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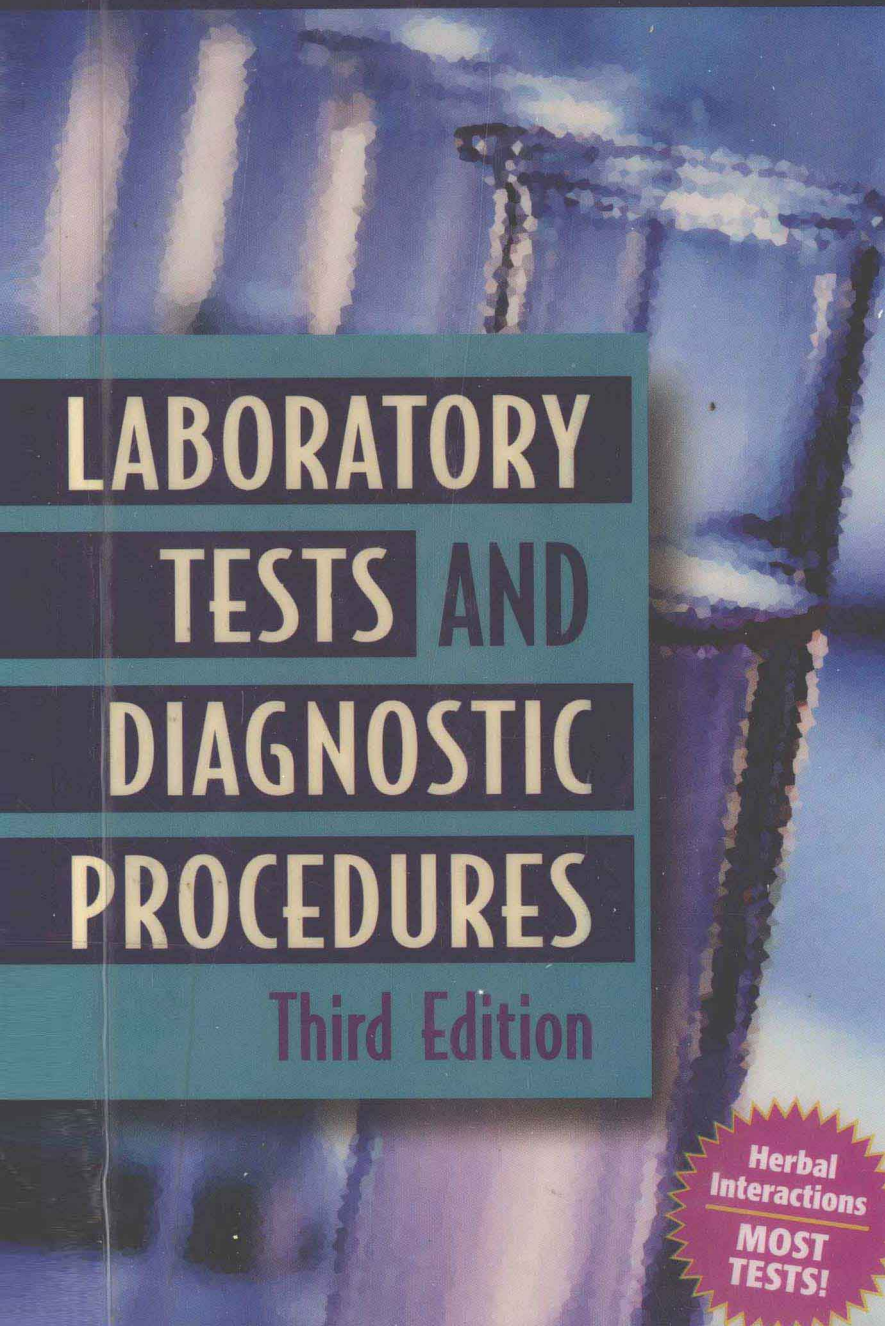

LABORATORY TESTS AND DIAGNOSTIC PROCEDURES

Third Edition

Herbal Interactions

MOST TESTS!

LABORATORY TESTS AND DIAGNOSTIC PROCEDURES

Third Edition

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Preface

We are pleased to announce the arrival of the third edition of *Laboratory Tests and Diagnostic Procedures.* The text is completely alphabetical, fully cross-referenced, and indexed. There is no need to know which body system is tested or whether the test uses blood or urine or is diagnostic to locate the test. The best advantage, we believe, is that all the information is complete and contained within one cover. There is no need to waste valuable time referring to multiple texts or flipping between sections to obtain test-specific information. A valuable new feature is the addition of herbal and natural-remedy effects on test results, timely information essential for screening clients before testing. Another new feature is the inclusion of Medicare-approved panels for laboratory testing. Other special features are inclusion of medicolegal implications, panic levels and symptoms and emergency treatment for panic levels, dialysis implications for timing of blood draws or treating high levels, client and family teaching, risks of and contraindications for procedures, and whether written consent is needed. The content is basic enough for novices and complete enough for seasoned practitioners. It has significant value for both students and practitioners of medical technology, medicine, and nursing and is the kind of reference to use throughout one's career. It is appropriate for the many specialties within the professions, and it includes information from across the life span.

The text is organized into two parts. Part One is designed to help the practitioner confirm a suspected diagnosis or condition as well as to provide additional conditions that may demonstrate similar symptoms. Part Two lists the tests and diagnostic procedures in alphabetical order with normal values; panic-level symptoms and treatment, including whether the substance is dialyzable; usage or conditions in which the values may be abnormal; and a concise description of the test and its significance. This edition also includes expanded information on consent requirements, risks and contraindications, client and family teaching, and the details of the test and client care, as well as integration of the most current scientific literature. Other features include the use of shading in Part Two for ease of use, reduction of blood sample volumes to the minimum amount required (to help avoid iatrogenic anemia), information on whether blood samples can be drawn during hemodialysis, expansion of age-specific norms, and improved quality-assurance information on factors that interfere with results. Finally, a comprehensive, international, up-to-date bibliography of specific resources is included to direct practitioners to additional information about each test or procedure.

Other features of this edition include the newest tests in many fields. Cross-referencing of the test and procedure names includes all associated acronyms to expedite the location of each. The index now includes a synthesis of diseases, tests, and procedures for the entire book in one place. The format of this text is the product of years of clinical practice and expertise. It has been written *by* practitioners *for* practitioners. The invaluable contributions of a large number of clinical experts and their contacts who freely shared the most up-to-date information about the tests, procedures, and medical conditions are a most valued feature of this edition.

The purpose of this text is to provide complete information to guide practitioners or students in the clinical care of clients. Applicability of information in a text of this type is relative. Although we have used reliable and current sources in the compilation of the book, variations in laboratory techniques and client conditions must be considered for interpretation. The normal and panic levels listed are not meant to be used as rigid separations of normal and abnormal but rather as guidelines for consideration within the context of individual client conditions and laboratory specifications.

We have provided information regarding procedures that may require separate consent forms, or those beyond the general institutional consent form. Certainly there is much variation among institutions regarding whether a consent form is necessary. At the minimum, oral consent is generally documented. We have provided what is general practice according to the literature and the experience of our expert contributors across the country. However, we caution that institutional protocols vary and should, of course, be consulted and followed. Regardless of whether formal consent is obtained, it is the responsibility of all health care professionals to educate clients undergoing *any* test or procedure. Teaching about the test or procedure must be tailored to the client's and the client's family's condition, language, comprehension, anxiety level, clinical goals, and other specific needs.

Most drugs in this text are listed by their generic names. This includes specific tests to determine drug levels in either blood or urine and includes within these tests names of drugs that may interfere with the test results. Generic names have been used to save valuable printed space and to avoid confusion attributable to multiple trade names. We must stress that, in judging possible drug interferences, the clinical evaluation of the client should remain primary in the process of interpreting test values. Clearly it is impractical to discontinue all medications to get a "pure value." If, however, a drug is known to cause severe interferences with the test results, it is clearly stated, and the drug should be discontinued when possible.

With concern about the transmission of blood-borne pathogens and in view of the content of this text, it is imperative to address the safe handling of specimens. In 1994, the Centers for Disease Control and Prevention (CDC) published "Standard Precautions," which include guidelines for isolation precautions in hospitals, designed to prevent the transmission of the hepatitis B virus and the human immunodeficiency virus (HIV). A condensed and current version of these recommendations is provided. Most institutions currently follow these guidelines in some version, and we recommend referral to individual institutional protocol.

Years of research and writing went into the completion of this text. It could not have been done without our many dedicated professional contributors, without the assistance and support of our editors Terri Wood and Brian Dennison, and without the support of our families, friends, and professional colleagues. We know that we have acquired much knowledge through the process of writing and editing this book. We believe that the book is a valuable tool for all health care professionals.

Cynthia C. Chernecky **Barbara J. Berger**

Acnowledgments

It is with humble thanks that I dedicate this book to all those who have helped in its creation, support, and update and in particular to those who use it in their practice and education. This book has been a labor of love and continues to be used on both the national and international levels. I fully believe that an excellent clinical book on labs and diagnostics is what the clinical caregiver needs to give excellent care to persons who are ill and to all persons who have a right to disease prevention. This book was designed by clinical practitioners and is updated by experts in various fields who share their expertise so that the fulfillment of up-to-date excellent care can be sustained as a reality. There are others who though they did not write were supportive in ways that we can all understand—these are people who have integrity, caring souls, faith, and a sense of humor: my mother Olga, late father Edward Chernecky, stepfather Robert McGuinness, godmother Helen Prohorik, godsons Jonathon Tarutis and Vincent Hunter, goddaughter Dawn Priscilla Payne, brother Dr. Richard Chernecky, nieces Ellie and Annie Chernecky, nephew Michael Chernecky, cousins Paula Smart, Karyn Tarutis, and Philip Prohorik, friends Marge Barriusso, Ursula Grimmett, Jack and Rebecca and MaryBeth Chaoussoglou, Mike and Lydia and Nina Mytrohovich, David and Janice Douglass, Deserra and Mark Halischack, colleagues Dr. Jean Brown, Dr. Mary Cooley, Dr. Lorraine Evangelista, Dr. Ann Kolanowski, Dr. Ruth McCorkle, Dr. Linda Sarna, Dr. Roma Williams, and those who keep me focused in life itself: Mother Thecla and Mother Helena of Saints Mary and Martha Orthodox Monastery in South Carolina, Priest Gregory and Presbytera Raisa Koo, Priest Antonio and Matushka Elizabeth Perdomo, and Priest Jason and Matushka Kappanadze. It never fails to surprise me when I meet an Orthodox member of His Holy, Catholic, and Apostolic Church who has found true joy in that he or she has found the truth in the faith that we trace back to the time of Christ himself. Although many people search for the real truth—not what other humans tell you is the truth to make you feel better—there are also many who do not seek the truth. I know from my life that the truth is worth the search, for glory and peace can be found only through the often grueling search and commitment to the one true faith.

To the universities that have shared their knowledge with me, I thank the University of Connecticut, Yale University, University of Pittsburgh, Clemson University, Case Western Reserve University, University of Wisconsin Oshkosh, University of California at Los Angeles, and the Medical College of Georgia.

As we continue in further editions of this book, I do not know what else to say about my coeditor, coauthor, friend, and colleague Barb Berger that I have not already said. We work well together, know how to laugh, know how to work hard, and have a commitment to care with an eye for quality research to make each and every edition packed with quality information and timely updates. This book is a massive project, and I could not have accomplished it without trust, equality, respect, and admiration, which is what Barb and I have for one another and why we make such a great team.

To all nurses, physicians, attorneys, and other health care professionals who give true meaning to this book by using it we respect your comments

and suggestions—after all we are all striving for the same goals in our respective services.

My personal thanks goes to Beverly Dickey, whose professional executive secretary skills made this edition a reality in more ways than I can ever count; to the people at Harcourt who it is a pleasure to work with: Barbara Nelson-Cullen, Catherine Ott, and Brian Dennison; and finally to my dogs, Sasha and Josh, who without their unconditional love I would be less happy and laughing a lot less (at least this time they did not eat part of the printed manuscript)!

Cynthia (Cinda) Cecilia Chernecky

My thanks and gratitude for their meticulous attention to detail and sharing of their expertise go to current and past contributors of this text. With sincere appreciation, I thank the nurses and physicians of University Hospitals Health Systems Bedford Medical Center. Seeing them frequently using the second edition helped keep me focused on making the third edition even more useful in practice. The reason we write this book is to provide busy health care providers and students with an accurate, sophisticated, up-to-date, ready reference of "need-to-know" information. The addition of herbal and natural-remedy effects on laboratory and diagnostic test results is the newest valuable feature of many that sets this book apart from others available. Special thanks go to Michael Petit, our University Hospitals of Cleveland core librarian who helped me with the herbal research, and to Carl Masthay, our production editor whose special knowledge of different languages helped make sure that the herbal names are spelled correctly. Thanks also go to our editor, Brian Dennison, for his good advice and helpfulness as we approached the completion of the manuscript. Thanks go to my husband, Stephan Berger, who shares my pride in this work and does more than his fair share keeping the home front running, so that I can spend time working on the manuscript. My mother, Alice Adams, and father, Arlington Adams, recently deceased, once again supported and encouraged my work on this third-edition text. Finally, thanks to Cinda Chernecky, my excellent coeditor and friend, who has rewritten the definition of "burning the candle at both ends" to "the candle is shaped like a star with many points of energy, all burning brightly at the same time."

Barbara J. Berger

How to Use This Book

This section of the book is designed to assist in full mastery of the format. Although its strictly alphabetical format makes the book easy to use, the following examples may clarify any confusion.

PART ONE

The purpose of this section is to assist practitioners in diagnosing and monitoring the progress of illness or wellness.

Part One is a selected alphabetical listing of diseases, conditions, and symptoms. Beneath each topic is a list of laboratory and diagnostic tests, also in alphabetical order. It is not expected that all the tests listed would necessarily be required or be abnormal for any one disease, condition, or symptom. Rather, any of the listed tests or a combination of tests would likely be performed to aid, confirm, monitor, or rule out that diagnosis or condition.

EXAMPLES

DIABETES INSIPIDUS

Antidiuretic hormone, Serum
Chloride, Sweat, Specimen
Concentration test, Urine
Cyclic adenosine monophosphate, Urine
Electrolyte, Blood or Urine
Osmolality, Serum
Osmolality, Urine
Sodium, Plasma or Serum
Sodium, Urine
Specific gravity, Urine

Additional Conditions

Amyloidosis, Renal
Breast cancer
Encephalitis
Hand-Schüller-Christian disease
Lung cancer
Pyelonephritis
Sickle cell anemia
Sjögren syndrome
Syphilis
Tuberculosis

HYPERNATREMIA

Cholesterol, Blood
Electrolyte, Blood or Urine
Glucose, Fasting, Blood
Glucose, Quantitative, 24-Hour urine
Glucose, Random, Serum
Osmolality, Serum
Sodium, Plasma or Serum
Sodium, Urine
Triglycerides, Blood

Additional Conditions

Dehydration
Diabetes insipidus
Diabetic ketoacidosis
HHNK
Hypotension
Tachycardia

"Additional Conditions" includes other related diseases or conditions that should be considered when one is postulating the diagnoses above. Many of these additional conditions are, in fact, listed elsewhere in the section with their own battery of tests. Notice that Diabetes Insipidus, listed in the Additional Conditions under Hypernatremia on the right above, has its own disorder entry as noted in the example on the left above.

PART TWO

The purpose of this section is to provide a comprehensive, concise, ready reference of practitioner "need-to-know" information about laboratory tests and diagnostic procedures. Features of this section include:

Alphabetical list of laboratory tests and diagnostic procedures.

EXAMPLE

ABDOMINAL AORTA ULTRASONOGRAPHY, DIAGNOSTIC
ABO GROUP AND Rh TYPE, BLOOD

Norms *Norms specific to all known units and all age groups.*

EXAMPLE

UREA NITROGEN, PLASMA OR SERUM

Norm:

		SI Units
Young adult, <40 years	5-18 mg/dL	1.8-6.5 mmol/L
Adult	5-20 mg/dL	1.8-7.1 mmol/L
Elderly, >60 years	8-21 mg/dL	2.9-7.5 mmol/L
Mild azotemia	20-50 mg/dL	7.1-17.7 mmol/L (children)
Cord blood	21-40 mg/dL	7.5-14.3 mmol/L
Premature infant, first 7 days	3-25 mg/dL	1.1-8.9 mmol/L
Full-term newborn	4-18 mg/dL	1.4-6.4 mmol/L
Infant	5-18 mg/dL	1.8-6.4 mmol/L
Child	5-18 mg/dL	1.8-6.4 mmol/L
Panic level	>100 mg/dL	>35.7 mmol/L

Panic Level Symptoms and Treatment *Toxic levels and panic levels with associated signs, symptoms, and emergency treatment.*

EXAMPLE

THEOPHYLLINE (AMINOPHYLLINE), BLOOD

Norm:

		SI Units
Therapeutic	10-20 mg/mL	44-111 mmol/L
Toxic level	>20 mg/mL	>111 mmol/L
Panic level	>30 mg/mL	>160 mmol/L

Panic Level Symptoms and Treatment

Symptoms. Dysrhythmias, gastrointestinal bleeding, headache, hypotension, nausea, restlessness, seizures, syncope, tachycardia, and vomiting.

Treatment
Maintain a patent airway.
Withhold the drug.
Perform gastric lavage.
Give activated charcoal.
Hydrate.
Give diazepam for convulsions.
40% of theophylline may be removed by hemodialysis.
Peritoneal dialysis will NOT remove theophylline.

Usage *Typical conditions or monitoring for which the test or procedure is commonly used.*

EXAMPLE

CARDIAC CATHETERIZATION, DIAGNOSTIC

Usage. Identification, documentation, and quantitation of congenital disorders of the heart and diseases and disorders of the greater vessels of the heart; evaluation of cardiac muscle function; evaluation of coronary artery patency; identification of ventricular aneurysms; and identification and quantitation of the severity of acquired or congenital cardiac valve disease.

Increased, Decreased or Positive, Negative *Conditions that cause abnormal results.*

EXAMPLES

VISCOSITY, SERUM

Increased. Arthritis (rheumatoid), dysproteinemias, hyperfibrinogenemia, myeloma (IgA), systemic lupus erythematosus, and Waldenström's macroglobulinemia.

Decreased. Herbal or natural remedies include *Cordyceps sinensis.*

COOMBS' TEST, DIRECT (DIRECT ANTIGLOBULIN TEST), SERUM

Positive. Arthritis (rheumatoid), elderly clients, erythroblastosis fetalis, hemolytic anemia (autoimmune, drug-induced), infection, neoplasm, renal disorders, systemic lupus erythematosus, and transfusion reaction. Drugs include (possibly because of IgG erythrocyte sensitization by the drugs) aminopyrine, cephalosporins, chlorpromazine, dipyrone, ethosuximide, hydralazine hydrochloride, insulin, isoniazid, levodopa, mefenamic acid, melphalan, methyldopa, methyldopate hydrochloride, oxyphenisatin, *para*-aminosalicylic acid, penicillins, phenacetin, phenytoin, phenytoin sodium, procainamide hydrochloride, quinidine gluconate, quinidine polygalacturonate, quinidine sulfate, rifampin, streptomycin sulfate, sulfonamides, and tetracyclines.

Negative. Hemolytic anemia (nonautoimmune, non–drug induced). Normal finding.

Description *Concise description of the test or procedure, including interpretation of results and significance for various conditions.*

EXAMPLE

UREA BREATH TEST (UBT), DIAGNOSTIC

Description. This simple, noninvasive test involves the measurement of gas released in the breath after ingestion of a radiolabeled urea isotope. The urease of *Helicobacter pylori* bacteria in the stomach generates labeled carbon dioxide (CO_2), known as ^{13}C, within 10 to 30 minutes. This ^{13}C is measured in the client's breath with a sensitivity of 95-98% and a specificity of 97% for the diagnosis of gastric *H. pylori* colonization. This test is useful in pediatrics and is a sensitive indicator of *H. pylori* eradication 6 weeks after treatment with antibiotics.

Professional Considerations *Includes seven types of information.*

❶ *Consent, risks, and contraindications.* Whether a separate special consent form IS or is NOT required. Where tests or procedures carry significant risks, the risks that should be explained to the client are included in a highlighted alert box. Contraindications are in a list of generally accepted conditions (in a highlighted alert box) in which the test or procedure should not be performed or relative contraindications in which the test or procedure should be modified, where applicable.

EXAMPLE

TRANSESOPHAGEAL ULTRASONOGRAPHY, DIAGNOSTIC

1. Consent form IS required.

Risks
Vasovagal bradycardia (common), drug-induced tachycardia (common), transient hypoxemia (common); esophageal perforation and pulmonary aspiration are possible.

Contraindications
Esophageal obstructions, stenosis, or fistula; history of radiation therapy to the esophagus or surrounding area; acute penetrating chest injuries. Neonates and young children are not candidates because of the unavailability of pediatric-sized TEE scopes.

❷ *Preparation.* Includes supplies needed, assessment for allergies, unusual scheduling requirements, procedural preparation requirements, such as establishing intravenous access, and medico-legal handling.

EXAMPLE

HEPATOBILIARY SCAN, DIAGNOSTIC

2. Preparation
   A. Assess for allergy to radionuclide dye, iodine, or shellfish.
   B. Establish intravenous access.
   C. Have emergency equipment readily available for use in the event of an anaphylactic reaction to the radionuclide.

❸ *Procedure.* Step-by-step description of specimen collection or procedural steps, including client positioning and participation, and monitoring required during the procedure. Note: For blood samples, minivolumes (1-3 mL) are listed for tests in which special manual tests may be run in smaller volumes for clients in whom blood preservation is essential. For clients not at risk for iatrogenic anemia as a result of frequent blood sampling, the quickest turnaround times are achieved with higher volumes, which enable automated testing.

EXAMPLE

^{125}I-LABELED FIBRINOGEN (FIBRINOGEN UPTAKE), LEG SCAN, DIAGNOSTIC

3. Procedure
   A. The client's legs are elevated during the scanning to prevent pooling of blood in the veins of the legs.
   B. Iodine-125-labeled fibrinogen is injected intravenously, and serial scans are performed on each leg 1, 4, 24, and 48 hours afterward. Surface radioactivity may be measured daily for as long as 2 days.
   C. Assess for allergic reaction after dye injection.
   D. The extremity is marked in segments along the course of the vein tract.
   E. Areas of fibrinogen incorporation into a thrombus are detected with the counter as areas exhibiting increased radioactivity, indicating increased concentration of radioactive tracer.

❹ *Postprocedure care.* Aftercare instructions regarding specimen handling, site dressing, activity restriction, vital signs, and postsedation monitoring.

EXAMPLE

BRONCHOSCOPY, DIAGNOSTIC

4. Postprocedure care:
   A. No food or fluids until the gag reflex has returned, about 2 hours after the procedure.
   B. The client should not attempt to swallow saliva until the gag reflex has returned. Saliva should be expectorated into an emesis basin. Observe the client's sputum for blood if a biopsy was performed. If a tumor is suspected, collect postbronchoscopy sputum specimens for cytologic testing.
   C. Observe postanesthesia precautions if a sedative was given. If deep sedation was used, follow institutional protocol for postsedation monitoring. Typical monitoring includes continuous heart rate monitoring and pulse oximetry, with continual assessments (every 5-15 minutes) of airway, vital signs, and neurologic status until the client is lying quietly awake and responds to commands spoken in a normal voice.
   D. Observe closely for postprocedure complications listed above under "Risks."

❺ *Client and family teaching.* Instructions the client or family should be associated with precare, procedural care, and aftercare and monitoring as well as disease-specific information, time frame for test results, and follow-up recommendations.

EXAMPLE

VENEREAL DISEASE RESEARCH LABORATORY TEST (VDRL), SERUM

5. Client and family teaching:
   A. Syphilis is a sexually transmitted disease where information regarding sexual partners is necessary for control of the disease.
   B. If testing positive for syphilis and diagnosis is confirmed:
      i. Notify all sexual contacts from the previous 90 days (if early stage) to be tested for syphilis.
      ii. Syphilis can be cured with antibiotics. These may worsen the symptoms for the first 24 hours.
      iii. Do not have sexual relations for 2 months and until after repeat testing has confirmed that the syphilis is cured. Use condoms after that for 2 years. Return for repeat testing every 3-4 months for the next 2 years to make sure that the disease is cured.
      iv. Do not become pregnant for 2 years because syphilis can be transmitted to the fetus.
      v. If left untreated, syphilis can damage many body organs, including the brain, over several years.

❻ *Factors that affect results.* Quality-assurance information about items that will interfere with the accuracy of results, such as improper collection techniques, improper specimen handling, drugs that cause false-positive or false-negative results, and cross-reactivity of other diseases or conditions.

EXAMPLE

PROTHROMBIN TIME (PT) and INTERNATIONAL NORMALIZED RATIO (INR), PLASMA

6. *Factors that affect results:*
   A. Reject hemolyzed or lipemic specimens or specimens received more than 3 hours after collection.
   B. Reject specimens in which collection tubes are incompletely filled because the volume of the sample is not enough for thorough mixture with the premeasured amount of anticoagulant.
   C. Reject specimens not promptly transported to the laboratory or refrigerated.
   D. Concurrent therapy with heparin can lengthen PT for up to 5 hours after dos-

ing. To minimize this influence, blood for PT determinations should be drawn 5 hours after IV heparin and 24 hours after subcutaneous heparin injection.

E. The problem of loss of accuracy or precision of the INR system can be resolved by use of sensitive thromboplastins with ISI values close to 1.0 (WHO reagent ISI = 1.0). However, even without this sensitivity, the INR system is shown to be more accurate than reporting the results as a PT ratio.

F. The use of automated clot detectors requires the use of sensitive thromboplastins or calibration of each new batch of thromboplastins with lyophilized plasmas with certified INR values obtained by the manual method to obtain valid and reliable results. ("True" INR values were obtained by the manual method.)

G. It is recommended that reagents insensitive to heparin be used to avoid obtainment of falsely elevated INRs when heparin and warfarin (Coumadin) are taken concurrently. Innovin and Thromboplastin C Plus meet this criterion.

H. Herbs or natural remedies that may increase PT and INR include *dan*^{1}*shen*^{1} ('red-ginseng', *Salvia miltiorrhiza*), *dang*^{1}*gui*^{1} (variants: *tangkuei, dong quai, Angelica sinensis*) (in clients receiving warfarin concurrently), feverfew, garlic, *Ginkgo biloba,* ginseng, and ginger.

I. Herbs or natural remedies that have a synergistic effect with warfarin to prolong bleeding include *dan*^{1}*shen*^{1} *(Salvia miltiorrhiza), dang*^{1}*gui*^{1} (variants: *tangkuei, dong quai, Angelica sinensis*), *chuan*^{1}*xiong*^{1} (*ch'uanhsiung, Ligusticum chuanxiong* or *L. wallichi, Cnidium,* or *Conioselinum universitatum*), papaya *(Carica papaya), tao*^{2}*ren*^{2} (*Prunus persica* and *P. davidiana,* semen Persicae, peach seed), *hong*^{2}*hua*^{1} (safflower, *Carthamus tinctorius*), and *shui*^{3}*zhi*^{4} (leech, *Hirudo* and *Whitmania*).

I. Antibiotic therapy, mineral oil, and clofibrate can affect the PT.

J. Diets excessively high in green leafy vegetables can increase the absorption of vitamin K, which shortens the PT.

K. A minimum of 100 g/dL of fibrinogen must be present for the PT to be accurate.

L. The PT is affected by many pharmacologic agents, including those that alter protein-binding patterns, those that inhibit the formation of intestinal microorganisms, and those that are precursors of enzyme production.

M. Contamination of the specimen with tissue thromboplastin may alter the results. This is the reason for the double-draw technique.

❼ *Other data.* Selected information from current research that may not yet be generalizable but could be helpful in decision-making for individuals or groups of clients; recommendations for confirmatory testing if the results are positive; direction to other tests related to the same diagnosis or condition and known association between tests; and national guideline information and recommendations, when available.

EXAMPLE

COOMBS' TEST, DIRECT (DIRECT ANTIGLOBULIN TEST), SERUM

7. Other data
   A. This test does not delineate the nature of the antibodies identified.
   B. The test must be completed within 24 hours of specimen collection.
   C. DeAngelis et al. found a high incidence of positive results in clients with antibodies to HIV and suggest that this test may be helpful as a prognostic indicator for the disease course.
   D. See also *Antibody identification, Red cell, Serum.*

Bibliography *Includes listings of current and updated research and literature from both national and international perspectives.*