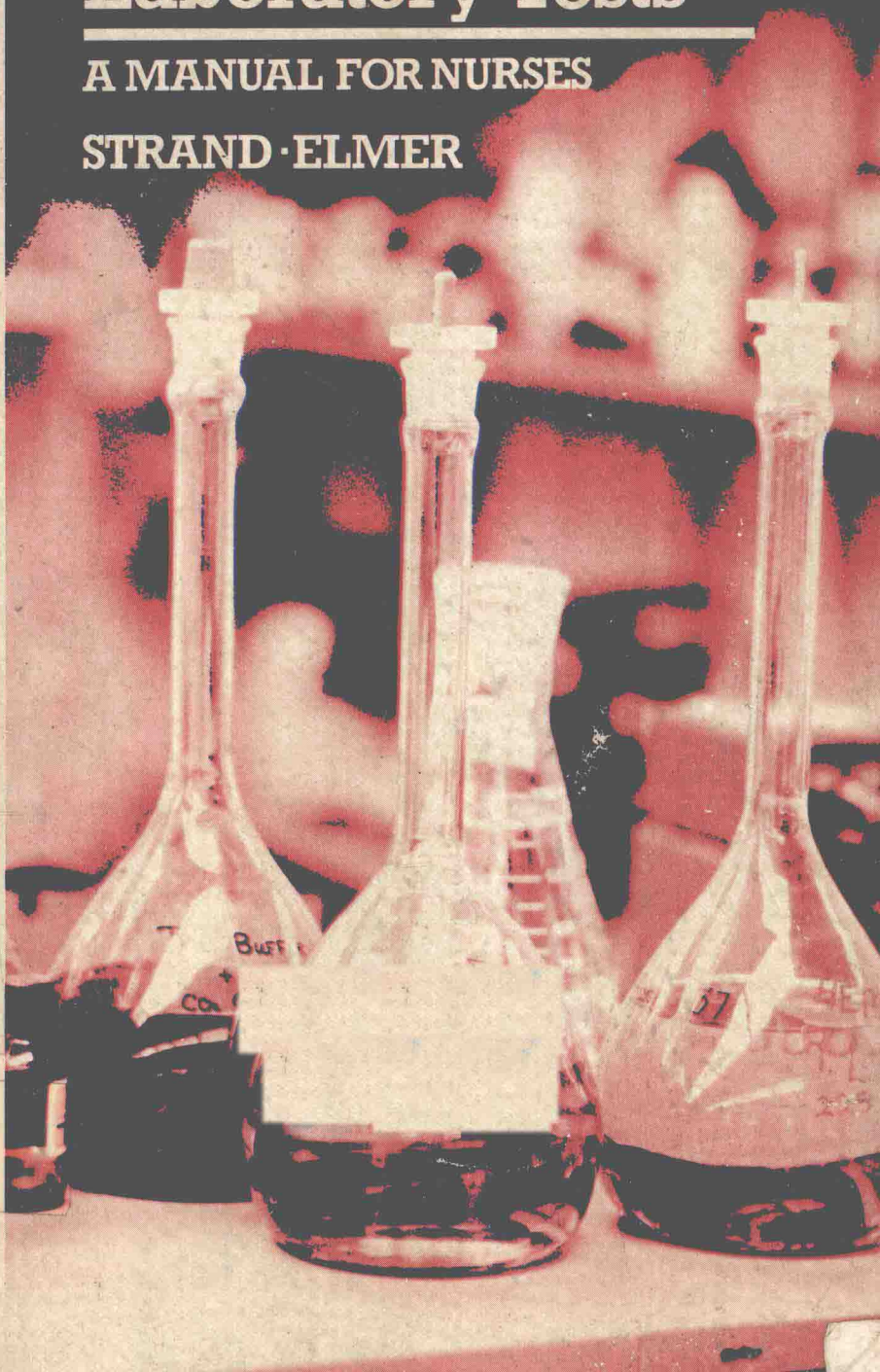
Clinical Laboratory Tests

THIRD EDITION

A MANUAL FOR NURSES

STRAND · ELMER



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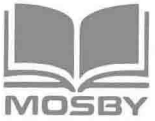

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Clinical Laboratory Tests

A MANUAL FOR NURSES

This little volume
is lovingly dedicated to our parents
Carl and **Amalie Elmer**

PREFACE to Third Edition

In this third edition, we have revised the discussions of many current clinical laboratory tests to clarify their meanings. We have deleted several outdated tests and added new procedures where warranted. Reference to body structure and function has been made when it might aid in understanding the laboratory test. Only some of the major drug interferences are listed. The reader is referred to a definitive source book on this subject. Major implications for nursing care have been added for selected tests. We believe that you, the reader, will find these revisions useful.

Marcella M. Strand
Lucille A. Elmer

PREFACE to Second Edition

Nurses in their key position in patient care must speak several paramedical languages. Among these is that of the clinical laboratory. The nurse must be able to transcribe physicians' orders, to explain tests to patients, and to collect or supervise the collection of laboratory specimens. Often the nurse is the first professional outside the laboratory to see the written reports. The ever increasing variety of laboratory procedures and reliance on laboratory results make optimum coordination between laboratory and nursing essential to patient care.

We believed that as a registered nurse and a medical technologist with extensive combined experience in our professions we could provide some clarification of laboratory practice and terminology. To this end we compiled this manual.

We drew from experience, from written reference material, and from dialogue with co-workers. Working in a health field is a continuing learning experience, and one would not know where to begin to thank individuals.

It is our hope that the student nurse and the practicing nurse will find this manual helpful in their relationship with laboratory services.

Marcella M. Strand
Lucille A. Elmer

CONTENTS

Introduction

How to Use this Manual

The format of the book is simple; it is designed for quick reference. Concepts of physiology, basic nursing, and medical-surgical nursing are included in test write-ups where relevant. Prior knowledge of or access to other areas of the standard nursing curriculum is assumed.

The numbers that follow most of the test names are explained on the inside of the cover. To avoid repetition the numbers serve as a guide to the usual nursing techniques involved in the tests. We are well aware that there is no general agreement on the items included in the key. With this in mind, blank pages are interspersed among the tests to provide space for individual notation.

Test names that are spelled out in the alphabetical listing are sometimes ordered by their abbreviations. A list of abbreviations related to the laboratory is found on pp. 135-146. This list should aid in transcribing physicians' orders. It should help also in reading laboratory request slips and reports. The abbreviation list is accompanied by some symbols common to laboratory reports and by some relevant units from the metric system.

The main body of the book, the alphabetical listing of laboratory procedures, places the data with the most common name of the test, but cross-references are numerous. Where there is general agreement, ranges of normal values are noted. These are adult normals unless otherwise specified. Pediatric laboratory medicine is quite a separate subject. Except for those

tests associated with one specific disorder, interpretations cite only outstanding examples. Most laboratory parameters are subject to alteration in so many clinical states that it is impractical to list all of them.

The subject of drug interference with clinical laboratory tests is overwhelming, and specialized references are necessary. Some of the most frequently encountered medications are mentioned, because it is seldom practical to prohibit intake of all medications in preparation for laboratory tests. Therefore, the physician is left with the problem of interpreting laboratory results in light of a patient's drug intake. Drugs can alter laboratory results in two ways: by causing a physiologic change in the constituent to be measured, or by directly affecting the laboratory method. The latter is a particular problem in chemistry, and inquiries from the laboratory regarding medications are common. Sometimes a different testing method can be used to avoid the drug interference; in other instances a bizarre result can be explained.

A glossary is appended.

Where the Test Is Done

The clinical laboratory makes the basic sciences available to the physician as aids in the diagnosis and treatment of the patient. Standard techniques from physical and biologic sciences have been adapted to make analysis of human materials possible. New tests are being developed and instrumentation is constantly being refined as medical knowledge progresses. To cope with the variety in types of specimens and to organize the methodologies used, the clinical laboratory is subdivided. The number of divisions, the names assigned them, and the tests performed in each of them vary from one institution to another.

The chemistry laboratory deals primarily with blood, but it also receives urine, cerebrospinal and other body fluids, and feces. Many mechanical and electronic instruments are employed. Most of the automation is based on older chemical methods but permits volume output with meticulous quality control.

In bacteriology, bacteria are cultivated under carefully controlled conditions so they may be identified. Since human materials can support many kinds of bacteria, biochemical and other tests are employed to aid in their classification and in ascertaining their pathogenicity. Procedures are available here that assist in determining which antibacterial therapy is likely to be most effective. Virology, mycology, and parasitology are often combined with bacteriology into a microbiology section.

The hematology laboratory is responsible for the examination of stained blood smears, the enumeration of blood cells and platelets, and the determination of hemoglobin level. Tests relating to blood dyscrasias, to collagen diseases, to hemoglobinopathies, and to coagulopathies are frequently performed in this section. Bone marrow specimen preparation and examination are also commonly performed in the hematology section.

The blood bank laboratory performs all tests relative to determining donor-recipient blood compatibility. The storage and release of donor blood and blood components are also part of the blood bank's responsibility.

Antigen-antibody reactions are employed in the serology or immunology section. The tests done there deal particularly with syphilis, the collagen diseases, infectious mononucleosis, and hepatitis.

Determining if a patient's blood clots normally or the reason it does not lies in the province of the coagulation division. The laboratory monitoring of anticoagulant therapy is also done there.

The urinalysis section performs chemical and microscopic examinations of urine.

Papanicolaou smears are referred to the cytology laboratory. Slide mounts made from body fluids are also examined there for malignant or otherwise abnormal cells.

Portions of body tissue removed by biopsy, surgery, or at autopsy are processed into permanent slide mounts in the histology or tissue laboratory. A variety of staining techniques is available to the pathologist, who is responsible for the reporting of tissue diagnoses.

One of the newer laboratory divisions contributing to

medicine is cytogenetics. The ability to correlate chromosomal abnormalities with human disorders, a subject of sustained research interest, has increasing clinical implications.

The nuclear medicine or isotopes laboratory employs radioisotopes of chemical elements. The isotopes are utilized for in vivo procedures such as scans and for in vitro methods, particularly in thyroid evaluation.

Toxicology is the scientific study of poisons. Increasing numbers of hospitals have toxicology sections in their laboratories, and if they do not, they perform at least some related procedures in the chemistry section. Some of the substances that a toxicology laboratory identifies and quantitates are alcohols, metals such as arsenic and iron, carbon monoxide, narcotics, phenothiazines, salicylates, amphetamines, antiepileptics, barbiturates, digitalis glycosides, and hallucinogens. The monitoring of therapy is a developing area.

Why Values Vary from One Laboratory to Another

It seems logical that any two laboratories operating under adequate quality control and measuring the same constituent in the same specimen should produce identical results. Indeed, it would be extremely helpful to physicians if this were the case. Instead, considerable variation is found, and the result of a patient's test must be evaluated with reference to the normal values of the laboratory in which the test was performed. This does not mean that one laboratory is right and another wrong.

There are many techniques available for measuring most constituents of medical interest. There is no uniform agreement on the types of units in which results are reported. Most laboratory work utilizes instruments, and these vary in their electronics and chemistry. If a manual method is used, the exact procedure prescribed in one laboratory is often different from that in another. Chemical reagents and antisera differ in specificity and speed of reaction.

Regulation of food and fluid intake has an effect on many parameters, and the procedure for this is not consistent from hospital to hospital. Consideration of the physical activity of the

patient is sometimes pertinent. Values for some tests are different at sea level than in the mountains.

The list of normal values for a laboratory therefore becomes a necessary reference. The normal range for a procedure is established by performing it on a large number of healthy persons. If it is known that age or sex influences a particular constituent, it may be necessary to run several series of normals. In addition to this method, for some tests it is necessary to take a known reference substance, usually commercially prepared, and run it each day or with each "batch" or with each patient. In this case the test's "normal control" is reported with the patient's test result.

Laboratory Tests in the Daily Nursing Routine

What do you as a nurse have to do with clinical laboratory testing? The obvious participation includes ordering the tests, and collecting and transporting the specimens. Less obvious is the need to be teacher and coordinator.

The nurse must be certain that the patient understands the test routine. In many hospitals pamphlets describing laboratory procedures are available for you to give to the patient, but this information often requires individual interpretation. For example, the patient may need to be told that medications will be withheld for a period of time before the test, or that the bedpan, not the toilet, should be used for any nighttime voidings so that a timed urine collection can be completed correctly. Elderly patients, who may be quite apprehensive or unfamiliar with hospital routine, must have procedures explained very carefully, often more than once. Explaining the test to patients can increase their cooperation and relieve their apprehension. These accomplishments are well worth the small investments of your time spent teaching.

Proper coordination between the laboratory and the nursing staff provides common understanding of methods and problems. All laboratory request slips must be filled out completely with requested information such as weight, period of gestation, or phase of menstrual cycle. Specimens must be sent in the

correct type of container, completely labeled. If a patient has a language problem, is deaf, blind, mentally retarded, or emotionally disturbed and agitated, the laboratory should be notified. Forewarning of this nature can be invaluable to the laboratory and will help to make the experience less difficult for the patient.

Coordination among members of the nursing staff is also essential. Information concerning patient preparation, scheduling, collection of specimens, and sequence of tests must be communicated to all shifts. Communication aids such as tape recorders, Kardex files, communications notebooks, and bulletin boards are commonly used. With their use, repeated telephone calls to the laboratory or to the physician for clarification of procedures or orders can be avoided. Repeating laboratory tests is often distressing to the patient and may result in additional days of costly hospitalization.

When completed laboratory reports are telephoned, sent to the nursing unit on a computer printout sheet, or recorded on the patient's chart, an alert nurse will be able to identify significant abnormal reports and to institute appropriate action. This might involve deciding between immediately notifying the physician of the report or waiting until his or her next rounds. The action might be to alert other members of the nursing staff to observe the patient for certain symptoms, or it might be to put the patient into isolation. The nurse needs to know the purpose of the test and the significance of its results.

The nurse who has a thorough understanding of the patient's and the nurse's roles in clinical laboratory testing contributes significantly to this aspect of patient care.

Collection and Handling of Blood Samples

The extent of the nurse's responsibility for obtaining blood samples varies from one setting to another. Certain precautions must be observed in performing the venipuncture, drawing the blood sample, and sending it to the laboratory. It is always necessary to verify established procedure. The nurse's first reference source for this kind of information is the hospital lab-

oratory procedure book or, if none is available, the laboratory itself.

Several variables are involved. It is essential to know what kind of collection tube should be used and the method of labelling it with patient identification, which tests require special skin antisepsis, the volume of blood required, which specimens require special safeguards against hemolysis, which need to be iced, and which specimens need to be brought to the laboratory immediately.

In addition to these specific points certain generalities apply to blood specimen collection. Blood samples must not be drawn from an extremity into which an intravenous infusion is running. There is a higher concentration of the infusion substances in those areas, and this will influence some test results. If the nurse has difficulty locating an acceptable vein, a hot pack may be applied to the site of the venipuncture to distend the blood vessel. This will not affect the blood sample. After drawing a blood sample into a tube that contains an anticoagulant, it is necessary to invert the tube several times to mix it with the sample, but the tube should not be shaken because of possible damage to red blood cells. It is especially important to prevent hemolysis in some laboratory tests. Listed below are some possible causes of hemolysis that the knowledgeable nurse can avoid:

1. Skin too wet with antiseptic
2. Moisture in the syringe or collection tube
3. Prolonged use of a tourniquet
4. Use of small-gauge needle to withdraw a large volume of blood
5. Use of suction on the syringe
6. Vigorous shaking of the blood specimen
7. Not removing the needle from the syringe before expelling the blood into the collection tube
8. Vigorous expulsion of blood from the syringe into the collection tube

The final step, the reporting of the result by the laboratory, reflects the quality of the specimen collection as much as it does the quality of the laboratory work.

Tests Done by the Nurse

Commercial methods are available that permit some tests to be done by nursing personnel or by the patient. Most of these tests involve the use of test paper or tablets, with a color chart for comparison to read the results. Some of the common tests are those for specific gravity of urine, sugar and ketones in urine, and occult blood in stool. Several companies supply test materials along with instructions for their proper use. The nurse must follow these instructions carefully since the tests have been designed exactingly by their developers, and therefore they will yield accurate results only if the proper procedures are followed. Short cuts must not be taken. In all instances a fresh specimen must be obtained in a clean container. The materials are affected by moisture, so containers should be kept tightly closed, and strips or tablets should not be touched with hands.

The test procedure for determining the specific gravity of urine is not complicated, but it must be properly done. The specific gravity is read from the urinometer (hydrometer). This small, fragile instrument is made of two parts: a cylindrical container for holding urine and a calibrated, bulb-tipped float. A urine specimen is poured into the container to within 2.5 cm (1 inch) of the top. The specimen must cool to room temperature because heat will influence the reading. The float is then placed in the urine with a gently spinning motion and allowed to settle, but not to rest on the bottom of the cylinder. Wetting the stem above the urine level should be avoided since this also will influence the reading. When the float comes to rest, the cylinder should be held at eye level with the float kept away from the side of the cylinder. The calibration on the float is a range from 1.000 to 1.040. Read the number on the float at the bottom of the meniscus of urine. The cylinder should be inverted or rinsed and dried after testing.

Data on Clinical Laboratory Tests

A

ABO grouping, blood This test classifies the patient's blood as group A, B, AB, or O. The factors determining these blood groups are inherited in accordance with Mendel's law. Subgroups of group A and of group AB can be determined.

acetone, serum or plasma See *ketones, serum* or *plasma.*

acetone, urine See *ketones, urine.*

acid phosphatase, serum (13, 18)* This enzyme is termed "acid" because it functions best at a pH of approximately 5. The enzyme is present in high concentration in the prostate gland. Patients with metastatic carcinoma of the prostate gland show elevated serum acid phosphatase levels. Since another form of acid phosphatase is present in erythrocytes and platelets, laboratory methods that delineate the "prostatic fraction" acid phosphatase are often employed. Normal values vary according to method used, and test results are expressed in several different kinds of units. The contribution of the prostate to seminal fluid gives the fluid so high an acid phosphatase level that a test for the enzyme is done on vaginal aspirate as a part of the examination for alleged rape.

*A key to numerical notations is given on inside front and back covers.