Week 4

Renal/Urinary

Edapt Questions

- Which of the following can help to prevent a UTI? Increase water consumption. Water consumption prevents UTI as it keeps bacteria flushed out of the urinary tract.
- Which of the following is true regarding a complicated urinary tract infection? A complicated UTI can be caused by a structural issue in the urinary tract.
- A symptom of a lower urinary tract infection includes: Urgency is a symptom of lower tract UTI.
- Women are at a higher risk for the development of a UTI because of having a shorter urethra.**TRUE**
- Which of the following is a risk factor for the development of a urinary tract infection (UTI)? Pregnancy is a risk factor the development of a UTI.
- The presence of nitrites indicates that the causative bacteria is gram-negative.
- There is a significant risk for men with benign prostatic hyperplasia (BPH) to develop cellular mutations that lead to prostate cancer. **FALSE.** BPH does not lead to prostate cancer.
- The peripheral zone of the prostate is the largest zone. **TRUE.** Anatomically, the peripheral zone is the largest one.
- On a digital rectal exam to assess the quality of the prostate, the NP would be concerned with which of the following findings? A hard nodule can indicate prostate cancer.
- The patient most often develops symptoms of BPH when: The cause of symptoms of BPH relates to the constriction of the prostatic urethra obstruction that affects that passage of urine.
- The purpose of straining in BPH is to overcome the obstruction encountered during urination. **TRUE.** The individual strains to overcome the obstruction in order to release the urine.

- The action of a 5-Alpha-reductase inhibitor causes: 5-alpha-reductase inhibitors shrink the size of the prostate by inhibiting the conversion of testosterone to dihydrotestosterone.
- The location of the characteristic hyperplastic nodules of BPH is: Prostate nodules are usually located in the periurethral zone.
- The prostate specific antigen (PSA) helps to liquefy semen post-ejaculation. **TRUE.** The luminal cells produce PSA which helps to liquefy semen post- ejaculation.
- The underlying cause of BPH is that normal prostate cells respond to increases in dihydrotestosterone that causes them to live longer and multiply. This statement is true. The underlying cause of BPH is that normal prostate cells respond to increases in dihydrotestosterone that causes them to live longer and multiply.
- Men who have BPH are prone to developing a UTI because: Stagnation of urine in the bladder promotes bacterial growth which can lead to a UTI.
- Renal calculi are typically confined to the bladder. **FALSE.** Renal calculi can be found in the ureter or bladder.
- Renal stones are formed when calcium and oxalate in the urine combine. **TRUE.** Stones form when calcium and oxalate in the urine combine.
- The gold standard for diagnosing a renal stone is a urinalysis. **FALSE.** The gold standard for diagnosing a renal stone is CT scan.
- The most common type of stone is: Calcium stones are the most commonly formed stones.
- The type of stone that forms due to a urinary tract infection is: Struvite stones commonly result from a UTI.
- Lithotripsy is an invasive procedure used to break up the stone. **FALSE.** Lithotripsy, is a non-invasive procedure and will be performed if the stone lodges on the way out.
- Renal colic is caused by the passing of the stone through the ureter. **TRUE.** Renal colic is caused by the passing of the stone through the ureter with obstruction and spasm.

- At least half of individuals with renal stones will have a reoccurrence within 10 years of the prior stone. **TRUE**
- The most common stone found in the patient with gout is: uric acid stone.
- The relay station in the brain that plays a major role in regulating micturition is: The pontine micturition center (PMC) located in the brainstem, performs a major role in regulating micturition.
- When the bladder is empty, the detrusor muscle relaxes, and the internal and external sphincters constrict. **TRUE.** When the bladder is empty, there is detrusor muscle relaxation and internal and external sphincter constriction.
- The location of the internal sphincter is under the urogenital diaphragm. **FALSE.** The internal sphincter is located in the bladder rather than the urogenital diaphragm.
- Which of the following actions will relax the detrusor muscle of the bladder? When Beta-2 receptors are activated by the sympathetic nervous system, the detrusor muscle will relax.
- The levator ani muscle plays a major role in constriction of the external sphincter. **TRUE.** Plays a major role in constriction of the external sphincter when the abdomen contracts, especially when abdominal pressure is exerted on the bladder.
- Involuntary loss of urine caused by dementia or immobility is known as: Functional incontinence is related to dementia or immobility.
- The pathophysiology of neurogenic bladder is: Neurogenic bladder involves lesions that alter the nervous system impulses that innervate the detrusor muscle to decrease bladder compliance and decreased sphincter tone.
- A sphincter malfunction that prevents urine from flowing out of the bladder would most likely result in: Overflow incontinence is due bladder distention caused by sphincter malformation that prevents urine from flowing out of the bladder.
- Which of the following is considered be a transient cause of urinary incontinence? A UTI is a transient cause of urinary incontinence because the symptoms subside once the issue is managed.

- The major cause of stress incontinence in women is hypermobility of the external sphincter. **TRUE**
- One of the major markers for glomerular filtration rate is creatinine. **TRUE.**
- One of the first pathophysiological responses to the decreased GFR in acute renal failure is: One of the first pathophysiological responses to the decreased GFR is the activation of the renin-angiotensin-aldosterone system.
- The most common cause of acute renal failure is due to a pre-renal failure. **TRUE**
- A pre-renal cause of acute renal failure is: Hypotension is a cause of pre-renal failure that reduces blood flow to the kidneys.
- Which of the following is the best indicator of a good prognosis for recovery from acute renal failure? If the kidneys respond to furosemide it indicates a good prognosis of recovery.
- In intrinsic renal failure, sodium and water excretion is increased which leads to a dilute urine. **TRUE.**
- Which of the following is true regarding creatinine? Creatine is freely filtered from the glomerulus.
- One of the issues that requires management of a patient with acute renal failure is hypokalemia **FALSE.** Hyperkalemia should be managed rather than hypokalemia.
- In post-renal failure, the damage occurs in the collecting duct. **TRUE**
- The result of vitamin D deficiency results in: Hypocalcemia. Vitamin D is responsible for decreasing gastrointestinal (GI) absorption of calcium and increasing bone reabsorption of calcium. If there is not enough vitamin D, then hypocalcemia results.
- The anemia seen in renal failure is due to the lack of iron. **FALSE.** Anemia occurs because there is a reduced production of erythropoietin which is responsible for triggering the production of RBCs rather than the lack of iron or a decrease in the RBCs.
- Stage III kidney disease is signified when the GFR drops below 60. **TRUE**

- Which of the following is a complication of decreased GFR? Anemia is a complication of decreased GFR.
- The number one cause of end-stage renal disease is diabetes mellitus and hypertension combined.
- End-stage renal disease is signified by a GFR of: ESRD is signified by a GFR <15.
- The major acid/base disturbance in renal failure is: The major acid/base disturbance in renal failure is metabolic acidosis.
- Dietary management of a patient with CKD includes: Patients with CKD will be on a low potassium, low sodium, and low phosphate diet.
- The decision to begin dialysis is guided by the patient's symptoms rather than GFR. **TRUE,** The decision to begin dialysis is guided by the patient's symptoms rather than GFR.
- Diuretic therapy is used in Stage IV kidney failures to stimulate kidney function. **FALSE.** Diuretics may be used to stimulate renal function for patients who are in Stage I-III. Dialysis is indicated for patients in Stage IV and V.
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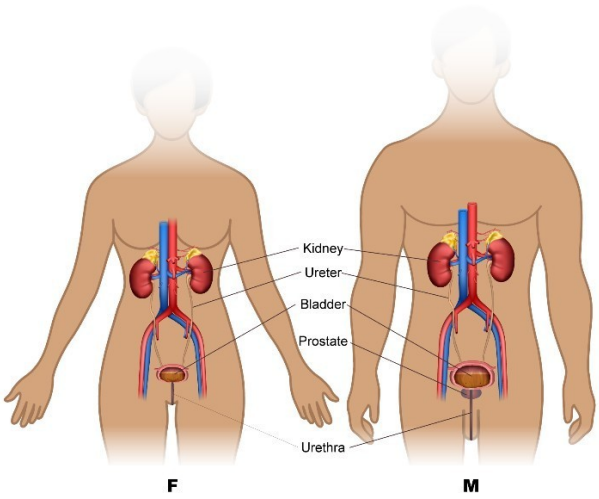
Urinary Tract Infections

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.



The pathophysiology of a UTI is simple. First, bacteria enter and contaminate the lower urinary tract. This causes the colonization of bacteria in the urethra and the bladder which triggers an inflammatory response in the lower urinary tract. Neutrophils are recruited to the area where the bacteria are present. The bacteria multiply which allows them to evade the immune system due to virulent factors. For example, Escherichia coli can bind to cells in the lower urinary tract and hide from the immune cells. The bacteria can form biofilms. A biofilm is any group of microorganisms that allow them to stick to one another and adhere to surfaces that help them survive. If the UTI progresses or is not treated, or if the patient is immunocompromised, the bacteria can ascend to the kidneys and colonize there. At this point, the infection becomes an upper UTI. From there, if left untreated, the bacteria can spread into the circulation via the renal veins causing bacteremia that could potentially lead to septic shock.

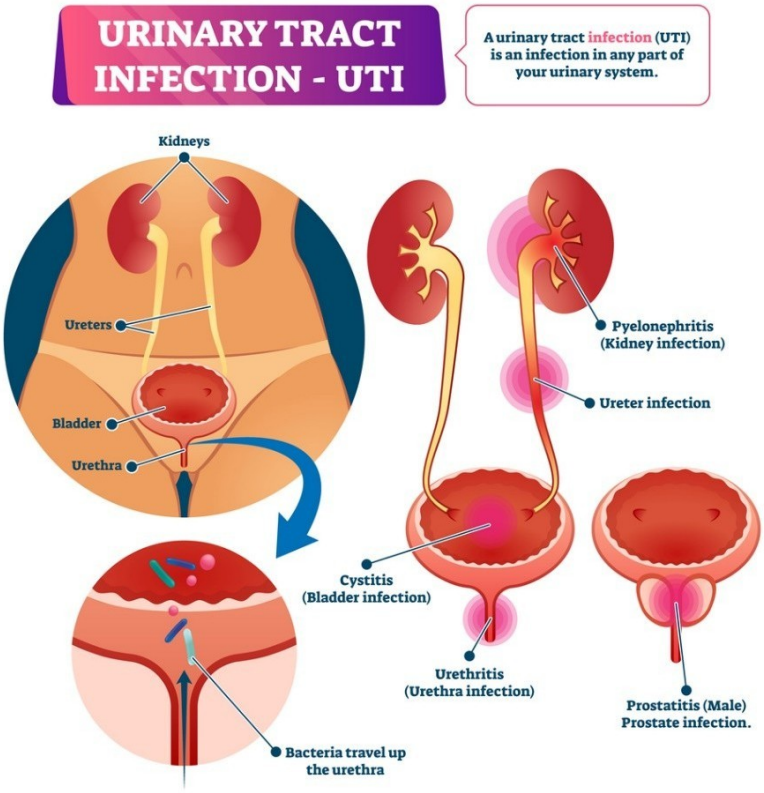
UTI Risk Factors

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.



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 – occurs in the normal urinary tract, responds well to short course of antibiotics, simple cystitis in non-pregnant woman w/o any urologic abnormalities.

Complicated UTI – extends beyond the bladder, caused by structural or functional tract abnormalities or untreated UTI, infants and older adults affected, associated with indwelling catheters, renal calculi, diabetes, 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:

1. 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).
2. WBCs: greater than 5 WBCs/hpf is considered abnormal. These will be present in a UTI.
3. Bacteria: will be present

4. 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.
5. 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 UTI	+ or -	+	+ or -	+	+ >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.

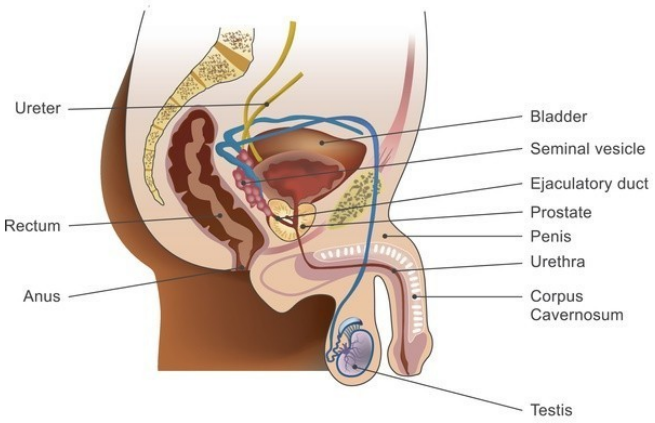
- Encourage the female to avoid holding urine for extended periods of time.
- Avoid the use of hygiene sprays and spermicides because they alter the normal microbial flora to enhance the risk for infection.
- Encourage the female to wipe from the front to the back after a bowel movement to avoid spreading bacteria to the urethra and
- Encourages showers rather than bathing to avoid the spread of bacteria.

Benign Prostatic Hypertrophy

Pathophysiology of BPH

In BPH, there is enlargement of the prostate gland by an increased number of benign cells. It is common in men over the age of 50 years. It is considered a normal part of aging. The prostate is a small gland that is shaped like a walnut located under the bladder and in front of the rectum as indicated in the diagram below. The urethra passes through the prostate before reaching the penis. This portion of the urethra is called the prostatic urethra.

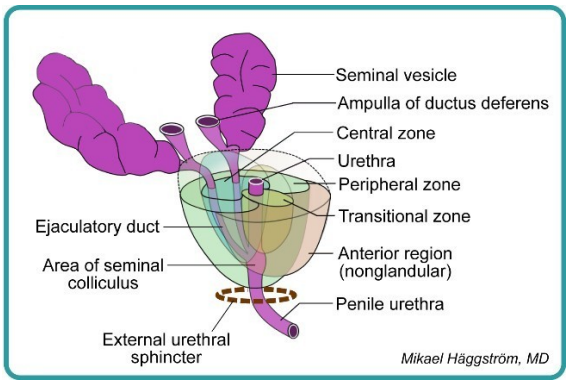
Male reproductive system



Location of the Prostate

The prostate is covered by tough connective tissue and smooth muscle and can be divided into zones. The peripheral zone is the largest zone and it is located in the

outermost posterior area of the prostate. Most (75%) of the prostate's glandular tissue is in the peripheral zone. The next section is the central zone. Only about 25% of the glandular tissue is contained here. The ejaculatory ducts that form with the urethra is also located here. The final zone is the transitional zone. It contains approximately 5% of the prostate's glandular tissue and a portion of the prostatic urethra. This area also contains transitional cells that can also be found in the bladder.



Each of the tiny glands that comprise the prostate is surrounded by a collagenous basement membrane. Sitting within the basement membrane is a ring of cube-shaped basal cells and some neuroendocrine cells. Finally, there is an inner ring of luminal columnar cells that are within the lumen. Luminal cells secrete substances into the prostatic fluid that makes it slightly alkaline and provide nutrients for the sperm to help it survive in the acidic environment of the vagina.

During ejaculation, sperm leave the testes and travel through the vas deferens into the ejaculatory ducts and then travel through the prostatic urethra. Smooth muscles in the prostate contract and push the prostatic fluid in the urethra where it joins the sperm and the semen which is the fluid that comes from the seminal vesicles. The luminal cells also produce prostate specific antigen (PSA) which helps to liquefy the gel-like semen after ejaculation. This frees the sperm to swim.

The basal and luminal cells of the prostate rely on stimulation from the androgens for male sex hormones for survival. The androgens include testosterone, which is produced by the testicles and dihydrotestosterone. Dihydrotestosterone is produced in the prostate. This androgen is produced by the prostatic enzyme 5 alpha-reductase which converts testosterone into the more potent dihydrotestosterone.

Since androgens are steroids, they can cross the cell membrane and bind to the androgen receptors in the cell's nucleus. This inhibits apoptosis. This allows the luminal and basal cells in the prostate to keep growing and multiplying. Dihydrotestosterone is much more potent than testosterone because it can combine to androgen receptors much longer.

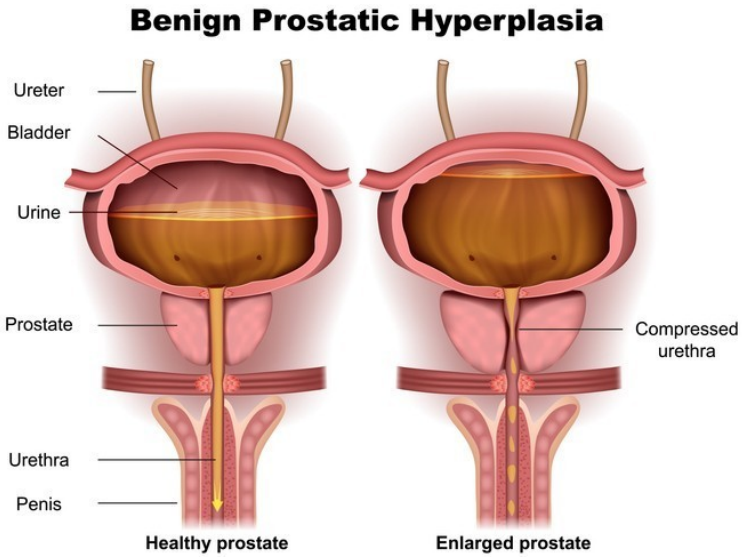
After around the age of 30, men produce about 1% less testosterone per year. However, 5-alpha reductase activity increases with age. Therefore, even with less testosterone, there can be an increase in dihydrotestosterone. Normal prostate cells respond to the increase in dihydrotestosterone by living longer and multiplying. That is the underlying cause of BPH. Again, this is a normal process of aging. By age 60, the majority of men will develop BPH and over 90% have it by the age of 85 years of age. Fortunately, in BPH, there is no risk for the male to develop cellular mutations that lead to prostate cancer. Instead, the entire prostate gland enlarges in a uniform fashion with the formation of hyperplastic nodules. On palpation, they feel smooth, elastic, and firm. They can sometimes be mistaken for prostate cancer. The location of the hyperplastic nodules is in the inner portion of the gland, specifically around the prostatic urethra in the periurethral zone. When the nodules and prostate tissue compress the prostatic urethra, it becomes more difficult for urine to pass through. The urine builds up in the bladder and causes it to dilate. In response, the smooth muscle of the bladder will contract harder, which leads to bladder hypertrophy, where the bladder walls thicken and become irritated. Finally, the stagnation of urine in the bladder promotes bacterial growth and can lead to a urinary tract infection (UTI).

Clinical Presentation of BPH

Symptoms of BPH may become prevalent when the prostatic urethra becomes obstructed. The male reports dribbling which is a weak and inconsistent urine stream. Straining is also reported as the male attempts to overcome the obstruction during urination. Pain on urination (dysuria) is also common as well as initiating urination (hesitancy). As urine accumulate in the bladder, it causes a constant sense of incomplete bladder emptying which increases the frequency of urination at night (nocturia).

BPH can be diagnosed by performing a digital rectal exam (DRE). The NP palpates the anterior wall of the rectum which lies along the posterior prostate. If enlarged, the NP can suspect BPH. If hard nodules are palpated, this could be a sign of prostate cancer. Levels of Prostate Specific Antigen (PSA) that is produced by healthy prostate cells are also elevated in BPH since there are more cells around to produce it.

Treatment of BPH focuses on relieving the obstruction to allow the urine to flow normally. 5-alpha reductase inhibitors are prescribed which shrinks the prostate gland by inhibiting the conversion of testosterone to dihydrotestosterone. Alpha-1 antagonists may also be prescribed to bind to alpha-1 receptors in the smooth muscles in the bladder neck, prostate and urethra. This causes relaxes and allows urine to pass. Sometimes surgery is indicated. A transurethral resection of the prostate (TURP) can be performed to remove part or all the prostate.



Clinical Application: BPH

A 72- year-old male presents to the primary care office with complaints of lower urinary frequency and urgency that have become progressively worse over the last 6 months. He also reports having to get up more than 5 times/night to urinate where he feels like his bladder is never emptied. He is especially embarrassed because of “leaking” after urination. He denies any fever, weight loss or bone pain. His only medical history is

hypertension where he takes atenolol 50 mg po daily and Aspirin 81 mg daily. His family history is negative for malignancy. A urinalysis was performed with negative results, ruling out UTI.

The NP performs a focused urological exam and notes the following:

- Digital rectal exam (DRE): a profusely enlarged prostate with normal shape and symmetry. No nodularity or tenderness is noted.
- Palpation of the suprapubic area reveals some bladder distention and discomfort.

Currently, the NP opts to prescribe a 5-alpha reductase inhibitor to shrink the prostate gland and an alpha-1 antagonist to relax the smooth muscle of the bladder next to increase urinary flow.

In terms of the cause of his symptoms, he is most likely experiencing age-related symptoms that are both irritative and obstructive in nature. Match each symptom below as either irritative or obstructive.

The irritative symptoms are urinary frequency, nocturia and urgency that result from bladder hypertrophy and dysfunction. The obstructive symptoms are incomplete emptying and postvoid dribbling. These are cause by narrowing of the bladder neck and prostatic urethra which leads to incomplete emptying of the bladder.

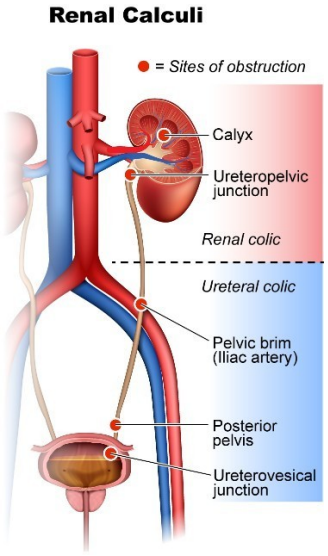
Pathophysiology of Renal Calculi

Renal calculi, or kidney stones, can be found in the ureter or bladder. Let's take a moment examine the urine. It consists of water and particles (sodium and potassium). The particles in urine combine to form a stone. Normally, there should not be stone formation in the urine. Our urine actually has inhibitors to prevent stone formation. These include citrate and magnesium.

Urine contains calcium and oxalate. When the calcium and oxalate combine, it forms a stone. Citrate and magnesium will prevent the formation. Individuals get kidneys stone due to lack of water ingestion or by increase of particles or solutes in the urine or by decreased stone inhibitors present in the urine.

Once the stone is formed it can either be easily eliminated in the urine or if large, can lodge in the ureter. It just depends on the size of the stone. Stones that are <0.5 mm

pass through the urine to be eliminated without difficulty. Stones that are > 1.0 cm are likely to cause an obstruction. The most common sites of stone obstruction include: ureteropelvic junction, intersection of ureter and iliac vessels, and the ureterovesicular junction. This is the most common site of stone obstruction. The diagram below depicts where renal stones can form.



Types of Kidney Stones

Calcium

This is the most common type of stone. It forms from the joining of calcium and oxalate or from the joining of calcium and phosphate. In some cases, individuals can form both types of calcium stone. Calcium stones are radio dense which indicates that they can be seen on x-ray. The cause of calcium stones is mostly idiopathic or unknown. Regardless of the cause, the individual becomes either hypercalcemic or presents with excess calcium in the urine (hypercalciuria). This causes the solutes to increase and form a stone. Treatment involves prescribing a thiazide diuretic to excrete urinary calcium.

Struvite

This type of stone occurs due to a urinary tract infection, most often by proteus, klebsiella and serratia and enterobacter species. Ammonium, magnesium, and phosphate form to create the stone. The bacteria contribute to the stone formation through the production of the enzyme, urease. Urea, in the presence of urease converts

to ammonia and a byproduct of CO2. This makes the urine alkaline which favors stone formation. Another name for this stone is the Staghorn stone. It obstructs the renal calyx. The location of the Staghorn stone is shown in the diagram below. The stone is given its name because of it contains irregular, horn-like structures.

Uric Acid

This is the type of stone that is found in a patient with gout. There is an increase in uric acid. Individuals who are at risk for getting gout include those with leukemia and myeloproliferative disorder; those undergoing chemotherapy. Chemotherapy destroys the cancer cells. DNA cells contain purine. When broken down, purine will increase uric acid levels that can lead to uric acid stone formation. Uric acid increases the acidity of the urine with resultant decrease in urine pH. Uric acid stones are radiolucent, meaning that the stones cannot be seen on x-ray. Treatment includes hydration and increasing the alkaline of the urine by giving potassium bicarbonate. Individuals will also be prescribed allopurinol, an anti-gout medication.

Cystine Stone

This is a rare type of kidney stone that is found mostly in children. It is caused by a genetic renal tubule defect that prevents the amino acid, cystine, from being reabsorbed that leads to the formation of a cystine stone. This stone can also from Staghorn shaped stones.

Clinical Presentation of Renal Calculi

Regardless of the type of kidney stones, patients will present in a similar way. The symptoms include:

Renal colic: this is flank or costovertebral angle (CVA) pain. It is caused by the passing of the stone through the ureter with obstruction and spasm. The characteristic of this pain begins mild and then greatly increases causing great discomfort to the patient. The pain begins in the flank and radiates to the groin. As the stone moves, the pain will be in the location of where the stone is located.

Hematuria: Hematuria will be found in 90% of individuals who have a kidney stone. While passing through the urinary tract, the stone will injure the urinary structures. It can also be associated with nausea and vomiting.