should be utilised and test results must be properly interpreted.
Cystocentesis is the most effective means of differentiating contaminants from pathogens and the detection of bacteria in urine samples collected by this method is highly suggestive of bacterial UTI.

If pollakiuria and dysuria preclude cystocentesis, a midstream sample may be collected. In this instance, the external genitalia should be cleaned and, if necessary, long hair clipped from the region. If catheters are used, appropriate aseptic techniques must be employed to prevent sample contamination and inadvertent iatrogenic UTI.

Regardless of the sampling method adopted, antimicrobial treatment should be withdrawn for three to five days prior to collection and urine deposited into a sterile container.

Bacterial counts can multiply rapidly in urine at room temperature; however, fastidious bacteria may soon die. Therefore, cultures should always be performed as rapidly as possible. Alternatively, the sample may be refrigerated for up to six hours without significant growth. Freezing may destroy the bacteria present. The use of commercial collection tubes containing preservatives, combined with refrigeration, may preserve urine for up to 72 hours.

The presence of bacteria in urine does not always indicate infection – it may occur as a consequence of post-collection contamination, or contamination by bacteria normally resident in the urethra or genital tract. As a rule, normal resident flora tends to be gram positive.

Qualitative urine culture confirms the presence and identification of bacterial species in urine and is useful for those samples collected using cystocentesis. For samples collected in other fashions (mid-stream or catherisation, or where contamination is a concern), a quantitative culture should be performed. This technique determines the number of bacteria or colony forming units (CFU) per unit of volume (see Table 2).

It is important to note that in samples collected by means other than cystocentesis, bacterial counts of 100,000 may occasionally occur in dogs without bacterial UTI. Low counts may also occur in dogs with clinical evidence of disease.

Therefore, results must always be interpreted in association with other findings and repeat cultures performed if doubt persists. Bacterial contamination of these urine samples is more common in females than males.

Once a bacterial UTI is confirmed, further information will be required to localise the site of infection. Clinical signs, a thorough physical examination, haematology and blood biochemistry, urinalysis and imaging techniques, such as radiology and ultrasonography, will aid the clinician in reaching the correct diagnosis.

**Pathogens**
As previously mentioned, many species involved come from the genitourinary and intestinal tract. Since approximately 80 per cent of bacterial UTIs in dogs are caused by a single pathogen, the presence of several species should raise concerns that one or more of them represent contaminants. Pathogens commonly isolated in UTIs are shown in Table 3.

**Treatment and control**

Once the pathogen has been identified and its sensitivity to antimicrobials determined, the clinician must decide on the dose, frequency and timing of treatment. Doses should be calculated according to the minimum inhibitory concentration (MIC). This is the lowest antimicrobial concentration that will inhibit bacterial growth.

In UTIs, the ideal is to select a drug that produces urinary concentrations of four times the MIC of the target pathogen. Standard disk-diffusion sensitivity tests use antibiotic concentrations based on expected serum levels. It is also worth noting that since urinary levels of an antibiotic are usually significantly higher than serum levels, an apparently resistant organism may show in-vivo sensitivity, despite in-vitro resistance.

The frequency of treatment depends on the antibiotic's properties and the optimum time of administration is immediately following urination, although this is not always practical.

The duration of treatment depends on the site and nature of infection. Seven to 10 days is usually sufficient for acute urethrocystitis, chronic cases may require four weeks. Pyelonephritis may require therapy for four to eight weeks and complicated UTIs may require months of treatment. Occasionally, ancillary medications such as urinary acidifiers, antispasmodics and analgesics may be required.

Urine should be monitored and a urine culture performed seven to 14 days following the cessation of therapy.

When renal failure is present, drug doses or frequency of dosing should be adjusted accordingly, to minimise drug accumulation and toxicity.

If culture results are not available, empirical treatment should be initiated.

Appropriate choices include amoxicillin-clavulanic acid, first-generation cephalosporins and trimethopim sulfa.

In some cases, relapses occur, despite appropriate dosing and the resolution of underlying factors. In these cases, chronic low-dose therapy (one third of the total daily dose once daily) for at least six months may be initiated. Urine cultures should be performed at regular intervals and if positive, a twoweek course at the full dose should be given.
Conclusion

Bacterial UTIs are a commonly occurring disease in dogs that can be easily misdiagnosed – unless urine cultures are performed. To give an accurate result, urine samples must be properly collected and prepared. Many factors may contribute to a false result, including properties of the urine itself, the bacterial species involved and the site of infection. As a rule, quantitative cultures provide the most accurate results. However, even these findings must be interpreted with caution and further investigative procedures carried out if indicated. As with all infections, treatment must be with an appropriate antibiotic for an adequate period of time, and continuously monitored until the resolution of clinical signs and laboratory findings.

Recurrent infections should prompt the clinician to identify host factors that may be responsible for treatment failures.

• References are available by contacting the editor.
Care must be taken to avoid urine sample contamination.
Extremes of urine pH can be seen in its antimicrobial properties.
<table>
<thead>
<tr>
<th>Host defences of the urinary tract</th>
<th></th>
</tr>
</thead>
</table>
| **Normal micturition**            | - Adequate urine volume  
                                   | - Frequent voiding  
                                   | - Complete voiding  |
| **Anatomical structures**         | - Urethral high-pressure zones  
                                   | - Surface characteristics of urethral uroepithelium  
                                   | - Urethral peristalsis  
                                   | - Prostatic secretions (antibacterial fractions and immunoglobulins) |
| **Mucosal defence barriers**      | - Antibody production  
                                   | - Surface layer (hydrophilic glycosaminoglycans)  
                                   | - Intrinsic mucosal antimicrobial properties  
                                   | - Exfoliation of cells  
                                   | - Commensal microbes (normal flora of distal urethra and genital tract) |
| **Antimicrobial properties of urines** | - Extremes of urine pH  
                                   | - Hyperosmolality  
                                   | - High concentration of urea  
                                   | - Organic acids  
                                   | - Small molecular weight carbohydrates  
                                   | - Tamm-Horsfall mucoprotein |
| **Systemic immuno-competence**    | - Cell-mediated immunity  
<pre><code>                               | - Humoral mediated immunity  |
</code></pre>
<table>
<thead>
<tr>
<th>Collection method</th>
<th>Significant</th>
<th>Suspicious</th>
<th>Contaminant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cystocentesis</td>
<td>&gt;1,000</td>
<td>100·1,000</td>
<td>&lt;100</td>
</tr>
<tr>
<td>Catheterisation</td>
<td>&gt;10,000</td>
<td>1,000·10,000</td>
<td>&lt;1,000</td>
</tr>
<tr>
<td>Voluntary voiding</td>
<td>&gt;100,000</td>
<td>10,000·90,000</td>
<td>&lt;1,000·10,000</td>
</tr>
<tr>
<td>Manual expression</td>
<td>&gt;100,000</td>
<td>10,000·90,000</td>
<td>&lt;1,000·10,000</td>
</tr>
</tbody>
</table>

**TABLE 2.** Interpreting quantitative urine cultures in dogs (CFU/ml urine)
<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Gram stain result</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Escherichia coli</em></td>
<td>Negative rod</td>
</tr>
<tr>
<td><em>Proteus mirabilis</em></td>
<td>Negative rod</td>
</tr>
<tr>
<td><em>Staphylococcus species</em></td>
<td>Positive cocci</td>
</tr>
<tr>
<td><em>Streptococcus species</em></td>
<td>Positive cocci</td>
</tr>
<tr>
<td><em>Enterobacter species</em></td>
<td>Positive cocci</td>
</tr>
<tr>
<td><em>Klebsiella pneumoniae</em></td>
<td>Negative rod</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>Negative rod</td>
</tr>
</tbody>
</table>

**TABLE 3.** Pathogens commonly isolated in UTIs