BONE DENSITOMETRY FOR TECHNOLOGISTS
BONE DENSITOMETRY FOR TECHNOLOGISTS

Second Edition

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DEDICATION

For Momma, Daddy and Sissy and Bo and his family
L.A.L.

For Mom and Dad, Tooney and Charles
S.L.B.
Preface

Bone densitometry is an extraordinary clinical and research tool. Most of us think of densitometry as a relatively recent technological development, but in fact, its history began more than 100 years ago. In the field of dentistry, crude devices by today’s standards were developed in the late 19th century to evaluate the density of the bone in the mandible. The advances in technology continued, albeit slowly, for the first half of the 20th century, gaining some speed in the 1960s and 1970s. The introduction of dual-energy X-ray absorptiometry in the late 1980s truly opened the door to clinicians’ offices for bone densitometry. In the last 10 years, the advances in technology and the introduction of new machines of various types has occurred with almost blinding speed compared with the pace of development during most of the 20th century.

As densitometry has matured as a field, the number of disease states in which bone density is known to be affected has increased. With this knowledge, physicians in many different fields of medicine now recognize the need to measure bone density as part of the management of their patients. More studies are being requested now than ever before. This demand for densitometry has also led to an increased need for qualified technologists to operate the machines.

Densitometry is a quantitative technique, as are measurements of blood pressure and cholesterol. That is, the technology is used to measure a quantity. But of all the quantitative techniques in use in clinical medicine today, there is none that has the potential to be more accurate or precise than bone densitometry. The technology is highly sophisticated. All of the devices in use today employ computer technology. In spite of this mechanical sophistication, however, the technology will only be as good as the technologist.

The densitometry technologist must have knowledge of skeletal anatomy, densitometry techniques, radiation safety, basic statistics, quality control procedures, and the processes of various diseases such as osteoporosis. The technologist must often make decisions about the conduct of testing without immediate input from the physician. The circumstances in which densitometry is usually performed create the opportunity for extended technologist–patient interaction and discussion. For technologists accustomed to performing radiologic procedures, this degree of interaction is unprecedented. Today’s densitometry technologist must be prepared for these encounters.

There is no substitute for the thoughtful training provided by the manufacturers of the various types of densitometry equipment when the devices are installed. There is also no substitute for careful study of the operator’s manuals that are supplied with these machines. The exact operation of each machine is different. To be proficient on any densitometry device, the technologist must be trained on that specific device. There is a broad knowledge base, however, that all technologists
should possess. Bone Densitometry for Technologists, Second Edition is intended to help provide that base.

It is always difficult to know where to begin. Like so many other fields of medicine, densitometry has its own language and conventions that must be explained so that in-depth discussions can be understood. Chapter 1 is an introduction to the terminology and conventions used in bone densitometry. In Chapter 2, a review of the various techniques and technologies used in quantifying bone mass is presented. This review provides some of the historical development of the field as well as discussing the attributes of the various technologies and the differences between them. In Chapter 4, descriptions provided by the manufacturers of all the devices that were approved by the Food and Drug Administration at the time this book went to press can be found, along with photographs of the devices. New models that have become available since the first edition of this book was published in 2002 have been added. This summary description should be useful in determining what skeletal regions can be studied with any particular device, the nature of the technology employed in the device, the patient radiation exposure during a study, as well as other machine specifics. Chapter 5 covers computer basics. Although technologists and physicians are becoming more comfortable using computers and some of us consider ourselves quite “computer-literate,” many of us are not. All of our machines are computer-driven. A basic knowledge of computers is almost mandatory for a densitometry technologist. This chapter cannot substitute for learning the nuances of the specific software that operates any given device, but it should help those who consider themselves beginners or even intermediate computer users. Since the first edition of Bone Densitometry for Technologists, processing speeds have become faster, hard drives larger, and new types of removable storage media have become available. This chapter has been updated to reflect these developments.

In Chapter 3, the skeletal anatomy of commonly measured densitometry sites is discussed, with an emphasis on those attributes of anatomy that are either unique to densitometry or would have an effect on the measurement of bone density at that site. This knowledge is indispensible for the densitometry technologist. It is equally important that the technologist understand the concept of precision and how to measure it. This is presented in Chapter 6. Without the technologist’s careful attention to precision, those factors that affect it, and knowledge of how to calculate it, the physician to whom the results are given will not be able to interpret follow-up bone density studies to determine if the bone density has changed.

All densitometers, as sophisticated as they are, are mechanical devices. Things can and do go wrong. It is imperative that machine malfunctions be recognized as

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soon as possible. Otherwise, the data from the machine that is provided by the technologist to the physician will be flawed. This means that a good quality control program must be in place. It is normally the responsibility of the technologist to not only to create this program but also to monitor it. Quality control procedures are discussed in Chapter 8. Almost all quality control procedures involve scanning a phantom. A discussion of the various types of phantoms has been added to Bone Densitometry for Technologists, Second Edition.

Most, but not all, densitometers are also X-ray devices. Radiation safety then must be a concern. Fortunately, both patient and technologist exposures from X-ray densitometry are incredibly small. Nevertheless, the concept of ALARA (as low as reasonably achievable) demands that the patient, the public, and the technologist be protected from unnecessary exposure to ionizing radiation. In Chapter 7, radiation safety concepts are discussed, with recommendations made for radiation safety procedures at densitometry facilities.

Two of the chapters may seem unusual in a book for technologists. Chapter 9 is a review of the disease for which densitometry is most commonly used, osteoporosis. Chapter 10 is a review of how the data that come from these machines are actually interpreted to diagnose osteoporosis and predict fracture risk. These chapters might at first seem more appropriate in a book written for physicians. However, the densitometry technologist normally spends a significant amount of time with the patient. There is ample opportunity for the patient to ask questions of the technologist about osteoporosis and about the test that he or she is about to undergo. The knowledgeable technologist can be a vital link in the education of the patient. He or she can allay unnecessary fears and encourage appropriate medical followup. The technologist is not usurping the role of the physician by doing so if the technologist understands the issues involved. Indeed, the complete medical care of the patient must involve a partnership between the technologist and the physician. The final diagnosis and treatment recommendations for any patient must be left to the physician, but within those bounds there is much that the technologist can do that will actually strengthen the patient's trust in the quality of their care and improve compliance with the medical recommendations. The technologist who understands as much as possible about what the physician will consider as he or she looks at the densitometry report will only be better able to aid that physician in the performance of their profession. Since the publication of the first edition of Bone Densitometry for Technologists, new drugs have been approved for the prevention and/or treatment of osteoporosis and new guidelines have been issued for bone density testing and pharmacologic intervention based on that testing. This information has been added to Chapter 9 in this edition.

In the last few years, densitometry has been applied increasingly in pediatrics. The technical considerations for pediatric densitometry are different from those of adult densitometry and the interpretation of data even more complex. This is an area that is expected to grow, however, and so many of the confounding issues in pediatric densitometry are addressed in Chapter 11 for the first time in this second edition.

Finally, in Chapter 12, there is a review of skeletal morphometry performed with dual-energy X-ray absorptiometry as well as body composition analysis.
These two applications of dual-energy X-ray absorptiometry take the technology beyond the measurement of bone density. Skeletal morphometry, particularly vertebral fracture assessment, is expected to become an integral part of the fracture risk assessment of the postmenopausal woman. Body composition analysis with DXA is an application that is only beginning to achieve some prominence in clinical practice, but its advantages become obvious when compared with other body composition methods. This chapter, like Chapter 11, is completely new in *Bone Densitometry for Technologists, Second Edition*.

The 12 appendices have been updated wherever necessary to reflect the most current information available. Contact information for densitometry equipment manufacturers and organizations of interest can be found in Appendix I. Every attempt was made to verify the accuracy of this information at the time this book went to press. Guidelines for bone density testing and CPT codes have been updated in Appendices III and V, respectively. New conversion equations have been added to Appendix VII and new terms have been added to Appendix XI. Finally, in Appendix XII, the contents of the new CD-ROM are reviewed. On this CD, you will find the Precision Calculator Companion that was first included with *Bone Densitometry in Clinical Practice, Second Edition*, and with which you will be able to calculate the short-term precision and least significant change values for your facility as well as the statistical confidence level for any measured change in BMD. These concepts are discussed thoroughly in Chapter 6. There is also a patient questionnaire that may be customized for your facility. A continuing education review is also found on the CD, which, if successfully completed, may result in the awarding of 15 hours of Category A credit acceptable to the American Society of Radiologic Technologists.

As a technology, bone densitometry is really quite extraordinary. The ability to quantify the density of the bones at a variety of skeletal sites has truly revolutionized the approach to a number of diseases, the most important of which is osteoporosis. Using the information from the machines, physicians can recommend and prescribe interventions that will stop bone loss and prevent disabling fractures. The remarkable advances in skeletal imaging with densitometry devices have made possible quantitative and diagnostic assessments of skeletal structure. But it is in fact the skill and concern of the technologist that enables all of this to happen. It is our hope that *Bone Densitometry for Technologists, Second Edition* assists you in your pursuit of excellence in your profession.

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CONTINUING EDUCATION

The Companion CD for this book contains a continuing education test good for 15 hours of Category A credit from the American Society of Radiologic Technologists (ASRT). Instructions for the test are contained within the program. The Program also includes links to a Patient Questionnaire in Word format and a Precision Calculator for Bone Densitometry Technologists in Excel format.

The CD-ROM program requires one of the following:
• A PC running windows 98 or higher
• Mac OSX 10.2 or later
• Mac OS 9.2

Additional software is required for use with the linked Word and Excel documents. A printer is required to print the results of the test.