Acute pyelonephritis: risk factors, diagnosis and treatment


Abstract
Pyelonephritis is an acute urological condition that involves infection of one or both kidneys. The condition is not generally associated with high levels of mortality, but patients can become acutely ill and experience severe pain. Early recognition and treatment of pyelonephritis may limit morbidity. This article identifies patients at increased risk of pyelonephritis and discusses appropriate strategies to prevent serious complications.

Author
James Bethel
Senior lecturer, University of Wolverhampton, and nurse practitioner, Sandwell and West Birmingham Hospitals NHS Trust.
Correspondence to: james.bethel@wlv.ac.uk

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Introduction
Pyelonephritis is a lower urinary tract infection that has ascended to the pelvis of the kidney. Severe cases of pyelonephritis can lead to pyonephrosis (accumulation of purulent material around the affected kidney), systemic sepsis, renal failure, multisystem failure and death (Fulop and Mena 2012).

It is estimated that one in every 830 people in the UK develops kidney infection annually (NHS Choices 2011). Females are six times more likely to develop an infection than males for several reasons, including (Shim et al 2009, NHS Choices 2011, Fulop and Mena 2012):
- Females have a shorter urethra than males, making it easier for bacteria to reach the kidneys.
- The proximity of the urethral orifice to the perianal and anal region in females makes them more susceptible to urinary tract infections.
- Pregnancy is associated with increased risk of infection, which is partly due to hormonal changes that reduce urinary flow during pregnancy (Willacy 2011).

Aims and intended learning outcomes
This article aims to increase the reader’s knowledge of pyelonephritis. Epidemiology, assessment, nursing management and treatment of the condition are discussed. After reading this article and completing the time out activities you should be able to:
- Identify the clinical signs and symptoms of pyelonephritis.
- Recognise individuals who may be at increased risk of developing the condition.
- Understand the nurse’s role in the assessment and management of patients with pyelonephritis.
- Discuss treatment options for patients with pyelonephritis and offer appropriate advice.
Females may be at increased risk of infection if they are sexually active. Engaging in frequent sex increases the risk of developing kidney infection.

**Epidemiology and risk factors**

Most cases of pyelonephritis are caused by gram-negative bacterial infection, most typically *Escherichia coli*, which is transmitted from the anal and perianal region to the urethra (Kelly 1999, Fulop and Mena 2012). Patients at increased risk of developing such infection include:

- Those with type 1 and type 2 diabetes (Ramakrishnan and Scheid 2005, Fulop and Mena 2012).
- Patients who are pharmacologically immunocompromised, for example following renal transplantation, or have an immunosuppressive illnesses such as acquired immune deficiency syndrome (AIDS) (Ramakrishnan and Scheid 2005, Fulop and Mena 2012).
- Individuals who have stress incontinence (Scholes *et al* 2005).
- Those who engage in anal sex (Scholes *et al* 2005).
- Patients with structural or congenital abnormalities, which may obstruct urinary flow, for example prostatic hypertrophy or malignancy, or obstruction secondary to renal calculi (Fulop and Mena 2012).
- Patients who have or have recently had an indwelling urinary catheter or who have experienced urinary tract obstruction (Fulop and Mena 2012).

**Complete time out activity**

**Presentation**

The presentation of pyelonephritis may depend on the age of the patient, his or her cognitive or sensory ability to express symptoms and the severity of the condition (National Institute for Health and Clinical Excellence (NICE) 2007a, Fulop and Mena 2012). However, typical signs and symptoms include (Ramakrishnan and Scheid 2005, NHS Choices 2011, Fulop and Mena 2012):

- Flank pain (in rare cases this can be bilateral).
- Haematuria and polyuria.
- Offensive smelling urine.
- Dysuria and urgency.
- Tachycardia and tachypnoea.
- Fever.

- Systemic ill health, rigor and chills.
- Anorexia and nausea.

It should be noted that presentation of urinary tract illness may differ in young children. Infants younger than three months in age may present with non-specific signs of fever, vomiting and irritability, while polyuria and dysuria may be reported in older children. Poor feeding, weight loss and failure to thrive, along with haematuria and offensive smelling urine, should indicate ascending infection or development of pyelonephritis in children of any age (NICE 2007a, 2007b). Risk of serious illness should be gauged with reference to the guidance *Feverish Illness in Children* (NICE 2007b). Children with bacteriuria, fever and loin pain are more likely to have ascending infection or pyelonephritis than those with bacteriuria but no systemic ill health (NICE 2007a).

Diagnosis of pyelonephritis may prove challenging in certain patients, for example children, individuals with cognitive or sensory impairments and frail older adults, who may have difficulty communicating their signs and symptoms. Diagnosis may also be difficult because fever and dysuria, which are considered to be predominant markers of pyelonephritis, may be present to varying degrees and are not specific to the condition.

Up to one in three older patients may develop pyelonephritis with absence of fever (Bass *et al* 2003). Onset of symptoms may vary from hours to several days and even weeks in some cases. Severity of symptoms also varies from gradual onset of comparatively mild symptoms to acute presentation of severe symptoms (Fulop and Mena 2012).

**Diagnosis and differential diagnoses**

Other conditions with similar symptoms to pyelonephritis, some of which may be potentially life threatening include (Fulop and Mena 2012):

- Ectopic pregnancy.
- Appendicitis.
- Sexually transmitted infections.
- Epididymitis (inflammation of the area where sperm is developed and stored).
- Acute pancreatitis.
- Renal calculi.
- Urinary tract infection.

Symptoms confined to the lower urinary tract, with the absence of significant pain, fever and systemic ill health in otherwise healthy sexually active young females, may be indicative of
lower, uncomplicated urinary tract infection. However, in patients with pyelonephritis, fever, flank pain and systemic features of ill health may indicate upper urinary tract or kidney infection (Fulop and Mena 2012). Given the unreliability and inconsistency of clinical signs and symptoms of pyelonephritis, certain diagnostic and investigative procedures may be necessary to enhance diagnostic accuracy.

**Urinalysis**

Gross haematuria is considered unusual in patients with pyelonephritis and should prompt exclusion of other diagnoses such as renal calculi, vasculitis or trauma (Fulop and Mena 2012). Dipstick urinalysis testing for the presence of elevated levels of leucocytes, indicative of infective illness, may be a useful screening tool for pyelonephritis, but is not specific enough to make a diagnosis (Mehnert-Kay 2005, Fulop and Mena 2012). Some clinicians advocate the use of urine dipstick analysis in combination with urine culture to establish diagnosis of pyuria (Ramakrishnan and Scheid 2005). Others suggest that routine culture of urine is unwarranted because a provisional diagnosis may be achieved by history taking and urinalysis, and that culture of urine should only be considered in those who fail to respond to treatment (Mehnert-Kay 2005). It has been noted that fever and leucocytosis are of little diagnostic value in patients with indwelling urinary catheters because these patients are at increased risk of developing chronic infection (Ramakrishnan and Scheid 2005).

Other more specialised investigative techniques have been recommended, particularly where diagnosis is challenging. The presence of urinary interleukin-6 has been found to be effective in distinguishing between lower and upper urinary tract infections, with higher levels indicating upper tract infection (Rodriguez et al. 2008). Retrospective dimercaptosuccinic acid (DMSA) scanning of the kidney has shown that children with pyelonephritis have significantly higher levels of urinary macrophage migratory inhibitory factor (a urine-based inflammatory marker) than those without pyelonephritis (Otukesh et al. 2009). Estimation of levels of procalcitonin (PCT) is thought to be useful in distinguishing renal involvement in urinary tract infection in paediatric patients; urine infection is more common in this age group and reporting of symptoms in the pre-verbal and young child may not yield the quality of information necessary for diagnosis (Nikfar et al. 2010).

**Blood culture**

Culturing of blood samples is not generally advocated in otherwise healthy patients who are responding to treatment and should not be undertaken as a routine measure (Ramakrishnan and Scheid 2005). It has been recommended that blood cultures should be undertaken in all patients admitted to hospital for treatment of pyelonephritis, but it is also acknowledged that only 12-20% yield positive bacteraemia results and that this has no influence on prognosis (Mills and Barros 2005, Fulop and Mena 2012).

**Treatment**

The treatment of non-pregnant patients with pyelonephritis has undergone change recently. The use of a short stay or clinical decision unit in emergency departments or assessment areas to initiate treatment and evaluate response to treatment has reduced the rate of hospital admission without compromising clinical outcomes (Ramakrishnan and Scheid 2005, Kim et al. 2008, Schrock et al. 2010). Between 70% and 90% of patients who would previously have been admitted to hospital are now treated at home (Ramakrishnan and Scheid 2005). It should also be noted that the use of a short-stay observation unit to initiate treatment, while reducing the rate of hospital admission, also reduces the rate of discharge for domiciliary care (Schrock et al. 2010).

More than 90% of patients who can tolerate oral fluids, who are not systemically unwell and do not experience any of the risk factors or comorbidities (discussed previously) that may make them prone to serious illness, can be treated successfully with oral medication on an outpatient basis with appropriate review and follow up (Ramakrishnan and Scheid 2005, Gilligan et al. 2007). However, it has been suggested that initial doses of intravenous medication are necessary before oral medication is commenced (Sanchez et al. 2002, Fulop and Mena 2012). An early switch to oral medication, even in hospital inpatients, has been found to reduce length of stay and is clinically safe and cost effective (Vouloumanou et al. 2008).

Most individuals with pyelonephritis can be managed appropriately as outpatients, although there are still those who will require hospital admission and/or intravenous therapy, for example antibiotics, opiates or non-steroidal anti-inflammatory drugs and fluids (Fulop and Mena 2012). Indications for admission...
to hospital for treatment include (Craig and Hodson 2004, Ramakrishnan and Scheid 2005, Schrock et al 2010):

- Persistent vomiting and/or clinical evidence of dehydration.
- Progression of a previously uncomplicated urinary tract infection.
- Suspicion of systemic sepsis.
- Uncertain diagnosis.
- Older patients, particularly if frail and with poor social support.
- Presence of anatomical abnormality or obstruction of the urinary tract.
- Patients who are immunocompromised, those with active malignancies or diabetes, and patients who have recently undergone organ transplant.
- Patients who are pregnant and exhibit symptoms of systemic illness or have other comorbidities and risk factors as previously discussed.
- Young infants.

**Prognosis**

Prognosis or complications related to episodes of pyelonephritis may be dependent on response to initial treatment and/or vulnerability to any complications outlined previously. Complications and morbidity related to pyelonephritis include (Richardson and Henderson 2009, Volpicelli et al 2009, Leroy et al 2010, You et al 2010, Fulop and Mena 2012):

- Xanthogranulomatous pyelonephritis (XGP).
- Renal abscess or haematoma formation.
- Emphysematous formation of air in tissues.
- Acute renal failure.
- Chronic renal damage leading to renal failure and hypertension.
- Sepsis.

XGP is an uncommon sequel of acute or chronic pyelonephritis. It involves chronic destruction and damage to parts of the kidney in association with long-term obstruction of the urinary tract and subsequent infection (Li and Parwani 2011). In general, XGP affects more females than males and may occur in any age group. Unlike some patients with pyelonephritis, patients with XGP are almost always systemically unwell with fever, flank pain, haematuria and weight loss (Li and Parwani 2011). There is often a mass palpable in the renal angle between the inferior margin of the 12th rib and the lateral border of the adjacent erector spinae muscles.

Suspicion of XGP based on these clinical findings may be confirmed by computed tomography (CT) scanning. Histological findings will support diagnosis. The presence of positive clinical, imaging and histological findings may necessitate the exclusion of renal malignancies. Treatment options for confirmed XGP include antibiotic therapy or, more commonly, surgical nephrectomy (Richardson and Henderson 2009, Li and Parwani 2011).

Formation of a renal abscess or haematoma following an episode of pyelonephritis has been documented. After an unusual cause (acute salmonella infection) of pyelonephritis in a child in Slovenia, Rus and Kersnik Levart (2010) noted the development of renal abscess and renal failure, which they attributed to salmonella-induced pyelonephritis rather than acute dehydration. Similar complications of renal haematoma subsequent to acute pyelonephritis have been noted elsewhere (You et al 2010).

Emphysematous formation of air in tissues is widely documented and is considered a particularly serious finding following episodes of pyelonephritis (Clark et al 2009, Lee et al 2009, Li and Parwani 2011). Despite this, a patient with diabetes exhibiting evidence of air collection in the soft tissues of both kidneys following pyelonephritis responded well enough to antibiotic therapy and nephrostomy (a surgical procedure used to insert a catheter directly into the kidney pelvis) to avoid nephrectomy (Lee et al 2009). Similar results, in terms of avoiding the need for nephrectomy, were documented in a 34-year-old patient with diabetes who also responded well to antibiotic therapy (Clark et al 2009). Therefore early and aggressive treatment may limit morbidity.

Other consequences of pyelonephrotic infection include renal scarring and formation of renal lesions, which may lead to a degree of acute or chronic renal failure and associated hypertension (Lohr et al 2012). In patients who experience recurrent or chronic episodes of pyelonephritis, progressive renal scarring may contribute to the development of hypertension, which in turn exacerbates renal damage (Lohr et al 2012).

A relatively high incidence of chronic and recurrent illness makes early diagnosis and management of pyelonephritis essential to avoid renal scarring (Kelly 1999, Lohr et al 2012). Conversely, it has been found that a degree of renal scarring can occur even after a single, first episode of urinary tract infection (Leroy et al 2010). There is a lack of consensus for routine and universal imaging for the identification of renal scarring and
lesions, particularly in children, and it is not recommended by NICE (2007a).

Vertebral osteomyelitis has also been documented as a rare consequence of venous spread of pyelonephritic infection. Although predominantly seen in otherwise vulnerable or older adults, a case was also documented in an otherwise healthy 14-year-old female with non-resolving symptoms and the development of high fever and back pain while being treated for pyelonephritis (Deshpande et al 2010). Complete time out activities 4 and 5.

Pyelonephritis in pregnancy

After anaemia, pyelonephritis has been identified as the second most common medical complication of pregnancy, affecting 1-2% of pregnant women with illness, and usually manifesting during the second or third trimesters (Sharma and Thapa 2007, Jolley and Wing 2010). Hormonal and chemical changes during pregnancy predispose women to upper urinary tract infections and pyelonephritis (Ramakrishnan and Scheid 2005, Lohr et al 2012). Widening of the renal pelvis and ureters may lead to pooling of urine. In addition, progesterone decreases peristalsis in the ureter and increases the capacity of the bladder, leading to reduced urine excretion rates. In the later stages of pregnancy, the enlarged uterus will displace the bladder to some extent, contributing to urine stasis and potential development of infection (Fulop and Mena 2012).

Up to 20% of pregnant women treated successfully for pyelonephritis during pregnancy will experience recurrence of illness before or shortly after giving birth (Jolley and Wing 2010). Although there is little evidence to demonstrate that pyelonephritis during pregnancy causes premature delivery or low birth weight among infants (Sharma and Thapa 2007, Jolley and Wing 2010), there may be significant consequences of the illness for the mother and fetus during pregnancy, including (Jolley and Wing 2010, Fulop and Mena 2012):

- Anaemia (reported in approximately 25% of pregnant women with pyelonephritis).
- Disseminated intravascular coagulation.
- Sepsis and shock.
- Adult respiratory distress syndrome (reported in 1-8% of cases, with symptoms ranging from comparatively mild to life threatening, which means they require ventilatory support).

Historically, pregnant women with pyelonephritis were routinely admitted to hospital to enable effective screening and management of potential complications. However, there is little evidence to support this practice and many otherwise healthy pregnant women with pyelonephritis? Annals of Emergency Medicine. 46, 3, 285-287.


Which of the following patients presenting with pyelonephritis would require admission to hospital?

- Young adult patient.
- Patient who is immunocompromised as a consequence of another illness.
- Patient with polyuria.
- Patient who is febrile.

Discuss your rationale with a colleague.

Identify some of the reasons why pregnant women may be more likely to develop pyelonephritis.

References


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TIME OUT

6 What practical advice might you give a pregnant woman who experiences recurring episodes of pyelonephritis?

7 Now that you have completed the article, you might like to write a practice profile. Guidelines to help you are on page 60.

Patient education

Depending on patient assessment and the severity of the illness, patient care will involve the administration of appropriate medication, including anti-pyretics and analgesics, and adequate hydration. Monitoring of vital signs is essential when patients are hospitalised. Comorbidities and risk factors that make certain patients more vulnerable to serious illness should also be managed and monitored. As the recurrence rate of the illness is relatively high, especially in certain patient groups such as pregnant women, patients should be advised of the causes of pyelonephritis and what steps they may take to prevent recurrence. For example:

- Be aware that certain comorbidities may make individuals more vulnerable to pyelonephritis and report any relevant signs and symptoms to the appropriate health professional as early as possible.
- Maintain personal and sexual hygiene by washing, showering and post-coital douching.
- Maintain adequate hydration; this is particularly important in high-risk groups such as those with diabetes or those who are immunocompromised.
- Be aware that there is an increased risk of pyelonephritis during pregnancy.

Conclusion

Acute pyelonephritis is a relatively uncommon urological illness. However, some patients will need to be admitted to hospital for assessment, treatment and monitoring to avoid renal impairment. If diagnosed and treated early, patients will have good clinical outcomes. It is important that nurses are aware of patient groups that are at increased risk of developing serious illness and life-threatening complications and know how best to treat such patients.

Complete time out activity 7

women with pyelonephritis may be treated as outpatients (Ramakrishnan and Scheid 2005). Women in the third trimester of pregnancy are still admitted to hospital for care (Sharma and Thapa 2007, Jolley and Wing 2010).


Report any relevant signs and symptoms to the appropriate health professional as early as possible.

Complete time out activity 7


Willacy H (2011) Urine Infection in Pregnancy. tinyurl.com/9b5qw2g (Last accessed: September 13 2012.)


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