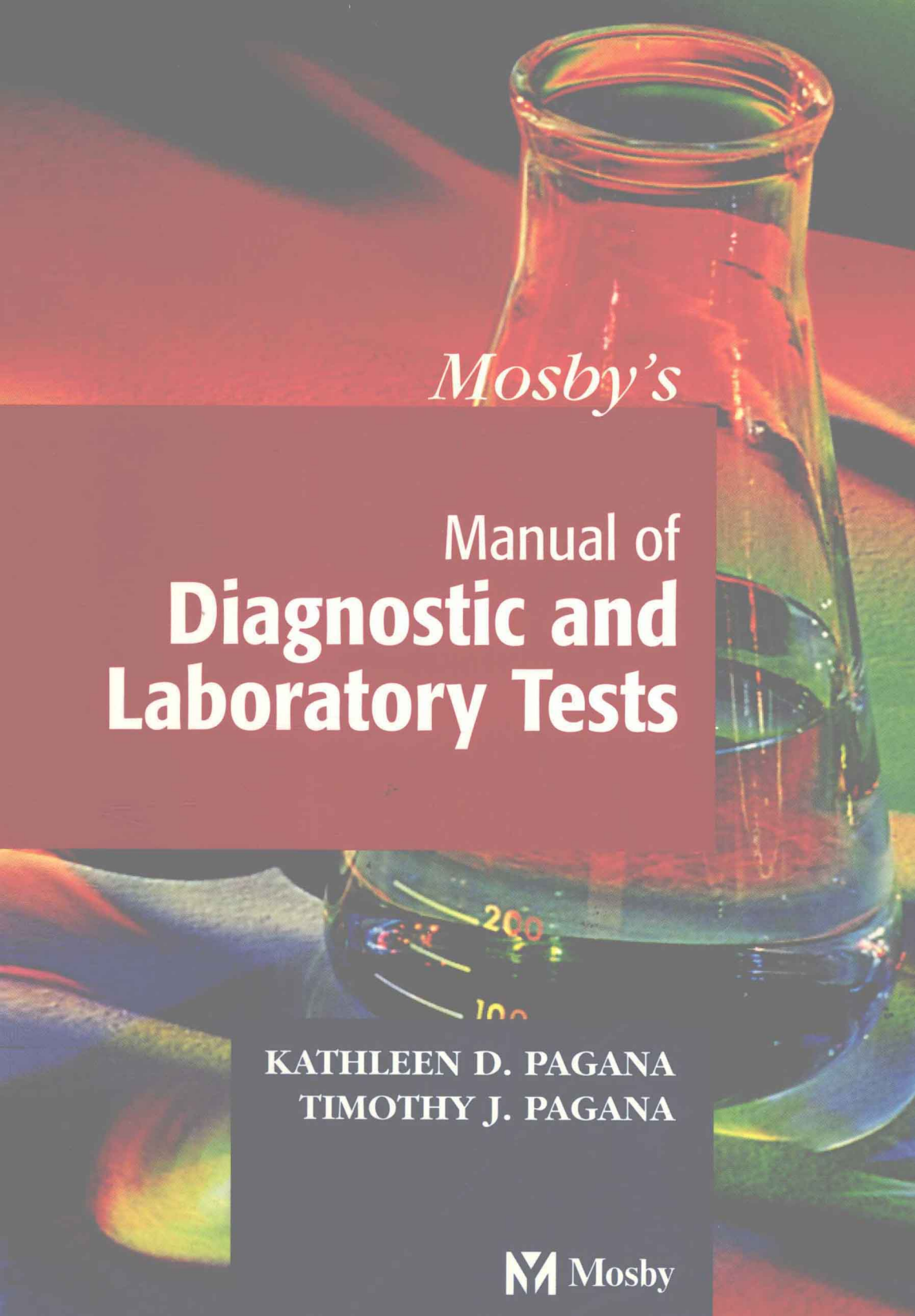
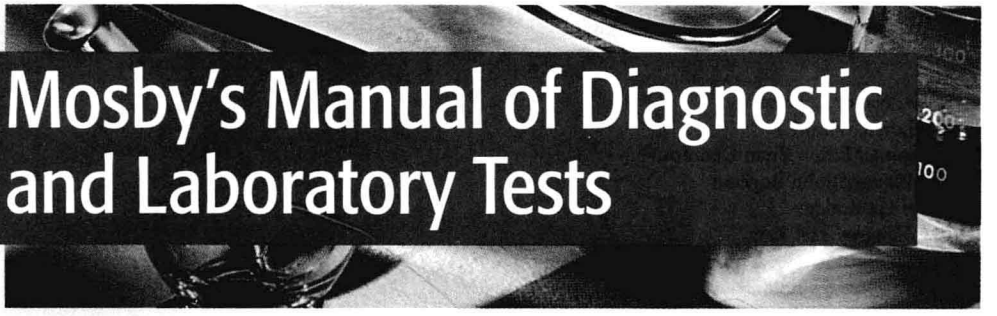


Mosby's

Manual of Diagnostic and Laboratory Tests

KATHLEEN D. PAGANA
TIMOTHY J. PAGANA

Mosby



Mosby's Manual of Diagnostic and Laboratory Tests

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Mosby's Manual of Diagnostic and Laboratory Tests

This book is dedicated to all healthcare workers who continually seek knowledge to improve their care of the sick.

Preface

This book provides the user with an up-to-date, extensive manual that allows rapid access to clinically relevant laboratory and diagnostic tests. A unique feature of this manual is its consistent format, which provides a comprehensive approach to laboratory and diagnostic tests. Tests are categorized according to either the method of testing (e.g., x-ray, ultrasound, nuclear scan) or the type of specimen (e.g., blood, urine, stool) used for testing. Each chapter of this book is based on this categorization. Each chapter begins with an alphabetical listing of all tests in the chapter to aid the user in locating discussions quickly. An overview follows the list and contains general information concerning test methods and related patient care.

Chapter One includes a discussion of guidelines for proper test preparation and performance. Universal precautions and other clinically important information for the healthcare provider are included to ensure accurate diagnostic and laboratory testing. This information is essential for healthcare economics so that tests are performed in a timely fashion and do not need to be repeated because of problems in patient preparation, test procedure, and/or specimen handling. Communication and collaboration with other healthcare providers are emphasized.

Throughout the book, information is explained in a comprehensive manner to enhance full understanding of each particular test. Every feature of test discussion is geared to provide complete information in a sequence that best simulates priorities in clinical practice. The following information is provided, whenever possible, for a thorough understanding of each diagnostic test:

- **Name of test**. Tests are listed by their complete name. A complete list of abbreviations and alternate test names follows each main entry.
- **Normal findings**. Normal values are listed, when applicable, for the infant, child, adult, and elderly person. Also, where appropriate, values are separated into male and female categories. We realize that normal ranges of laboratory tests vary significantly, depending on the method of testing and the particular laboratory. For this reason, we strongly encourage the user to check the normal values at the institution where the test is performed. This should be relatively easy because most laboratory reports indicate normal values.
- **Critical values**. These values give an indication of results that are well outside the usual range of normal. These results generally require immediate intervention.

- **Indications**. This section describes the main uses for each test. Emphasis is placed on the type of patient signs and symptoms that lead to the indications for each test.
- **Test explanation**. This section provides a comprehensive description of each test. The explanation includes fundamental information about basic pathophysiology related to the test methods, what diseases the test results may indicate, and the location where the test is generally performed. Also, in this section, patient sensation, test duration, and the type of healthcare professional involved in the testing are described.
- **Contraindications**. This information alerts the user to patients who should not have the test performed. As in other segments of the book, each contraindication is fully explained with an in-depth rationale. Patients frequently highlighted in this section include those who are pregnant, who are allergic to iodinated or contrast dye, or who have bleeding disorders.
- **Potential complications**. This section alerts the user to potential problems that will necessitate astute post-testing assessments and interventions. Not only is each complication fully explained in detail, but patient symptoms and appropriate interventions are described. For example, a potential complication of an IVP is renal failure, especially in the elderly patient. An appropriate intervention may be to hydrate the patient before the test and force fluids afterwards.
- **Interfering factors**. This section includes a thorough discussion of factors that can invalidate or alter the test results. An important feature of this section is the inclusion of drugs that can interfere with test results. Drugs that increase or decrease test values are indicated by a drug icon ( ) for quick access.
- **Procedure and patient care**. This section emphasizes the role of nurses and other healthcare providers in diagnostic and laboratory testing by addressing psychosocial and physiologic interventions. Patient education and rationales are thoroughly discussed. For quick location of essential information concerning the testing procedure, this section is divided into *before*, *during*, and *after* time sequences.

  Before. This section addresses the need to explain the procedure and to allay patient concerns or anxieties. Dietary restrictions, bowel preparations, baseline pretest assessment, and the need for informed consent are discussed.

  During. This section provides a complete and thorough description of the testing procedure, alternate procedures, and methods of testing. In most instances, a step-by-step description of testing procedures is provided. This information is important because all healthcare providers involved in the particular test should have a good understanding of what the procedure entails in order to assist more completely in the testing process.

  After. This section includes vital information that the nurse or other healthcare provider should know concerning post-procedure care of the patient. This includes specific post-test assessment, medication administration, recognition of post-test complications (with suggestions for nursing interventions), home care, and follow-up information.
- **Test results and clinical significance**. As the name implies, this section describes the significance of the test findings. A unique feature of this manual, in comparison to

other books on diagnostic and laboratory tests, is an extensive discussion of the pathophysiology of the disease process and how it relates to the test result. This provides enhanced understanding of the diagnostic test and better understanding of many disease processes.

- **Related tests**. This section, another unique feature of the text, includes a list of tests that are related to the main test under discussion. This includes tests that provide similar information, tests that provide confirmatory information, or other tests used to evaluate the same organ, disease process, or symptom complex. A short description and page numbers for all related tests are included for ease in cross-referencing. This provides the reader with a broader understanding of diagnostic testing and indicates where the reader may go to obtain more information on the topic of interest.

This logical format emphasizes clinically relevant information. The clarity of the format will facilitate a full understanding of content essential to both students and healthcare providers and its uniformity will allow the user to quickly recognize where information of interest may be found.

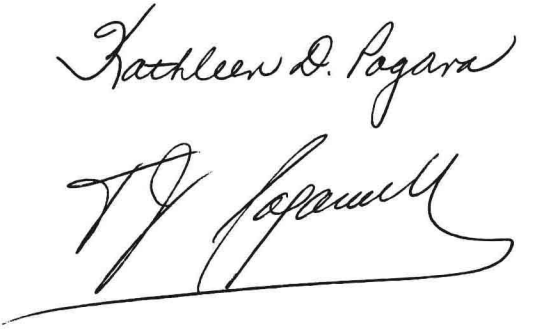
Multiple colors have been used to help locate tests, highlight critical information, and generally improve the readability of the text. Also, another key feature is the use of color photographs and illustrations throughout the book. Many tables are also included to simplify or summarize complex material regarding clinical care, test categories, or disease processes.

Feature boxes are used throughout the book in order to highlight and summarize important clinical data. They allow the reader to assimilate important information at a glance. There are three types of feature boxes: clinical priorities, age-related concerns, and home care responsibilities. *Clinical Priorities* emphasize pertinent information specific to understanding and performing a particular test. For example, coagulation studies need to be assessed prior to invasive studies (e.g., liver biopsy) that may cause bleeding. Chest x-rays should be performed after procedures (e.g., pleural biopsy) that may cause a pneumothorax. *Age-Related Concerns* primarily address pediatric and geriatric priorities. For example, the risk of dye-induced renal failure is emphasized in the dehydrated elderly patient scheduled for an IVP. The bowel preparation for children of different ages is described in the barium enema study. *Home Care Responsibilities* focus on factors that need to be addressed after a test is performed. With an increasing number of procedures being performed on an out-patient basis, the patient has the responsibility for detecting problems and knowing what to do when they occur. Often, the patient returns home with instructions or guidelines for recognizing problems (such as infection, bleeding, urinary retention).

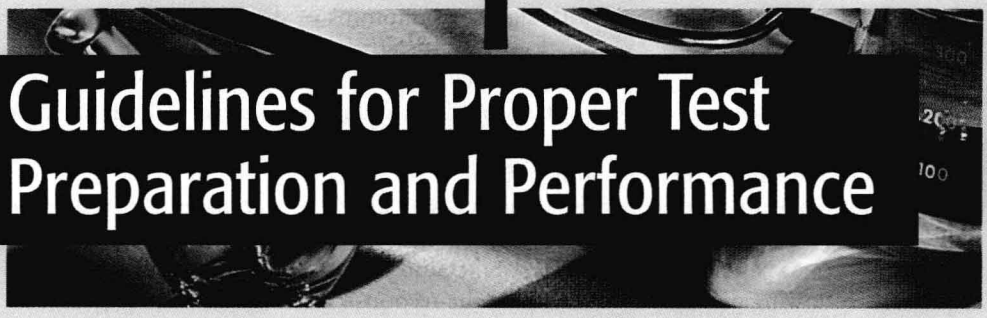
Appendix A *Alphabetical Listing of Tests*, helps the user locate specific tests at a glance. **Appendix B** *List of Tests by Body System*, familiarizes the user with other related studies the patient or client may need or the user may want to review. This information should be especially useful for students and healthcare providers working in specialized areas. For example, all tests related to infertility are listed in the reproductive system section. **Appendix C** contains a list of *Abbreviations for Diagnostic and Laboratory Tests*. Finally, a comprehensive index includes the names of all tests and their synonyms and

other relevant terms found within the tests. *Typical Abbreviations and Units of Measurement* are located on the inside cover.

We sincerely thank our editors for their enthusiasm and continual support. We invite comments from users of this book so that we may improve our goal of providing useful and relevant diagnostic and laboratory test information to users of future editions.



Contents



1 Guidelines for Proper Test Preparation and Performance

A complete evaluation of patients with signs or symptoms of disease usually requires a thorough history and physical examination as well as efficient diagnostic testing. The correct use of diagnostic testing can confirm or eliminate the presence of disease and improve the cost efficiency of screening tests in a community of people without signs or symptoms of disease. Finally, appropriate and thoughtfully timed use of diagnostic testing allows monitoring of disease and treatment.

Furthermore, health care economics demands that laboratory and diagnostic testing be performed accurately and in a timely fashion. Tests should not have to be repeated because of improper patient preparation, test procedures, and/or specimen collection technique. The following guidelines will describe the responsibilities of health care providers to ensure safety and accuracy in diagnostic testing.

Patient education is the single most important factor in ensuring accuracy and success of test results. All phases (before, during, and after) of the testing process must be thoroughly explained to the patient. A complete understanding of these factors is essential to the development of nursing processes and standards of care for diagnostic testing.

The interpretation of diagnostic testing is no longer left to the physician alone. In today's complex environment of high-tech testing and economic restrictions, individuals representing many health care professions must be able to interpret diagnostic tests to develop a timely and effective treatment plan.

Universal precautions

The spread of hepatitis B virus (HBV) and human immunodeficiency virus (HIV) has made all health care organizations aware of the need to protect health care providers. This threat prompted the Centers for Disease Control (CDC) to release its guidelines for universal precautions in 1987 (Box 1-1). This policy recommends that blood and body fluid precautions be used for all patients regardless of their infection status. All patients should be considered potentially infectious. The universal precautions apply to all blood and tissues. Serous fluids such as pleural, peritoneal, amniotic, cerebrospinal, and synovial fluids are included. Semen and vaginal secretions should also be considered hazardous. Other clinical specimens (e.g., sputum, stool, urine) are of less concern, and the universal precautions apply only if these specimens contain visible amounts of blood.

These precautions require the use of protective barriers (gloves, gowns, masks, protective eyewear) to avoid skin and mucous membrane exposure to blood and body fluids. A fundamental principle of universal precautions is frequent handwashing between patients and when gloves are changed. All specimens should be collected and transported in containers that prevent leakage. Blood-tinged stains or spills must be decontaminated immediately. All needles and other sharp items must be handled carefully and discarded in puncture-resistant containers. Needles should not be recapped, broken, bent, or removed from a syringe to avoid the risk of puncturing the finger or hand. Special reusable needles are placed in metal containers for transport to a special area for sterilization or disinfection.

Vaccination against HBV is another safety precaution recommended by the CDC.

Proper sequencing and scheduling of tests

Because of the cost and complexity of laboratory and diagnostic testing, it is important that tests be scheduled in the most efficient sequential manner. Since one type of test can interfere with another, certain guidelines apply when multiple tests must be performed in

Box 1-1 Universal Precautions *

These precautions have been mandated by the Occupation Safety and Health Administration (OSHA). Their purpose is to protect health care workers from contracting illnesses from the specimens they handle, the patients they care for, and the environment in which they work. They can be summarized as follows:

- Wear gowns, gloves, protective eyewear, face masks, and protective clothing (including laboratory coat) whenever exposed to blood or other body fluids.
- If the health care worker's skin is opened, gloves should be worn whenever direct patient care is performed.
- Mouth-to-mouth emergency resuscitation equipment should be available in strategic locations. The mouthpieces should be individualized for each health care worker. Ambu bags are preferable. Saliva is considered an infectious fluid.
- Dispose all sharp items in puncture-resistant containers.
- Do not "recap," bend, break, or remove needles from syringes.
- Immediately remove gloves that have a hole or tear in them.
- All disposed patient-related wastes must be labeled as a "biohazard."
- All specimens must be transported in leakproof containers.
- Eating, drinking, applying cosmetics, or handling contact lenses is prohibited in patient care areas.
- Presume all patients have HBV and HIV.
- If a health care worker has experienced an exposure incident to blood or other body fluids (e.g., needlestick), testing of the health care worker and the patient for HBV and HIV is necessary.

*Centers for Disease Control, 1987

a limited amount of time. X-ray examinations that do not require contrast material should precede examinations that do require contrast media. X-ray studies using barium should be scheduled after ultrasonography studies. For example, x-ray studies using barium should follow x-rays using iodine contrast dye (such as intravenous pyelography [IVP]), which should follow x-ray studies using no contrast because contrast agents can obscure visualization of other body areas on subsequent x-ray tests. Also, stool specimens should be collected before x-ray studies using barium.

Test sequencing affects the ability to efficiently perform tests in a limited time period. An essential component of this process is communication and collaboration with other health care workers in numerous departments.

Before the test

Patient preparation is vital to the success of any diagnostic test. Patient education is essential and will be discussed later in this chapter. Development of and adherence to patient care guidelines in regard to patient preparation for the test require an understanding of the procedure. A thorough history to identify *contraindications* to the specific test is vital. Recognition of patients at risk for *potential complications* and counseling the patient about those complications is important. The fears and concerns of the patient should be elicited and addressed prior to testing. Documentation and a thorough understanding of ongoing factors (e.g., medications, previous test, other variables as discussed later in this chapter) that could *interfere* with the test results are essential to avoid misinterpretation of diagnostic testing.

Pretest preparation procedures must be followed closely. Dietary restriction is often an important factor in preparing the patient for tests. Studies requiring fasting should be performed as early in the morning as possible to diminish patient discomfort. Adherence to

dietary restriction is important for test accuracy in some cases. Many blood tests and procedures require fasting. Studies such as a barium enema, colonoscopy, upper GI series, and IVP are more accurate if the patient has been on NPO status for several hours prior to the test. Sometimes dietary restrictions are important for safety, especially if a sedative is to be administered during testing. For example, upper GI endoscopy requires that the patient remain NPO for 8 to 12 hours before the test to prevent gagging, vomiting, and aspiration. Bowel preparation is necessary for many procedures designed to evaluate the mucosa of the GI tract.

Equally important to total patient care is the coordination of ongoing therapy (e.g., physical therapy, administration of medications, other diagnostic testing). Finally, correct timing of testing is key to accurate interpretation of results. For example, blood samples for cortisol, parathormone, and fasting glucose levels (among others) must be obtained in the early morning hours.

Patient identification

Proper identification of the patient is a critical safety factor. The conscious patient should be asked to state his or her full name. The name should be verified by checking the identification band and requisition slip. The identity of an unconscious patient should be verified by family or friends. No specimens should be collected or procedure performed without properly identifying the patient. Costly tests on the wrong patient are useless and may instigate legal action. Confusion can occur when patients with the same name are on the same nursing unit. Most units have some type of warning or "name alert" to address this concern.

Patient education

Once the patient is properly identified and the proper test or procedure is scheduled, patient education begins. Patients want to know what tests they are having and why they are needed. An informed patient is less apprehensive and more cooperative. Patient education helps ensure that the test will not need to be repeated because of improper preparation. Fasting requirements and bowel preparations must be clearly explained to the patient. Written instructions are essential. Sometimes medications may need to be discontinued for a period of time before certain tests. This information should be determined in consultation with the physician. Medications that are not discontinued are often listed on the requisition to aid in interpretation of test results.

Variables affecting test results

Many laboratory tests are affected by individual variables that must be considered in test result interpretation. Several of these key variables are discussed below.

Age. Pediatric reference values differ from adult values. For some tests, values vary according to the week of life of the infant. For example, in the first week of life, newborns have elevated levels of serum bilirubin, growth hormone, blood urea nitrogen (BUN), and fetal hemoglobin. They have decreased levels of cholesterol and haptoglobin. Healthy newborns also have increases in total white blood cells and decreases in IgM and IgA immunoglobulins. For some tests, children have different reference values based on their developmental stage. For example, alkaline phosphatase levels in children are much higher than adult values because of rapid bone growth.

Age-related changes are also apparent in the middle adult and older adult years. For example, albumin and total protein levels begin to decline in the mid-adult years. Reference values for cholesterol and triglyceride levels begin to increase in the mid-adult years. Creatinine clearance levels decrease with age relative to changes in glomerular filtration rate.

Gender. Sex is another variable that affects values in men and women. Differences are usually related to increased muscle mass in men and differences in hormonal secretion. For example, men usually have higher reference values for hemoglobin, blood urea nitrogen, serum creatinine, and uric acid. Males also have higher serum levels of cholesterol and triglycerides as compared with premenopausal women. Sex-specific hormones will also differ, with men having higher testosterone levels and women having higher levels of estrogens, follicle-stimulating hormone, and luteinizing hormones.

Race. Generally race has little effect on laboratory values. It has a greater effect on genetic diseases, such as sickle cell anemia in blacks and thalassemia in those with origins near the Mediterranean Sea.

Pregnancy. Many endocrine, hematologic, and biochemical changes occur during pregnancy. Pregnant women have increased levels of cholesterol, triglycerides, lactic dehydrogenase, alkaline phosphatase, and aspartate aminotransferase. They may have lower values of hemoglobin, hematocrit, serum creatinine, urea, glucose, albumin, and total protein.

Food ingestion. Several serum values are markedly affected by food. For example, levels of glucose and triglycerides rise after a meal. To avoid the effects of diet on laboratory tests, many tests are obtained when the patient is in the fasting state.

Posture. Changes in body position affect the concentration of several components in the peripheral blood. Therefore it is often important to note whether the patient was in the supine, sitting, or standing position when blood was drawn. Examples of laboratory values affected by posture include norepinephrine, epinephrine, renin, aldosterone, protein, and potassium.

During testing

Often many different health care professionals are necessary to successfully perform a diagnostic procedure. The health care provider's knowledge of the procedure will be a major determinant of the success of the procedure. Furthermore, the presence of a knowledgeable and supportive health care provider during any procedure is invaluable to the patient and to the accuracy of the test.

Specimen collection

Protocols and guidelines are available for each type of specimen collection. These are essential for appropriate preparation and collection. For example, the selection of the color-coded tube varies with the type of blood test needed. Guidelines for the collection of a 24-hour urine collection must be followed to obtain a representative urine sample. These and other examples are described in detail in the following chapter overviews.

Transport and processing of the specimen

Preparing the patient and collecting the specimen are essential. Getting the specimen to the laboratory in an acceptable state for examination is just as important. In general, the specimen should be transported to the laboratory as soon as possible after collection. Delays may result in rejection of the specimen.

A note about SI units

The International System of Units (SI units) is a system of reporting laboratory values in terms of standardized international measures. This system is currently used in many countries, and it is expected to be adopted worldwide. Throughout this book results are given in conventional units and SI units when possible.

After the test

Posttest care is an important aspect of total patient care. Attention should be directed to the patient's concerns about possible results or the difficulties of the procedure. Appropriate treatment subsequent to testing must be provided. For example, after a barium test, a cathartic is indicated. However, if a bowel obstruction has been identified, catharsis is contraindicated.

Recognition and rapid institution of treatment of complications (e.g., bleeding, shock, bowel perforation) is often vital in caring for the patient who has just had a diagnostic procedure. Procedures often require heavy sedation or a surgical procedure. In these situations, aftercare is similar to postoperative care.

Reporting test results

Although proper patient preparation and skill and accuracy in performing test procedures are vital, timeliness in reporting test results is no less essential. To be clinically useful, results must be reported promptly. Delays in reporting test results can make the data useless. The data must be included in the appropriate medical record and presented in a manner that is clear and easily interpreted. As in all phases of testing, communication among health professionals is important. Health care providers need to understand the significance of test results. For example, often nurses on the evening shift may be the first to see the results of a culture and sensitivity report on a patient with a urinary tract infection. If the results indicate that the infecting organism is not sensitive to the prescribed antibiotic, the doctor should be informed and an appropriate antibiotic order obtained.

The impact of an abnormal test result on the patient must always be appreciated and support for concerns provided. Ethical standards for disclosure of test results must be strictly adhered to. The physician usually communicates the test results to the patient and family, but occasionally the nurse must provide that information. Knowledge of the implications of various test results and an understanding of the disease process are as important as the communicative skills required to inform the patient and the family.

Succinct documentation of test results may be required before the "official" result is included in the patient's chart. Here again, a thorough understanding of the test is essential. Adequate follow-up is as important as all previously mentioned factors for successful diagnostic testing. The patient must be educated regarding home care, the next doctor's visit, and treatment options.

• • •

Knowledgeable interpretation of diagnostic tests is key for effective collaboration among health care providers if the most efficient patient care is to be provided. The safety and success of diagnostic testing often depend on the nurse and other health care professionals. The safety of the patient and health care professionals depends on the creation of practice guidelines and standards of care. These can only be effectively developed with a thorough understanding of laboratory and diagnostic testing.

2 Blood Studies

TESTS