NURSING
Manual of Laboratory Tests



Ramnik Sood

2nd Edition

JAYPEE

JAYPEE BROTHERS

Contents

1. Common Abbreviations Used in Laboratory Investigations 1

- Conventional Units *1*
- SI Units (International System of Units) *1*

2. Introduction 2

- The Probabilistic Nature of Diagnosis *2*
- Purposes for Ordering Laboratory Tests *2*
- Diagnosis *2*
- Monitoring Therapy *3*
- Screening *3*

3. Sample Collection by Technical Personnel and Ward Sisters 4

- Procedure of Sample Collection *4*
- Procedure of Venipuncture *5*
- Order of Draw *6*
- Sample Collection Order Form/Requisition *8*
- Procedural Issues *8*
- Performance of Fingerstick Collection *10*
- Other Collection Issues *10*
- Safety and Infection Control *12*
- Troubleshooting Guidelines *13*
- Blood Sampling System *15*

4. SI Units and Conversion Tables 16

- Litre *16*
- Gram *16*
- Mole (Mol) *17*
- International Unit (U) *18*
- Conversion Factors between Conventional and System International Units (SIU) *18*

5. Body Excreta Analysis 30

Urine Analysis 30

- Composition of Urine *30*
- Gross Examination of Urine *32*
- Multiple® Reagent Strips for Urinalysis *38*

Stool Examination 49

JAYPEE BROTHERS

6. Body Fluids Analysis 56

Cerebrospinal and Other Body Fluids 56

- Cerebrospinal Fluid *56*
- Pleural Fluid *58*
- Pericardial Fluid *59*
- Peritoneal Fluid *60*
- Amniocentesis and Amniotic Fluid Analysis, Diagnostic *61*

7. Sputum Examination 64

- Specimen Collection *64*
- Sputum Examination *65*

8. Laboratory Investigations 67

- Hematology *67*
- Serum, Plasma and Whole Blood Chemistries *69*
- Urine Chemistry *76*
- Immunodiagnostic Test *80*
- Cerebrospinal Fluid *82*
- Miscellaneous Values *82*

9. Profile of Laboratory Tests According to Body Systems 86

- Cardiovascular System *86*
- Pulmonary System *89*
- Neurological System *90*
- Hematological System *92*
- Endocrine System *95*
- Renal and Urologic System *99*
- Musculoskeletal System *102*
- Hepatobiliary–GI Systems *104*
- Reproductive System *108*
- Immune and Autoimmune Conditions *113*
- Tumors *114*

10. Molecular Diagnosis 116

- Molecular Pathology *116*
- Instrumentation of PCR *116*
- Summary *122*
- Immunohistochemistry *123*
- Body Wise Parameters *125*

Index 127

JAYPEE BROTHERS

5 CHAPTER Body Excreta Analysis

URINE ANALYSIS

COMPOSITION OF URINE

Urine composition is affected mainly by three factors:
1. Nutritional status
2. State of metabolic processes
3. Ability of the kidney to selectively handle the material presented to it.

Physicochemical Characteristics of Urine

Dry weight	55–70 gm/24 hr
Osmolality	38–1400 mOsm/kg water (Average = 500–800 mOsm/kg water)
pH	4.6–8.0 (mean = 6.1)
Specific gravity	
Neonates	1.012
Infants	1.002–1.006
Adults	1.003–1.030
Volume	*Per day*
Neonates	30–60 ml
10–60 days	250–450 ml
60–365 days	400–500 ml
Children	
1–3 years	500–600 ml
3–5 years	600–700 ml
5–8 years	650–1000 ml
8–14 years	800–1400 ml
Adults	600–2500 ml (Avg: 1200 ml)

Inorganic Constituents per 24 Hours

Iron	0.06–0.1 mg
Chlorides	6 (4–10) gm on usual diet
Sodium	4 gm on usual diet

JAYPEE BROTHERS

Phosphate	0.8–1.3 gm on usual diet
Sulphur	2 gm
Calcium	< 150 mg

Organic Constituents per 24 Hours

Nitrogenous—total	25–35 gm
Urea	15–30 gm
Creatinine	1.4 (1–1.8) gm
Ammonia	0.7 (0.3–1) gm
Uric acid	0.45 (0.3–0.6) gm
Protein (albumin)	0–0.1 gm

Creatine, in children: 10–50 mg (Excreted in urine in adults in hepatic or muscle disorders or thyrotoxicosis).
Glucose fasting range: 2–20 mg% (Diabetic may lose up to 100 gm/day)
Amylase (diastase): 40–260 units/hour.

Cells and Casts

As per Addis count		
	Range	***Mean***
RBC	Up to 1 million /day (more in females)	130,000/day
Casts		
Hyaline and occasionally granular	Up to 5,000/day	2,000/day
Leucocytes	Up to 5 million /hour (more in females)	108,000/hr, females; 28,000/hr, males
Epithelial cells	Up to 2.5 lakh/hour (more in males)	68,000/hr, females; 78,000/ hr, males
Squamous cells epithelial	Variable	

Collection of Urine

The urine sample should be collected in a clean, dry container and should be examined fresh. For cultures sterile containers should be used. With time, RBC, and leucocytes tend to be destroyed due to hypotonicity of the urine. Casts too tend to get decomposed. Bacterial contamination of stale urine is frequent and causes alkalinization of the urine due to conversion of urea to ammonia and loss of glucose. This rise in pH accelerates loss of leucocytes and epithelial cells. For ordinary qualitative tests a random sample is enough. For diabetes mellitus, a 2 hours postprandial sample is desirable; for nephritis, a morning specimen is best as it has higher specific gravity and lower pH desirable for preservation of formed elements.

JAYPEE BROTHERS

Repeated samples are necessary sometimes, as for orthostatic proteinuria.

Whenever needed, a 24-hour urine should be collected in a large container. Have patient void and discard urine at any particular time, save all urine for the next 24-hours, and then void at the same hour to finish the collection.

Preservation of Specimen

Urinary decomposition occurs quickly in warm temperatures. Hence, fresh specimens should be examined, if not, then it should be refrigerated. As far as possible, the need for preservation should not arise. However, the following preservatives can be used:

- *Toluol:* Best for preservation of chemical constituents. Add 2 ml toluol/100 ml urine.
- *Thymol:* A small floating lump of thymol can preserve the urine for several days in a bottle. Thymol may, however, cause a false-positive reaction for protein.
- *Formalin:* 1 drop/30 ml urine is good for preserving formed elements. It can precipitate proteins and can reduce Benedict's solution.
- *Boric acid:* 0.3 g/120 ml of urine. However, yeasts can still grow and uric acid crystals get precipitated.

GROSS EXAMINATION OF URINE

Color and Appearance

Normal urine is clear and pale yellow (straw) in color.

- *Colorless:* Dilution; diabetes mellitus/insipidus, nervousness, diuretic or alcohol intake.
- *Milky:* Purulent genitourinary tract disease; chyluria.
- *Orange:* Urobilinogenuria, fever, excessive sweating, concentrated urine.
- *Red:* Beetroot ingestion, hematuria, hemoglobinuria, phenolphthalein, pyridium, sulfonal.
- *Greenish:* Jaundice, phenol poisoning.
- *Dirty blue or green:* Putrefying urine, in typhus or cholera, methylene blue.
- *Dark brown, brown red, or yellow:* Very concentrated urine. Acute febrile diseases. Bilirubinuria.
- *Brown-yellow or brown-red (if acidic) or bright red (if alkaline):* Due to rhubarb, cascara, aloes.
- *Brown, brown black or black:* Hemorrhage in urinary tract if urine is acidic (Acid-hematin); hemoglobinuria; porphyria, methemoglobinuria; myoglobinuria, melanin, phenol poisoning, homogentisic acid (alkaptonuria). In porphyria, urine turns dark brown on exposure to sunlight or boiling.

Interfering Factors

- Normally, urine darkens on standing. This occurs because of oxidation of urobilinogen to urobilin. Decomposition of urine commences in half an hour.

JAYPEE BROTHERS

- Some foods cause change in urine color
  - Beets turn the urine red
  - Rhubarb changes color of urine to brown
- Many drugs are also responsible for urinary color change
  - Cascara and senna laxatives in acidic urine will turn the urine reddish-brown, in alkaline urine they will turn the urine red
  - Phenazopyridine (pyridium), amidopyrine turn urine orange in color
  - Pyridium, ethoxazene turn urine to orange/orange-red
  - Orange to purple red may occur due to chlorzoxazone
  - Salicylazosulfapyridine, anisindone, or phenindione turn urine color to orange-yellow in alkaline urine
  - Sulphonamides and nitrofurantoins produce rust-yellow to brownish color
  - Dilantin (dephenydantoin) dioctyl calcium sulphosuccinate, phenolphthalein and phenothiazine turn urine color to pink to red or red-brown
  - Phenolphthalein may also produce magenta-color
  - Amidopyrine, pyridium, aniline dyes, BSP, PSP in alkaline urine or phenolphthalein and pyridium in acid urine or deferoxamine can produce red urine.
  - Phenolphthalein in alkaline urine produces purple-red color
  - Phenylhydrazine and phenolic drugs produce dark brown urine
  - Cascara may produce brown-black urine
  - Riboflavin or pyridium in alkaline urine produce bright yellow color
  - Methylene blue and amitriptyline produce blue or green colored urine
  - Levodopa causes urine to darken on standing
  - Iron salt consumption produces dark-colored urine
  - Phenothiazine tranquilizers cause pink to brown color
  - Triameterene causes pale blue-colored urine.

Reaction

Average range: 4.6–8, Average pH = 6.0

Litmus paper or other pH indicator papers broad range (pH 1–12) or narrow range pH papers can be used. Another simple method is to add 2 drops of 0.4% alcoholic solution of methyl red to 5 ml of urine. Note the color change—if red = acidic; orange = neutral; yellow = alkaline. Digital electronic pH meters for better accuracy can be used—here, the electrode is dipped in urine and pH is read off directly from the digital display.

Amongst urinary tract infections, *Escherichia coli* produces acidic urine, while *Proteus* (urea splitting) produces alkaline urine. Meat protein diet causes urinary acidification, while consumption of citrus fruits makes the urine alkaline.

JAYPEE BROTHERS

Urine pH

Finding and condition	*Causes and comments*
Acidic urine	
Ketosis	Diabetes, starvation, febrile illness in children.
Systemic acidosis	Except with impaired renal tubular function, respiratory or metabolic acidosis provokes intense urine acidity and decreased NH^+ excretion.
Acidification	Used in treating urinary tract infections, and to prevent precipitation of calcium carbonate or phosphates or magnesium ammonium phosphate.
Alkaline urine	
Postprandial Alkaline tide Vegetarianism	Normal finding in specimens voided shortly after meals. Meats produce fixed acid residue, vegetarian diet does not.
Systemic	As may occur in severe vomiting, hyperventilation, excess alkali ingestion.
Urinary tract infection	*Proteus* or *Pseudomonas* infections, they split urea to HCO_3^- and ammonia.
Alkalinization	Used to prevent crystallization of uric acid, oxalate, cystine, sulphonamides, streptomycin.
Stale specimen	Bacterial overgrowth. If true infection exists, the sediment should show pus cells.
Renal tubular	Impaired tubular acidification causes inappropriately high urine pH with systemic acidosis and low serum HCO_3^-.

Interfering Factors

- On standing, urinary pH becomes alkaline because CO_2 will diffuse into the air
- Alkaline urine specimens tend to cause hemolysis of red cells and disappearance of casts
- High protein diets will cause excessively acidic urine
- Ammonium chloride and mandelic acid may produce acidic urines
- Alkaline urine after meals is a normal response to the secretions of HCl in gastric juices
- Sodium bicarbonate, potassium citrate, and acetazolamide may produce alkaline urines.

Be Careful

- Only a freshly voided sample is suitable for measuring pH. Refrigerate the sample if any delay is expected
- Alkaline urine occurs from vegetarian diets, citrus fruits, milk and other dairy products

JAYPEE BROTHERS

- Highly concentrated urine such as that formed in hot, dry environments is strongly acidic and may be irritating
- While sleeping, decreased pulmonary ventilation causes respiratory acidosis and urine becomes highly acidic
- Chlorothiazide diuretic will cause acidic urine to be excreted
- Bacterial contamination and overgrowth will result in alkaline urine. Bacteria in urine will convert to ammonia.

Odor

Important in fresh specimens only and is aromatic because of volatile fatty acids. Bacterial action causes ammoniacal odor, while ketosis leads to a fruity odor in urine.

Specific Gravity

Specific gravity depends upon the concentration of various solutes in the urine.

- *Urinometre:* Urine should be foamless. Transfer urine (about 70–80 ml) into the urinometre container and let the urinometre float freely without touching the sides or the bottom of the container **(Fig. 5.1)**. Read graduations at the lowest level of urinary meniscus. If the urine amount is less, dilute the urine to raise the volume till 70–80 ml, take the reading and multiply the last two digits by the dilution factor.
- *Refractometre:* Only small amount of urine is needed. It measures the concentration of solutes (related to refractive index). In Goldberg refractometre the specific gravity of urine can be read directly from the calibration.
- Can be tested with *Dipstick* also.
- *Osmometry:* Gives the most accurate assessment.

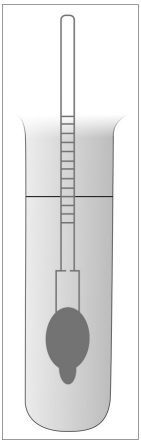

Fig. 5.1: Urinometre.

Correction factor for temperature: While using urinometer, add or subtract 0.001 for each 3°C above or below the standardization temperature of the instrument.

Urines of low specific gravity are called hyposthenuric (<1.007) while urines of fixed specific gravity of about 1.010 are known as isothenuric.

High specific gravity

- Excessive sweating
- Glycosuria
- Acute nephritis
- Albuminuria
- All causes of oliguria.

JAYPEE BROTHERS

Low specific gravity (less than 1.010)

- Excessive water intake
- Chronic nephritis
- Diabetes insipidus
- All causes of polyuria except diabetes mellitus.

Low and fixed specific gravity (1.010 to 1.012)

- Chronic nephritis (end-stage kidney) when concentration power of renal tubules is low
- ADH deficiency
- Arteriosclerotic kidney.

Interfering Factors

- Specific gravity is maximum in the first morning sample
- Specific gravity is increased whenever there is an excessive loss of water. It occurs in:
  - Sweating
  - Fever
  - Vomiting
  - Diarrhea
- Drugs leading to false-positive:
  - Dextran
  - Radiopaque contrast media used in X-rays of the urinary tract.
- Temperature of urine specimens affects specific gravity when specific gravity is measured in urine removed from the refrigerator. Specific gravity will be falsely higher.
- Reagent strip testing of urine containing glycosuria greater than 1% may cause a low specific gravity. Highly buffered alkaline urine may also cause a low reading.
- Elevated reading may occur in presence of moderate (100–750 mg/dl) amounts of proteinuria.

Urinary Volume

The average 24-hour urinary output in an adult is around 1200 to 1500 ml and the night urine should not be more than 400 ml.

A volume more than 2000 ml is termed polyuria. Oliguria implies excretion of urine less than 500 ml and anuria is complete cessation. Nocturia is excretion by an adult of urine more than 500 ml with a specific gravity of less than 1.018 at night (characteristic of chronic glomerulonephritis).

Polyuria

- Neurotic polydipsia
- Diabetes mellitus/insipidus

JAYPEE BROTHERS

- Diuretics
- Intravenous saline/glucose
- Chronic renal failure
- Addison's disease, decrease of adrenocortical hormones.

Oliguria

- Dehydration:
  - Vomiting
  - Diarrhea
  - Excessive sweating
- Renal ischemia
- Acute renal tubular necrosis
- Acute glomerulonephritis
- Obstruction to urinary outflow.

Turbidity

Normally—fresh urine is clear.

The appearance of cloudy urine provides a warning of possible abnormalities such as the presence of pus, RBCs or bacteria. Sometimes, however, excretion of cloudy urine may not be abnormal since the change in urine pH may cause precipitation within the bladder of normal urinary constituents. Alkaline urine may appear cloudy because of presence of phosphates, and urine may appear cloudy because of urates.

- Pathologic urines are often turbid or cloudy, but so are many normal urines. Cloudy urine may appear from precipitation of crystals due to rapid cooling of the urine.
- Occasionally, urine turbidity may result from urinary tract infections.
- Abnormal urines may be cloudy on account of presence of RBCs, pus cells or bacteria.

Interfering Factors

- After ingestion of food, urates or phosphates may produce cloudiness in normal urine.
- Vaginal contamination in female patients is often a cause of turbidity
- Greasy cloudiness may be caused by lipiduria
- Many normal urines will develop haziness or turbidity after being refrigerated or on standing at room temperature.

Rapid Diagnostics

Rapidity of diagnosis is of utmost importance in today's context.

Many manufacturers now provide rapid strip tests (qualitative and semiquantitative). Important amongst them are as follows.

JAYPEE BROTHERS

Strip Tests from Boehringer-Knoll Limited

Product	*Determines*
A. Combur 9 test	◆ Leucocytes, nitrite, pH, protein, glucose, ketone bodies, urobilinogen, bilirubin, blood
B. Combur 8 test	◆ All of A except leucocytes
C. Combur 7 test	◆ All of B except nitrite
D. Combur 6 test	◆ All of C except bilirubin
E. Combur 4 test	◆ Protein, glucose urobilinogen, blood
F. Ecur test	◆ Protein, glucose, blood
G. Combur test	◆ Glucose, protein, pH

Various other combinations or single test strips are also available, e.g., pertaining only to liver/kidney disorders.

Strip Tests from Bayer India Limited

Now with improved pad order and efficacy.

Product	*Determines*
A. Diastix	◆ Glucose
B. Hemastix	◆ Blood
C. Ictotest (tablets)	◆ Bilirubin
D. Keto-diastix	◆ Glucose and ketones pH
E. Multistix	◆ Protein, glucose, ketones, bilirubin, blood, urobilinogen
F. Uristix	◆ Glucose and protein
G. Combistix SG	◆ Glucose, protein, pH and specific gravity
H. Multistix SG	◆ All of E + Specific gravity
I. Neostix 3	◆ Blood, glucose and protein

MULTIPLE® REAGENT STRIPS FOR URINALYSIS

Tests for Glucose, Bilirubin, Ketone (Acetoacetic Acid), Specific Gravity, Blood, pH, Protein and Urobilinogen in Urine. Refer to the carton and bottle label for specific reagent areas on the product you are using.

Summary and Explanation/Intended Use

Bayer Reagent strips for urinalysis are firm plastic strips to which are affixed several separate reagent areas. Depending on the product being used, Bayer Reagent strips provide tests for glucose, bilirubin, ketone (acetoacetic acid). specific gravity, blood, pH, protein, and urobilinogen in urine. *Please refer to the carton and bottle label for specific reagent areas on the product you are using.* Test results may provide information regarding the status of carbohydrate metabolism, kidney and liver function, and acid-base balance.

The reagent test areas on Bayer Reagent strips are ready to use upon removal from the bottle and the entire reagent strip is disposable. The strips

JAYPEE BROTHERS

may be read visually, requiring no additional laboratory equipment for testing. Certain configurations of strips may also be read instrumentally, using the CLINITEK® family of urine chemistry analyzers and the appropriate program module or program card.

The directions must be followed exactly. Accurate timing is essential to provide optimal results. The reagent strips must be kept in the bottle with the cap tightly closed to maintain reagent reactivity. To obtain optimal results, it is necessary to use fresh, well-mixed, uncentrifuged urine.

Chemical Principles of the Procedure

Glucose

This test is based on a double sequential enzyme reaction. One enzyme, glucose oxidase, catalyzes the formation of gluconic acid and hydrogen peroxide from the oxidation of glucose. A second enzyme, peroxidase, catalyzes the reaction of hydrogen peroxide with a potassium iodide chromogen to oxidize the chromogen to colors ranging from green to brown.

Bilirubin

This test is based on the coupling of bilirubin with diazotized dichloroaniline in a strongly acid medium. The color ranges through various shades of tan.

Ketone

This test is based on the development of colors ranging from buff-pink, for a negative reading, to purple when acetoacetic acid reacts with nitroprusside.

Specific Gravity

This test is based on the apparent pKa change of certain pretreated polyelectrolytes in relation to ionic concentration. In the presence of an indicator, colors range from deep blue-green in urine of low ionic concentration through green and yellow-green in urines of increasing ionic concentration.

Blood

This test is based on the peroxidase-like activity of hemoglobin, which catalyzes the reaction of disopropylbenzene dihydroperoxide and 3.3', 5,5'-tetramenthylbenzidine. The resulting color ranges from orange through green; very high levels of blood may cause the color development to continue to blue.

pH

The test is based on the double indicator principle that gives a broad range of color covering the entire urinary pH range. Colors range from orange through yellow and green to blue.

JAYPEE BROTHERS

Protein

This test is based on the **protein error indicators** principle. At a constant pH, the development of any green color is due to the presence of protein. Colors range from yellow for "Negative" through yellow-green and green to green-blue for "Positive" reactions.

Urobilinogen

This test is based on a modified Ehrlich reaction, in which ρ-diethylamino-benzaldehyde in conjunction with a color enhancer reacts with urobilinogen in a strongly acid medium to produce a pink-red color.

Reagents

Based on dry weight at time of impregnation.

Glucose

2.2% w/w glucose oxidase (microbial, 1.3 IU); 1.0% w/w peroxidase (horseradish, 3300 IU); 8.1% w/w potassium iodide; 69.8% w/w buffer; 18.9% w/w nonreactive ingredients.

Bilirubin

0.4% w/w 2, 4–dichloroaniline diazonium salt; 37.3% w/w buffer; 62.3% w/w nonreactive ingredients.

Ketone

7.1% w/w sodium nitroprusside; 92.9% w/w buffer.

Specific Gravity

2.8% w/w bromothymol blue; 68.8% w/w poly (methyl vinyl ether/maleic anhydride); 28.4% w/w sodium hydroxide.

Blood

6.8% w/w diisopropylbenzene dihydroperoxide; 4.0% w/w 3.3', 5,5'-tetramethylbenzidine; 48.0% w/w buffer; 41.2% w/w nonreactive ingredients.

pH

1.2% w/w methyl red; 2.8% w/w bromothymol blue; 97.0% w/w nonreactive ingredients.

Protein

1.3% w/w tetrabromophenol blue; 97.3% w/w buffer; 2.4% w/w nonreactive ingredients.

JAYPEE BROTHERS

Urobilinogen

0.2% w/w ρ-diethylaminobenzaldehyde; 99.8% w/w nonreactive ingredients.

Warning and Precautions

Bayer reagent strips are for in vitro diagnostic use.

Storage

Storage below 30°C in a cool, dry place. Do not refrigerate. Keep out of direct sunlight. Do not use after expiration date.

Recommended Procedures for Handling Bayer Reagent Strips

All unused strips must remain in the original bottle. Transfer to any other container may cause reagent strips to deteriorate and become unreactive. Do not remove desiccant(s) from bottle. **Do not remove strip from the bottle until immediately before it is to be used for testing. Replace cap immediately and tightly after removing reagent strip. Do not touch test areas of the reagent strip.** Work areas and specimen containers should be free of detergents and other contaminating substances.

Dip test areas in urine completely, but briefly, to avoid dissolving out the reagent. If using strips visually, read test results carefully at the time specified, in a good light (such as fluorescent) and with the test area held near the appropriate color chart on the bottle label. Do not read the strips in direct sunlight. If the strips are used instrumentally, carefully follow the directions given in the appropriate instrument operating manual.

Important

Protection against ambient moisture, light and heat is essential to guard against altered reagent reactivity. Discoloration or darkening of reagent areas may indicate deterioration. If this is evident, or if test results are questionable or inconsistent with expected findings, the following steps are recommended:

- Confirm that the product is within the expiration date shown on the label.
- Check performance against known negative and positive control materials (e.g., CHEK- STIX** Control Strips);
- Retest with fresh product. If proper results are not obtained, consult your local product representative for advice on testing technique and results.

Specimen Collection and Preparation

Collect urine in a clean container and test it as soon as possible. Do not centrifuge. The use of urine preservatives is not recommended. If testing

JAYPEE BROTHERS

cannot be done within an hour after voiding, refrigerate the specimen immediately and let it return to room temperature before testing.

It is especially important to use fresh urine to obtain optimal results with the tests for bilirubin and urobilinogen, as these compounds are very unstable when exposed to room temperature and light.

Prolonged exposure of urine to room temperature may result in microbial proliferation with resultant changes in pH. A shift to alkaline pH may cause false positive results with the protein test area. Urine containing glucose may decrease in pH as organisms metabolize the glucose. Bacterial growth from contaminating organisms may cause false positive blood reactions from the peroxidases produced.

Contamination of the urine specimen with skin cleansers containing chlorhexidine may affect protein (and to a lesser extent specific gravity and bilirubin) test results. The user should determine whether the use of such skin cleansers is warranted.

Procedure

Must be followed exactly to achieve reliable test results.

- Collect FRESH urine specimen in a clean, dry container. Mix well immediately before testing.
- Remove one strip from bottle and replace cap. Completely immerse reagent areas of the strip in fresh urine and remove immediately to avoid dissolving out reagents.
- While removing, run the edge of the entire length of the strip against the rim of the urine container to remove excess urine. Hold the strip in a horizontal position to prevent possible mixing of chemicals from adjacent reagent areas and/or contaminating the hands with urine.
  - If reading visually, compare reagent areas to corresponding Color Chart on the bottle label at the times specified. *Hold strip close to color blocks and match carefully*. Avoid lying the strip directly on the Color Chart, as this will result in the urine soiling the chart.
  - If reading instrumentally, carefully follow the directions given in the appropriate instrument operating manual.

Proper read time is critical for optimal results. If using strips visually, read the glucose and bilirubin tests at 30 seconds after dipping. Read the ketone test at 40 seconds; the specific gravity test at 45 seconds; pH, protein, urobilinogen and blood at 60 seconds. The pH and protein areas may also be read immediately or at any time up to 2 minutes after dipping.

After dipping the strip, check the pH area. If the color on the pad is not uniform, read the reagent area immediately, comparing the darkest color to the appropriate Color Chart. All reagent areas may be read between 1 and 2 minutes for identifying negative specimens and for determination of the pH and SG. Color changes that occur after 2 minutes are of no diagnostic value.

JAYPEE BROTHERS

If using strips instrumentally, the instrument will automatically read each reagent area at a specified time.

Results

Results with Bayer Reagent Strips are obtained in clinically meaningful units directly from the Color Chart comparison when using strips visually. With instrumental use, the reagent pads are "read" by the instrument and the results are displayed or printed. The color blocks and instrumental display values represent nominal values; actual values will vary around the nominal values.

Limitations of Procedures

As with all laboratory tests, definitive diagnostic or therapeutic decisions should not be based on any single result or method.

Substances that cause abnormal urine color, such as drugs containing Azo dyes (e.g., Pyridium®, Azo Gantrisin®, Azo Gantanol®), nitrofurantoin (Macrodantin®, Furadantin®), and riboflavin, may affect the readability of the reagent areas on urinalysis reagent strips. The color development on the reagent pad may be masked, or a color reaction may be produced on the pad that could be interpreted visually and/or instrumentally as a false positive.

Glucose

Ascorbic acid concentrations of 50 mg/dl or greater may cause false negatives for specimens containing small amounts of glucose (75–125 mg/dl). Ketone bodies reduce the sensitivity of the test; moderately high ketone levels (40 mg/dl) may cause false negatives for specimens containing small amounts of glucose (75–125 mg/dl) but the combination of such ketone levels and low glucose levels is metabolically improbable in screening. The reactivity of the glucose test decreases as the SG of the urine increases. Reactivity may also vary with temperature.

Bilirubin

Indican (Indoxyl sulfate) can produce a yellow-orange to red color response that may interfere with the interpretation of a negative or a positive bilirubin reading. Metabolites of Lodine® (etodolac) may cause false positive or atypical results; ascorbic acid concentrations of 25 mg/dl or greater may cause false negatives. Since very small amounts of bilirubin may be found in the earliest phases of liver disease, the user must consider whether the sensitivity of Bayer Reagent Strips to bilirubin is sufficient for the intended use.

JAYPEE BROTHERS

Ketone

False positive results (Trace or less) may occur with highly pigmented urine specimens or those containing large amounts of levodopa metabolites. Compounds such as mesna (2–mercapto-ethane sulfonic acid) that contain sulfhydryl groups may cause false positive results or an atypical color reaction.

Specific Gravity

The chemical nature of the Bayer SG test may cause slightly different results from those obtained with other specific gravity methods when elevated amounts of certain urine consti- tuents are present. Highly buffered alkaline urines may cause low readings relative to other methods. Elevated specific gravity readings may be obtained in the presence of moderate quantities (100–750 mg/dl) of protein.

Blood

Elevated specific gravity may reduce the reactivity of the blood test. Clapoten® (captopril) may also cause decreased reactivity. Certain oxidizing contaminants, such as hypochlorite, may produce false positive results. Microbial peroxidase associated with urinary tract infection may cause a false positive reaction. Levels of ascorbic acid normally found in urine do not interfere with this test.

pH

If proper procedure is not followed and excess urine remains on the strip, a phenomenon known as "runover" may occur, in which the acid buffer from the protein reagent will run onto the pH area, causing a false lowering of the pH result.

Protein

False positive results may be obtained with highly buffered or alkaline urines. Contamination of the urine specimen with quaternary ammonium compounds (e.g., from some antiseptics and detergents) or with skin cleansers containing chlorhexidine may also produce false positive results.

Urobilinogen

The reagent area may react with interfering substances known to react with Ehrlich's reagent, such as p-aminosalicylic acid and sulfonamides. Atypical color reactions may be obtained in the presence of high concentrations of ρ-aminobenzoic acid. False negative results may be obtained if formalin is present. Strip reactivity increases with temperature; the optimum

JAYPEE BROTHERS

temperature is 22–26°C. The test is not a reliable method for the detection of porphobilinogen. The absence of urobilinogen cannot be determined with this test.

Expected Values

Expected values for the typical "normal" healthy population and the abnormal population are listed below for each reagent. Exact agreement between visual results and instrumental results might not be found because of the inherent differences between the perception of the human eye and the optical systems of the instruments.

Glucose

Small amounts of glucose are normally excreted by the kidney. These amounts are usually below the sensitivity of this test but on occasion may produce a color between the negative and the 100 mg/dl color blocks, and that is interpreted by the instrument as a positive result. Results at the first positive level may be significantly abnormal if found consistently.

Bilirubin

Normally no bilirubin is detectable in urine by even the most sensitive methods. Even trace amounts of bilirubin are sufficiently abnormal to require further investigation. Atypical colors (colors that are unlike the negative or positive color blocks shown on the Color Chart) may indicate that bilirubin-derived bile pigments are present in the urine sample and may be masking the bilirubin reaction. These colors may indicate bile pigment abnormalities and the urine specimen should be tested further.

Ketone

Normal urine specimens ordinarily yield negative results with this reagent. Detectable levels of ketone may occur in urine during physiological stress conditions such as fasting, pregnancy and frequent strenuous exercise. In ketoacidosis, starvation or with other abnormalities of carbohydrate or lipid metabolism, ketones may appear in urine in large amounts before serum ketone concentrations are elevated.

Specific Gravity

Random urines may vary in specific gravity from 1.001–1.035. Twenty-four-hour urines from normal adults with normal diets and normal fluid intake will have a specific gravity of 1.016–1.022.

JAYPEE BROTHERS

Blood

The significance of the Trace reaction may vary among patients, and clinical judgment is required for assessment in an individual case. Development of green spots (intact erythrocytes) or green color (free hemoglobin/myoglobin) on the reagent area within 60 seconds indicates the need for further investigation. Blood is often, but not always, found in the urine of menstruating females. This test is highly sensitive to hemoglobin and thus complements the microscopic examination.

pH

Both the normal and abnormal urinary pH range is from 5 to 9.

Protein

Normally no protein is detectable in urine, although a minute amount is excreted by the normal kidney. A color matching any block greater than Trace indicates significant proteinuria. For urine of high specific gravity, the test area may most closely match the Trace color block even though only normal concentrations of protein are present. Clinical judgment is needed to evaluate the significance of Trace results.

Urobilinogen

The normal urobilinogen range obtained with this test is 0.2 to 1.0 mg/dl. A result of 2.0 mg/dl represents the transition from normal to abnormal, and the patient and/or urine specimen should be evaluated further.

The following table lists the generally detectable levels of analytes in contrived urine; however, because of the inherent variability of clinical urines, lesser concentrations may be detected under certain conditions.

Reagent area	*Sensitivity*
◆ Glucose	◆ 75–125 mg/dl glucose
◆ Bilirubin	◆ 0.4–0.8 mg/dl bilirubin
◆ Ketone	◆ 5–10 mg/dl acetocetic acid
◆ Blood	◆ 0.015–0.062 mg/dl hemoglobin
◆ Protein	◆ 15–30 mg/dl albumin

Glucose

The test is specific for glucose; no substance excreted in urine other than glucose is known to give a positive result. The reagent area does not react with lactose, galactose, fructose nor reducing metabolites of drugs (e.g., salicylates and nalidixic acid). This test may be used to determine whether the reducing substance found in urine is glucose. Reactivity may be influenced by urine specific gravity and temperature. In dilute urines containing less than 5 mg/dl ascorbic acid, as little as 40 mg/dl glucose may produce a color change

JAYPEE BROTHERS

that might be interpreted as positive. The test is more sensitive than the copper reduction test (e.g., CLINITEST® Reagent Tablets). If the color appears somewhat mottled at the higher glucose concentrations, match the darkest color to the color blocks.

Bilirubin

The test has a sensitivity of 0.4–0.8 mg/dl bilirubin.

Ketone

The test reacts with acetoacetic acid in urine. It does not react with acetone or 3-hydroxybutyric acid. Some high specific gravity/low pH urines may give reactions up to and including Trace. Clinical judgment is needed to determine the significance of reactions up to and including Trace.

Specific Gravity

The specific gravity test permits determination of urine specific gravity between 1.000 and 1.030. In general, it correlates within 0.005 with values obtained with the refractive index method. For increased accuracy, 0.005 may be added to readings from urines with pH equal to or greater than 6.5. Strips read instrumentally are automatically adjusted for pH by the instrument. The Bayer SG test is not affected by certain nonionic urine constituents such as glucose nor by the presence of radiopaque dye.

Blood

The sensitivity of this test may be reduced in urines with high specific gravity. The test is equally sensitive to myoglobin as to hemoglobin. The appearance of green spots on the reacted reagent area indicates the presence of intact erythrocytes in the urine. The Color Chart includes examples of Trace and moderate nonhemolyzed color blocks. Reactions ranging from Trace to large, with proportionately more numerous spots, may be observed (A hemoglobin concentration of 0.015–0.062 mg/dl is approximately equivalent to 5–20 intact red blood cells per microlitre). Because of the optical systems of urine chemistry instruments, the sensitivity to intact erythrocytes is lower than that perceived visually.

pH

The pH test area measures pH values generally to within 1 unit in the range of 5–8.5 visually and 5–9 instrumentally. pH readings are not affected by variations in the urinary buffer concentration.

Protein

The reagent area is more sensitive to albumin than to globulins, hemoglobin, Bence-Jones protein, and mucoprotein; a negative result does not rule out the presence of these other proteins.

JAYPEE BROTHERS

Urobilinogen

This test area will detect urobilinogen in concentrations as low as 0.2 mg/dl (approximately 0.2 EU/dl) in urine. The absence of urobilinogen in the specimen cannot be determined.



Fig. 5.2: Multistix® urinalysis strips.

Multistix® Urinalysis Strips (Fig. 5.2)

Dependable Results When and Where You Need Them

Bayer's Multistix strips lead the market in providing a range of rapid urine testing results. When read visually or automatically on either the Clinitek 50 or Clinitek 500 readers they enable on the spot clinical decisions to be made with confidence.

Easy to Use (Figs. 5.3 to 5.5)



Fig. 5.3: Dip.

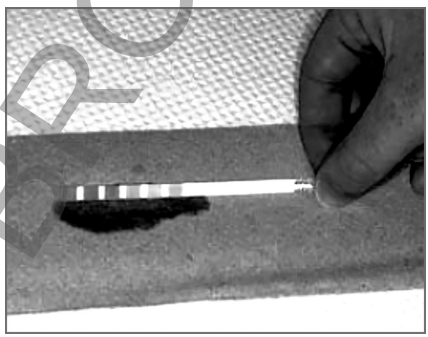

Fig. 5.4: Blot.



Fig. 5.5: Read at correct time.

JAYPEE BROTHERS

Multistix Configurations

	Leuc	*Nitrite*	*Urobil*	*Prot*	*pH*	*Blood*	*SG*	*Ket*	*Bill*	*Gluc*
Multistix 10 SG	√	√	√	√	√	√	√	√	√	√
Multistix 8 SG	√	√		√	√	√	√	√		√
Multistix GP	√	√		√	√	√	√	√		√
N-Multistix SG		√	√	√	√	√	√	√	√	√
Multistix SG			√	√	√	√	√	√	√	√
Labstix SG				√	√	√	√	√		√
N-Labstix		√		√	√	√		√		√
Bili-Labstix				√	√	√		√	√	√
Labstix				√	√	√		√		√
Haema-Combistix				√	√	√				√
Uristix				√						√
Albustix				√						

Rapid Results

- Fast, reliable results available in 1–2 minutes
- Automated reading provided in 1 minute using.

First Line Health Screen for a Variety of Settings

Menu: Glucose, Ketones, Bilirubin, Urobilinogen, Specific Gravity, Blood , pH, Protein, Nitrite, Leucocytes.

Improved Use of Resources

- **Diabetes Management/Renal checks using microalbumin (Albumin : Creatinine Ratio) while the patient waits**
- Screens out non-infected urine samples so that only the positives need to be referred for laboratory follow-up in cases of Urinary Tract Infection.

STOOL EXAMINATION

Average healthy adults defecate from three times a day to three times a week. Common pattern is once a day. The stool tends to be soft and bulky on a diet high in vegetables and small and dry on a diet high in meat. Two thirds of the stool weight is attributable to its water content. The normal brown color is of still undetermined origin. The odor results from indole and skatole, produced by bacteria from tryptophan.

JAYPEE BROTHERS

Feces are Composed of

- Waste residue of indigestible material in food
- Bile (pigments and salts)
- Intestinal secretions, including mucus
- Leucocytes that migrate from the bloodstream
- Shed epithelial cells
- Large number of bacteria that make up to one-third of total solids
- Inorganic material (10–20%) that is chiefly calcium and phosphates
- Digested food (present in very small quantities).

Specimen Collection

A wide mouthed jar with a screw cap is good enough, provided it is neat, clean, and without any extraneous material in it. It should, however, never be overfilled and should be opened slowly to release the gas that accumulates frequently in it (if not done so, the contents may be released explosively). Since rectal evacuation is not completely at will and feces passed correlate very poorly with the food consumed; hence, collection should be done over a period of 3 days. The accuracy of this method can be enhanced somewhat by having the patient ingest carmine dye (0.3 g) and charcoal (1 g) at the beginning and the end of a collecting period, respectively, collecting the stools from the beginning of the appearance of the dye to the beginning of the appearance of the charcoal.

Be Careful

- Feces should be urine free when collected. Collect the entire stool and transfer to another container by a tongue blade. Deliver to the laboratory immediately after collection.
- Warm stools are best for detecting ova and parasites. Do not refrigerate for ova and parasites.
- Some coliform bacilli produce antibiotic substances that destroy enteric pathogens.
- Refrigerate stool if it cannot be examined immediately. Never place a stool in an incubator.
- A diarrheal stool will usually give good results.
- A freshly passed stool is the specimen of choice.
- Preferably, stool specimens should be collected before antibiotic therapy is initiated and as early in the course of disease as possible.
- Only a small amount of stool is needed; the size of a walnut. If mucus and blood are present, they should be included in part of the specimen to be examined.
- Do not use a stool that has been passed into the toilet bowl or that has been contaminated with barium or other X-ray medium.
- Label all stool specimens with patient's name, date, and reason for examination/testing.

JAYPEE BROTHERS

NURSING Manual of Laboratory Tests

Nursing is one of the most important aspects of the medical field. While consultants come and go, General Duty Medical Officers also are not available round the clock, but nurses (the Florence Nightingales of the institution) are available round the clock. Nurses are taught the basics of almost all medical fields, however, laboratory tests have a very specific place in their understanding of disease and the recovery process that follows after appropriate medical or surgical care. It is important for Nurses to be able to read and understand the Diagnostic Laboratory Reports in order to redflag and/or wait for conveyance of results to the Consultants. Until the Specialists arrive, they can at least initiate basic care. All of this is possible with adequate and in-depth knowledge of test results and their normal biological values. This book effectively serves this purpose without overwhelming your mind. So do not hesitate, take a look to stay informed about the latest advancements in molecular diagnostics tests as well.

Ramnik Sood MBBS PGEn&OH MD (Pathology, Gold Medalist) is Director, Speciality Diagnostic Labs, Panjim, Goa, India. He is an eminent, internationally acclaimed medical author and has scores of books to his credit especially on Medical Laboratory Technology and Allied Sciences. He has also authored over 150 Techno-commercial Journals for In-Vitro Diagnostic Industry and Medical Group Chains. This book is the second edition under this title and has been popular for several years. It has been much appreciated for its comprehensiveness and ease of understanding by Nurses and Nursing students (undergraduates/postgraduates) and practicing nurses alike. A quick internet search of RAMNIK SOOD will reveal his significant contributions as an author to the global medical community.

Scan for more nursing titles..

JAYPEE BROTHERS

Buy from ejaypee

JAYPEE BROTHERS

ISBN 978-93-6616-340-6