INTRODUCTION
Urosepsis, an uncommonly reported condition in veterinary medicine, refers to sepsis associated with a complicated urinary tract infection (UTI). In humans, urosepsis has been associated with acute bacterial pyelonephritis, emphysematous pyelonephritis, pyonephrosis, renal abscessation, fungal infections, bladder perforation, prostatic and testicular infections and urinary catheter associated infections. Although many of these conditions are often diagnosed in the veterinary patient, little information currently exists in the veterinary literature regarding the incidence of urosepsis as a complication of these conditions. Early and accurate recognition of conditions associated with urosepsis in the dog and cat as well as the institution of appropriate treatment are necessary to avoid morbidity and mortality.

PATHOGENESIS
In most cases of urosepsis, bacteria isolated from the rectum, genital and perineal area serve as the principle source of infection. These bacteria can then migrate from this region to the lower and then upper urinary tract. Similar to human patients, E. coli is the most common uropathogen affecting dogs and cats and accounts for up to ½ of the urine isolates. Since E. coli is the most common pathogen affecting the urinary tract, its virulence has been extensively investigated. Although hundreds of serotypes of E. coli are known, fewer than 20 account for most bacterial UTI’s. Gram positive cocci, including Staphylococci, streptococci and Enterococci account for up to 1/3 of bacteria isolated and, although uncommonly diagnosed, Pseudomonas, Klebsiella, Pasteurella, Corynebacterium and Mycoplasma account for the remaining isolates. In patients with structural or functional abnormalities of the urinary tract or those with altered defenses, infections can be caused by gram negative aerobic bacilli other than E. coli, gram positive cocci, and by bacterial strains that normally lack uropathogenic properties. In patients that have a septic peritonitis associated with a urinary tract disorder, the visceral and parietal peritoneum provide a large surface area for absorption of bacteria and endotoxins resulting in septic shock.

The development of urosepsis often represents a balance between host defenses and the quantity and pathogenicity of the infectious agents. Initial defense in preventing ascending infections include normal micturition, normal urinary tract anatomy, extensive renal blood supply, ureteral and urethral peristalsis, mucosal defense barriers, antimicrobial properties of the urine and systemic immunocompetence. Systemic defenses are important in preventing hematogenous spread of the infection. Patients with a UTI and risk factors including the presence of an anatomic abnormality, prior urinary tract disease, renal failure, a urinary tract obstruction, nephrolithiasis, neurological disease, diabetes, Cushing’s and/or immunosupression should be considered to have a complicated UTI and are more prone to the development of urosepsis. Additionally, a urinary tract infection diagnosed in pregnant or intact dogs and cats should also be considered complicated.

Clinical and laboratory findings in a patient diagnosed with urosepsis may include lethargy, fever or hypothermia, hyperemic mucous membranes, tachypnea, tachycardia, bounding pulses, a positive blood culture and a leukogram that reveals a leukocytosis or leukopenia with or without a left shift. Additionally, early laboratory findings may identify abnormalities specifically related to the urinary tract including azotemia, an active urine sediment and a positive urine culture. In these cases, a positive urine culture is extremely helpful in confirming blood culture results by
isolation of the same organisms with the same antimicrobial profile. In cases of severe sepsis, multiple organ dysfunction may be identified on clinical and laboratory evaluations.

Although treatment protocols vary depending on clinical presentation, bacteria identified and the underlying cause of the urosepsis, aggressive treatment is often necessary. Treatment often includes a combination of intravenous fluid and broad spectrum antimicrobial therapy. Once the culture and sensitivity information is available, antibiotic coverage should be adjusted to specific therapy against the isolated organism. Additionally, in order to prevent progression as well as recurrence, the underlying condition as well as any complicating factors need to be corrected. Although there is some overlap in the clinical picture for different causes of urosepsis in the veterinary patient, some clinical findings, laboratory results and treatments are unique to each condition.

CAUSES OF UROSEPSIS

Pyelonephritis
Although the kidneys and ureters are most commonly affected by ascending bacteria rather than via hematogenous infections, the presence of a urinary tract obstruction or renal trauma may increase the incidence of hematogenous spread. Urosepsis resulting from a pyelonephritis has been uncommonly reported in dogs and cats. Although these patients would likely be treated with aggressive medical management, surgery may be indicated in cases of renal abscessation in conjunction with a pyelonephritis or in patients with a pyelonephritis associated with obstructive urolithiasis.

Bladder rupture
Although uncommonly reported in the veterinary literature, urosepsis may result from a bladder and/or a proximal urethral rupture in a patient with a UTI. Rupture in dogs and cats can occur following blunt trauma, penetrating injuries, aggressive catheterization, rupture secondary to prolonged urethral obstruction or excessive force during bladder expression. Physical examination may reveal dehydration, lack of a bladder on palpation, fluid accumulation within the peritoneal cavity and ventral abdominal bruising. Clinical signs are often vague initially, but can worsen as the uremia progresses and sepsis not addressed. Signs may include vomiting, anorexia, depression and abdominal pain. Abdominal fluid to peripheral blood creatinine and potassium ratios are often diagnostic of uroperitoneum and the presence of bacteria on cytology confirms a septic peritonitis.

Treatment involves early repair and/or urinary diversion to halt continued accumulation of septic urine into the abdominal cavity. The bladder defect is debrided of any devitalized tissue and then closed using a single or double layer closure. If concerns exist regarding tissue viability of the bladder wall, a closed indwelling urinary catheter system can be used to maintain bladder decompression postoperatively. In patients with urethral trauma, treatment options include primary urethral repair, placement of a urethral catheter to stent the urethra, placement of a cystostomy tube for urinary diversion until the urethra heals or the combination of a cystostomy tube and a urethral catheter.

Prostatic infection
Despite normal host defense mechanisms, bacterial colonization of the prostate can occur through both ascension of urethral bacteria or by the hematogenous route. Suppurative prostatitis and prostatic abscessation are the most common causes of urosepsis in the canine surgical patients. Dogs with suppurative prostatitis usually have a history of an acute onset of illness. Patients can present with signs of anorexia, vomiting, tenesmus, lethargy, fever,
dehydration, injected mucous membranes, weight loss, pain upon rectal examination, caudal abdominal discomfort and/or pain in the pelvic and lumbar region. Additionally, hematuria, pyuria, stranguria, hemorrhagic prepuceal discharge, urinary incontinence or the inability to urinate can also be identified. If the infection is not treated, microabscesses can form which can eventually coalesce into a large abscess. Septicemia and endotoxemia quickly develop, particularly if the abscess has ruptured into the abdominal cavity. Infectious agents can often be identified on gram stain of the urine and urine culture avoiding techniques such as prostatic palpation, traumatic catheterization and aspiration which can be dangerous for the patient. Abdominal ultrasound may reveal varying echogenicity with symmetrical or asymmetrical enlargement of the gland. Cyst like structures may also be present and may represent abscess formation. It is important to note, however, that dogs with prostatitis may have a normal ultrasound examination underscoring the need to make a definitive diagnosis using a previously mentioned technique.

Suppurative prostatitis and prostatic abscessation are serious life threatening disorders. In patients with acute suppurative prostatitis, treatment involves fluid therapy to correct dehydration and treat cardiovascular shock and antibiotic therapy based on culture and sensitivity of prostatic fluid. Antibiotics should be administered for 3-4 weeks and then the urine or prostatic fluid should be cultured following discontinuation of antibiotic therapy and again in 2-4 weeks to determine if the infection is eliminated. Castration is also recommended. In addition to the above mentioned treatments, surgical drainage or excision is often the treatment of choice in a patient with a prostatic abscess. Surgical techniques that have been described to treat prostatic abscessation include prostatic omentalization, placement of penrose drains, marsupialization of the abscess, ultrasound guided percutaneous drainage and subtotal or excisional prostatectomy.

**Pyometra**

Pyometra is the most common cause of urosepsis that has been reported in the dog and cat. Urosepsis can occur in patients with pyometra with or without uterine rupture. Although many aerobic and some anaerobic bacteria have been identified in both dogs and cats with pyometra including *Staphylococcus*, *Streptococcus*, *Pasteurella*, *Klebsiella*, *Proteus*, *Pseudomonas*, *Aerobacter*, *Haemophilus*, *Moraxella* species and *Serratia marcescens*, *E. coli* is the most common bacteria isolated. Although culture results are rarely negative in the dog, in cats, aerobic culture results are negative 15-31% of the time. Dogs diagnosed with a pyometra often present systemically sick with signs of anorexia, lethargy, depression, polydipsia, vomiting, diarrhea and, if the cervix is patent, a vaginal discharge. When abdominal pain is present, septic peritonitis is likely. Body temperature may be normal, elevated or subnormal. Clinical signs in cats are similar, but often are more subtle. Clinicopathological abnormalities in both species can occur to varying degrees and may include anemia, leukocytosis or leukopenia with a left shift, azotemia, hypoalbuminemia, hypo or hyperglycemia, hyperglobulinemia, increased alkaline phosphatase and acidosis. Prior to surgery, medical therapy is instituted and includes intravenous fluid and antibiotic therapy to correct deficits, acidosis and sepsis. Surgery is not postponed in the very sick animals for more than a few hours because of the continued bacteremia and septicemia that is occurring. Treatment for pyometra is ovariohysterectomy. If the uterus ruptures at surgery, the abdomen is lavaged and the patient treated for a septic peritonitis.

**Catheter associated urinary tract infection**

In human patients, the catheterized urinary tract has repeatedly been demonstrated to be the most common source of gram negative sepsis. Although nosocomial UTI’s following the use of
an indwelling urinary catheter in both dogs and cats has been reported, the subsequent development of urosepsis is uncommon. In both veterinary and in human hospitals, pathogens can be introduced from the hands of hospital staff, via instrumentation or contaminated disinfectants. The most common location for bacteria to enter the system can occur at the catheter-collecting tube junction or at the drainage bag portal. Intestinal flora can migrate along the catheter into the bladder from the perineal area of the patient. In order to prevent or minimize the incidence of catheter associated infections, clinicians should avoid indiscriminate use of catheters. Additionally, catheters should be used cautiously in patients with preexisting urinary tract disease, those undergoing diuresis or those whose immune system is compromised. A sterile closed collection system, as well as appropriate antimicrobial therapy if an infection is present, is also recommended. Since a longer duration of catheterization has been associated with antimicrobial resistant bacteria and since one cannot predict the duration of catheterization, prophylactic use of antimicrobials is not recommended. Additionally, diagnostic and therapeutic procedures that may result in the introduction of bacteria into the urinary system should also be minimized.

CONCLUSION
Urosepsis is an uncommonly diagnosed, but serious problem that can affect both dogs and cats. Conditions in veterinary medicine that have been associated with urosepsis include bacterial pyelonephritis and renal abscessation, bladder rupture in patients with a UTI, prostatic suppuration and abscessation, testicular and vaginal abscessation, pyometra and catheter associated urinary tract infections. Risk factors that may cause patients to be more prone to the development of urosepsis or complicate treatment include the presence of an anatomic abnormality, a urinary tract obstruction, nephrolithiasis, prior urinary tract disease, renal failure, neurological disease, diabetes, Cushing’s and immunosuppression. Accurate recognition and aggressive therapy addressing the underlying condition, complicating risk factors and the associated inflammatory response are necessary to prevent significant morbidity and mortality.