Wyatt Hurts

A Case Report of Canine Pyelonephritis

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Introduction:

Pyelonephritis, or inflammation of the renal pelvis and neighboring parenchyma, usually results from an ascending bacterial infection originating in the distal urogenital tract. This condition can have an acute or chronic clinical presentation. Canine patients presenting with acute pyelonephritis tend to exhibit non-specific systemic signs including fever, lumbar pain, and other signs consistent with uremia, such as vomiting, diarrhea, anorexia, and lethargy. On the other hand, dogs presenting with chronic pyelonephritis can be difficult to diagnose, as they may not display any systemic signs.[1]

Presumptively diagnosing pyelonephritis is based on urinalysis findings, compatible clinical signs, improved azotemia following antimicrobial therapy, and compatible ultrasonographic and/or excretory urography findings. Pyelectasia, hydroureter/ureteral dilation, renal hyperechogenicity, and retroperitoneal fluid accumulation can all be observed on ultrasound. A urine culture showing aerobic bacterial growth also supports the diagnosis. Numerous organisms have been isolated from the urogenital tract of dogs affected by pyelonephritis. *Escherichia coli*, *Staphylococcus* spp., *Streptococcus* spp., *Enterococcus* spp., *Proteus mirabilis*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* are some of the most common isolates, with *E. coli* being overwhelmingly the most common. Polymicrobial infections have also been observed. A definitive diagnosis is possible by collection of a positive bacterial culture through pyelocentesis or renal biopsy, though these procedures are rarely performed due to their invasive nature.[1]

Predisposing factors, such as an altered urothelium, neoplasia, immunosuppressive therapy, altered urine composition, incontinence, urinary tract anatomic defect, and urolithiasis have been discussed in the canine patient.[1] The duration and severity of infection is variable,

though prognosis is generally good with early diagnosis and treatment.[3] The following report describes a case of acute pyelonephritis diagnosed in a young canine patient, and highlights the diagnostic processes and treatments employed.

History and Presentation:

Wyatt, an 11-week-old male intact golden retriever, presented to the Mississippi State University College of Veterinary Medicine Animal Health Center Emergency service on June 9th, 2018, for evaluation after an acute onset of vomiting, inappetance, and lethargy. Wyatt was reported to have been doing well the morning of presentation, with normal eating and drinking observed. Around 4:00 PM, he was seen vomiting a green liquid which contained pieces of food and treats. Wyatt vomited a total of seven times with the last two episodes producing a clear liquid. Following emesis, Wyatt became inappetant and stopped drinking water, though no diarrhea or abnormal urination was noted. He was taken to his primary veterinarian on Thursday June 7th, 2018, at which time he received his third round of puppy vaccines and was diagnosed with hookworms. Wyatt had chew toys and bones at home, but he was not seen ingesting any large fragments.

On presentation, Wyatt was depressed but responsive. He weighed 6.3 kg and had a body condition score of 5/9. His heart and lungs auscultated normally with no murmurs, arrhythmias, crackles, or wheezes appreciated. He had a heart rate of 120 beats per minute, a respiratory rate of 32 breaths per minute, and a temperature of 102.1 F. His mucous membranes were pink and slightly tacky with a capillary refill time of 2 seconds. All lymph nodes were symmetrical, smooth, and non-painful. His abdomen was soft, but severe pain was elicited on palpation, particularly in the cranial region. Rectal examination revealed no abnormalities. The remainder of the physical exam was unremarkable.

A triage examination revealed a SpO2 of 100% and a blood pressure of 160/121 mmHg (MAP-134). Electrocardiography was performed, which was within normal limits. The abdominal FAST scan showed a scant amount of free fluid with hypermotile, but non-dilated intestines.

Diagnostic Approach/Considerations:

Due to Wyatt's age and gastrointestinal signs, a SNAP Parvo Test was done and revealed a negative result. A NOVA showed a mild respiratory alkalosis and mild hypochloremia (105 mEq/L). He had a packed cell volume and total protein of 34% and 5.4 g/dL, respectively. Three-view abdominal radiographs were taken for further evaluation of the abdominal pain and discomfort uncovered on physical examination. The images acquired showed generalized decreased serosal detail, thus limiting the evaluation of abdominal soft tissue structures. No evidence of a small intestinal mechanical obstruction was observed. However, two smoothly marginated, mineral opaque, irregularly shaped structures were seen superimposed over the area of the left kidney, with the larger of the two measuring 2 x 1 x 2.5 mm. Considerations for this finding included intestinal mineral-opaque material or nephroliths; therefore, repeat abdominal radiographs and/or an abdominal ultrasound were recommended.

The morning following presentation, a complete blood count and chemistry panel were run, showing a PCV of 24%, mild neutrophilia (21,208/uL), moderate hyponatremia (134.8 mmol/L), mild hypochloremia (105.9 mmol/L), mild hypoalbuminemia (2.3 g/dL), and mild hypoglobulinemia (1.9 g/dL). Urine was collected via cystocentesis, and a urinalysis and culture were submitted. Urinalysis revealed a pH of 8.0, white blood cell count of 25-50, and red blood cell count of 5-10, with few bacteria seen. A moderate amount of triple phosphate crystals were also found. Results of the urine culture showed >100,000 cfu/ml, with the causative organism

being *Proteus mirabilis*. Following review of these results, Wyatt was diagnosed with a urinary tract infection.

On June 11th, 2018, an abdominal ultrasound was performed. Findings included a markedly dilated left renal pelvis, measuring 1.02 cm, within which multiple hyperechoic, irregularly marginated structures were seen, demonstrating twinkle artifact and distal acoustic shadowing. The margin of the left kidney was undulated, the medullae were rounded, and the left renal cortex was decreased in volume and hyperechoic in appearance. Dilation of the left proximal ureter was observed and remained dilated in appearance to the level of its mid-body. Considerations for the changes observed in the left kidney and ureter included left renal nephrolithiasis, acute tubular nephrosis/necrosis, glomerular or interstitial nephritis, nephrocalcinosis, pyelonephritis, and hydronephrosis resulting from infectious/inflammatory etiologies or an ectopic ureter. The retroperitoneal fat lateral and dorsal to the left kidney and extending caudally to the area of the apex of the bladder, was severely hyperechoic with multiple loculated hypoechoic pockets of fluid noted. Differentials included retroperitonitis secondary to an abscess or ruptured ureter. The urinary bladder wall was mildly thickened, measuring 0.28 mm, suggesting cystitis, and a 0.40 cm isoechoic, pedunculated structure was seen projecting into the lumen. Numerous hyperechoic foci were observed in suspension within the urinary bladder. Another hyperechoic structure was visualized within the prostate, and distal acoustic shadowing was seen. Consideration for this finding was given to urinary calculi within the prostatic urethra or parenchymal mineralization. Fine-needle aspirates of the hyperechoic retroperitoneal fat and loculated hypoechoic fluid were collected using 22 gauge 1.5 inch needles. Given the positive urine culture showing *Proteus mirabilis* and demonstration of a dilated left renal pelvis and ureter as well as a hyperechoic renal cortex, a presumptive diagnosis

of acute pyelonephritis was made. Pyelocentesis and/or renal biopsy were not pursued for confirmation of the diagnosis due to the invasiveness of these procedures. Nephrolithiasis was also diagnosed based on the ultrasound examination, abdominal radiographs, and urinalysis.

Results of the fine-needle aspirates showed mild to moderate neutrophilic inflammation. Culture of the samples returned growth from enrichment broth of *Proteus mirabilis*. Although no bacteria were visualized on cytology to definitely confirm an abscess, a presumptive diagnosis of a left retroperitoneal abscess was made. Due to the presence of the same organism, the initial antimicrobial therapy chosen for treatment of the urinary tract infection was continued.

A repeat urinalysis was completed on June 12th, 2018, which revealed a normal pH of 6.5, with no crystals or bacteria, and only 5-10 white blood cells observed. A renal profile did not show any major abnormalities. The following day, a focal urinary ultrasound was performed and compared to the previous study. The left renal pelvis was still dilated but was smaller than previously noted, measuring 0.56 cm in diameter. The retroperitoneal fat near the left kidney remained hyperechoic in appearance, but the fluid pockets were decreased in number and volume. The thickness of the urinary bladder wall had returned to within normal limits. Hyperechoic material was still seen in suspension within the urinary bladder. The remainder of the ultrasound examination remained unchanged. These findings supported improvement of the pyelonephritis and renal/perirenal abscess.

Pathophysiology:

Pyelonephritis usually arises from an ascending infection from the urethra to the urinary bladder. Commonly implicated causal organisms tend to be the same bacteria that colonize the gastrointestinal tract and are able to gain entry into the urinary tract following establishment of

the peri-urethral region. The bacteria reach the bladder and continue to ascend to the ureters and kidneys, ultimately resulting in an upper urinary tract infection and pyelonephritis. Hematologic spread of bacteria has also been rarely reported as a cause of pyelonephritis and is often associated with prolonged bacteremia, such as that seen with endocarditis. As previously discussed, there are many bacterial agents that have been implicated in pyelonephritis, and each has an individual means of urinary tract colonization and unique virulence factors. *Proteus mirabilis*, the organism isolated in Wyatt's case, possesses a myriad of virulence factors, namely the MR/P fimbriae, which are associated with bladder colonization and infection.[2,5] This organism also produces a urease enzyme that hydrolyzes urea, resulting in carbon dioxide and ammonia. This process causes a rise in the urine pH, which facilitates magnesium ammonium phosphate, or struvite, crystal formation. These crystals can ultimately agglomerate and form nephroliths. Renal calculi serve as a nidus for bacteria and can lead to alteration of the host mucosal defense barrier.[2] Patients presenting with acute pyelonephritis tend to display severe systemic illness, including uremia, painful kidneys, fever, and/or sepsis. In contrast, chronic pyelonephritis tends to be associated with a slowly progressing azotemia, progressive kidney damage, and, if left untreated, renal failure. Systemic signs are not usually demonstrated in the chronic presentation of the infection. Urinalysis findings are the same as those seen with urinary tract infections, such as hematuria, pyuria, and bacteriuria. Blood work may reveal evidence of kidney dysfunction, like azotemia, anemia, electrolyte disturbances, and/or hypoalbuminemia. A leukocytosis with a left shift may also be observed.[6]

Numerous host factors are in place to protect the urinary tract from infection. Physical barriers, such as unidirectional flow of urine, the innate immune system, particularly neutrophils, the presence of proteins hindering adherence of bacteria, and a generally hypoxic renal medulla

all serve to prevent infection.[1,2,4] The kidneys are also generally protected by vesicoureteral flap valves. Vesicoureteral reflux, or the backward flow of urine from the bladder to the ureter(s) and kidney(s), is the result of dysfunction of these flap valves and serves as an example of one possible means of an impaired host defense system.[4] Immunosuppressive therapy and neurogenic micturition represent other scenarios in which the host's defenses may be overcome.[2]

Treatment and Management:

While awaiting urine culture and sensitivity results, empirical therapy is usually initiated, in the form of parentally, rather than orally, administered antibiotics. In general, a broad-spectrum drug, such as a fluoroquinolone, is chosen as a first-line empirical therapy, and definitive treatment is ultimately based on culture and susceptibility results. Acute pyelonephritis necessitates hospitalization for administration of parenteral antibiotics and intravenous fluids. Parenteral therapy is continued until eating and drinking are within normal limits. If azotemia is present, treatment with aggressive fluid therapy and repeat bloodwork/urinalyses should be utilized until values normalize. Thereafter, the infection is treated as a complicated urinary tract infection, with a minimum of 6-8 weeks of antimicrobial therapy. Regular monitoring for recurrent infection should be employed both during and after therapy. Chronic pyelonephritis cases generally do not require hospitalization but are also treated as complicated urinary tract infections.[4] Struvite urolithiasis can be addressed by dietary modification (acidifying the urine) and appropriate antimicrobial therapy. If medical management fails, laser lithotripsy or cystotomy may be elected.[4] In the case of Wyatt, he was started on intravenous Unasyn® while the urine culture and sensitivity test was pending. The culture showed growth of *Proteus mirabilis* that was susceptible to multiple antimicrobial drugs, including Unasyn®. Wyatt therefore remained on this treatment for 3 days before being transitioned to oral Clavamox®.

While in hospital, Wyatt was also started on Cerenia®, pantoprazole, and hydromorphone for nausea, gastroprotection, and pain control, respectively. He received intravenous fluids in the form of Lactated Ringer's Solution (LRS). A lidocaine constant rate infusion (CRI) was started to better control his pain, and Prazosin was added to facilitate ureteral relaxation and passage of uroliths.

Outcome:

Wyatt was discharged on June 13th, 2018, with Clavamox®, prazosin, Tylenol® with codeine, Cerenia®, and fenbendazole. He was monitored at home and scheduled to return for a recheck examination in 7-14 days for evaluation of his response to therapy. On June 25th, a repeat urinalysis and culture as well as an abdominal ultrasound were performed. The urinalysis revealed no bacteria with maintenance of a normal pH. No aerobic or anaerobic growth was seen on the urine culture. Left renal pelvic dilation, nephrolithiasis, and the probable renal abscess were still present. The left ureter was distended and adjacent lymph nodes were enlarged. Wyatt continued Clavamox® and prazosin and returned for an abdominal ultrasound on August 1st, 2018. The owner reported that Wyatt had begun dribbling a small volume of urine when excited, asleep, and immediately following normal urination. On ultrasound, left renal pelvic dilation and nephrolithiasis were still evident but improved from the prior evaluation. The renal abscess previously observed was no longer present. Clavamox® was continued, but prazosin was stopped at this time. On September 24, 2018, Wyatt presented for re-evaluation. He was still seen dribbling urine at home, and a computed tomography (CT) with contrast was recommended to diagnose a cause of the urinary incontinence. At this time, the pyelonephritis was resolved.

Wyatt did not return for advanced diagnostic imaging. The cause of his urinary incontinence and development of acute pyelonephritis remains unknown, though a congenital

defect was suggested due to his young age. He continues to do well at home and has not experienced any recurrent urinary infections.

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