Diagnostic Methods used for Urine Analysis

Unit-2 (ZOOG-SEC-B-6-4-TH)

Urine Ananlysis –

Physical characteristics of Urine:

The urinary system's ability to filter the blood resides in about 2 to 3 million tufts of specialized capillaries—the glomeruli—distributed more or less equally between the two kidneys. Because the glomeruli filter the blood based mostly on particle size, large elements like blood cells, platelets, antibodies, and albumen are excluded. The glomerulus is the first part of the nephron, which then continues as a highly specialized tubular structure responsible for creating the final urine composition. All other solutes, such as ions, amino acids, vitamins, and wastes, are filtered to create a filtrate composition very similar to plasma. The glomeruli create about 200 liters (189 quarts) of this filtrate every day, yet you excrete less than two liters of waste you call urine.

Characteristics of the urine change, depending on influences such as water intake, exercise, environmental temperature, nutrient intake, and other factors (Table 1). Some of the characteristics such as color and odor are rough descriptors of your state of hydration. For example, if you exercise or work outside, and sweat a great deal, your urine will turn darker and produce a slight odor, even if you drink plenty of water. Athletes are often advised to consume water until their urine is clear. This is good advice; however, it takes time for the kidneys to process body fluids and store it in the bladder. Another way of looking at this is that the quality of the urine produced is an average over the time it takes to make that urine. Producing clear urine may take only a few minutes if

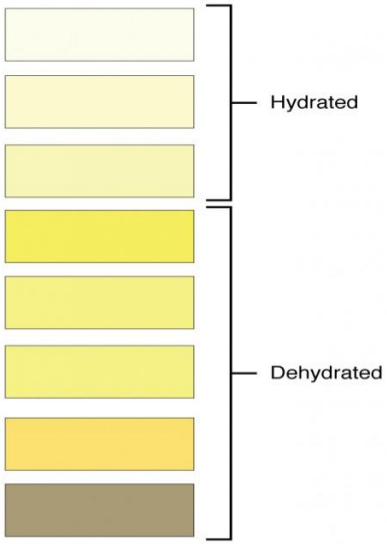
you are drinking a lot of water or several hours if you are working outside and not drinking much.

Table 1. Normal Urine Characteristics

Characteristic	Normal values
Color	Pale yellow to deep amber
Odor	Odorless
Volume	750–2000 mL/24 hour
pH	4.5–8.0
Specific gravity	1.003–1.032
Osmolarity	40–1350 mOsmol/kg
Urobilinogen	0.2–1.0 mg/100 mL
White blood cells	0–2 HPF (per high-power field of microscope)
Leukocyte esterase	None
Protein	None or trace
Bilirubin	<0.3 mg/100 mL
Ketones	None
Nitrites	None
Blood	None
Glucose	None

Urinalysis (urine analysis) often provides clues to renal disease. Normally, only traces of protein are found in urine, and when higher amounts are found, damage to the glomeruli is the likely basis. Unusually large quantities of urine may point to diseases like diabetes mellitus or hypothalamic tumors that cause diabetes insipidus. The color of urine is determined mostly by the breakdown products of red blood cell destruction (Figure 1).

The “heme” of hemoglobin is converted by the liver into water-soluble forms that can be excreted into the bile and indirectly into the urine. This yellow pigment is **urochrome**. Urine color may also be affected by certain foods like beets, berries, and fava beans. A kidney stone or a cancer of the urinary system may produce sufficient bleeding to manifest as pink or even bright red urine. Diseases of the liver or obstructions of bile drainage from the liver impart a dark “tea” or “cola” hue to the urine. Dehydration produces darker, concentrated urine that may also possess the slight odor of ammonia. Most of the ammonia produced from protein breakdown is converted into urea by the liver, so ammonia is rarely detected in fresh urine. The strong ammonia odor you may detect in bathrooms or alleys is due to the breakdown of urea into ammonia by bacteria in the environment. About one in five people detect a distinctive odor in their urine after consuming asparagus; other foods such as onions, garlic, and fish can impart their own aromas! These food-caused odors are harmless.



Urine colour (figure)

Urine volume varies considerably. The normal range is one to two liters per day. The kidneys must produce a minimum urine volume of about 500 mL/day to rid the body of wastes. Output below this level may be caused by severe dehydration or renal disease and is termed **oliguria**. The virtual absence of urine production is termed **anuria**. Excessive urine production is **polyuria**, which may be due to diabetes mellitus or diabetes insipidus. In diabetes mellitus, blood glucose levels exceed the number of available sodium-glucose transporters in the kidney, and glucose appears in the urine. The osmotic nature of glucose attracts water, leading to its loss in the urine. In the case of diabetes insipidus, insufficient pituitary antidiuretic hormone (ADH) release or insufficient numbers of ADH receptors in the collecting ducts means that too few water channels are inserted into the cell membranes that line the collecting ducts of the kidney. Insufficient numbers of water channels (aquaporins) reduce water absorption, resulting in high volumes of very dilute urine.

Table 2. Urine Volumes

Volume condition	Volume	Causes
Normal	1–2 L/day	
Polyuria	>2.5 L/day	Diabetes mellitus; diabetes insipidus; excess caffe disease; certain drugs, such as diuretics; sickle cell a intake
Oliguria	300–500 mL/day	Dehydration; blood loss; diarrhea; cardiogenic s enlarged prostate
Anuria	<50 mL/day	Kidney failure; obstruction, such as kidney stone or tu

The pH (hydrogen ion concentration) of the urine can vary more than 1000-fold, from a normal low of 4.5 to a maximum of 8.0. Diet can influence pH; meats lower the pH, whereas citrus fruits, vegetables, and dairy products raise the pH. Chronically high or low pH can lead to disorders, such as the development of kidney stones or osteomalacia.

Specific gravity is a measure of the quantity of solutes per unit volume of a solution and is traditionally easier to measure than osmolarity. Urine will always have a specific gravity greater than pure water (water = 1.0) due to the presence of solutes. Laboratories can now measure urine osmolarity directly, which is a more accurate indicator of urinary solutes than **specific gravity**. Remember that osmolarity is the number of osmoles or milliosmoles per liter of fluid (mOsmol/L). Urine osmolarity ranges from a low of 50–100 mOsmol/L to as high as 1200 mOsmol/L H_2O.

Cells are not normally found in the urine. The presence of leukocytes may indicate a urinary tract infection. **Leukocyte esterase** is released by leukocytes; if detected in the urine, it can be taken as indirect evidence of a urinary tract infection (UTI). Protein does not normally leave the

glomerular capillaries, so only trace amounts of protein should be found in the urine, approximately 10 mg/100 mL in a random sample. If excessive protein is detected in the urine, it usually means that the glomerulus is damaged and is allowing protein to “leak” into the filtrate.

Ketones are byproducts of fat metabolism. Finding ketones in the urine suggests that the body is using fat as an energy source in preference to glucose. In diabetes mellitus when there is not enough insulin (type I diabetes mellitus) or because of insulin resistance (type II diabetes mellitus), there is plenty of glucose, but without the action of insulin, the cells cannot take it up, so it remains in the bloodstream. Instead, the cells are forced to use fat as their energy source, and fat consumed at such a level produces excessive ketones as byproducts. These excess ketones will appear in the urine. Ketones may also appear if there is a severe deficiency of proteins or carbohydrates in the diet.

Nitrates (NO_3^-) occur normally in the urine. Gram-negative bacteria metabolize nitrate into nitrite (NO_2^-), and its presence in the urine is indirect evidence of infection. There should be no blood found in the urine. It may sometimes appear in urine samples as a result of menstrual contamination, but this is not an abnormal condition.

Abnormal constituents of urine

(a) Proteinurea:

It means the presence of protein in the urine. Normal urine in all animal species contains little or small amount of protein from desquamation of epithelial cells and other sources, but the amount is insufficient to produce a positive reaction to the standard test. One exception is the urine of newborn calves 40 hrs old after receiving colostrums and sheds urine of high protein contents. Also, urine of equines has an increased protein level, and consequently their urine appears turbid.
Proteinuria is usually associated the following disease conditions:

- Hemoglobinuria, myoglobinuria, hematuria.

- Glomerulonephritis, renal infarction, nephrosis, amyloidosis, congestive heart failure.

Excessive excretion of protein in the urine leads to hypoproteinarmia and manifested clinically as muscular weakness, general depression and reduced work capability of the animal. The clinical significance of proteinuria as an indication of renal diseases is much greater when the formed elements including casts and cells are present in the urine of the diseased animal.

Chronic proteinuria or massive acute proteinuria may cause hypoproteinemia as in case of oglomerulonephritis, acute tubular nephrosis in horses and in amyloidosis in cattle.

(b) Casts and cells:

Casts are organized, tubular structures, which vary in appearance depending on there composition. They occur only when the kidneys are involved in the disease process. They present as an indication of inflammatory or degenerative changes in the kidney where they formed by agglomeration of desquamated cells and protein. R.B.Cs, W.B.Cs and epithelial cells may originate at any part of the urinary tract.

(c) Hematuria:

It is the presence of intact blood cells in the urine. It may appear as gross blood clots passed at the beginning, during, or at the end of urination or as more uniformed discoloration of the urine throughout the urination without clots. It large clots are present, obstruction of U.T. may occur, resulting in stranguria and dysuria.

Haematuria may result from prerenal, renal or postrenal causes as following:

Prerenal causes of hematuria:

When vascular damage occurs such as:

- Trauma to kidneys.
- Septicemia.
- Purpura hemorrhagica in horses.

Renal causes of hematuria:

- Acute glomerulonephritis.

- Pyelonephritis.
- Tubular damage due to toxic insults such as sulphonamide toxicity.
- Embolism or Renal A.
- Renal infarction.

Post renal causes of hematuria:

- Urolithiasis.
- Urethritis, cystitis.
- Enzootic hematuria in cattle tumor in U.B., which is usually accompanied by blood losses.

(d) Crystalluria:

It is the presence of crystals in the urine the presence of crystals in urine of herbivorous animals have no special significance unless they occur in large numbers and one associated with irritation of U.T. It may occur with no clinical signs or may indicate a severe problem in renal tissues or U.T. infection. Calcium carbonate and triple phosphate crystals are more common as urine. It they are observed, the possibilities of urinary tract infection and / or a potential for obstruction should be considered.

If they congregate into large masses, they may obstruct renal pelvis, ureters, urethra or the urethral opening while smaller formations may obstruct the individual nephrons.

(e) Pyuria:

It is the presence of purulent debris in the urine. Pyuria indicates an inflammatory exudation at any point of the urinary tract, usually renal pelvis and bladder. This purulent debris may appear in the form of grass clots or shreds or only detectable by microscopic examination. Pyuria is usually accompanied by the presence of bacteria in the urine. Also, dysuria, stranguria and crystalluria are evident. A fever may or may not be present in such cases, but urine scalding of the perineum is usually present.

(f) Hemoglobinuria:

It is defined as presence of hemoglobin in the urine. False hemoglobinuria occurs with cases of hematuria when the R.B.Cs are destroyed and liberate their contents of hemoglobin into urine.

Meanwhile, true hemoglobinuria is manifested by deep red discoloration of the urine caused by lysis of R.B.Cs due to many diseases such as:

- Bacillary hemoglobinuria.
- Babesiasis.
- Copper intoxication.
- Water intoxication.

(g) Myoglobinuria:

It is the presence of myoglobin in the urine. Myoglobinuria is a good evidence of severe muscular destruction such as in azoturia in horses. It may be observed inenzootic muscular dystrophy but the amount of myoglobin in such young animals is insufficient to cause the problem. Because the molecule of myoglobin is much smaller than that of hemoglobin, it is usually excreted in the urine in the diseased cases without staining of blood serum.

(h) Glucosuria and Ketonuria:

Glucosuria is not common in large animals but occurs usually in pet animals such as in diabetes mellitus. Glucosuria in large animals is usually associated with the following disease conditions:

- Enterotoxaemia is caused by clostridium peferinges type D.
- Rabred cattle.
- Administration of dextrose solution, treatment by using adrenocorticotrophic hormones, cortisone.
- Cases of nephrosis.
- Meanwhile, ketonuria is more common in cattle and sheep as in cases of starvation, pregnancy toxemia and acetonemia in cattle.

(i) Indicanuria:

It is the presence of Indican substance in the urine (potassium indoxyl sulphonate). Presence of excessive amount of this substance in the urine indicates an increased absorption of the detoxificated end products from gastrointestinal tract. Such condition is usually associated the cases of constipation and obstruction of the intestine.

(j) Creatinuria:

Excessive breakdown of muscular tissues leads to increase amount of creatinine in the urine and considered a good indication for muscular dystrophy.

Urine Culture –

A urine culture is a lab test to check for bacteria or other germs in a urine sample. It can be used to check for a urinary tract infection in adults and children.

How the Test is Performed

Most of the time, the sample will be collected as a clean catch urine sample in your health care provider's office or your home. You will use a special kit to collect the urine. A urine sample can also be taken by inserting a thin rubber tube (catheter) through the urethra into the bladder. The urine drains into a sterile container, and the catheter is removed. Rarely, the provider may collect a urine sample by inserting a needle through the skin of the person's lower abdomen into the bladder. The urine is taken to a lab to determine which, if any, bacteria or yeast are present in the urine. This takes 24 to 48 hours.

How to Prepare for the Test

If possible, the sample is collected when urine has been in the bladder for 2 to 3 hours.

How the Test will Feel

When the catheter is inserted, one may feel pressure. A special gel is used to numb the urethra.

Why the Test is Performed

A person's provider may order this test if that person have symptoms of a urinary tract infection or bladder infection, such as pain or burning when urinating. The person also may have a urine culture after he or she

have been treated for an infection. This is to make sure that all of the bacteria are gone.

Normal Results

"Normal growth" is a normal result. This means that there is no infection. Normal value ranges may vary slightly among different laboratories. Some labs use different measurements or test different samples. Talk to your doctor about the meaning of your specific test results.

What Abnormal Results Mean

A "positive" or abnormal test is when bacteria or yeast are found in the culture. This likely means that you have a urinary tract infection or bladder infection. Other tests may help your provider know which bacteria or yeast are causing the infection and which antibiotics will best treat it. Sometimes more than one type of bacteria, or only a small amount, may be found in the culture.

Risks

There is a very rare risk for a hole (perforation) in the urethra or bladder if your provider uses a catheter.

Considerations

One may have a false-negative urine culture if the one has been taking antibiotics.

There are a variety of methods aimed at specimen collection to diagnose a UTI (Urinary Tract Infection). Some of the factors that dictate the method used include patient comfort, the ability to void, and reducing the small risk of iatrogenic infection. Sterile collection methods can be employed, such as a suprapubic puncture or urethral catheterization, in an effort to reduce over diagnosis and subsequent overtreatment._Even

so, patients are instructed to collect their own samples from a variety of acceptable techniques.

Specimen Collection

There are a variety of collection techniques for urine culture, including suprapubic aspiration, straight catheter technique, and mid-stream catch with or without cleansing. In pediatric patients who are not toilet trained, diaper collection, and sterile bag, urine collection methods are used. Suprapubic collection is the best method to avoid specimen contamination with bacteria, particularly in the distal urethra. Owing to patient discomfort, invasiveness, lack of indication (except in rare instances), and inappropriate resource use, this method is rarely deployed. Urine collection with a single catheter (straight catheter technique) is the next best option. Still, due to labor intensiveness as well as the possibility of introducing bacteria into the bladder, potentially causing a UTI, this technique is seldom used and only when indicated. The previously aforementioned methods of specimen collection are therefore reserved for those patients who are unable to self-collect. Hence, the most common method a urine sample is obtained for urine culture is via a clean-catch midstream technique, which is neither invasive nor uncomfortable. Colony counts from these samples correlate reasonably well compared to suprapubic aspiration and single catheter technique.

The current standards for self-collection include mid-stream clean-catch technique, mid-stream catch without prior cleansing, and random sampling delivered without instruction. There are no clinically significant differences seen between the various self-collection techniques._However, studies have shown that depending on the patient's demographic, such as adult male, adult female, or infant/child, there may be preferred methods of sample collection over other methods. For females, contamination and diagnostic accuracy did not significantly change between midstream urine collection with or without prior cleansing; there is no recommendation without regard to cleansing prior to collection.In adult males, contamination was significantly

decreased when mid-stream catch is utilized as the method of collection, becoming favorable over first-void specimen collection. Mid-stream collection was not significantly altered with prior cleansing. However, in children and infants, mid-stream collection with prior cleansing was favorable in reducing contamination over other methods, including mid-stream collection without cleansing, sterile bag urine collection, and diaper collection. Therefore, pre-collection cleansing procedures have been considered unnecessary in most adult populations as they do not decrease the risk of contamination from commensal bacteria._Even so, patients continue to follow the traditional directive of cleansing as the first step in urine specimen collection despite no change in diagnosis, course, or treatment.

Specimen Transportation

Owing to the probable increase risk of growth of colony-forming units (CFU) non-indicative of the patient's true sample, urine specimens must be plated within two hours of collection, unless refrigerated or placed in a preservative. This measure decreases the risk of false-positive cultures, directly leading to a decrease in overtreatment while maintaining appropriate antibiotic stewardship.

Procedures

Specimen Preservation and Processing

Preservation of the urine sample can be achieved with a boric acid solution or refrigeration for up to 24 hours. Both techniques yield adequate preservation of the sample. Samples that are left at room temperature for greater than 4 hours run the risk of bacterial overgrowth of causative and contamination organisms. However, based on a meta-analysis of preservation techniques, the statistical analysis of this data was rated as low._Nonetheless, common gram-negative organisms causing UTIs such as *Escherichia coli* and *Klebsiella pneumoniae*, have been noted to be inhibited when boric acid is used as a storage medium. Therefore, careful consideration of the storage medium should be practiced, and timely refrigeration must be prioritized.

Specimens are processed routinely using calibrated loops for plating. This method allows for CFU/mL findings as well as the isolation of colonies for identification and susceptibility testing. Some of the most utilized media are blood agar and MacConkey agar. The temperature of the plates should be kept between 35 to 37 degrees Celcius with a recommended incubation time of 24 to 48 hours. However, *Oligella urolytica*, a slow-growing, gram-negative, and rare UTI-causing organism, has been reported to have an incubation of over 48 hours._Specimens from outpatients do not need to be plated on selective media. However, in hospitalized patients, where enterococci are the second leading cause of UTI, laboratory technicians should consider inoculating urine specimens to a medium that is selective for these gram-positive cocci.

Indications

Routine bacterial urine cultures are not always necessary in the evaluation of outpatients with uncomplicated UTIs and simple lower UTIs, such as uncomplicated cystitis._An important classification of uncomplicated UTI versus complicated UTI distinguishes the need for urine culture. Since UTIs are composed of lower UTIs (e.g., cystitis) and upper UTIs (e.g., pyelonephritis), clinically differentiating the two by symptomology is necessary as the first step in determining the need for urine culture. A patient experiencing cystitis could report dysuria (with or without frequency), urgency, hematuria, or suprapubic pain, while a patient suffering from pyelonephritis may or may not have the symptoms of cystitis, but will typically report fever, chills, flank pain with or without cost vertebral tenderness. Should these patients have a complicating factor, a urine culture is likely warranted. Some of the complicating factors include male sex, chronic obstruction, chronic renal insufficiency, nephrolithiasis, poorly controlled diabetes, pregnancy, indwelling urinary catheters, indwelling urinary stent or nephrostomy tube, and immunosuppression (chronic high-dose corticosteroid use, use of other immunosuppressive agents, neutropenia, etc.). Furthermore, outpatients with recurrent UTIs, treatment failure, complicated UTIs,

and inpatient UTIs require urine culture to not only document infection, but to confirm the causative organism in order to prevent complications and for antimicrobial susceptibility resistance. These examples warrant further investigation beyond clinical diagnosis and urinalysis.

Additionally, new-onset or worsening sepsis without evidence of an alternate source is also another appropriate indication for urine culture. New-onset or worsening sepsis is a major cause of morbidity and mortality in hospitalized patients globally and should be swiftly recognized clinically for the purposes of swift urine culture collection. Fever or alteration of consciousness without evidence of a source may also warrant a urine culture. For patients in early pregnancy or prior to certain urology procedures, screening for asymptomatic bacteriuria is warranted. Additionally, preoperative evaluations may trigger the utilization of urine culture, especially when mucosal bleeding is expected. Finally, urine cultures are sometimes appropriate in cases of spinal cord injury, where the patient may experience an increase in spasticity, autonomic dysreflexia, and a sense of unease. These patients are at an increased risk of UTI due to autonomic dysregulation leading to stagnating urine, which becomes a nidus for infection.

Urine culture is not indicated and is therefore deemed inappropriate when the urine characteristics are odorous, cloudy, or discolored in the absence of other localizing signs or symptoms, reflex urine cultures based on results of urinalysis such as pyuria in the absence of other indications, and to document successful response to therapy. Screening for asymptomatic bacteria in most groups is also unnecessary, as it does not alter the course of therapy. Patients with asymptomatic bacteriuria are typically not treated unless pregnant. Yet, some studies have shown that in pregnant women with pyelonephritis, the patient course dictates antibiotic treatment, not necessarily the culture and sensitivities themselves.

Potential Diagnosis

The positive findings of a urine culture can lead to the diagnosis of UTI (uncomplicated vs. complicated), asymptomatic bacteriuria (ASB),

catheter-associated UTI (CA-UTI), and catheter-associated asymptomatic bacteriuria (CA-ASB). These diagnoses lead to the possible identification of the source of sepsis. Proper diagnosis lends itself to proper antibiotic stewardship and decreases in morbidity and mortality. As up to 25% of hospitalized patients in North America receive indwelling catheter placement, utilization of the urine culture is of utmost importance to determine potential diagnoses._Consequently, differentiation between catheterized patients and non-catheterized patients is common, as is the differentiation between UTI and asymptomatic bacteriuria.

Normal and Critical Findings

Normal Findings

Urine is normally sterile. However, there is a possibility of contamination. Hence, samples from patients without UTI symptoms with low colony counts certainly below the threshold for bacteriuria, and no detection of organisms, are considered to be normal samples.

Critical Findings

- **UTI**: UTI symptoms. Gold standard confirmation is the urine culture. Positive urine cultures are observed when there is significant microbial growth determined by standard microbiological criteria. Although not completely standardized, many laboratories set the cut-off at greater than or equal to 100,000 CFUs/ml for a UTI. However, this particular threshold may miss relevant infections. Consequently, other recommendations have noted a cut off of greater than or equal to 1,000 CFUs/ml in order to capture other bacterial infections.
- **CA-UTI:** According to the Infectious Diseases Society of America's (IDSA) 2010 guideline for diagnosis of CA-UTI, it is defined as patients with an indwelling catheter with the presence of symptoms or signs compatible with UTI with no other identified source of infection. They must also have greater than or equal to 1000 CFU/ml with more than one bacterial species in a single

catheter urine specimen or in a midstream voided urine specimen in patients whose urinary catheter (urethral, suprapubic or condom) has been removed within the past 48 hours. According to the United States Centers for Disease Control and Prevention (CDC), the patient must meet the following three criteria:

1) The patient must have an indwelling urinary catheter in place for more than 2 days on the date of the event.

2) The patient has a fever (of greater than or equal to 38 degrees Celsius, cost vertebral angle (CVA) pain or tenderness, suprapubic tenderness, urgency, frequency or dysuria.

3) The patient has a urine culture with no more than two species of organisms identified, at least one being a bacterium of greater than or equal to 1000 CFU/ml.

- **CA-ASB:** Positive urine culture in the absence of UTI symptoms. Asymptomatic catheter-associated bacteriuria and candiduria exhibit a urine culture of at least 100,000,000 CFU/mL of an identified organism(s) in the absence of signs and symptoms of a UTI. These cases do not require treatment and generally resolve upon the removal of catheters.
- **Bacteriuria**: The most commonly used cut-off for significant bacteriuria is greater than or equal to 100,000 CFU/ml of urine. Asymptomatic bacteriuria is present when the patient does not have any signs of a UTI clinically coupled with 100,000 CFU/ml exceeded in two consecutive samples of midstream urine (from women). For men, a single detection of more than 100,000 CFU/ml is adequate for diagnosis. Although pyuria is non-diagnostic in itself, the detection of leukocytes could support the diagnosis of CA-ASB.

The most common cause of UTIs in both inpatient and outpatient settings is *Escherichia coli*, accounting for the overwhelming majority of cases. *E. coli* is followed by coagulase-negative staphylococci, *Klebsiella* species, *Proteus* species,

and *Enterobacter* species. Each unique organism can be part of urine culture results. Owing to the differences in the microbiology of each organism, proper identification leads to increased antibiotic stewardship by selecting the proper antibiotic coverage, subsequently leading to decreases in antibiotic resistance.

Interfering Factors

Urine culture results may be deemed faulty and inconclusive due to patient factors. Recent antibiotic use is a major culprit, as this therapy may mask the presence of UTI-causing organisms. Furthermore, the use of diuretics or the consumption of large amounts of fluids may also dilute the urine and invariably lead to a decrease in the number of bacteria present in the sample. Moreover, the large consumption of ascorbic acid has been long known to interfere with the results of urine dipstick results.

Culture results are invariably affected by faulty collection techniques, leading to the contamination of urine and invariably, by urogenital flora. Operator error in the handling of urine specimens may also lend to increasing CFUs, leading to false-positive results. Unless refrigerated or kept in a preservative, urine samples should be plated within two hours of collection. Urine samples where plating is delayed, especially over 24 hours, are deemed useless due to the possibility of a bacterial overgrowth that is not representative of the patient's original sample. Consequently, laboratory delay is a significant issue interfering with the validity of the urine culture.

Complications

The various stages of urine collection, whether collection itself, storage, and preservation, have a tremendous impact on the results of a urine culture. Without adequate care, specimens can become contaminated with perineal, vaginal, or periurethral flora. The presence of the true pathogenic agent can be obscured due to the contamination, whether due to an overgrowth or an inhibition of the true pathogens. Even more than that, the medium in which the specimen is stored also plays a significant

role in the true urinary pathogen. Inhibition of *Escherichia coli* and *Klebsiella pneumoniae* have been observed with the use of boric acid as the storage and preservation medium. Owing to these issues with contamination and obscuration of true UTI-causative organisms, misdiagnosis, and subsequent poor patient management and faulty antibiotic stewardship will result, with the most feared complication becoming a complicated UTI and possibly leading to urosepsis. Consequently, proper detection of UTI or asymptomatic bacteriuria is of paramount importance. For instance, swift detection of asymptomatic bacteriuria in pregnancy is necessary in order to prevent the feared complication of pyelonephritis with subsequent harm to the child. Ordering urine cultures when indicated and proper handling of the urine specimen provides for proper diagnosis and therefore preventing complications associated with poorly diagnosed and treated UTI.

Patient Safety and Education

Specimen collection by means of clean-catch midstream technique poses no risk to the patient. Despite the longstanding belief that pre-cleansing yields an uncontaminated specimen, several studies have shown that pre-cleansing has no significant effect on test results. Prevention of UTI is worthy of discussion and has been traditionally under-researched in the past. Patients should be educated on correct wiping methods, adequate hydration, frequent urination, avoiding feminine products, precoital bathing, and postcoital voiding, and avoid the use of a number of certain birth control products. With these increased measures aimed at improving hygiene, health behaviors, and sexual practices, UTI-related morbidity, and the use of antibiotics for these infections would invariably decrease.

Clinical Significance

Accurate diagnosis of patients experiencing symptoms of a UTI is paramount in efforts to practice proper antibiotic stewardship, by limiting antibiotic misutilization and overutilization. Some of the pitfalls of inappropriate antibiotic use include an increased incidence

of *Clostridium difficile* infections, adverse drug reactions, and colonization or infection of resistant bacteria. Some of the advantages of urine culture stewardship include absolute decreases in the total number of unnecessary urine cultures, the inappropriate treatment of ASB, as well as the costs related to the overtreatment of various infections. Since hospitalized patients have the highest risk of UTI as a nosocomial acquired infection, efforts to increase clinical acumen while decreasing unnecessary testing and antibiotic use benefit the patient by decreasing chances of antibiotic resistance as well as allocating resources properly for those who truly need urine cultures and subsequent treatment.