Book reviews


This book is a data source rather than a standard text. It should provide valuable material to aid medical physicists in performing calculations relating to patients dose and image quality. The text is well written and often gives a different slant on topics to standard texts. Many useful figures are included to aid the understanding of relationships between the various quantities. The book contains a wealth of data for use in dose calculation and evaluation of image quality put together by physicists working in diagnostic X-ray equipment development and hospitals. The data are based on measurements from diagnostic X-ray tube assemblies, supplemented with results of measurements on phantoms and computer simulations.

The book consists of four parts of which the first is a brief introduction about the content. The second part on physical principles contains seven chapters. Straightforward explanations are given of X-ray production, interactions of X-ray photons with matter, radiation dosimetric quantities, the importance of scatter, the penetration of X-rays, and brief treatments of image receptors and image quality. The application to some clinical problems is considered in the third part of the book, which contains three chapters. The assessment of patient dose is discussed, with X-ray mammography being treated in some detail. Problems relating to scattered radiation are considered in the second chapter and optimization to achieve the correct balance between patient dose and image quality in the last one. The final part of the book (page 117 to the end) is a supplement containing tables of data and graphical portrayals of X-ray spectra, interaction coefficients, characteristics of X-ray beams, anti-scatter grids and detectors, and other data which might be useful in patient dose calculations. Graphs are included to show how quantities such as contrast improvement, signal to noise ratio, scatter fractions and relative dose depend on X-ray tube voltage. This is complemented by a CD-ROM containing folders with Excel data files for the user to employ in calculations and it is this that will be the most valuable component for the user.

The book and CD will be a useful addition to the library of those involved in calculations of patient dose. It is designed for the specialist and although it is well written and provides an insight into the various topics covered, it is not sufficiently comprehensive to be a standard textbook. However, those trying to understand in more depth the factors involved in optimizing imaging parameters and carrying out practical simulations of diagnostic applications will find it a useful reference.

C J MARTIN


This is a large, weighty tome dealing with clinical applications of PET in considerable technical detail. The book is divided into 10 parts with the initial 12 chapters in part one on the basic sciences and development of PET imaging, tracer kinetic modelling in PET, quantitative methods for PET and the development of molecular markers for PET. Part two looks at applications in the central nervous system with seven chapters looking at specific clinical areas including dementia, movement disorders and cerebrovascular disease. Part three looks at cardiorespiratory applications focusing on pulmonary function and myocardial perfusion and viability. Part four, which is a large component of the book, with 18 chapters looks at the applications of PET in oncology with excellent detailed sections written by leading figures in the oncological imaging field, which cover the majority of oncological applications. Part five on infectious diseases and six on paediatrics are relatively small but detailed and parts seven, eight, nine and ten deal with technology developments, the evaluation of PET technology and its use in none clinical applications such as drug development and gene therapy.

I would not pretend to have read this book from cover to cover. I have, however, dipped repeatedly and in some depth into some of its parts and have found it to be an incredibly useful source of education. The descriptions of the technical applications of PET and its problems and of the isotopes available are excellent. Some sections inevitably become highly mathematical but there is good text explanation of the implications of the maths and the less mathematically literate should not be put off reading these chapters since they are well constructed and the major points are made quite clearly without recourse to the maths.

Overall this is a superb book for anybody working with PET, whether it be as an introduction to the speciality or for those really quite experienced in specific areas. For those seeking an introduction to applications of PET in particular clinical diseases it is absolutely excellent, giving not only a superb up to date overview of the application but also strong referencing, which allows the reader to find appropriate articles in any given area.

I would not have any hesitation in recommending this book to clinicians involved in PET imaging at any level.

A JACKSON


This report is a comprehensive re-appraisal of absorbed dose specification as applied in nuclear medicine. It is
common practice, at present, to use mean absorbed dose to assess radiological risk or to quantify the efficacy of a therapeutic procedure, with the underlying assumption that the radionuclide is distributed homogeneously within the target tissue. It is unusual for any assessment to be made of the effect of the varying dose rate as the dose is delivered. With regard to radiological risk, the question is whether mean absorbed dose provides an appropriate prediction of the risk. (In one example noted in the report, Auger electron emitters incorporated in the DNA chain were found to be more radiotoxic than expected from the mean absorbed dose.) The report examines the consequences of non-uniform distributions of radioactivity, variation in dose rate and its effect on biological response, the need for individual rather than standardized dose estimates (particularly in targeted radionuclide therapy), and advances in technology that facilitate more accurate measurement of the parameters that determine absorbed dose. The MIRD schema, along with its strengths and limitations, are reviewed.

After the Executive Summary and Introduction, the bulk of the report is contained in four chapters and two appendices. The first of these chapters is a review of the biological responses to ionizing radiation, dealing with DNA damage and repair, chromosomal aberrations, germ-cell damage, developmental defects, carcinogenesis and response to therapy. Unlike external beam therapy, irradiation from internal radionuclides is characterized by declining dose rates and marked discontinuities in dose distribution and hence there is a need to understand how biological responses are affected by dose distributions in space and time. Several aspects of radionuclide therapy are discussed. For instance, a feature of most therapeutic radionuclides is that the radiation dose is delivered at a low rate with an effective half time of days, which is long compared with the repair half-time for cultured mammalian cells (range minutes to hours). This renders the dose less effective than an acute dose of the same magnitude. It is also noted that fractionation and protraction of external beam therapy are thought to allow previously hypoxic cancerous tissue to re-oxygenate, hence reducing radioresistance. In order to achieve the benefits of re-oxygenation, targeted radionuclide therapy would require to be fractionated, which poses practical difficulties, although multiple administrations in animal models have been shown to mimic fractionation. Tumour size and the uniformity of uptake also influence therapeutic effectiveness. The report points out that there is a conflict in the requirements of an ideal radionuclide: one with short range emissions would be best for microscopic disease whereas one with long range emissions would be best if the radionuclide distribution is non-uniform. Hence the reason for the proposed use of “cocktails” of radionuclides.

The next chapter is a description of the MIRD schema, which is widely used within the nuclear medicine community. In considering its strengths and limitations, the report reiterates that the MIRD schema was originally devised to produce mean organ doses in diagnostic procedures for the assessment of risk. However, more recent adaptations have included the calculation of cellular “S” values and the use of a revised model of the adult head and brain to produce regional “S” values. The use of a constant “S” value is inappropriate in situations where the mass of the target may change whilst the radionuclide is still present (e.g. an irradiated tumour undergoing growth or shrinkage).

Dosimetric aspects of non-uniform distributions of radioactivity are covered in the next chapter. Included also is basic information on the different types of radionuclide decay processes, the corresponding radiations emitted, and the energy deposition and range of the same in tissue. There are several figures illustrating non-uniform uptake within assorted tissue elements. Some of the distribution data are tabulated, with one of the tables showing the subcellular distribution of several common radiopharmaceuticals. In the case of $^{99m}$Tc pertechnetate, for example, 93% of the cellular activity is contained in the cytoplasm and 7% in the cell nucleus, with half of the latter localized on the DNA. The dosimetric consequences are significant. In one of the examples given in the report, it was shown that $^{99m}$Tc albumin colloid concentrates in macrophages in the spleen and liver of mice. These cells occupy only 0.1–1% of the total volume of the organ and consequently receive absorbed doses that are 10–60 times those to surrounding cells. The increasing awareness and observation of non-uniform distribution of radionuclide has led to more sophisticated modelling and hence regional “S” factors including subcellular “S” factors for alpha particles and Auger electrons.

The chapter ends with a review of models used to describe the time course of radionuclide in the regions of interest and methods used to control, and alter, the same. Guidance is given on extrapolation of animal data to humans.

The final chapter includes an overview of the techniques used to quantify radionuclide uptake and to determine its localization volume. Published work on the use of SPECT and PET in these areas is reviewed as well as techniques used to compare estimated with actual measurements of absorbed dose. The question of individual patient dosimetry is addressed, the main requirements being: (1) knowledge of the anatomy (CT or MRI image set); (2) knowledge of the radionuclide distribution (SPECT or PET image set); (3) method of linking these two together with co-registration of the image sets; (4) method of calculating absorbed dose. In other words, the practical implications are not inconsiderable and would place a substantial strain on resources.

Appendix I explains the concept of biologically equal effective dose and its application in radionuclide therapy as against external beam therapy. In essence, it is a means of assessing the effectiveness of absorbed doses delivered in high dose rate fractions or, in the case of radionuclide therapy, delivered continuously with a declining rate, taking into account the ability of cells to repair. Appendix 2 contains basic decay schemes for a few radionuclides used in nuclear medicine. However the schemes lack detail, there being a paucity of data on the nature of the emissions, their intensity and energy.

In summary, the report succeeds in being a comprehensive review of the challenges facing the specification of absorbed dose in state-of-the-art nuclear medicine. With around 600 references it is unlikely that any relevant or significant work has been excluded. Whether it should found in the bookshelves of all nuclear medicine...

The message about this book is do not be put off by the title. On reading the title I expected a dense tome of indecipherable physics. I was therefore very pleasantly surprised when I eventually steeled myself for what I thought was going to be a difficult review to find this book readable and only in part as a non physicist difficult to follow. The books contents are wider than the remit of the title would suggest containing chapters not only on Doppler waveforms but a clear summary of cardiovascular physiology and also of haemodynamics. Less than half the book is in fact on blood flow and Doppler physics and measurement. The book is clearly illustrated and contains numerous examples of Doppler flow patterns from normal physiology and good clinical examples of pathology.

The book will be of primary interest to staff working in vascular labs but the book will hold interest among radiologists both in training and established ultrasonographers. There is some general radiological content as topics do include studies on hepatic blood flow and explanations of renal artery disease and blood flow in other organs. The primary focus of clinical interest is however in the carotid artery and the peripheral system, these areas are covered in depth there is a particularly helpful section of appendices at the end, which shows reference images of normal waveforms. Although cardiac physiology is discussed well in the book, this is not a book which deals with clinical cases of cardiac disease or normal cardiac Doppler findings and therefore the interest to cardiologists would be limited.

In summary this is a good value book, which would be of value to trainee and consultant radiologists, sonographers, radiographers and physicists involved, in non-cardiac Doppler investigations.

M R Rees