Radiation Exposure and Image Quality in X-Ray Diagnostic Radiology

Horst Aichinger, Joachim Dierker, Sigrid Joite-Barfuß, and Manfred Säbel

New York, NY: Springer, 2003, 212 pages, $99

Radiation Exposure and Image Quality in X-Ray Diagnostic Radiology provides a clear understanding of the relationship between radiation dose and image quality in optimizing medical diagnostic radiology. The book would be useful for medical physicists, engineers, and diagnostic radiologists working on problems of image quality and patient-dose estimation. Included are 199 figures and 78 tables of data needed to calculate the important metrics described in the book (e.g., image quality and patient dose). A complementary CD-ROM contains data in the form of Excel (Microsoft) files for calculating these metrics.

The book begins with an introduction describing the structure and contents of the 3 main parts of the book. The first of these parts, "Physical Principles," contains 7 chapters reviewing the basic physics of diagnostic radiology. Chapters 2 and 3 describe the physics of x-ray production and measurement and the interaction of x-rays with matter. Chapter 4 introduces the terms describing the radiation field and dosimetric quantities. Chapter 5 covers attenuation of x-rays by the patient and x-ray system. Chapter 6 thoroughly discusses the properties of scattered radiation and techniques to reduce scatter at the image receptor. Phosphor screens and digital image receptors are briefly discussed as well. Image quality and its dependence on exposure parameters are discussed in chapter 7.

The second of the 3 main parts of the book, "Clinical Applications," contains chapters addressing radiation exposure to the patient, image quality, and optimization of imaging equipment. A thorough evaluation of the dose to the patient is presented in chapter 1. Specific dosimetric quantities used to evaluate doses to patients and organs are discussed. Dose calculations are specifically discussed for radiography, fluoroscopy, mammography, and CT. Calculations of the absorbed dose and effective dose are joined with a discussion of the uncertainties in estimating doses. The influence of scattered radiation on image quality and dose are described in detail in chapter 2, as are the grids commonly used to reduce scatter. Finally, methods of optimizing image quality and dose are presented for general radiography, mammography, and angiography.

The final part of the book, "Supplement," contains 6 chapters providing an extensive collection of figures and tables needed for the calculations discussed in the earlier parts. Specifically, the data provided in the supplemental section include x-ray spectra for diagnostic radiography and mammography, x-ray interaction coefficients, characteristics of the primary radiation beam and the imaging radiation field, and data for estimating patient dose.

Considering that mammography is increasingly being used for cancer screening, its detailed coverage in the book is appropriate. On the other hand, the presentation of CT is confined to dose estimation only, and the discussion of various image receptors used in clinical diagnostic radiography is somewhat brief. Furthermore, the physics and mechanism by which radiographs are acquired and processed by different image receptors, and radiography using computed radiography plates, have not been included.

Nevertheless, this book is of particular importance because it comes at a time when hybrid imaging, such as PET/CT and SPECT/CT, in nuclear medicine is gaining widespread acceptance. In this regard, the book provides an excellent reference for basic information on the terms and methods used for measuring radiation exposure and for calculating patient dose, topics that are becoming increasingly important for development of protocols using hybrid scanners. Detailed examples of such calculations using various CT prescriptions of the PET/CT or SPECT/CT scanners, however, are not provided.

In summary, this book is an excellent reference and resource for medical physicists, engineers, and diagnostic radiologists working on problems of image quality and patient-dose estimation. Each chapter is clearly organized and accompanied by current and appropriate references. The electronic database on the CD-ROM facilitates calculation of important metrics described in the book. In particular, the figures and tables should enable a medical physicist to calculate the scatter-free properties of the x-ray field, estimate patient dose (organ dose, effective dose), optimize radiographic and fluoroscopic exposure parameters, and take into account the influence of scatter radiation on image quality and dose.

S. Cheenu Kappadath, PhD
Osama Mawlawi, PhD
University of Texas M.D. Anderson Cancer Center
Houston, Texas