

Pyelonephritis: Diagnosis, and Management Approach

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Abstract

Background: Pyelonephritis is a type of urinary tract infections (UTIs) that can cause severe systemic troublesome manifestations. Untreated cases of pyelonephritis can let the inflammation to damage the renal pelvis and its parenchyma. Also, an untreated infection may lead to sepsis, which can increase the rate of mortality. **Objective:** To review the published literature and provide an adequate review about evaluating and managing pyelonephritis properly. **Method:** PubMed database was used for article selection, and the following keys were used in the mesh ((“Pyelonephritis”[Mesh]) AND (“management” [Mesh]) OR (“evaluation”[Mesh])). **Conclusion:** The diagnosis of pyelonephritis should depend on clinical findings as well as laboratory values and imaging studies. Hydration and choosing the proper antibiotics are the mainstay of UTI treatment.

Keywords: Pyelonephritis, Diagnosis, Management Approach.

Introduction

Pyelonephritis is a type of UTIs that can be associated with serious outcomes (Lee et al., 2009). In the United States, its incidence is 250,000 cases per year. Among females, 11.7 cases per 10,000 of the population are hospitalized due to pyelonephritis while the number of hospitalized cases per 10,000 population among males is 2.4 cases (Bergeron, 1995).

It is also called upper UTI as it develops when the bacterial infection reaches the kidneys via the ureter or through the bloodstream (Kang et al., 2018; Hooton, 2012; Darkhor et al., 2018; Mathialagan et al., 2018; Sundus et al., 2018). Pyelonephritis can lead to not only local symptoms but it can cause severe systemic troublesome manifestations such as fever, chills, nausea, **Arkan Adnan Alhassan, Nada Abdullah Bamaarof, Wejdan Abdullah Alzahrani, Rowaa Mohammed Al-Juhani, Raghad Fahad Alotaibi, Huda Taha Halabi, Reem Ziad Alharbi, Fatima Aqeel Alzubaidi, Jawaher Mansour Alshorfa*** Faculty of Medicine, Ibn Sina National College of Medicine, Jeddah, KSA.

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and vomiting (Lee et al., 2009). In cases of untreated pyelonephritis, the inflammation may damage the renal pelvis and its parenchyma. Also, an untreated infection may lead to sepsis, which can increase the rate of mortality in such cases to 10-20% (Roberts et al., 1991; Ispahani et al., 1987). In this article, we aim to review the literature that discussed pyelonephritis and to provide a summarized review explaining the proper evaluation and approaching cases of pyelonephritis.

Methods:

PubMed database was used for article selection, and the following keys were used in the mesh ((“Pyelonephritis”[Mesh]) AND (“management” [Mesh]) OR (“evaluation”[Mesh])).

In regards to the inclusion criteria, the articles were selected based on the inclusion of one of the following topics: Pyelonephritis, evaluation, and management.

Exclusion criteria were all other articles, which did not have one of these topics as their primary endpoint.

Discussion:

Pyelonephritis can occur in healthy individuals without any functional nor structural anomalies present in the urinary tract (Kang et al., 2018; Hooton, 2012). Pyelonephritis can present as an uncomplicated case or complicated. Uncomplicated cases present usually with mild symptoms and can be treated as an outpatient. On the other hand, complicated pyelonephritis cases usually need hospitalization to avoid life-threatening complications such as sepsis, septic shock, and multiorgan failure (Venkatesh, 2017).

Risk factors of complicated pyelonephritis include stones, obstruction, abnormal urinary tract, diabetes, pregnancy, and an immunocompromised state. There is a wide range of possibilities regarding the clinical course of pyelonephritis as it ranges from only mild symptoms to emphysematous pyelonephritis with a fulminant course (Venkatesh, 2017; Stunell et al., 2007).

In pyelonephritis, *Escherichia coli* is the responsible bacteria for most cases. *Klebsiella pneumoniae* and *Enterococcus faecalis* are other common causative agents (Kang et al., 2018; Scholes et al., 2005; Efstathiou et al., 2003; Farrell et al., 2003).

The diagnosis of pyelonephritis should depend on clinical findings as well as laboratory values. Clinically, patients of pyelonephritis may present with high-grade fever (more than 38.5 C), dysuria, increased frequency of micturition, flank pain, and costovertebral tenderness. The fever can be associated with rigors. In urinalysis, it is expected to find pus, bacteria, red blood cells, and white cell casts. Urine culture is usually positive (Venkatesh, 2017).

Nevertheless, the clinical and laboratory findings alone cannot estimate the severity and clarify the extent of the condition. Therefore, imaging is also needed to treat properly the true nature of the disease (Talner et al., 1994). However, the recent recommendations are against radiological imaging routine use in cases of uncomplicated pyelonephritis, especially in female patients (Nikolaidis et al., 2018). In cases of suspected complicated pyelonephritis, cases with urinary tract anomalies, and immunocompromised patients, imaging is recommended, especially in male patients (Kolman, 2019; Solomon, 2018). It is also recommended when there is no improvement after 72 hours of antibiotic treatment initiation (Venkatesh, 2017).

The recommended imaging modalities are ultrasound and computed tomography (CT). Ultrasound is useful and helpful but the main imaging tool is CT because CT can show highly specific findings (Craig et al., 2008). Ultrasound is routinely used as a first-line tool to evaluate the urinary tract and to look for any positive findings. However, negative findings may appear in most clinically suspected cases of pyelonephritis. This is mostly because interstitial nephritis is not well defined on gray-scale images (Craig et al., 2008; June et al., 1985). However, ultrasound can detect a variety of positive findings in pyelonephritis cases such as congenital anomalies and renal parenchyma changes. Renal parenchyma changes include renal enlargement, edema, hemorrhages, hydronephrosis, and abscesses. Nevertheless, ultrasound is still considered limited regarding differentiating definitively between intraparenchymal gas (emphysematous changes) and calcification as well as accurately predicting the extension of perinephric infections (Craig et al., 2008; Rigsby et al., 1986).

On the other hand, emphysematous change, parenchymal calcification, calculi, obstructions, and inflammatory masses can be detected and identified using CT abdomen. CT abdomen with contrast is even more superior to MRI but in patients with contrast allergy, ultrasound and MRI are the alternatives.

Also, the classification of emphysematous pyelonephritis is based on the findings from the CT scan. Emphysematous pyelonephritis is the presence of gas in the renal parenchyma, perinephric tissue, or collecting system. The classes of emphysematous pyelonephritis range from gas only in the collecting system to bilateral emphysematous pyelonephritis.

It is important to evaluate the potential cases properly to detect and avoid serious complications like systemic inflammatory response syndrome (SIRS), sepsis, severe sepsis, and septic shock. SIRS has criteria, which are relied on to define and diagnose. It should include ≥ 2 of the following findings: high temperature (more than

38.5 C) or hypothermia (less than 36 C), tachycardia, tachypnea, leukocytosis, or leukopenia.

SIRS can develop into sepsis if a clinical infection accompanied it. If the case was associated with hypoperfusion abnormalities like hypotension, oliguria, prerenal azotemia, or altered level of consciousness, it is considered severe sepsis. If the systolic blood pressure remained low (less than 90 mmHg) for at least 1 hour, the case should be diagnosed as septic shock. Without proper intervention, it may subsequently lead to multiple organ dysfunction syndromes (MODS). Therefore, adequate and early evaluation and management are crucial (Umesha et al., 2018).

Management:

The mainstay of UTIs treatment is antibiotics (Kolman, 2019). Choosing the proper antibiotic is a challenge facing the physician. Choosing the antibiotic relies on the infection type, the level of complications, the nature of the condition, and the domestic patterns of antibiotics resistance. *Escherichia coli* has increased its resistance along with other pathogens throughout the years. This has led to many adjustments regarding UTI treatment in the guidelines (Gupta et al., 2011). Nevertheless, some uncomplicated cases of UTIs in females can improve without antibiotics in the first week (Knottnerus et al., 2013).

As an alternative, the use of nonsteroidal anti-inflammatory drugs (NSAIDs) in UTIs cases has been studied to reduce the use of antibiotics but NSAIDs could not replace the antibiotics even in uncomplicated cases (Gágyor et al., 2015; Vik et al., 2018).

As we mentioned earlier, antibiotic treatment should be chosen properly. Identification of the bacterial pathogen with a urine culture helps the approach and the choice of the antibiotics. However, there are recommended guidelines regarding the empirical treatment for outpatient management. Oral fluoroquinolones, such as ciprofloxacin (500 mg twice daily for 7 days) or levofloxacin (750 mg once daily for 5 days) are the recommended options when the known local rate of resistance to fluoroquinolone are $<10\%$. If the local resistance fluoroquinolone rates are $>10\%$, a single dose of intravenous ceftriaxone and one week of an oral fluoroquinolone is the preferred option. If susceptibilities are not known, a single dose of intravenous ceftriaxone and 1-2 weeks of trimethoprim/sulfamethoxazole (TMP-SMX) (160/800 mg twice daily) are recommended.

Regarding oral cephalosporins, their efficacy is relatively low in comparison with other choices. Nevertheless, they should be used in limited cases such as when the susceptibilities are known and there are no other proper options. If an enterococcus infection is suspected, ampicillin can be used putting in mind its high rates of resistance for the typical gram-negative bacteria that are common in the UTIs (Gupta et al., 2011).

Regarding inpatient management, one of a wide variety of intravenous antibiotics can be the appropriate empiric choice as long as the choice was made depending on local resistance patterns and it is suitable for the patient (Gupta et al., 2011). There is no

specific period when to switch to oral antibiotics but it is commonly accepted to choose the proper oral agent when the culture and the sensitivity of the bacteria become available (Kolman, 2019).

Every antibiotic agent differs regarding the course duration and the efficacy may vary because of the different durations. Therefore, it is important to know the appropriate duration that should be used for the chosen antibiotic. The recommendations advise using the shortest effective duration possible to participate in decreasing the rate of antimicrobial resistance (Eliakim-Raz et al., 2013).

Regarding fluoroquinolones, the shortest recommended durations are 5 days for levofloxacin and 7 days for ciprofloxacin. TMP-SMX is recommended by the infectious diseases society of America (IDSA) to be used for 2 weeks (Gupta et al., 2011). However, studies have shown that 1 week of TMP-SMX has equivalent efficacy to a longer duration of the same agent and 1 week of ciprofloxacin (Eliakim-Raz et al., 2013; Fox et al., 2017).

As we mentioned earlier, antibiotics are the mainstay of the treatment but there is a cardinal step in the management, which is hydration. Hydration is key especially when there is associated dehydration with the condition (Chishti et al., 2010). Pyelonephritis is expected to be associated with dehydration especially in children. If fever is present, the risk of dehydration increases because of fluid and calories loss. Pyelonephritis can also decrease appetite and reduce fluid intake as well as induce vomiting that increases the level of dehydration (Berg, 1981; Åbyholm and Monn, 1979).

Therefore, hydration orally or intravenously is an important factor in the management process. Proper hydration can hasten the clearance of bacteria from the urinary system. Moreover, intravenous fluids are recommended to optimize renal perfusion and urine excretion. Normal saline is the adequate choice as an immediate rehydration fluid in cases of pyelonephritis. For longer rehydration plans and maintenance, dextrose 5% normal saline and half normal saline are the preferred options. Nevertheless, iatrogenic hyponatremia should be avoided when intravenous fluids are administered. Therefore, solutions less than half normal saline are the recommended options to use in long rehydration plans (Chishti et al., 2010).

The physician should always consider therapeutic failure and relapse as outcomes. Therapeutic failure is considered when the symptoms persist or even worsen after 5 days of proper management and relapse is the recurrence of the signs and symptoms of the same infection within the first month after completing the antibiotic course. Relapse sometimes can occur due to different bacterial pathogens causing a new infection. Therefore, proper reevaluation and repeated laboratory testing are recommended (Umesha et al., 2018).

Conclusion:

There is a wide range of possibilities regarding the clinical course of pyelonephritis as it ranges from only mild symptoms to

emphysematous pyelonephritis with a fulminant course. The diagnosis of pyelonephritis should depend on clinical findings as well as laboratory values. Imaging is also needed to treat properly the true nature of the disease.

The mainstay of UTI treatment is antibiotics. Choosing the proper antibiotic is a difficult challenge facing the physician. Hydration is also cardinal in managing UTIs especially when there is associated dehydration with the condition.

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