

CHAPTER

3

Introduction to Urinalysis

LEARNING OBJECTIVES

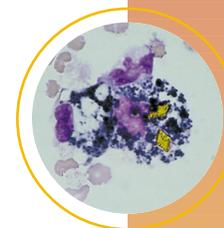
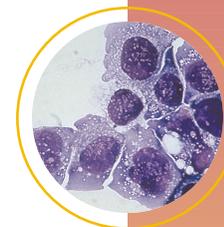
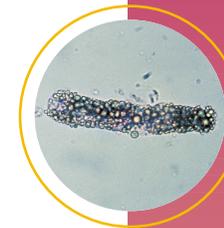
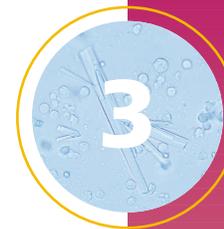
Upon completion of this chapter, the reader will be able to:

- 1 List three major organic and three major inorganic chemical constituents of urine.
- 2 Describe a method for determining whether a questionable fluid is urine.
- 3 Recognize normal and abnormal daily urine volumes.
- 4 Describe the characteristics of the recommended urine specimen containers.
- 5 Describe the correct methodology for labeling urine specimens.
- 6 State four possible reasons why a laboratory would reject a urine specimen.
- 7 List 10 changes that may take place in a urine specimen that remains at room temperature for more than 2 hours.
- 8 Discuss the actions of bacteria on an unpreserved urine specimen.
- 9 Briefly discuss five methods for preserving urine specimens, including their advantages and disadvantages.
- 10 Instruct a patient in the correct procedure for collecting a timed urine specimen and a midstream clean-catch specimen.
- 11 Describe the type of specimen needed to obtain optimal results when a specific urinalysis procedure is requested.

KEY TERMS

anuria
 catheterized specimen
 chain of custody
 fasting specimen
 first morning specimen
 2-hour postprandial specimen
 midstream clean-catch specimen

nocturia
 oliguria
 polyuria
 suprapubic aspiration
 three-glass collection
 timed specimen



History and Importance

The analysis of urine was actually the beginning of laboratory medicine. References to the study of urine can be found in the drawings of cavemen and in Egyptian hieroglyphics, such as the Edwin Smith Surgical Papyrus. Pictures of early physicians commonly showed them examining a bladder-shaped flask of urine (Figure 3–1). Often these physicians never saw the patient, only the patient's urine. Although these physicians lacked the sophisticated testing mechanisms now available, they were able to obtain diagnostic information from such basic observations as color, turbidity, odor, volume, viscosity, and even sweetness (by noting that certain specimens attracted ants). These same urine characteristics are still reported by laboratory personnel today. However, modern urinalysis has expanded its scope to include not only the physical examination of urine but also the chemical analysis and microscopic examination of the urinary sediment.

Many well-known names in the history of medicine are associated with the study of urine, including Hippocrates, who in the 5th century BC wrote a book on “uroscopy.” During the Middle Ages, physicians concentrated their efforts very heavily on the art of “uroscopy,” with physicians receiving instruction in urine examination as part of their training (Figure 3–2). By 1140 AD, color charts had been developed that described the significance of 20 different colors (Figure 3–3). Chemical testing progressed from “ant

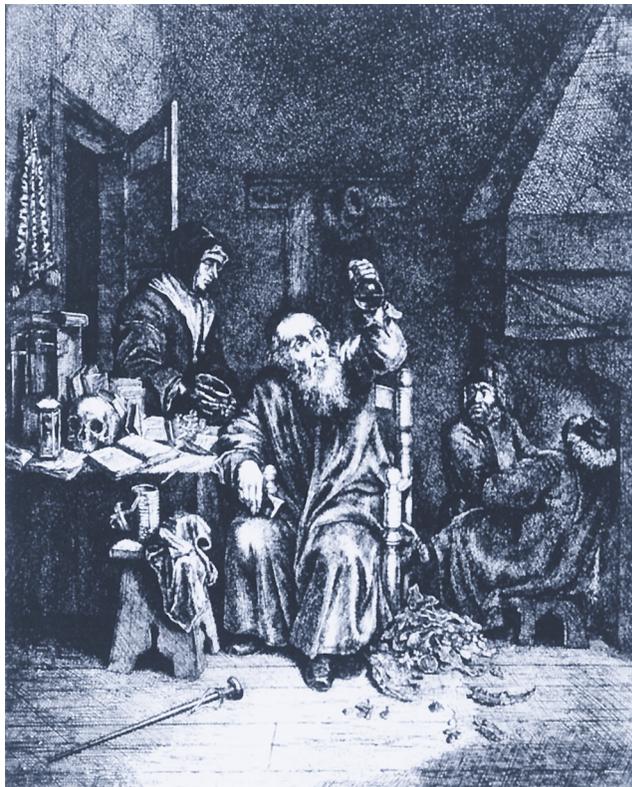


FIGURE 3–1 Physician examines urine flask. (Courtesy of the National Library of Medicine.)



FIGURE 3–2 Instruction in urine examination. (Courtesy of the National Library of Medicine.)

testing” and “taste testing” for glucose to Frederik Dekkers’ discovery in 1694 of **albuminuria** by boiling urine.⁵

The credibility of the urinalysis became compromised when charlatans without medical credentials began offering their predictions to the public for a healthy fee. These charlatans, called “pisse prophets,” became the subject of a book published by Thomas Bryant in 1627. The revelations in this book inspired the passing of the first medical licensure laws in England—another contribution of urinalysis to the field of medicine!

The invention of the microscope in the 17th century led to the examination of urinary sediment and to the development by Thomas Addis of methods for quantitating the microscopic sediment. Richard Bright introduced the concept of urinalysis as part of a doctor’s routine patient examination in 1827. By the 1930s, however, the number and complexity of the tests performed in a urinalysis had reached a point of impracticality, and the urinalysis began to disappear from routine examinations. Fortunately, the development of modern testing techniques rescued the routine urinalysis, which has remained an integral part of the patient examination.

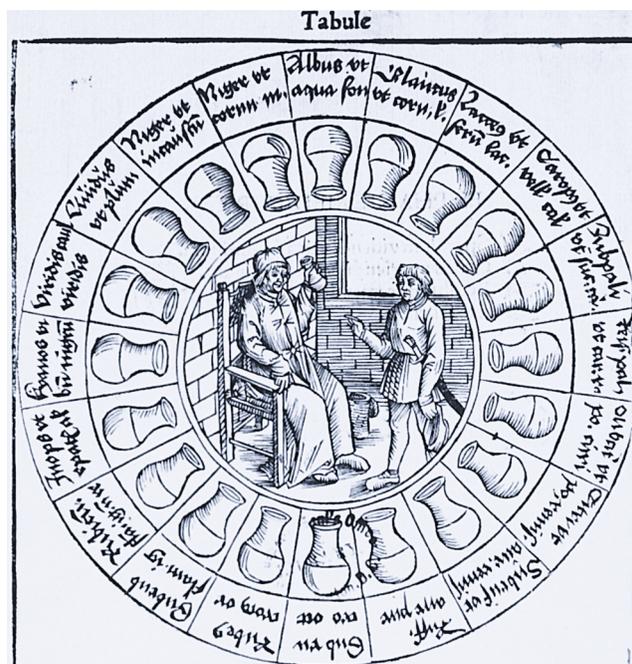


FIGURE 3-3 A chart used for urine analysis. (Courtesy of the National Library of Medicine.)

Two unique characteristics of a urine specimen can account for this continued popularity:

1. Urine is a readily available and easily collected specimen.
2. Urine contains information about many of the body's major metabolic functions, and this information can be obtained by inexpensive laboratory tests.

These characteristics fit in well with the current trends toward preventive medicine and lower medical costs. In fact, the National Committee for Clinical Laboratory Standards (NCCLS) defines urinalysis as “the testing of urine with procedures commonly performed in an expeditious, reliable, accurate, safe, and cost-effective manner.” Reasons for performing the urinalysis identified by NCCLS include aiding in the diagnosis of disease, screening asymptomatic populations for undetected disorders, and monitoring the progress of disease and the effectiveness of therapy.⁷

Urine Formation

As detailed in Chapter 2, the kidneys continuously form urine as an ultrafiltrate of plasma. Reabsorption of water and filtered substances essential to body function converts approximately 170,000 mL of filtered plasma to the average daily urine output of 1200 mL.

Urine Composition

In general, urine consists of urea and other organic and inorganic chemicals dissolved in water. Considerable variations in the concentrations of these substances can occur

owing to the influence of factors such as dietary intake, physical activity, body metabolism, endocrine functions, and even body position. Urea, a metabolic waste product produced in the liver from the breakdown of protein and amino acids, accounts for nearly half of the total dissolved solids in urine. Other organic substances include primarily creatinine and uric acid. The major inorganic solid dissolved in urine is chloride, followed by sodium and potassium. Small or trace amounts of many additional inorganic chemicals are also present in urine (Table 3-1). Dietary intake greatly influences the concentrations of these inorganic compounds, making it difficult to establish normal levels. Other substances found in urine include hormones, vitamins, and medications. Although not a part of the original plasma filtrate, the urine also may contain formed elements, such as cells, casts, crystals, mucus, and bacteria. Increased amounts of these formed elements are often indicative of disease.

Should it be necessary to determine whether a particular fluid is actually urine, the specimen can be tested for its urea and creatinine content. Since both of these substances are present in much higher concentrations in urine than in other body fluids, a high urea and creatinine content can identify a fluid as urine.

Urine Volume

Urine volume depends on the amount of water that the kidneys excrete. Water is a major body constituent; therefore, the amount excreted is usually determined by the body's state of hydration. Factors that influence urine volume include fluid intake, fluid loss from nonrenal sources, variations in the secretion of antidiuretic hormone, and the necessity to excrete increased amounts of dissolved solids, such as glucose or salts. Taking these factors into consideration, it can be seen that although the normal daily urine output is usually 1200 to 1500 mL, a range of 600 to 2000 mL may be considered normal.⁴

Oliguria, a decrease in the normal daily urine volume, is commonly seen when the body enters a state of dehydration as a result of excessive water loss from vomiting, diarrhea, perspiration, or severe burns. Oliguria leading to **anuria**, cessation of urine flow, may result from any serious damage to the kidneys or from a decrease in the flow of blood to the kidneys. The kidneys excrete two to three times more urine during the day than during the night. An increase in the nocturnal excretion of urine is termed **nocturia**. **Polyuria**, an increase in daily urine volume, is often associated with diabetes mellitus and diabetes insipidus; however, it also may be artificially induced by the use of diuretics, caffeine, or alcohol, all of which suppress the secretion of antidiuretic hormone.

Diabetes mellitus and diabetes insipidus produce polyuria for different reasons, and analysis of the urine is an important step in the differential diagnosis (Figure 3-4). Diabetes mellitus is caused by a defect either in the pancreatic production of insulin or in the function of insulin that results in an increased body glucose concentration. The kidneys do not reabsorb excess glucose, necessitating the

TABLE 3-1 Composition of Urine Collected for 24 Hours

Component	Amount	Remark
Organic		
Urea	25.0–35.0 g	60–90% of nitrogenous material; derived from the metabolism of amino acids into ammonia
Creatinine	1.5 g	Derived from creatine, a nitrogenous substance in muscle tissue
Uric acid	0.4–1.0 g	Common component of kidney stones; derived from the catabolism of nucleic acid in food and cell destruction
Hippuric acid	0.7 g	Benzoic acid is eliminated from the body in this form; increases with high-vegetable diets
Other substances	2.9 g	Carbohydrates, pigments, fatty acids, mucin, enzymes, and hormones; may be present in small amounts depending on diet and health
Inorganic		
Sodium chloride (NaCl)	15.0 g	Principal salt; varies with intake
Potassium (K ⁺)	3.3 g	Occurs as chloride, sulfate, and phosphate salts
Sulfate (SO ₄ ²⁻)	2.5 g	Derived from amino acids
Phosphate (PO ₄ ³⁻)	2.5 g	Occurs primarily as sodium compounds that serve as buffers in the blood
Ammonium (NH ₄ ⁺)	0.7 g	Derived from protein metabolism and from glutamine in kidneys; amount varies depending on blood and tissue fluid acidity
Magnesium (Mg ²⁺)	0.1 g	Occurs as chloride, sulfate, and phosphate salts
Calcium (Ca ²⁺)	0.3 g	Occurs as chloride, sulfate, and phosphate salts

Adapted from Tortora, GJ, and Anagnostakos, NP: Principles of Anatomy and Physiology, ed 6, Harper & Row, New York, 1990, p. 51.

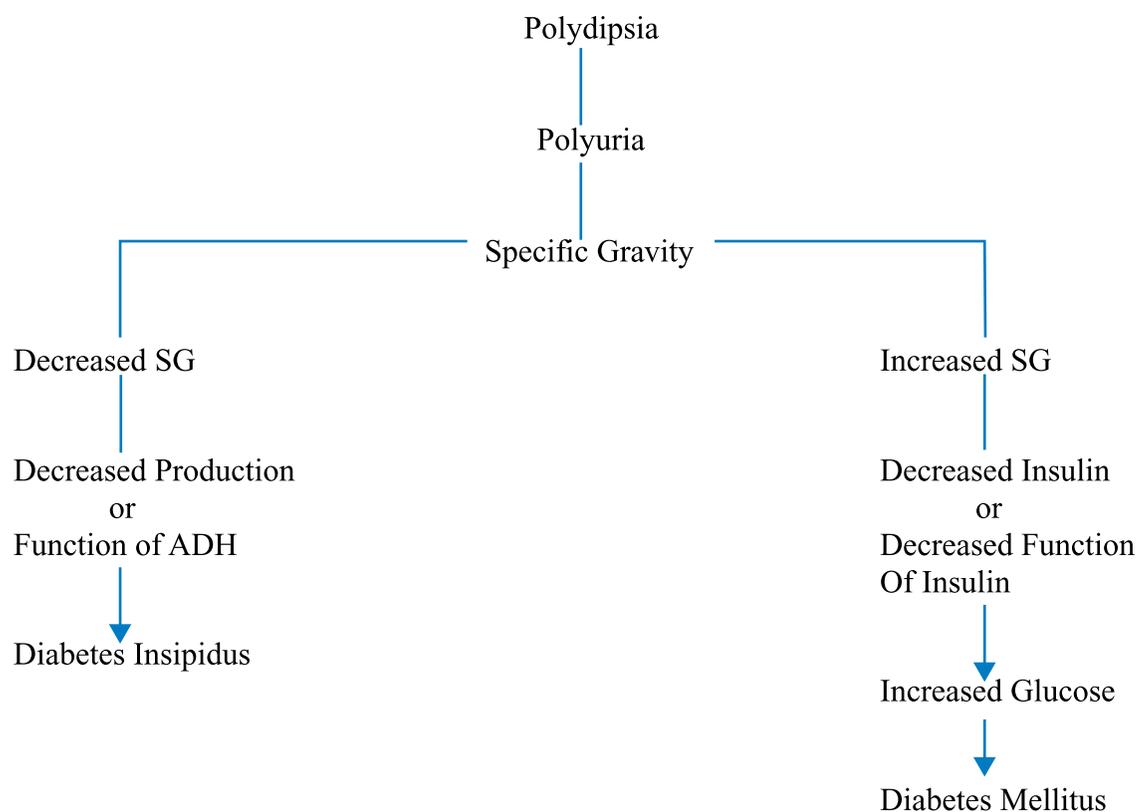


FIGURE 3-4 Differentiation between diabetes mellitus and diabetes insipidus.

excretion of increased amounts of water to remove the dissolved glucose from the body. Although appearing to be dilute, a urine specimen from a patient with diabetes mellitus will have a high specific gravity because of the increased glucose content.

Diabetes insipidus results from a decrease in the production or function of antidiuretic hormone; thus, the water necessary for adequate body hydration is not reabsorbed from the plasma filtrate. In this condition, the urine will be truly dilute and will have a low specific gravity. Fluid loss in both diseases is compensated for by increased ingestion of water (**polydipsia**), producing an even greater urine volume. Polyuria accompanied by increased fluid intake is often the first symptom of either disease.

Specimen Collection

As discussed in Chapter 1, urine is a biohazardous substance that requires the observance of Standard Precautions. Gloves should be worn at all times when in contact with the specimen.

Specimens must be collected in clean, dry, leak-proof containers. Disposable containers are recommended because they eliminate the chance of contamination due to improper washing. These disposable containers are available in a variety of sizes and shapes, including bags with adhesive for the collection of pediatric specimens and large containers for 24-hour specimens. Properly applied screw-top lids are less likely to leak than are snap-on lids.

Containers for routine urinalysis should have a wide mouth to facilitate collections from female patients and a wide, flat bottom to prevent overturning. They should be made of a clear material to allow for determination of color and clarity. The recommended capacity of the container is 50 mL, which will allow collection of the 12 mL of specimen needed for microscopic analysis, additional specimen for repeat analysis, and enough room for the specimen to be mixed by swirling the container.

All specimens must be properly labeled with the patient's name and identification number, the date and time of collection, and additional information, such as the patient's age and location and the physician's name, as required by institutional protocol. Labels must be attached to the container, not to the lid, and should not become detached if the container is refrigerated.

A requisition form (manual or computerized) must accompany specimens delivered to the laboratory. The information on the form must match the information on the specimen label. Additional information present on the requisition form can include method of collection or type of specimen, possible interfering medications, and the patient's clinical information. The time the specimen is received in the laboratory should be recorded on the form.

Improperly labeled and collected specimens should be rejected by the laboratory, and appropriate personnel should be notified to collect a new specimen. Examples of unacceptable specimens include those in unlabeled containers, nonmatching labels and requisition forms, specimens contaminated with feces or toilet paper, containers

with contaminated exteriors, specimens of insufficient quantity, and specimens that have been improperly transported. Laboratories should have a written policy detailing their conditions for specimen rejection (see Chap. 7).

Specimen Handling

The fact that a urine specimen is so readily available and easily collected often leads to laxity in the treatment of the specimen after its collection. Changes in urine composition take place not only *in vivo* but also *in vitro*, thus necessitating correct handling procedures after the specimen is collected.

SPECIMEN INTEGRITY

Following collection, specimens should be delivered to the laboratory promptly and tested within 2 hours. A specimen that cannot be delivered and tested within 2 hours should be refrigerated or have an appropriate chemical preservative added. Table 3–2 describes the 11 most significant changes that may occur in a specimen allowed to remain unpreserved at room temperature for longer than 2 hours. Notice that most of the changes are related to the presence and growth of bacteria.

These variations are discussed again under the individual test procedures. At this point it is important to realize that improper preservation can seriously affect the results of a routine urinalysis.

TABLE 3–2 Changes in Unpreserved Urine

Analyte	Change	Cause
Color	Modified/ Darkened	Oxidation or reduction of metabolites
Clarity	Decreased	Bacterial growth and precipitation of amorphous material
Odor	Increased	Multiplication of bacteria or bacterial breakdown of urea to ammonia
pH	Increased	Breakdown of urea to ammonia by urease-producing bacteria/loss of CO ₂
Glucose	Decreased	Glycolysis and bacterial use
Ketones	Decreased	Volatilization and bacterial metabolism
Bilirubin	Decreased	Exposure to light/photo oxidation to biliverdin
Urobilinogen	Decreased	Oxidation to urobilin
Nitrite	Increased	Multiplication of nitrate-reducing bacteria
Red and white blood cells and casts	Decreased	Disintegration in dilute alkaline urine
Bacteria	Increased	Multiplication

SPECIMEN PRESERVATION

The most routinely used method of preservation is refrigeration at 2°C to 8°C, which decreases bacterial growth and metabolism. Refrigeration of the specimen can increase the specific gravity when measured by urinometer and the precipitation of amorphous phosphates and urates, which may obscure the microscopic sediment analysis. Allowing the specimen to return to room temperature prior to performing chemical testing by reagent strips is required. This will correct the specific gravity and may dissolve some of the amorphous urates.

When a specimen must be transported over a long distance and refrigeration is impossible, chemical preservatives may be added. The ideal preservative should be bactericidal, inhibit urease, and preserve formed elements in the sediment. At the same time, it should not interfere with chemical tests. Unfortunately, as can be seen in Table 3–3, the ideal preservative does not currently exist; therefore, a preservative that best suits the needs of the required analysis should be chosen.

Types of Specimens

To obtain a specimen that is truly representative of a patient's metabolic state, regulation of certain aspects of specimen collection often is necessary. These special conditions may include time, length, and method of collection and the patient's dietary and medicinal intake. It is important to instruct patients when they must follow special collection procedures. Frequently encountered specimens are listed in Table 3–4.

RANDOM SPECIMEN

This is the most commonly received specimen because of its ease of collection and convenience for the patient. The **random specimen** is useful for routine screening tests to detect obvious abnormalities. However, it may also produce erroneous results caused by dietary intake or physical activity just prior to the collection of the specimen. The patient

TABLE 3–3 Urine Preservatives

Preservatives	Advantages	Disadvantages	Additional Information
Refrigeration	Does not interfere with chemical tests	Raises specific gravity by hydrometer Precipitates amorphous phosphates and urates	Prevents bacterial growth for 24 h ²
Thymol	Preserves glucose and sediments well	Interferes with acid precipitation tests for protein	
Boric acid	Preserves protein and formed elements well Does not interfere with routine analyses other than pH	May precipitate crystals when used in large amounts	Keeps pH at about 6.0 Is bacteriostatic (not bactericidal) at 18 g/L; can be used for culture transport Interferes with drug and hormone analyses ⁹
Formalin (formaldehyde)	Is an excellent sediment preservative	Acts as a reducing agent interfering with chemical tests for glucose, blood, leukocyte esterase, and copper reduction	Rinse specimen container with formalin to preserve cells and casts
Toluene	Does not interfere with routine tests	Floats on the surface of specimens and clings to pipettes and testing materials	
Sodium fluoride	Prevents glycolysis	Inhibits reagent strip tests for glucose, blood, and leukocytes	May use sodium benzoate instead of fluoride for reagent strip testing ⁸
Phenol	Is a good preservative for drug analyses ¹¹ Does not interfere with routine tests	Causes an odor change	Use 1 drop per ounce of specimen
Commercial preservative tablets	Are convenient when refrigeration is not possible Have controlled concentration to minimize interference	May contain one or more of the above preservatives including sodium fluoride	Check tablet composition to determine possible effects on desired tests
Urine C + S Transport Kit (Becton Dickinson, Rutherford, NJ)	Can run urinalysis and culture on the same specimen ^{6,10}	Decreases pH	Preservative is boric acid
Saccomanno's Fixative	Preserves cellular elements		Used for cytology studies

TABLE 3-4 Types of Urine Specimens

Type of Specimen	Purpose
Random	Routine screening
First morning	Routine screening Pregnancy tests Orthostatic protein
Fasting (second morning)	Diabetic screening/monitoring
2-h postprandial	Diabetic monitoring
Glucose tolerance test	Accompaniment to blood samples in glucose tolerance test
24-h (or timed)	Quantitative chemical tests
Catheterized	Bacterial culture
Midstream clean-catch	Routine screening Bacterial culture
Suprapubic aspiration	Bladder urine for bacterial culture Cytology
Three-glass collection	Prostatic infection

will then be requested to collect additional specimens under more controlled conditions.

FIRST MORNING SPECIMEN

Although it may require the patient to make an additional trip to the laboratory, this is the ideal screening specimen. It is also essential for preventing false-negative pregnancy tests and for evaluating orthostatic **proteinuria**. The **first morning specimen** is a concentrated specimen, thereby assuring detection of chemicals and formed elements that may not be present in a dilute random specimen. The patient should be instructed to collect the specimen immediately upon arising and to deliver it to the laboratory within 2 hours.

FASTING SPECIMEN (SECOND MORNING)

A **fasting specimen** differs from a first morning specimen by being the second voided specimen after a period of fasting. This specimen will not contain any metabolites from food ingested prior to the beginning of the fasting period. It is recommended for glucose monitoring.³

2-HOUR POSTPRANDIAL SPECIMEN

With this specimen, the patient is instructed to void shortly before consuming a routine meal and to collect a specimen 2 hours after eating. The specimen is tested for glucose, and the results are used primarily for monitoring insulin therapy in persons with diabetes mellitus. A more comprehensive evaluation of the patient's status can be obtained if the results of the **2-hour postprandial specimen** are compared with those of a fasting specimen and corresponding blood glucose tests.

GLUCOSE TOLERANCE SPECIMENS

Glucose tolerance specimens are sometimes collected to correspond with the blood samples drawn during a glucose

tolerance test (**GTT**). The number of specimens varies with the length of the test. GTTs may include fasting, ½-hour, 1-hour, 2-hour, and 3-hour specimens, and possibly 4-hour, 5-hour, and 6-hour specimens. The urine is tested for glucose and ketones, and the results are reported with the blood test results as an aid to interpreting the patient's ability to metabolize a measured amount of glucose and are correlated with the renal threshold for glucose.

24-HOUR (OR TIMED) SPECIMEN

Often measuring the exact amount of a urine chemical is necessary rather than just reporting its presence or absence. A carefully **timed specimen** must be used to produce accurate quantitative results. When the concentration of the substance to be measured varies with daily activities such as exercise, meals, and body metabolism, 24-hour collection is required. If the concentration of a particular substance remains constant, the specimen may be collected over a shorter period. Care must be taken, however, to keep the patient adequately hydrated during short collection periods. Patients must be explicitly instructed on the procedure for collecting a timed specimen. To obtain an accurately timed specimen, the patient must begin and end the collection period with an empty bladder. Keep in mind that the concentration of a substance in a particular time period must be calculated from the urine volume produced during that time. Addition of urine formed prior to the start of the collection period or failure to include urine produced at the end of the collection period will produce inaccurate results.

Upon its arrival in the laboratory, a 24-hour specimen must be thoroughly mixed and the volume accurately measured and recorded. If only an aliquot is needed for testing, the amount saved must be adequate to permit repeat or additional testing. If a specimen is collected in two containers, the contents of the two containers should be combined and thoroughly mixed prior to aliquoting. Consideration also must be given to the preservation of specimens col-

PROCEDURE

24-Hour (Timed) Specimen Collection Procedure

- Provide patient with written instructions and explain the collection procedure.
- Issue the proper collection container and preservative.
- Day 1—7 AM Patient voids and discards specimen. Patient collects all urine for the next 24 hours.
- Day 2—7 AM Patient voids and adds this urine to the previously collected urine.
- Upon arrival in the laboratory, the entire 24-hour specimen is thoroughly mixed, and the volume accurately measured and recorded.
- An aliquot is saved for testing and additional or repeat testing. Discard remaining urine.

lected over extended periods. All specimens should be refrigerated or kept on ice during the collection period and also may require the addition of a chemical preservative. The preservative chosen must be nontoxic to the patient and should not interfere with the tests to be performed. Appropriate collection information is included with test procedures and should be referred to before issuing a container and instructions to the patient. To ensure the accuracy of a 24-hour specimen, a known quantity of a nontoxic chemical marker, such as 4-aminobenzoic acid, may be given to the patient at the start of the collection period. The concentration of excreted marker in the specimen is measured to determine the completeness of the collection.¹ Use of an injected inert marker, the concentration of which can be controlled, is recommended over measurement of endogenous urine creatinine, which varies with dietary intake and body mass.

CATHETERIZED SPECIMEN

This specimen is collected under sterile conditions by passing a hollow tube (catheter) through the urethra into the bladder. The most commonly requested test on a **catheterized specimen** is a bacterial culture. If a routine urinalysis is also requested, the culture should be performed first to prevent contamination of the specimen.

A less frequently encountered type of catheterized specimen is used to measure functions in the individual kidneys. Specimens from the right and left kidneys are collected separately by passing catheters through the ureters of the respective kidneys.

MIDSTREAM CLEAN-CATCH SPECIMEN

As an alternative to the catheterized specimen, the **midstream clean-catch specimen** provides a safer, less traumatic method for obtaining urine for bacterial culture and routine urinalysis. It provides a specimen that is less contaminated by epithelial cells and bacteria and, therefore, more representative of the actual urine than the routinely voided specimen. Patients must be provided with appropriate cleansing materials, a sterile container, and instructions for cleansing and voiding. Strong bacterial agents such as hexachlorophene or povidone-iodine should not be used as cleansing agents. Mild antiseptic towelettes are recommended. Patients are instructed to wash their hands prior to beginning the collection. Male patients should clean the **glans** beginning at the urethra and withdrawing the foreskin, if necessary. Female patients should separate the **labia** and clean the **urinary meatus** and surrounding area. When cleansing is complete, patients are to void first into the toilet, then collect an adequate amount of urine in the sterile container, and finish voiding into the toilet. Care should be taken not to contaminate the specimen container.

SUPRAPUBIC ASPIRATION

Occasionally urine may be collected by external introduction of a needle through the abdomen into the bladder. Because the bladder is sterile under normal conditions, **suprapubic aspiration** provides a sample for bacterial culture

that is completely free of extraneous contamination. The specimen also can be used for cytologic examination.

THREE-GLASS COLLECTION

Similar to the midstream clean-catch collection, the **three-glass collection** procedure is used to determine prostatic infection. Instead of discarding the first urine passed, it is collected in a sterile container. Next the midstream portion is collected in another sterile container. The prostate is then massaged so that prostate fluid will be passed with the remaining urine into a third sterile container. Quantitative cultures are performed on all specimens, and the first and third specimens are examined microscopically. In prostatic infection, the third specimen will have a white blood cell/high-power field count and a bacterial count 10 times that of the first specimen. Macrophages containing lipids also may be present. The second specimen is used as a control for bladder and kidney infection. If it is positive, the results from the third specimen are invalid because infected urine has contaminated the specimen.¹²

PEDIATRIC SPECIMEN

Collection of pediatric specimens can present a challenge. Soft, clear plastic bags with adhesive to attach to the genital area of both boys and girls are available for collecting routine specimens. Sterile specimens may be obtained by catheterization or by suprapubic aspiration. Specimens for culture also may be obtained using a clean-catch cleansing procedure and a sterile collection bag. Care must be taken not to touch the inside of the bag when applying it. For quantitative testing, bags are available that allow a tube to be attached and excess urine transferred to a larger container.

DRUG SPECIMEN COLLECTION

Urine specimen collection is the most vulnerable part of a drug-testing program. Correct collection procedures and documentation are necessary to ensure that the drug testing results are those of the specific individual submitting the specimen. The **chain of custody (COC)** is the process that provides this documentation of proper sample identification from the time of collection to the receipt of laboratory results. The COC is a standardized form that must document and accompany every step of drug testing, from collector to courier to laboratory to medical review officer to employer.

For urine specimens to withstand legal scrutiny, it is necessary to prove that no tampering of the specimen took place, such as substitution, adulteration, or dilution of the urine. All personnel handling the specimen must be noted. The specimen must be handled securely with a guarantee that no unauthorized access to the specimen was possible. Proper identification of the individual whose information is indicated on the label is required. Acceptable identification includes photo identification or identification by an employer representative with photo ID who can positively identify the donor.

PROCEDURE**Urine Drug Specimen Collection Procedure^{13,14}**

- 1** The collector washes hands and wears gloves.
- 2** The collector adds bluing agent (dye) to the toilet water reservoir to prevent an adulterated specimen.
- 3** The collector eliminates any source of water other than toilet by taping the toilet lid and faucet handles.
- 4** The donor provides photo identification or positive identification from employer representative.
- 5** The collector completes step 1 of the Chain of Custody (COC) form and has the donor sign the form.
- 6** The donor leaves his or her coat, briefcase, and/or purse outside the collection area to avoid the possibility of concealed substances contaminating the urine.
- 7** The donor washes his or her hands and receives a specimen cup.
- 8** The collector remains in the restroom, but outside the stall, listening for unauthorized water use, unless a witnessed collection is requested.
- 9** The donor hands specimen cup to the collector. Transfer is documented.
- 10** The collector checks the urine for abnormal color and for the required amount (30–45 mL).
- 11** The collector checks that the temperature strip on the specimen cup reads between 32.5–37.7°C. The collector records the in-range temperature on the COC form (COC step 2). If the specimen temperature is out of range or the specimen is suspected to have been diluted or adulterated, a new specimen must be collected and a supervisor notified.
- 12** The specimen must remain in the sight of the donor and collector at all times.
- 13** With the donor watching, the collector peels off the specimen identification strips from the COC form (COC step 3) and puts them on the capped bottle covering both sides of the cap.
- 14** The donor initials the specimen bottle seals.
- 15** The date and time are written on the seals.
- 16** The donor completes step 4 on the COC form.
- 17** The collector completes step 5 on the COC form.
- 18** Each time the specimen is handled, transferred, or placed in storage, every individual must be identified and the date and purpose of the change recorded.
- 19** The collector follows laboratory-specific instructions for packaging the specimen bottles and laboratory copies of the COC form.
- 20** The collector distributes the COC copies to appropriate personnel.

Urine specimen collections may be “witnessed” or “unwitnessed.” The decision to obtain a witnessed collection is indicated when it is suspected that the donor may alter or substitute the specimen or it is the policy of the client ordering the test. If a witnessed specimen collection is ordered, a same-gender collector will observe the collection of 30 to 45 mL of urine. Witnessed and unwitnessed collections should be immediately handed to the collector.

The urine temperature must be taken within 4 minutes from the time of collection to confirm the specimen has not been adulterated. The temperature should read within the range of 32.5°C to 37.7°C. If the specimen temperature is not within range, the specimen temperature should be recorded and the supervisor or employer contacted immediately. Urine temperatures outside of the recommended range may indicate specimen contamination. Recollection of a second specimen as soon as possible will be necessary. The urine color is inspected to identify any signs of contaminants. The specimen is labeled, packaged, and transported following laboratory-specific instructions.

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STUDY QUESTIONS

- 1.** State two characteristics of urine that make it an ideal laboratory specimen.
- 2.** What is the primary constituent of normal urine?

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3. Name the primary organic constituent of normal urine.
4. An unidentified fluid is received in the laboratory with a request to determine if the fluid is urine or another body fluid. Using routine laboratory tests, how could you determine that the fluid is most probably urine?
5. Place the following terms in order from lowest to highest urine volume: oliguria, polyuria, and anuria.
6. A patient presenting with polyuria, nocturia, polydipsia, and a high urine specific gravity is exhibiting symptoms of what disorder?
7. Why are disposable containers with a capacity of 50 mL recommended for the collection of specimens for routine urinalysis?
8. What error in specimen labeling could cause the improper reporting of two urine specimens?
9. List five reasons why a laboratory could consider a urine specimen unacceptable.
10. State two parameters of the routine urinalysis that are falsely increased if the specimen is not tested within 2 hours.
11. Describe three changes that will affect the results of the microscopic examination of urine that is not tested within 2 hours.
12. What is the primary cause of the changes that take place in unpreserved urine?
13. Name two chemical parameters not affected by the answer to Study Question #12?
14. Why is refrigeration the method of choice for preservation of routine urinalysis samples?
15. What chemical preservative can be used to preserve a specimen for a culture and a routine urinalysis? What urinalysis parameter is affected?
16. A properly labeled urine specimen for routine urinalysis is delivered to the laboratory in a gray-top blood collection tube. Is this specimen acceptable? Explain your answer.
17. What is the specimen of choice for routine urinalysis? Why?
18. Will failure to begin a 24-hour urine collection with an empty bladder cause the results to be falsely elevated or decreased?

19. Name three types of urine specimens that would be acceptable for culture to diagnose a bladder infection.
20. Why is the COC form an essential part of urine collections for drug analysis?


**CASE STUDIES AND
CLINICAL SITUATIONS**

1. A 24-hour urine collection received in the laboratory for creatinine analysis has a volume of 500 mL.
 - a. Should this specimen be rejected and a new specimen requested? Why or why not?
 - b. State a possible source of error, if the creatinine concentration per 24 hours is abnormally low.
2. Mary Johnson brings a urine specimen to the laboratory for a glucose analysis. The test result is negative. The physician questions the result because the patient has a family history of diabetes mellitus and is experiencing mild clinical symptoms.
 - a. What two sources of error related to the urine specimen could account for the negative test result?
 - b. How could a specimen be collected that would more accurately reflect Mary's glucose metabolism?
3. A three-glass specimen for determination of possible prostatic infection is sent to the laboratory. Specimens #1 and #3 contain increased white blood cell levels.
 - a. If all three specimens have positive bacterial cultures, does the patient have a prostatic infection? Explain your answer.
 - b. Why is the presence of white blood cells in specimen #2 not part of the examination?
 - c. If the amount of bacteria and white blood cells in specimen #1 is significantly lower than in specimen #3, what is the significance?
4. A worker suspects that he or she will be requested to collect an unwitnessed urine specimen for drug analysis. He or she carries a substitute specimen in his or her pocket for 2 days before being told to collect the specimen. Shortly after the worker delivers the specimen, he or she is instructed to collect another specimen.
 - a. What test was performed on the specimen to determine possible specimen manipulation?
 - b. How was the specimen in this situation affected?
 - c. If a specimen for drug analysis tests positive, state a possible defense related to specimen collection and handling that an attorney might employ.
 - d. How can this defense be avoided?