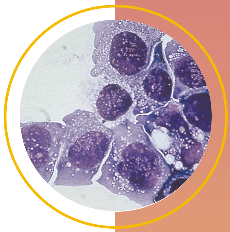
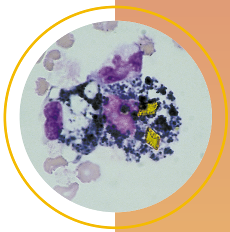
CHAPTER 4



Physical Examination of Urine

LEARNING OBJECTIVES

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

1. List the common terminology used to report normal urine color.
2. Discuss the relationship of urochrome to normal urine color.
3. State how the presence of bilirubin in a specimen may be suspected.
4. Discuss the significance of cloudy red urine and clear red urine.
5. Name two pathologic causes of black or brown urine.
6. Discuss the significance of phenazopyridine in a specimen.
7. State the clinical significance of urine clarity.
8. List the common terminology used to report clarity.
9. Describe the appearance and discuss the significance of amorphous phosphates and amorphous urates in freshly voided urine.
10. List three pathologic and four nonpathologic causes of cloudy urine.
11. Define specific gravity, and tell why this measurement can be significant in the routine analysis.
12. Describe the principles of the urinometer, refractometer, and harmonic oscillation densitometry methods for determining specific gravity.
13. State two advantages of performing specific gravity by refractometer rather than by urinometer.
14. Given the concentration of glucose and protein in a specimen, calculate the correction needed to compensate for these high-molecular-weight substances in the refractometer specific gravity reading.
15. Name two nonpathogenic causes of abnormally high specific gravity readings using a refractometer.

KEY TERMS

clarity
harmonic oscillation densitometry
hypersthenuric
hyposthenuric
isosthenuric
refractometry
specific gravity
urinometry

The physical examination of urine includes the determination of the urine color, ***clarity***, and ***specific gravity***. As mentioned in Chapter 3, early physicians based many medical decisions on the color and clarity of urine. Today, observation of these characteristics provides preliminary information concerning disorders such as glomerular bleeding, liver disease, inborn errors of metabolism, and urinary tract infection. Measurement of specific gravity aids in the evaluation of renal tubular function. The results of the physical portion of the urinalysis also can be used to confirm or to explain findings in the chemical and microscopic areas of urinalysis.

Color

The color of urine varies from almost colorless to black. These variations may be due to normal metabolic functions, physical activity, ingested materials, or pathologic conditions. A noticeable change in urine color is often the reason a patient seeks medical advice; it then becomes the responsibility of the laboratory to determine whether this color change is normal or pathologic. The more common normal and pathologic correlations of urine colors are summarized in Table 4–1.

NORMAL URINE COLOR

Terminology used to describe the color of normal urine may differ slightly among laboratories but should be consistent within each laboratory. Common descriptions include light yellow, yellow, dark yellow, and amber. Care should be taken to examine the specimen under a good light source, looking down through the container against a white background. The yellow color of urine is caused by the presence of a pigment, which Thudichum named **urochrome** in 1864. Urochrome is a product of endogenous metabolism, and under normal conditions the body produces it at a constant rate. The actual amount of urochrome produced is dependent on the body's metabolic state, with increased amounts produced in thyroid conditions and fasting states.[4] Urochrome also increases in urine that stands at room temperature.[9]

Because urochrome is excreted at a constant rate, the intensity of the yellow color in a fresh urine specimen can give a rough estimate of urine concentration. A dilute urine will be pale yellow and a concentrated specimen will be dark yellow. Remember that, owing to variations in the body's state of hydration, these differences in the yellow color of urine can be normal.

Two additional pigments, **uroerythrin** and **urobilin**, are also present in the urine in much smaller quantities and contribute little to the color of normal, fresh urine. The presence of uroerythyrin, a pink pigment, is most evident in specimens that have been refrigerated, resulting in the precipitation of amorphous urates. Uroerythrin attaches to the urates, producing a pink color to the sediment. *Urobilin*, an oxidation product of the normal urinary constituent, urobilinogen, imparts an orange-brown color to urine that is not fresh.

ABNORMAL URINE COLOR

As can be seen in Table 4–1, abnormal urine colors are as numerous as their causes. Certain colors, however, are seen more frequently and have a greater clinical significance than others.

Dark Yellow/Amber/Orange

Dark yellow or amber urine may not always signify a normal concentrated urine but can be caused by the presence of the abnormal pigment bilirubin. If bilirubin is present, it will be detected during the chemical examination; however, its presence is suspected if a yellow foam appears when the specimen is shaken. Normal urine produces only a small amount of rapidly disappearing foam when shaken, and a large amount of white foam indicates an increased concentration of protein. A urine specimen that contains bilirubin may also contain hepatitis virus, reinforcing the need to follow Standard Precautions. The photo-oxidation of large amounts of excreted urobilinogen to urobilin will also produce a yellow-orange urine; however, yellow foam does not appear when the specimen is shaken. Photo-oxidation of bilirubin imparts a yellow-green color to the urine.

Also frequently encountered in the urinalysis laboratory is the yellow-orange specimen caused by the administration of phenazopyridine (Pyridium) or azo-gantrisin compounds to persons with urinary tract infections. This thick, orange pigment not only obscures the natural color of the specimen but also interferes with chemical tests based on color reactions. Recognition of the presence of phenazopyridine in a specimen is important so that laboratories can use alternate testing procedures. Specimens containing phenazopyridine will produce a yellow foam when shaken, which could be mistaken for bilirubin.

Red/Pink/Brown

One of the most common causes of abnormal urine color is the presence of blood. Red is the usual color that blood produces in urine, but the color may range from pink to brown, depending on the amount of blood, the pH of the urine, and the length of contact. Red blood cells **(RBCs)** remaining in an acidic urine for several hours will produce a brown urine due to the oxidation of hemoglobin to methemoglobin. A fresh brown urine containing blood may also indicate glomerular bleeding.[1]

Besides RBCs, two other substances, hemoglobin and myoglobin, produce a red urine and result in a positive chemical test result for blood (Figure 4–1). When RBCs are present, the urine will be red and cloudy; however, if hemoglobin or myoglobin is present, the specimen will be red and clear. Distinguishing between hemoglobinuria and myoglobinuria may be possible by examining the patient's plasma. Hemoglobinuria resulting from the in vivo breakdown of RBCs is accompanied by red plasma. Breakdown of skeletal muscle produces myoglobin. Myoglobin is more rapidly cleared from the plasma than is hemoglobin and, therefore, does not affect the color of the plasma. Fresh

TABLE 4–1 Laboratory Correlation of Urine Color[6]

Color	Cause	Clinical/Laboratory Correlations
Colorless	Recent fluid consumption	Commonly observed with random specimens
Pale yellow	Polyuria or diabetes insipidus	Increased 24-hour volume
	Diabetes mellitus	Elevated specific gravity and positive glucose test result
Dark yellow	Concentrated specimen	May be normal after strenuous exercise or in first morning specimen
Amber		Dehydration from fever or burns
Orange	Bilirubin	Yellow foam when shaken and positive chemical test results for bilirubin
	Acriflavine	Negative bile test results and possible green fluorescence
	Phenazopyridine (Pyridium)	Drug commonly administered for urinary tract infections
		May have orange foam and thick orange pigment that can obscure or interfere with reagent strip readings
	Nitrofurantoin	Antibiotic administered for urinary tract infections
	Phenindione	Anticoagulant, orange in alkaline urine, colorless in acid urine
Yellow-green Yellow-brown	Bilirubin oxidized to biliverdin	Colored foam in acidic urine and false-negative chemical test results for bilirubin
Green	*Pseudomonas* infection	Positive urine culture
Blue-green	Amitriptyline	Antidepressant
	Methocarbamol (Robaxin)	Muscle relaxant, may be green-brown
	Clorets	None
	Indican	Bacterial infections
	Methylene blue	Fistulas
	Phenol	When oxidized
Pink Red	RBCs	Cloudy urine with positive chemical test results for blood and RBCs visible microscopically
	Hemoglobin	Clear urine with positive chemical test results for blood; intravascular hemolysis
	Myoglobin	Clear urine with positive chemical test results for blood; muscle damage
	Porphyrins	Negative chemical test results for blood Detect with Watson-Schwartz screening test or fluorescence under ultraviolet light
	Beets	Alkaline urine of genetically susceptible persons
	Rifampin	Tuberculosis medication
	Menstrual contamination	Cloudy specimen with RBCs, mucus, and clots
Brown Black	RBCs oxidized to methemoglobin	Seen in acidic urine after standing; positive chemical test result for blood
	Methemoglobin	Denatured hemoglobin
	Homogentisic acid (alkaptonuria)	Seen in alkaline urine after standing; specific tests are available
	Melanin or melanogen	Urine darkens on standing and reacts with nitroprusside and ferric chloride
	Phenol derivatives	Interferes with copper reduction tests
	Argyrol (antiseptic)	Color disappears with ferric chloride
	Methyldopa or levodopa	Antihypertensive
	Metronidazole (Flagyl)	Darkens on standing

urine containing myoglobin frequently exhibits a more reddish-brown color than that of hemoglobin. The possibility of hemoglobinuria being produced from the in vitro lysis of RBCs also must be considered. Chemical tests to distinguish between hemoglobin and myoglobin are available (see Chap. 5).

Urine specimens containing porphyrins also may appear red resulting from the oxidation of **porphobilinogen** to **porphyrins**. They are often referred to as having the color of port wine.

Nonpathogenic causes of red urine include menstrual contamination, ingestion of highly pigmented foods, and

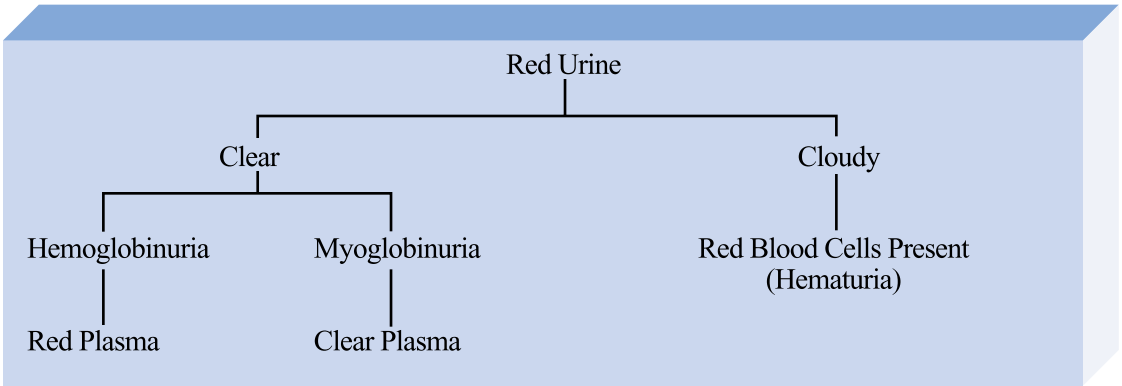


FIGURE 4–1 Differentiation of red urine testing chemically positive for blood.

medications. In genetically susceptible persons, eating fresh beets will cause a red color in alkaline urine.[10] Ingestion of blackberries can produce a red color in acidic urine. Many medications, including rifampin, phenolphthalein, phenindione, and phenothiazines, produce red urine.

Brown/Black

Additional testing is recommended for urine specimens that turn brown or black on standing and have negative chemical test results for blood, inasmuch as they may contain melanin or homogentisic acid. Melanin is an oxidation product of the colorless pigment, melanogen, produced in excess when a malignant **melanoma** is present. Homogentisic acid, a metabolite of phenylalanine, imparts a black color to alkaline urine from persons with the inborn-error of metabolism, called alkaptonuria. These conditions are discussed in Chapter 9. Medications producing brown/black urines include levodopa, methyldopa, phenol derivatives, and metronidazole (Flagyl).

Blue/Green

Pathogenic causes of blue/green urine color are limited to bacterial infections, including urinary tract infection by *Pseudomonas* species and intestinal tract infections resulting in increased urinary indican. Ingestion of breath deodorizers (Clorets) can result in a green urine color.[5] The medications methocarbamol (Robaxin), methylene blue, and amitriptyline (Elavil) may cause blue urine.

PROCEDURE

Color and Clarity Procedure

- Use a well-mixed specimen.
- View through a clear container.
- View against a white background.
- Maintain adequate room lighting.
- Evaluate a consistent volume of specimen.
- Determine color and clarity.

Observation of specimen collection bags from hospitalized patients frequently detects abnormally colored urine. This may signify a pathologic condition that requires the urine to stand for a period of time before color development or the presence of medications. Phenol derivatives found in certain intravenous medications will produce green urine on oxidation.[2] A purple staining may occur in catheter bags and is caused by the presence of indican in the urine or a bacterial infection frequently caused by *Klebsiella* or *Providencia* species.[3]

Clarity

Clarity is a general term that refers to the transparency/turbidity of a urine specimen. In routine urinalysis, clarity is determined in the same manner that ancient physicians used; that is, by visually examining the mixed specimen while holding it in front of a light source. The specimen should, of course, be in a clear container. Color and clarity are routinely determined at the same time. Common terminology used to report clarity includes clear, hazy, cloudy, turbid, and milky. As discussed under the section on urine color, terminology should be consistent within a laboratory. A description of urine clarity reporting is presented in Table 4–2.

NORMAL CLARITY

Freshly voided normal urine is usually clear, particularly if it is a midstream clean-catch specimen. Precipitation of amorphous phosphates and carbonates may cause a white cloudiness.

TABLE 4–2 Urine Clarity

Clarity	Term
Clear	No visible particulates, transparent.
Hazy	Few particulates, print easily seen through urine.
Cloudy	Many particulates, print blurred through urine.
Turbid	Print cannot be seen through urine.
Milky	May precipitate or be clotted.

TABLE 4–3 Nonpathologic Causes of Urine Turbidity

Squamous epithelial cells
Mucus
Amorphous phosphates, carbonates, urates
Semen, spermatozoa
Fecal contamination
Radiographic contrast media
Talcum powder
Vaginal creams

NONPATHOLOGIC TURBIDITY

The presence of squamous epithelial cells and mucus, particularly in specimens from women, can result in a hazy but normal urine.

Specimens that are allowed to stand or are refrigerated also may develop turbidity that is nonpathologic. As discussed in Chapter 3, improper preservation of a specimen results in bacterial growth and this will increase specimen turbidity but is not representative of the actual specimen.

Refrigerated specimens frequently develop a thick turbidity caused by the precipitation of amorphous phosphates, carbonates, and urates. Amorphous phosphates and carbonates produce a white precipitate in urine with an alkaline pH, whereas amorphous urates produce a precipitate in acidic urine that resembles pink brick dust due to the presence of uroerythyrin.

Additional nonpathologic causes of urine turbidity include semen, fecal contamination, radiographic contrast media, talcum powder, and vaginal creams (Table 4–3).

PATHOLOGIC TURBIDITY

The most commonly encountered pathologic causes of turbidity in a fresh specimen are RBCs, white blood cells (**WBCs**), and bacteria. Other less frequently encountered causes of pathologic turbidity include abnormal amounts of nonsquamous epithelial cells, yeast, abnormal crystals, lymph fluid, and lipids (Table 4–4).

The clarity of a urine specimen certainly provides a key to the microscopic examination results, because the degree of turbidity should correspond with the amount of material observed under the microscope. Questionable causes of urine turbidity can be confirmed by chemical tests shown in Table 4–5.

A clear urine is not always normal. However, with the increased sensitivity of the routine chemical tests, most abnormalities in clear urine will be detected prior to the microscopic analysis. Current criteria used to determine the necessity of performing a microscopic examination on all urine specimens include both clarity and chemical tests for RBCs, WBCs, bacteria, and protein.

TABLE 4–4 Pathologic Causes of Urine Turbidity

Red blood cells
White blood cells
Bacteria
Yeast
Nonsquamous epithelial cells
Abnormal crystals
Lymph fluid
Lipids

TABLE 4–5 Laboratory Correlations in Urine Turbidity[6]

Acidic Urine
Amorphous urates
Radiographic contrast media
Alkaline Urine
Amorphous phosphates, carbonates
Soluble with Heat
Amorphous urates, uric acid crystals
Soluble in Dilute Acetic Acid
Red blood cells
Amorphous phosphates, carbonates
Insoluble in Dilute Acetic Acid
White blood cells
Bacteria, yeast
Spermatozoa
Soluble in Ether
Lipids
Lymphatic fluid, chyle

Specific Gravity

The ability of the kidneys to selectively reabsorb essential chemicals and water from the glomerular filtrate is one of the body's most important functions. The intricate process of reabsorption is often the first renal function to become impaired; therefore, an assessment of the kidney's ability to reabsorb is a necessary component of the routine urinalysis. This evaluation can be performed by measuring the specific gravity of the specimen. Specific gravity also will detect possible dehydration or abnormalities in antidiuretic hormone and can be used to determine whether specimen concentration is adequate to ensure the accuracy of chemical tests.

Specific gravity is defined as the **density** of a solution compared with the density of a similar volume of distilled water at a similar temperature. Because urine is actually water that contains dissolved chemicals, the specific gravity of urine is a measure of the density of the dissolved chemicals in the specimen. As a measure of specimen density, specific gravity is influenced not only by the number of particles present but also by their size. Large urea molecules contribute more to the reading than do the small sodium and chloride molecules. Therefore, because urea is of less value than sodium and chloride in the evaluation of renal concentrating ability, it also may be necessary to test the specimen's osmolarity. This procedure is discussed in Chapter 2. For purposes of routine urinalysis, however, the specific gravity provides valuable preliminary information and can be easily performed using a urinometer (hydrometer), a refractometer, a reagent strip, or an automated instrument. This chapter will discuss the physical methods for determining specific gravity. The chemical reagent strip method is covered in Chapter 5.

URINOMETER

The urinometer consists of a weighted float attached to a scale that has been calibrated in terms of urine specific gravity. The weighted float displaces a volume of liquid equal to its weight and has been designed to sink to a level of 1.000 in distilled water. The additional mass provided by the dissolved substances in urine causes the float to displace a volume of urine smaller than that of distilled water. The level to which the urinometer sinks, as shown in Figure 4–2, represents the specimen's mass or specific gravity.

Urinometry is less accurate than the other methods currently available and is not recommended by the National Committee for Clinical Laboratory Standards (NCCLS).[8] A major disadvantage of using a urinometer to measure specific gravity is that it requires a large volume (10 to 15 mL) of specimen. The container in which the urinometer is floated must be wide enough to allow it to float without touching the sides and from resting on the bottom. When using the urinometer, an adequate amount of urine is first poured into a proper-size container, and the urinometer is added with a spinning motion. The scale reading is then taken at the bottom of the urine meniscus.

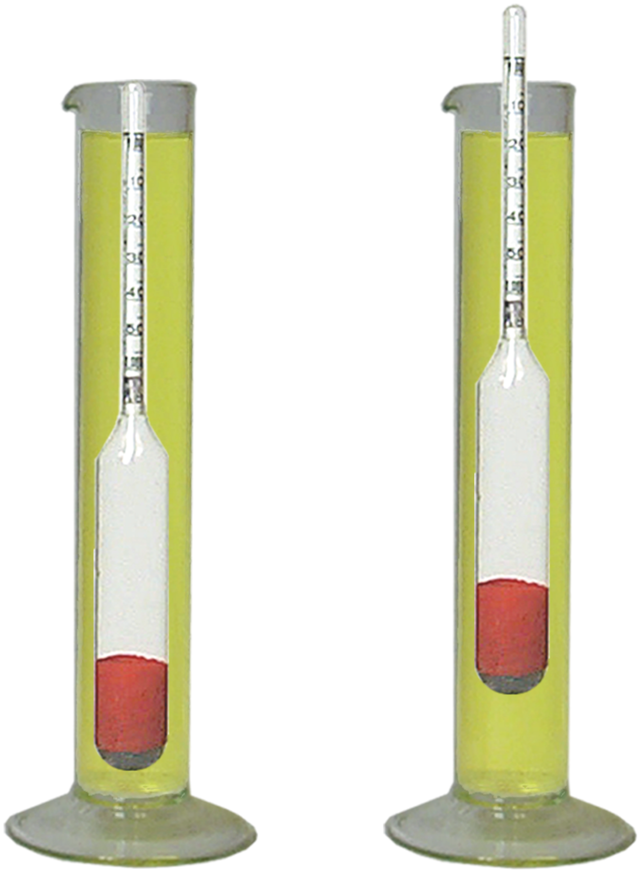


FIGURE 4–2 Urinometers representing various specific gravity readings.

The urinometer reading may also need to be corrected for temperature, inasmuch as urinometers are calibrated to read 1.000 in distilled water at a particular temperature. The calibration temperature is printed on the instrument and is usually about 20°C. If the specimen is cold, 0.001 must be subtracted from the reading for every 3°C that the specimen temperature is below the urinometer calibration temperature. Conversely, 0.001 must be added to the reading for every 3°C that the specimen measures above the calibration temperature.

A correction also must be calculated when using either the urinometer or the refractometer if large amounts of glucose or protein are present. Both glucose and protein are high-molecular-weight substances that have no relationship to renal concentrating ability but will increase specimen density. Therefore, their contribution to the specific gravity is subtracted to give a more accurate report of the kidney's concentrating ability. A gram of protein per deciliter of urine will raise the urine specific gravity by 0.003, and 1 g glucose/dL will add 0.004 to the reading. Consequently, for each gram of protein present, 0.003 must be subtracted from the specific gravity reading, and 0.004 must be subtracted for each gram of glucose present.

EXAMPLE

A specimen containing 1 g/dL of protein and 1 g/dL of glucose has a specific gravity reading of 1.030. Calculate the corrected reading.

$$\begin{aligned} 1.030 - 0.003 \text{ (protein)} &= 1.027 - 0.004 \text{ (glucose)} \\ &= 1.023 \text{ corrected specific gravity} \end{aligned}$$

REFRACTOMETER

Refractometry, like urinometry, determines the concentration of dissolved particles in a specimen. It does this by measuring refractive index. Refractive index is a comparison of the velocity of light in air with the velocity of light in a solution. The concentration of dissolved particles present in the solution determines the velocity and angle at which light passes through a solution. Clinical refractometers make use of these principles of light by using a prism to direct a specific (monochromatic) wavelength of daylight against a manufacturer-calibrated specific gravity scale. The concentration of the specimen determines the angle at which the light beam enters the prism. Therefore, the specific gravity scale is calibrated in terms of the angles at which light passes through the specimen.

The refractometer provides the distinct advantage of determining specific gravity using a small volume of specimen (one or two drops). Temperature corrections are not necessary because the light beam passes through a temperature-

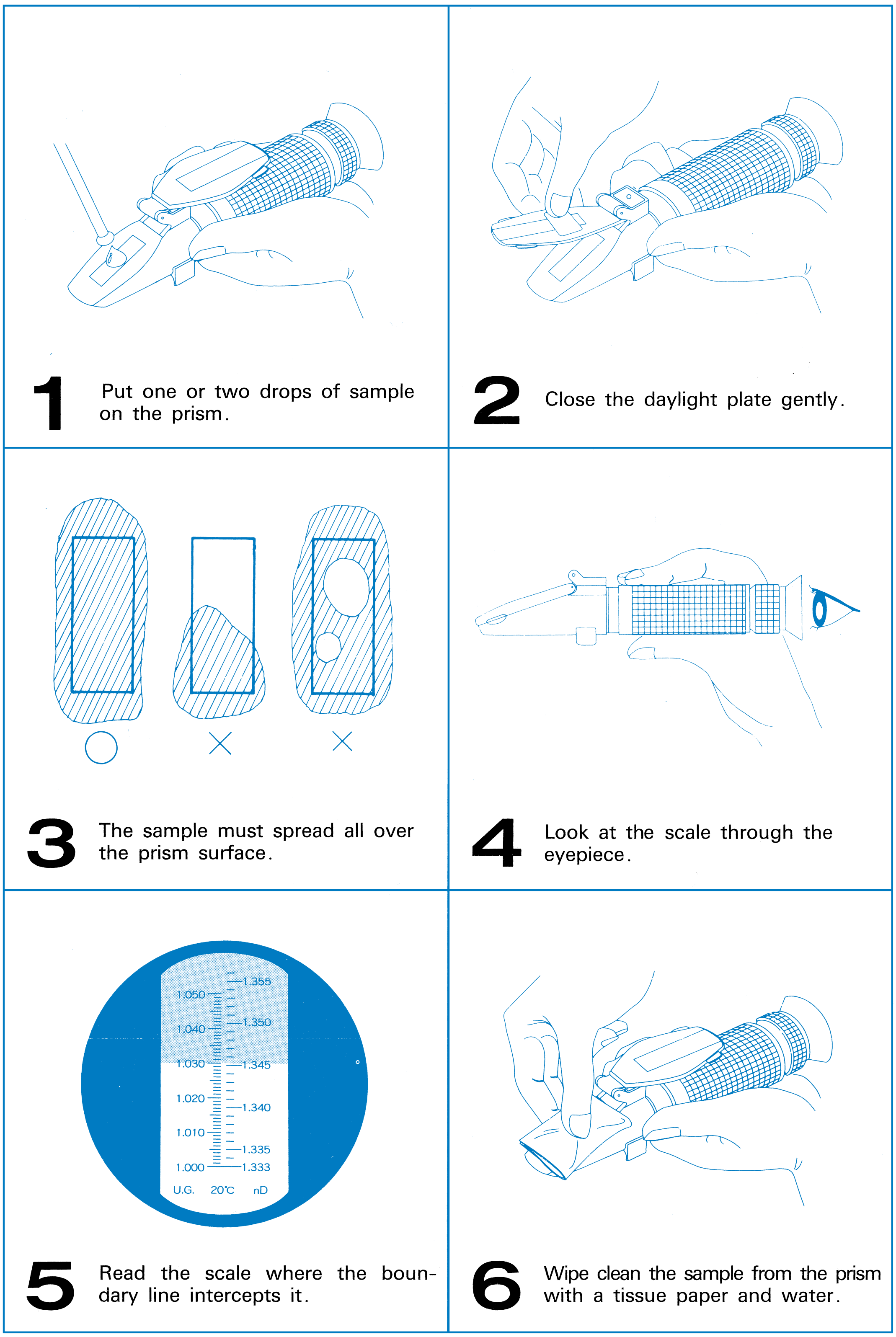


FIGURE 4–3 Steps in the use of the urine specific gravity refractometer. (Courtesy of NSG Precision Cells, Inc., 195G Central Ave., Farmingdale, NY, 11735, 516-249-7474.)

compensating liquid prior to being directed at the specific gravity scale. Temperature is compensated between 15°C and 38°C. Corrections for glucose and protein are still calculated, although refractometer readings are less affected by particle density than are urinometer readings.

When using the refractometer, a drop of urine is placed on the prism, the instrument is focused at a good light source, and the reading is taken directly from the specific gravity scale. The prism and its cover should be cleaned after each specimen is tested. Figure 4–3 illustrates the use of the refractometer.

Calibration of the refractometer is performed using distilled water that should read 1.000. If necessary, the instrument contains a zero set screw to adjust the distilled water reading (Figure 4–4). The calibration is further checked using 5 percent NaCl, which as shown in the refractometer conversion tables should read 1.022 ± 0.001, or 9 percent sucrose that should read 1.034 ± 0.001. Urine control samples representing low, medium, and high concentrations should also be run at the beginning of each shift. Calibration and control results are always recorded in the appropriate quality control records.

HARMONIC OSCILLATION DENSITOMETRY

Harmonic oscillation densitometry is based on the principle that the frequency of a sound wave entering a solution will change in proportion to the density of the solution. The Yellow Iris (International Remote Imaging Systems, Chatsworth, CA) automated urinalysis workstations discussed in more detail in Appendix A use this method to determine specific gravity. A portion of the urine sample enters a U-shaped tube. A sound wave of specific frequency is generated at one end of the tube, and as the sound wave passes (oscillates) through the urine its frequency is altered by the density of the specimen. A microprocessor at the other end of the tube measures the change in sound wave frequency, compensates for temperature variations, and converts the reading to specific gravity (Figure 4–5).

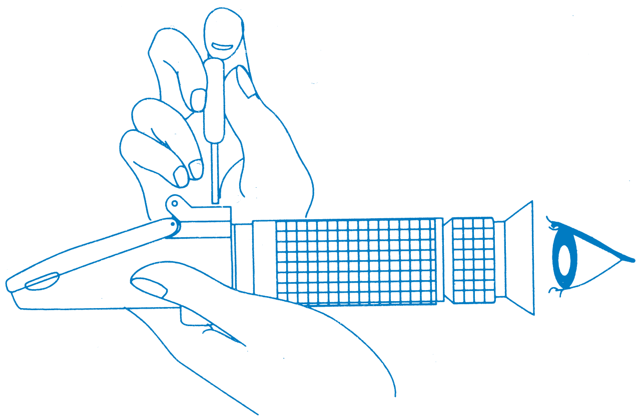


FIGURE 4–4 Calibration of the urine specific gravity refractometer. (Courtesy of NSG Precision Cells, Inc., 195G Central Ave., Farmingdale, NY, 11735, 516-249-7474.)

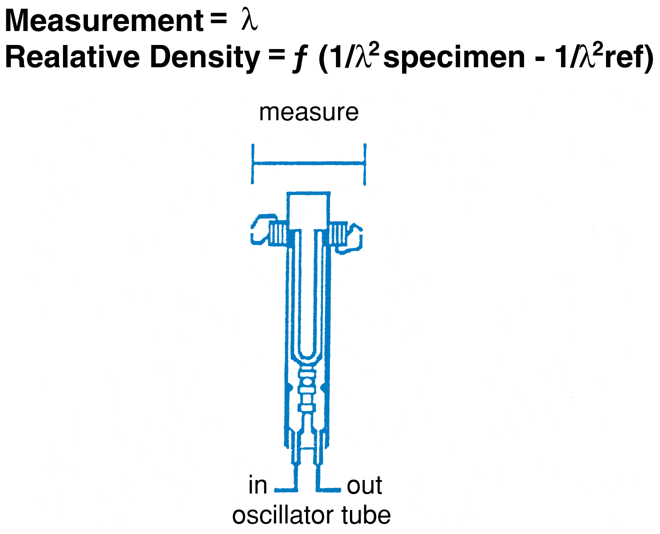


FIGURE 4–5 Mass gravity meter used to perform specific gravity measurement by harmonic oscillation. (Courtesy of International Remote Imaging Systems, Chatsworth, CA.)

Clinical Correlations

The specific gravity of the plasma filtrate entering the glomerulus is 1.010. The term ***isosthenuric*** is used to describe urine with a specific gravity of 1.010. Specimens below 1.010 are ***hyposthenuric***, and those above 1.010 are ***hypersthenuric***. One would expect urine that has been concentrated by the kidney to be hypersthenuric; however, this is not always true. Normal random specimens may range from 1.003 to 1.035, depending on the patient's degree of hydration. Specimens measuring lower than 1.003 probably are not urine. Most random specimens fall between 1.015 and 1.025, and any random specimen with a specific gravity of 1.023 or higher is generally considered normal. If a patient exhibits consistently low results, specimens may be collected under controlled conditions as discussed in Chapter 2.

Abnormally high results—over 1.035—are seen in patients who have recently undergone an intravenous pyelogram. This is caused by the excretion of the injected radiographic contrast media. Patients who are receiving dextran or other high-molecular-weight intravenous fluids (plasma expanders) will also produce urine with an abnormally

Summary of Urine Specific Gravity Measurements

Method	Principle
Urinometry	Density
Refractometry	Refractive index
Harmonic oscillation densitometry	Density
Reagent strip	pK_a changes of a polyelectrolyte

TABLE 4–6 **Common Causes of Urine Odor**[6]

Odor	Cause
Aromatic	Normal
Foul, ammonia-like	Bacterial decomposition, urinary tract infection
Fruity, sweet	Ketones (diabetes mellitus, starvation, vomiting)
Maple syrup	Maple syrup urine disease
Mousy	Phenylketonuria
Rancid	Tyrosinemia
Sweaty feet	Isovaleric acidemia
Cabbage	Methionine malabsorption
Bleach	Contamination

high specific gravity. Once the foreign substance has been cleared from the body, the specific gravity will return to normal. In these circumstances, urine concentration can be measured using the reagent strip chemical test or osmometry because they are not affected by these high-molecular-weight substances.[11] When the presence of glucose or protein is the cause of high results, this will be detected in the routine chemical examination. As discussed previously, this can be corrected for mathematically.

Specimens with specific gravity readings greater than the refractometer or urinometer scale can be diluted and retested. If this is necessary, only the decimal portion of the observed specific gravity is multiplied by the dilution factor. For example, a specimen diluted 1:2 with a reading of 1.025 would have an actual specific gravity of a 1.050.

Odor

Although it is seldom of clinical significance and is not a part of the routine urinalysis, urine odor is a noticeable physical property. Freshly voided urine has a faint aromatic odor. As the specimen stands, the odor of ammonia becomes more prominent. The breakdown of urea is responsible for the characteristic ammonia odor. Causes of unusual odors include bacterial infections, which cause a strong, unpleasant odor, and diabetic ketones, which produce a sweet or fruity odor. A serious metabolic defect results in urine with a strong odor of maple syrup and is appropriately called maple syrup urine disease. This and other metabolic disorders with characteristic urine odors are discussed in Chapter 9. Ingestion of certain foods, including onions, garlic, and asparagus, can cause an unusual or pungent urine odor. Studies have shown that although everyone who eats asparagus produces an odor, only certain genetically predisposed people can smell the odor.[7] Common causes of urine odors are summarized in Table 4–6.

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STUDY QUESTIONS

1. Why is it possible to estimate the concentration of a normal urine specimen by its color?
2. State a pathologic cause of yellow urine foam and of white urine foam.
3. How does the presence of phenazopyridine affect routine urinalysis testing?
4. What is the significance of a cloudy, red urine?
5. Why is there a difference in the color of the serum from persons with hemoglobinuria and myoglobinuria?
6. Under what conditions will a port-wine urine color be observed in a urine specimen?
7. Why might a brown/black urine have a positive chemical test result for blood?
8. State the conditions required for urines containing melanin or homogentisic acid to appear brown/black.
9. Name a pathologic cause and a nonpathologic cause of blue/green urine.
10. Differentiate between the appearance of amorphous phosphates and urates in a refrigerated urine specimen. What chemical test is critical to the differentiation?
11. In what circumstance might a sediment be slightly warmed prior to microscopic examination?
12. How will collection of a urine specimen using the midstream clean-catch method affect urine clarity?
13. When should a microscopic examination be performed on a clear urine specimen?
14. For what part of the routine urinalysis does specimen clarity serve as a method of quality control?
15. Define specific gravity.

16. Can a cloudy urine specimen have a low specific gravity? Why or why not?

17. How can specific gravity be used to determine the quality of a specimen for urinalysis?

18. Why is specific gravity of less value than osmolarity in evaluating renal concentration ability?

19. State three disadvantages of the urinometer not encountered with the refractometer.

20. Describe the calibration of the refractometer.

21. What conclusion can be drawn from a specimen with a specific gravity of 1.001?

22. The specific gravity of a first morning specimen containing 2 g of protein and 2 g of glucose is 1.023 measured by refractometer. Does this indicate normal concentrating ability? Why or why not?

23. Describe two methods by which a specific gravity that is higher than the refractometer scale can be measured.

24. Why might a urine specimen from a patient who has just returned from radiology have an abnormally high specific gravity? Why might a urine specimen from a patient who has recently experienced a severe hemorrhage have an abnormally high specific gravity?

25. State a pathologic and nonpathologic reason why a urine specimen would have a strong odor of ammonia.

CASE STUDIES AND CLINICAL SITUATIONS

1. A concerned male athlete brings a clear, red urine specimen to the physician's office.
   a. Would you expect to see RBCs in the microscopic examination? Why or why not?
   b. Name two pathologic causes of a clear, red urine. Under what conditions do these substances appear in the urine?
   c. The patient reported that the urine appeared cloudy when he collected it the previous evening, but it was clear in the morning. Is this possible? Explain your answer.
   d. If the urine is chemically negative for blood, what questions should the physician ask the patient?

2. Upon arriving at work, a technologist notices that a urine specimen left beside the sink by personnel on the nightshift has a black color. The initial report describes the specimen as yellow.
   a. Should the technologist be concerned about this specimen? Explain your answer.
   b. If the specimen had an initial pH of 6.0 and now has a pH of 8.0, what is the most probable cause of the black color?
   c. If the specimen has a pH of 6.0 and was sitting uncapped, what is the most probable cause of the black color?
   d. If the original specimen was reported to be red and to contain RBCs, what is a possible cause of the black color?

3. While performing a routine urinalysis on a specimen collected from a patient in the urology clinic, the technician finds a specific gravity reading that exceeds the 1.035 scale on the refractometer.
   a. If the urinalysis report has a 1+ protein and a negative glucose, what is the most probable cause of this finding?
   b. The technician makes a 1:4 dilution of the specimen, repeats the specific gravity, and gets a reading of 1.015. What is the actual specific gravity?
   c. Using 1 mL of urine, how would the technician make the above dilution?
   d. How could a specific gravity be obtained from this specimen without diluting it?

4. Mrs. Smith frequently shops at the farmer's market near her home. She notices her urine has a red color and brings a sample to her physician. The specimen tests negative for blood.
   a. What is a probable cause of Mrs. Smith's red urine?
   b. Mrs. Smith collects a specimen at the physician's office. The color is yellow and the pH is 5.5. Is this consistent with the previous answer? Why or why not?

5. A urinalysis supervisor requests a new specimen in each of the following situations. Support or disagree with the decisions.
   a. A green-yellow specimen with negative test results for glucose and bilirubin
   b. A dark yellow specimen that produces a large amount of white foam
   c. A cloudy urine with a strong odor of ammonia
   d. A hazy specimen with a specific gravity greater than 1.035 by refractometer