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Medical Imaging Physics, 4th ed. Wiley-Liss, New York. 2002

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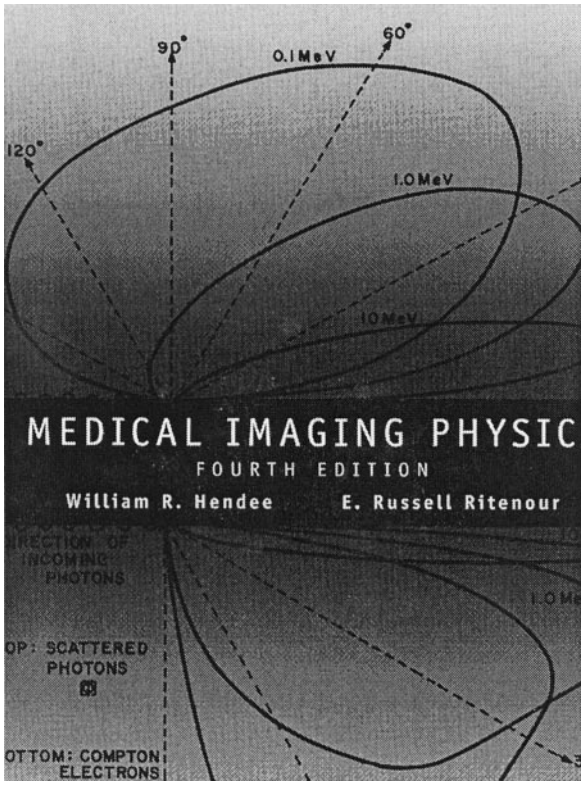
William R. Hendee and E. Russell Ritenour, eds. 4th ed. New York: Wiley-Liss; 2002. 536 pages, $130.00.

Since the introduction of CT in the early 1970s, neuroradiologists have had to be conversant with digital imaging technology and how it affects the diagnostic value of their patients' images. This has never been truer than at the present time, in the face of the broad array of imaging modalities such as CT, MR imaging, digital fluoroscopy, and digital radiography. Add to this that each of these modalities continues to develop. Understanding this technology is not only the task of physical scientists, engineers, and computer mavens, and not even only of the academic clinical scientist. Rather, understanding is needed in the day-to-day radiology trenches to assure the maximum and appropriate clinical use of the technology. Likewise understanding is needed for appropriate decision making concerning equipment purchase and practical implementation of the technology. This textbook purports to, and indeed does, provide a first step toward accomplishing the above mission.

This book is the fourth edition of a well-accepted basic and comprehensive text on medical physics and medical imaging. A number of very valuable features that enhance the learning experience, however, have been incorporated into this new edition that makes it quite different from your father's basic physics textbook. For example, one major innovation is that the authors have included many margin notes. These notes include historical vignettes, explanatory notes, and summaries amplifying the text. One cannot help but enthusiastically read these notes even before reading the main text. Further innovations include a statement of teaching objectives before each chapter and a summary at the end of each chapter. For most chapters, there are numerous examples with worked-out solutions. With few exceptions, there are study questions at the end of each chapter, many of which have answers listed in the back of the book. Finally, each chapter has its own bibliography. These features and innovations make for easy reading and greatly enhance the learning process as well as enable the busy radiologist to access and digest the material quickly.

This text is divided into 30 chapters and four attached appendices. It has 512 pages, including the table of contents. Each chapter has a generous number of graphic illustrations, figures, and images that with few exceptions are of high quality. The following is a short description of each section.

The first chapter is an overall review of medical imaging. It includes a historical review covering CT, MR imaging, and nuclear medicine technology. On the basis of rapidly evolving applications in functional MR imaging and positron emission tomography (PET), the authors correctly state that medical imaging has evolved from a technology-driven discipline to one of clinical demands and unresolved biological questions important to the diagnosis and treatment of diseases. This new emphasis encourages new imaging methods and approaches.



Six chapters are devoted to basic radiologic physics. This includes the usual topics in structure of matter, radioactive decay, interactions of radiation with matter, radiation production, radiation units, and radiation detection. The three following chapters further emphasize nuclear medicine topics in probability statistics as well as nuclear and clinical instrumentation. One of these chapters has a particularly useful section on radioactive agents for clinical studies and mechanisms of radiopharmaceutical localization. The section on PET is, unfortunately, somewhat brief. These chapters are useful to the neuroradiologist who may want a quick and simplified description of the more important aspects of nuclear medicine technology.

One chapter is dedicated to computer systems, networks, and PACS. More on these topics would have been welcome. One chapter each covers the areas of radiography and fluoroscopy. These latter chapters include an introduction to computerized and digital radiography as well as digital fluoroscopy. Digital

fluoroscopy, however, has scant coverage and can serve only as a very brief introduction. Three excellent chapters on image quality measures and visual perception follow. Of particular value is the section on receiver operating characteristic curves and associated discussion on sensitivity and specificity. This reader would have welcomed even more material in this area. The one chapter covering CT is somewhat thin. It covers spiral scanning only briefly, and there is no mention of multidetector row technology.

Three somewhat comprehensive chapters are dedicated to sonography. Coverage in these chapters include not only basic sonography and Doppler physics but also discussions on transducer design and beam-intensity envelopes as well as the expected coverage on linear and phased arrays. What is missing, however, is mention of the recently evolving applications of nonlinear technology, harmonic, and power imaging and contrast media effects. Color flow and sonography artifact discussion is brief. Three chapters are also dedicated to MR imaging. These MR imaging chapters provide a very basic introduction to MR imaging physics and spectroscopy. Included are sections on magnet types, bioeffects, and site planning. The interested reader would have to go to the specialized sources for more in-depth discussions on pulse sequences, MR angiography, and fast imaging.

There are two excellent chapters on radiobiology followed by two comprehensive chapters on radiation safety. Patient radiation dose is of great concern to the neuroradiologist. This is due to the necessity for extended time neurointerventional procedures and the escalating doses resulting from CT fluoroscopy, multisection CT, and three-dimensional imaging techniques. These chapters include not only the basic principles of radiobiology, but also very useful reviews on dose-response models and radiation risk estimates. The radiation safety chapters cover protection from external and internal sources of radiation. The external sources chapter describes effective dose limits for radiation workers and for the general public. Of great value and interest is the section on patient dose estimation for both radiography and for fluoroscopy. Included are very useful tables showing radiation doses to the skin and the embryo or fetus. Also included is in-depth coverage of barrier shielding design of facilities. Although neuroradiologists may not actually perform such calculations, this section does make clear the factors involved that determine final barrier thicknesses needed and the resultant costs. The internal sources chapter is heavily loaded with radiation dose mathematical calculations, more than what a clinical neuroradiologist would normally care to wade through. This presentation, however, is consistent with what a general medical physics text is expected to cover.

The thirtieth and last chapter of this book is the authors' peek into the future and the challenges to imaging technology that can be expected. The authors rightly point out that the imaging revolution is not yet over and that many of the advances now and in the future will be based more on functionality than on anatomy. A very interesting list of emerging and potentially viable imaging technologies is presented. Included are discussions of electrical source imaging, magnetic source imaging, electrical impedance imaging, optical imaging, and phase-contrast imaging. The attractive features, as well as the current limitations of each of these modalities, are discussed. The bibliography presented will allow further exploration by the interested reader. Finally, some of the challenges in information management and image communications that must be overcome in the future are discussed.

The four appendices include a review of mathematics, the Fourier transform as applied to Doppler sonography and MR imaging, multiples and prefixes, and the expected table of isotopes, listing of mass numbers, and atomic mass units.

In addition to the basic physics sections, the Image Perception, Radiation Safety and Radiobiology sections were quite comprehensive; however, due to the very introductory coverage of CT, MR imaging, digital fluoroscopy, image processing, and PET, the interested reader will have to go to other more specialized sources for detailed in-depth discussions concerning these topics. The authors facilitate this by providing an abundant bibliography. The bibliography itself is specific for text citations; more references to recent review articles would have been highly welcomed.

Overall this text was found to be an excellent, first-stop resource on basic medical physics imaging technology. It is an introduction to basic radiologic physics typical of texts catering to the needs of radiology residents. It also covers the basic physics and introduction to the various imaging modalities of interest to the neuroradiologist and is therefore recommended for this purpose.