Urinary Tract Infections

Urinary tract infections (UTI) are commonly seen in clinical practice. Bacteria from the gut can invade the urinary epithelium to cause inflammation and infection anywhere along the urinary tract such as the urethra, bladder, ureter, or kidney. Some individuals are predisposed to developing a UTI. It is more common for women to develop a UTI especially when pregnant, sexually active, during post-menopause with estrogen-deficiency and when being treated with antibiotics where the normal bacteria flora is diminished. Although less common, men may develop a lower UTI. An upper UTI is less common in men due to the longer urethra and ureter structures that make it more difficult for bacteria to reach the kidney. An indwelling urinary catheter can also contribute the development of a UTI. Finally, individuals who experience urinary obstruction, diabetes or neurogenic bladder are also at risk for developing a UTI.

A UTI can be discussed in terms of its severity. It can be complicated or uncomplicated. It can also be discussed according to its location, where it can occur anywhere along the urinary tract (upper vs. lower tract disorders). It is under these categories that UTI will be discussed. Finally, common organisms that cause UTI are covered. This information is essential as the NP is responsible for identifying the organism so that appropriate treatment can be initiated.

The diagram below compares the male and female urinary tracts. Note that the female has a shorter urethra which predisposes her to an increased risk of infection than the male.

UTI Risk Factors

There are several risk factors that predispose individuals to the development of a UTI. For women, pregnancy is a risk factor. During pregnancy, progesterone relaxes smooth muscle that causes stasis of urine, allowing the bacteria to colonize. Also, the female ureter is shorter and allows for the entrance of bacteria into the urethra.

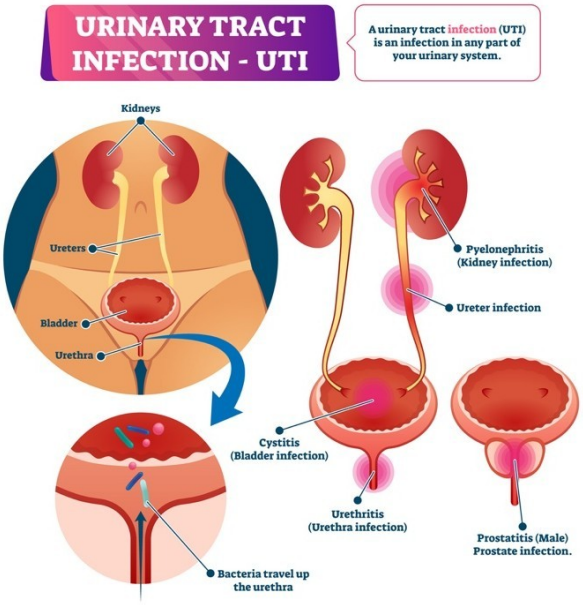
Post-menopausal women are also at risk for developing a UTI. The lack of estrogen results in vaginal and urethral dryness that promotes an environment for bacteria to grow. Sexual intercourse also contributes to the development of a UTI where bacteria can be easily introduced into the urethra. If spermicides are used during sexual intercourse, this also puts the woman at risk for a UTI.

Indwelling urinary catheterization is also a major cause of a UTI, especially in females. The catheter itself can introduce infections directly into the bladder. The bacteria will colonize in the bladder and initiate an immune response. The neutrophils enter the area to further promote inflammation. Fibrinogen accumulates on the catheter which provides an ideal environment for the attachment of uropathogens that express fibrinogen-binding proteins. After the initial attachment to the fibrinogen-binding proteins on the catheter, the bacteria multiply to form biofils. This results in epithelial damage to the urinary tract that leads to a kidney infection.

Lower vs. Upper Tract Disorders

A UTI can be discussed in terms of its location. Note that a UTI can occur anywhere along the urinary tract and can be associated with another issue in the area. For example, if the infection

occurs at the opening of the urethra, then the condition is termed urethritis. Overall, cystitis is a condition of the lower urinary tract that denotes a bladder infection. Cystitis can occur in both females and males. In males, the cystitis may be associated with prostatitis.



A UTI is an infection in any part of your urinary system

Recognizing the signs and symptoms of the UTI is important in categorizing it as either a lower or upper urinary tract disorder. In a lower urinary tract disorder, the individual experiences urgency associated with burning on urination. Other common symptoms of a lower UTI is frequency, dysuria, and suprapubic pain. The urine may also appear cloudy and have an odor.

An infection of the lower urinary tract can progress to an upper urinary tract infection if the bacteria ascends from the bladder to the kidney. The condition is pyelonephritis. Because the infection involves the kidney, it is a more serious condition as it can cause acute renal failure if it is not treated. The signs and symptoms of pyelonephritis include all the symptoms associated with cystitis plus fever, flank pain, costovertebral angle (CVA) tenderness, nausea, and vomiting. Malaise is also a common complaint for the patient with pyelonephritis. There can also be signs of shock if the infection has entered the circulation from the kidney via the renal vein. Think of the symptoms of pyelonephritis in a classic triad: vomiting, flank pain and fever.

The NP can also collect a urine sample to determine the presence of a lower vs. upper UTI. A urine dipstick can be observed for the presence of leukocyte esterase and nitrites. These should be considered together when diagnosing a UTI. Leukocyte esterase is an enzyme that is released by the WBCs (leukocytes). It is a qualitative measure of WBCs in the urinary tract. On the actual dipstick test, you may just note leukocytes. But note that the dipstick does not measure the

number of leukocytes. It just provides an indication of enzyme activity and the presence of inflammation. Using the urinalysis to diagnose a UTI is covered in a section below.

Initially, a urine dipstick can be performed to identify hematuria, proteinuria, and the presence of nitrites. The presence of nitrites is highly specific for bacterial infection. Note that an individual can have a negative urine dipstick but still present with signs and symptoms of a UTI. If this is the case, then the NP can send the urine for a culture and sensitivity (C&S) test and microscopy.

On microscopic exam of the urine, a patient with cystitis will have a white blood cell (WBC) count of greater than 5000 high power field (hpf) and hematuria. For the patient with pyelonephritis, the urine will present with WBC casts. The presence of casts in the urine indicates that the protein in the lumen of the kidney tubules has solidified, especially in the nephron. This indicates kidney disease rather than a lower UTI.

Uncomplicated vs. Complicated Urinary Tract Infections (UTI)

A UTI may be classified as complicated or uncomplicated in terms of its severity. An uncomplicated UTI indicates that the urinary tract and renal function is normal. In a complicated UTI, there is decreased renal function and an abnormal urinary tract. In differentiating between a lower and upper UTI above, the presence of WBC casts indicates the presence of kidney involvement which requires a more complicated treatment plan. The patient is also at higher risk for extensive and permanent kidney damage as well as sepsis. If sepsis is suspected, a blood culture may be drawn to identify the causative organism or rule it out.

The severity of the UTI can also be determined based on the interventions that are necessary to treat the infection. The more intervention required, the more complicated the infection. In general, individuals are treated for a UTI only when they are symptomatic. Although the urine results may confirm a UTI, if the patient denies symptoms, then an antibiotic is not prescribed. The exception would be during pregnancy due to the ureteral dilation that occurs that increases the risk for pyelonephritis. Even though she may be asymptomatic, treatment would be initiated to prevent damage to the fetus in utero. An uncomplicated, symptomatic UTI (cystitis) will typically require a 3-7 days course of appropriate antibiotic therapy. A complicated UTI (pyelonephritis) will require intravenous (IV antibiotics) until the patient is afebrile, followed by a course of oral antibiotics. Overall, the course of antibiotics for a complicated infection is longer than in an individual that has an uncomplicated infection.

Intervention may also require the assistance of specialists in the case of a complicated UTI. A referral to a urologist is necessary if the individual does not respond to antibiotic treatment or if there are recurrent UTIs, specifically 3 or more in one year. Because upper UTI is uncommon in males, they should be referred to a urologist. Finally, the presence of hematuria would warrant a referral to the urologist to determine the presence of significant renal disease.

Finally, sometimes the patient's presentation can seem complicated when examining the patient who has symptoms like a UTI but may be something else. For example, when there is vaginal

discharge or itching involved, the NP may need to include a genital exam as well to rule out or diagnose a sexually transmitted infection (STI).

From the summary below identify if each aspect is part of a complicated or uncomplicated UTI.

Uncomplicated UTI	Complicated UTI
• Occurs in the normal urinary tract • Simple cystitis in non-pregnant women without any urologic abnormalities • Responds well to a short course of antibiotic therapy	• A UTI that extends beyond the bladder • Caused by structural or functional urinary tract abnormalities or untreated UTI • Infants and older adults affected • Associated with: 1. indwelling catheters 1. renal calculi 1. Diabetes 1. Pregnancy

Common Organisms that Cause Urinary Tract Infections

The most common organisms that cause a UTI is Escherichia coli (E. Coli), Staphylococcus saprophyticus, Proteus Mirabilis, and Klebsiella. E. coli causes approximately 80% of the cases of UTI because it is the most common organism contained in the fecal matter that is easily accessible from the anus to the urethra. Bacteria enter the urethra and colonize in the bladder to eventually cause a UTI. In healthy individuals, they can maintain a sterile urinary tract and bladder. Even when bacteria enter the bladder, the immune defenses can prevent it from clinging to the walls of the bladder or the upper urinary tract. A UTI will occur when bacteria overwhelm the individual's defense mechanisms allowing it to quickly reproduce.

A urinalysis is used to diagnose a UTI. If nitrites are present, this indicates that the causative organism is gram negative. A urine culture may also be performed to determine infection. A positive culture indicates that there are greater than 100,000 colony forming units/ml.

Using the Urinalysis to Diagnose a Urinary Tract Infection

A urinalysis can be used in a couple of ways to diagnosis a UTI. A dipstick can be used to identify leukocyte esterase and nitrites. Nitrites detect the presence of the Enterobacteriaceae (gram negative bacteria) family that converts nitrates into nitrites. It is important to also note that some bacteria are unable to produce nitrites. This is the case of Enterococcus. Therefore, the individual may still have a UTI even if nitrites are not present via the dipstick. The presence of nitrites is the most specific finding and has the highest positive predictive value.

Leukocyte esterase, WBCs and even bacteria on microscopic exam are not specific and therefore, do not necessarily indicate infection. The diagnosis of a UTI needs to also consider the presence of symptoms and a positive urine culture if one is completed. It is typically not completed in a young, and otherwise healthy female with typical symptoms.

Urine can also be examined microscopically to determine the presence of a lower or upper UTI. The following may be seen in urine examined under microscopy:

- **RBCs** (red blood cells): greater than 3 RBCs/hpf is considered abnormal. Abnormal morphology of the RBC strongly suggests glomerular disease. RBCs are often present with a UTI (hematuria).
- **WBCs**: greater than 5 WBCs/hpf is considered abnormal. These will be present in a UTI.
- **Bacteria**: will be present
- **Crystals**: these are microscopic solids composed of a small number of different ions and molecules. These are common in the urine and if they remain small, are not pathologic.
- **Casts**: are long cylindrical structures formed in the renal tubules due to the precipitation of Tamm-Horsfall mucoprotein. It is the most abundant protein excreted by the urine. Casts form in concentrated and/or acidic urine. The most common casts are hyaline casts
  that only consist of Tamm-Horsfall protein without other constituents. They are non-specific and may be seen in dehydration. Muddy brown casts suggest acute tubular necrosis. Waxy casts are suggestive of acute and chronic renal failure. Fatty casts are suggestive of nephrotic syndrome; RBC casts suggest glomerulonephritis and WBC casts suggest interstitial inflammation.

A typical UA presentation for uncomplicated and complicated UTI is presented below:

	Protein	**Leukocyte Esterase**	**Nitrites**	**RBCs**	**WBCs**	**Casts**
Uncomplicated UTI	+ or –	+	+ or –	+ or –	+ > 5000/hpf	None
Complicated	+ or –	+	+ or –	+	+	+

	Protein	Leukocyte Esterase	Nitrites	RBCs	WBCs	Casts
UTI					> 100,000/hpf	

Patient Education

The NP should take advantage of the opportunity to educate patients on the prevention of UTIs while the patient is in the office. Some of the most basic information to convey to a patient is:

- Drink more water.
- Although there are differences of opinions, cranberry juice and vitamin C can help to acidify the urine.
- Urinate before and after sexual intercourse to remove bacteria from the urethral area.
- Encourage the female to avoid holding urine for extended periods of time.
- Avoid the use of hygiene sprays and spermicides because they alter the normal microbial flora to enhance the risk for infection.
- Encourage the female to wipe from the front to the back after a bowel movement to avoid spreading bacteria to the urethra and
- Encourages showers rather than bathing to avoid the spread of bacteria.