PRIMARY CARE TECHNIQUES

Laboratory tests in ambulatory facilities

RITA A. FLEMING

V. Mosby Company

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RITA A. FLEMING, R.N., B.S.N., M.S.N., F.N.C.

Assistant Professor, Department of Nursing,
Murray State University,
Murray, Kentucky

with 101 *illustrations by* **Kathleen Gatto Johnson**

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To

Virginia M. George, R.N., M.N.

. . . a leader in nursing

and

Clegg F. Austin, M.D. **William A. Altemeier, M.D.**

. . . believers in nursing

Preface

This laboratory manual is designed as a detailed guide for health care providers in expanded roles, particularly nurse practitioners, public health nurses, and physician's assistants, practicing in ambulatory facilities. It is also intended as a source for students learning basic skills of diagnostic testing. This manual differs from current laboratory textbooks in that only procedures involving manual techniques are included, since it is presumed that automatic equipment is inaccessible in most of these settings. Many of the convenient commercially prepared kits useful in screening clients in primary care clinics are included, with instructions for their use.

A laboratory is an essential component of the primary care center, but even the best-equipped laboratory is of little value if the personnel do not learn to perform techniques skillfully and interpret results accurately. This manual is written to acquaint the health care professional with routine procedures of urinalysis, stool examination, hematology, and microbiology useful in health maintenance and management of certain common acute and chronic disorders. Each chapter begins with a description of the particular type of specimen and explains the methods of specimen collection. Each procedure is described with an introduction of purpose, basic physiology, step-by-step instructions for performing the procedure, expected values in children and adults, and an interpretation of abnormal results. The reader is also cautioned about factors that may interfere with test results, such as ingestion of certain medications or improper storage of the specimen. References and Suggested Readings are listed after each chapter. Finally, tables of normal values, an index of manufacturers' names and addresses, and a list of equipment recommended for the ambulatory facility are included in the Appendices.

It is difficult for the beginning student in the laboratory to become proficient using only a textbook, and supervised practice is strongly

recommended until the reader feels competent in performing these techniques. Even then, if the reader is uncertain of the findings, consultation is advised.

This manual represents the coordinated effort of many persons. I would especially like to express my gratitude to Kathy Johnson for her fine illustrations, Marion Elkins for her expert preparation of the manuscript, and Sally Cox and Pat Klapper for their helpful reviews. But most of all, I want to thank John, Bridgette, and Jesse for their loving support, despite a house full of cluttered books and scattered papers.

Rita A. Fleming

Contents

1

Urinalysis

A routine urinalysis is an essential part of a health assessment. Much of the body's delicate fluid and electrolyte balance is regulated by the kidneys, where water, inorganic salts, and nitrogenous waste products are removed from the blood and concentrated in the urine. Although the proportions of the constituents may vary considerably in a healthy person, significant alterations may indicate renal disease or certain metabolic disorders.

SPECIMEN COLLECTION

To obtain accurate data, the specimen must be properly collected. For most tests the first voided urine in the morning is ideal, since the concentration of urine is high and formed elements are most likely found, but the specimen can be collected at other times. Do not force the client to drink large quantities of water in order to obtain a specimen immediately, as results may be less accurate.

Clean catch method

The clean catch method is usually sufficient for a routine urinalysis of children and adults, provided the specimen is relatively uncontaminated.

Equipment: Cleansing agent (povidone-iodine [Betadine], green soap, or other), sterile water or a 1:1000 benzalkonium (Zephiran) solution, sterile container and label, sterile gauze.

Procedure:

1. Wash hands thoroughly.
2. Separate the labia for females, or retract the foreskin for uncircumcised males.
3. Use gauze to cleanse the perineal area, wiping from front to back. Throw away gauze after each stroke. Males should thoroughly cleanse the glans.

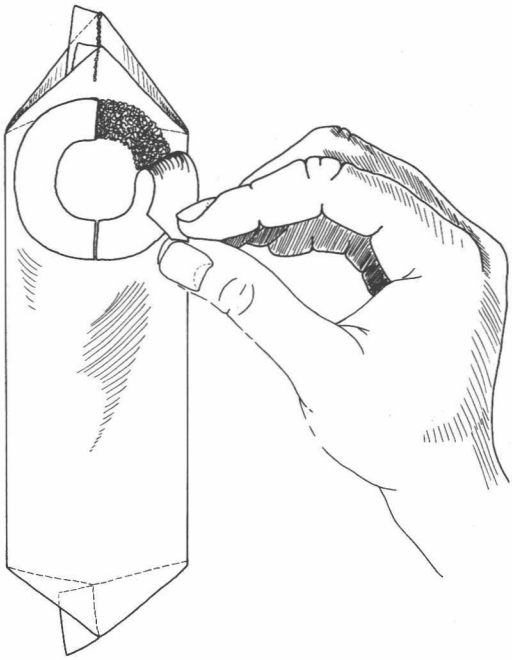

Fig. 1-1. Pediatric urine collection bag.

4. Rinse the area with sterile water or benzalkonium solution.
5. Have client start to void; then collect a midstream specimen in the sterile container.
6. Dry perineum, label container, and if possible, examine.

Urine collection in infants

Equipment: Cleansing agent, sterile water or 1:1000 benzalkonium solution, plastic urine collection bag, sterile gauze.

Procedure:

1. Cleanse the perineum in the manner described for the clean catch method. Allow the area to air-dry before proceeding.
2. Remove gummed adhesive strips from collection bag, and press the adhesive surface firmly to the perineum. Be sure to center the urethral opening in the bag's hole (Figs. 1-1 and 1-2). For male infants the scrotum can be placed inside the bag provided it fits without constriction. Direct the long end of the bag toward the infant's rear.
3. Replace the diaper, and check the bag frequently. After void-

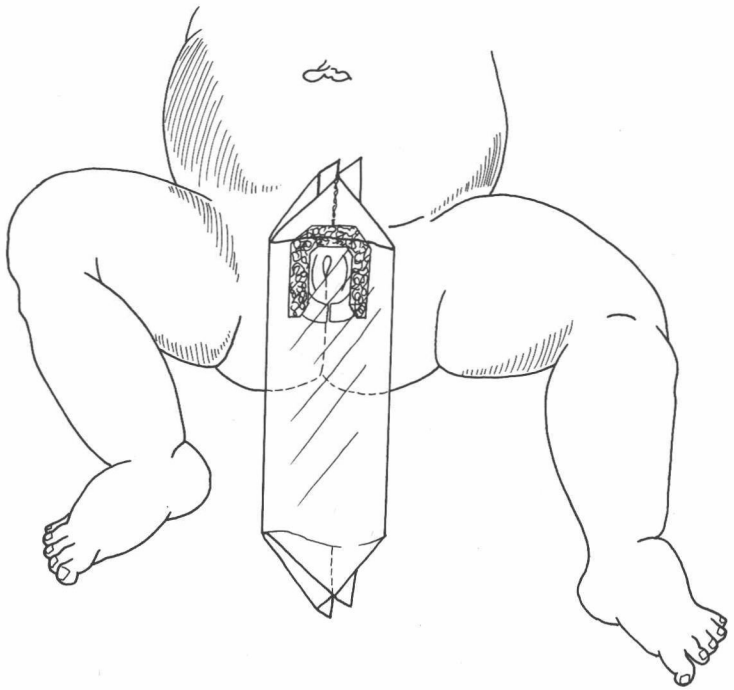

Fig. 1-2. Collection bag in place.

ing, tip the bag to one side, clip the empty corner, and pour urine into a sterile container. (Use the Perez reflex [Fig. 1-3] if the infant does not void. Turn him face down, supporting his trunk, and apply a firm stroke down the paraspinal muscles. The infant will startle, cry, and hopefully, void.)

Suprapubic aspiration of urine

A suprapubic aspiration, or percutaneous bladder tap, is a reliable means of obtaining a sterile specimen and is especially useful for cultures and sensitivity testing. However easy it seems, the procedure should not be performed by inexperienced persons, although few complications have been reported. Maintain aseptic technique throughout the procedure.

Equipment: Povidone-iodine and alcohol; sterile gauze; 1½ inch, 22-gauge needle attached to a 5 ml syringe; sterile gloves; sterile container; culture media.

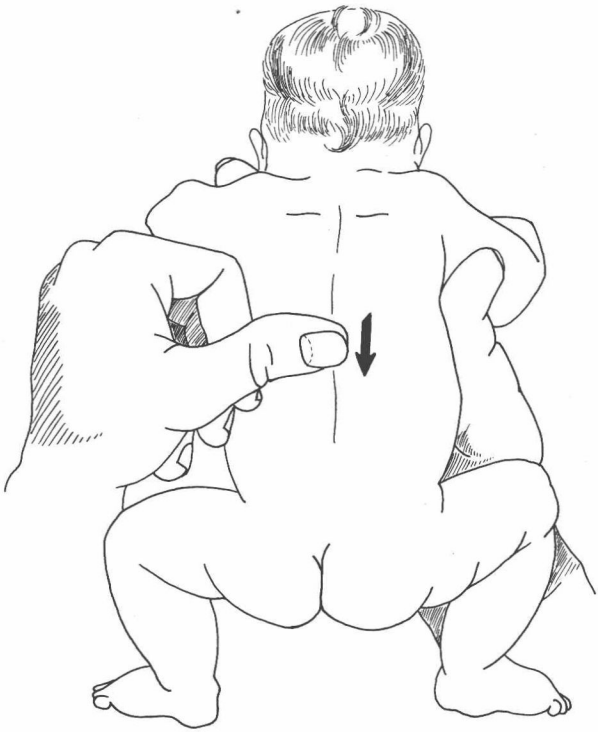

Fig. 1-3. Elicitation of Perez reflex.

Procedure:

1. Try to arrange the tap an hour after voiding or at least when the infant's diaper is dry. This allows time for the urine to incubate in the bladder.
2. Position the child on his back, and have someone immobilize his legs in a froglike position (Fig. 1-4).
3. Prepare the suprapubic area with povidone-iodine, then alcohol.
4. Select a point in the midline approximately 1 to 2 cm above the symphysis pubis. Insert the needle at about a 60° angle, aiming slightly caudal. Gently aspirate while advancing the needle until urine flows into the syringe. A depth of 2 to 3 cm is usually necessary to penetrate the bladder (Fig. 1-5). With experience, the nurse will recognize a sensation of changing pressure when entering the bladder.

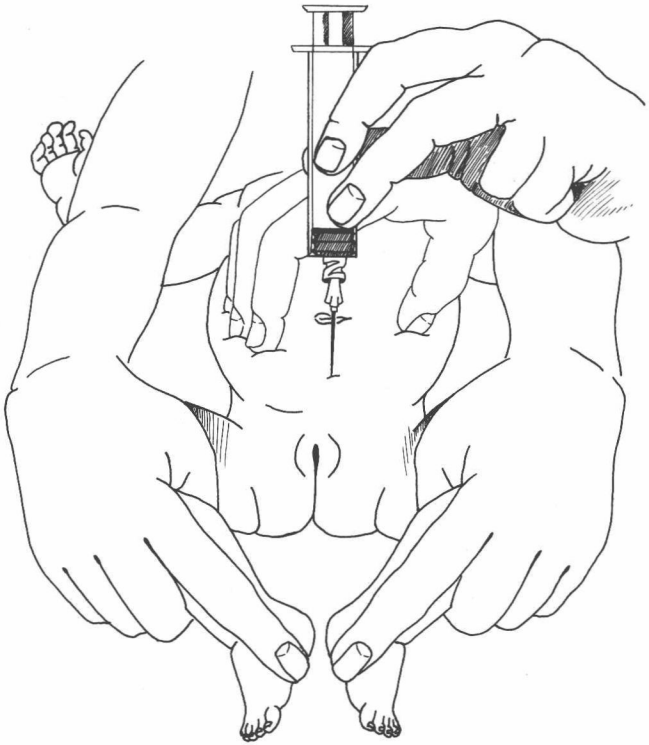

Fig. 1-4. Suprapubic aspiration of urine from infants.

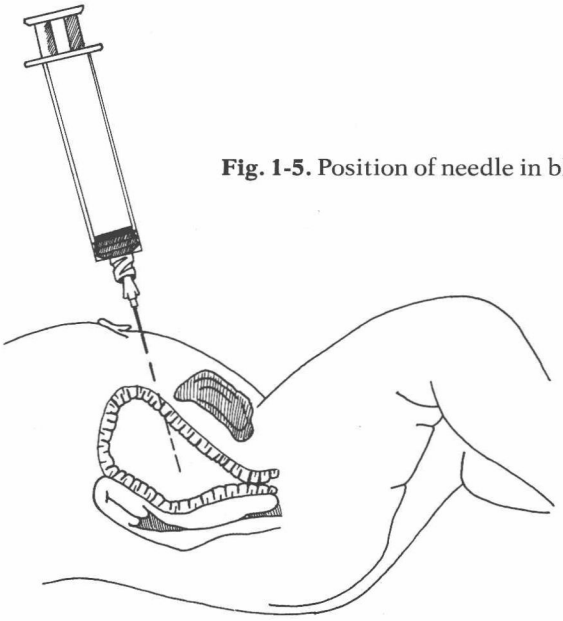

Fig. 1-5. Position of needle in bladder.

5. When enough urine is collected, withdraw the needle, and place urine in a sterile container or prepare for microscopic examination and culture. (For more details about urine cultures, see Chapter 4.)
6. Observe for bleeding at puncture site, and warn parents that slight hematuria may occur with the next voiding.

EXAMINATION OF URINE

A routine urinalysis includes gross inspection for appearance and macroscopic particles, determination of volume, specific gravity and pH, presence of abnormal elements and odor, chemical analysis, and microscopic examination.

Reagent strips

The routine urinalysis has been greatly simplified with the introduction of plastic strips impregnated with various reagents. Dip-and-read combination reagent strips (Fig. 1-6), such as N-Multistix and Labstix (Ames Co., Division of Miles Laboratories, Elkhart, Ind.), are helpful in determining many parameters of urine testing, but accurate results can only be obtained when careful technique is used. Keep in mind the following points:

- Store strips in the container supplied by the manufacturer. Keep tightly closed and away from moisture.

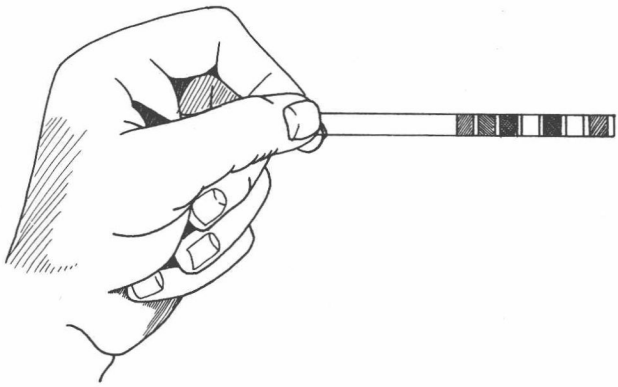

Fig. 1-6. Dip-and-read reagent strip.

- Check expiration dates on container frequently.
- Avoid touching reagent areas.
- Do not use a strip if the reagent area is discolored.
- Use a freshly voided specimen or one that has been properly preserved.
- Dip strip in urine briefly; then tap on the side of the specimen container to remove excess.
- Observe the recommended waiting period before reading results.

Only the urine specimen, a watch, the reagent strip, and its container are needed for the majority of the reagent strip tests described in this chapter. A list of equipment for the procedures will be included only when additional items are needed.

Volume

The amount of urine voided each day varies from average of 250 ml for the young infant, to 800 ml for the preschooler, to 1200 ml for the adult. The number of voidings varies from 20 times per day for the young infant, to 8 to 10 times a day for the preschooler, to 4 to 6 times for the adult.

An excessive amount of urine, or *polyuria,* is associated with diabetes insipidus; early juvenile diabetes mellitus; some chronic renal diseases, especially pyelonephritis and glomerulonephritis; diuretic therapy; and excessive intake of alcohol, coffee, or cola.

Oliguria, or diminished urine volume, may occur in dehydration; burns; congestive heart failure; acute renal diseases, such as glomerulonephritis; poisoning; urinary tract obstruction; and with use of anticholinergic drugs and some antibiotics.

Complaints of *frequent* urination, without an actual increase in volume, are common with a partial obstruction, such as prostatic hypertrophy, and with urinary tract infection.

Appearance

Urine is normally clear, with a straw to amber color, depending on the presence of urinary pigments and other solutes. An acid urine is generally darker than an alkaline urine. Certain foods, drugs, and metabolic by-products may alter the color of urine (Table 1-1).

Turbidity in urine may result from standing too long (even with refrigeration), presence of mucus or bacteria, or precipitation of urates in an acid urine or phosphates in an alkaline urine.

Table 1-1. Color of urine and significance

Color	Possible causes
Dark yellow	Sulfonamides, riboflavin
Orange	Phenazopyridine hydrochloride (Pyridium), rifampin, riboflavin
Green	Amitriptyline hydrochloride (Elavil), methocarbamol (Robaxin), bile pigments, foods containing carotene, *Pseudomonas* infection
Blue	Methylene blue, triamterene (Dyrenium)
Pink to dark red	Methyldopa (Aldomet), phenytoin (Dilantin), phenothiazides, urates, fresh blood, blackberries
Red	Pyrvinium (Povan), certain artificial colors and flavors, beets, porphyrins (when exposed to light)
Tea colored	Urobilinogen, degraded blood
Brown	Metronidazole (Flagyl), phenacetin, cascara, melanin, bile, bilirubin, red cells (especially in glomerulonephritis)

Odor

Fresh urine has a characteristic odor. Some *unusual odors* of diagnostic importance include the foul, coliform smell associated with an extensive urinary tract infection and the fruity-smelling, acetone odor that can indicate diabetes mellitus. Musty, mousy-smelling urine is associated with phenylketonuria. Urine with the odor of sweaty feet is found with isovalericacidemia, a rare disease (but worth mentioning) involving an inability to utilize certain proteins.

Urine and sweat of children with maple syrup disease, or branched-chain ketoaciduria, smell like maple syrup. This usually fatal disease results from faulty metabolism of certain amino acids. The urine of a person with cystinuria has a sulfurlike odor.

Specific gravity

The specific gravity of urine is a measure of the concentration, or ratio, of solute to water and provides a rough estimate of the kidney's ability to concentrate or dilute urine. Water has a specific gravity of 1.000, which increases with the addition of solutes such as protein and glucose.

The normal range for urine specific gravity is 1.005 to 1.030. A dilute urine has a specific gravity of less than 1.010, while concentrated urine has a value greater than 1.025. An early morning specimen is likely to be quite concentrated.

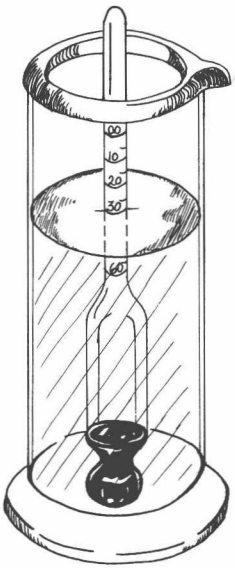

Fig. 1-7. Reading urinometer.

URINOMETER METHOD

A hydrometer, or urinometer, measures the specific gravity of urine against that of distilled water. Its major disadvantages are that it requires frequent calibration and a specimen volume of at least 10 to 15 ml, which can present a problem for very young clients. It is accurate to about ±0.002.

Equipment: Urinometer, distilled water.

Procedure:

1. Fill the urinometer cylinder with urine until almost three-fourths full.
2. Spin the calibrated, bulb-shaped piece in the urine. Do not let it stick to the sides of the cylinder.
3. Read the value (Fig. 1-7) from the calibrated scale at the lower level of the meniscus (the concave curve at the surface of the urine.)

Avoid contamination of the specimen, which might give a false reading. Also, make the following adjustments in calculation when necessary:

1. If the volume collected is inadequate, add an equal part distilled water and multiply the last two numbers of the reading

by two. For example, if after dilution the urinometer reads 1.009, the corrected value would be 1.018.

2. If the specimen was refrigerated, subtract 0.001 for each 3 C that the urine temperature is below the calibration temperature. For example, if the urinometer was calibrated at 24 C and the temperature of the urine is 5 C after refrigeration, subtract 0.007 from the urinometer reading.

REFRACTOMETER METHOD

A *refractometer* is an instrument that measures the solute concentration by its refractive index on transmitted light. It is simple to use and requires only one or two drops of urine, making it ideal for pediatric clients. Although the instrument is expensive (about $400), it is very useful when screening large numbers of children.

Equipment: Refractometer, damp cloth.

Procedure:

1. Clean the cover and the prism with a damp cloth. Allow to dry.
2. Close cover; then place one drop of urine in the notch on the cover. The urine will spread over the prism.
3. Direct the refractometer toward a light source and focus.
4. Read the value for specific gravity at the line where the shadowed and light areas meet.

A *low* specific gravity may occur with excessive water intake, diabetes insipidus, and in conditions involving renal tubular damage.

A *high* specific gravity may be associated with diabetes mellitus, nephrosis, dehydration, congestive heart failure, liver disease, and any disorder where a large amount of solute is excreted or urinary volume is diminished.

If the kidneys lose the ability to dilute and concentrate urine, the specific gravity will consistently be that of plasma, 1.010, and the urine is isothenuric.

pH

The pH of urine reflects the concentration of hydrogen ions and is useful in determining the degree of acidity or alkalinity of the specimen. The pH can normally vary from 4.5 to 8.0. A pH of less than 7.0 indicates an acid urine. If greater than 7.0 the urine is alkaline. Persons on a normal diet will usually produce slightly acid urine, with a pH of about 6.0.

Use a freshly voided specimen for accurate interpretation of pH. Urine will become alkaline if allowed to stand, due to bacterial con-