

Preface

Positron emission tomography (PET), a powerful research tool 20 years ago, has recently gained widespread application in oncology and is now a procedure clinically available on each continent. Despite the fact only a few PET centers are dedicated to children, data from Children's Oncology Group indicate that virtually all children in North America have easy access to a PET center. As the table of contents of this book indicates, clinical and research applications of PET for children with cancer represent only a fraction of the current pediatric uses for PET technology. Small animal PET scanners are now available commercially as there has been tremendous interest in applying PET technology to in vivo imaging of animal models.

PET can dynamically image trace amounts of radiopharmaceuticals in vivo. By applying appropriate tracer kinetic models, tracer concentrations can be determined quantitatively. In addition to superior spatial resolution and quantitative potential, PET also offers much greater sensitivity (i.e., number of γ -rays detected per unit injected dose) than single photon emission computed tomography (SPECT). Furthermore, the biologic ubiquity of the elements that are positron emitters gives PET unprecedented power to image the distribution and kinetics of natural and analog biologic tracers. Because of the exquisite sensitivity of detection systems to γ -ray emission, these biologic probes can be introduced in trace amounts (nano- or even picomolar concentrations) that do not disturb the biologic process under investigation. By combining a tracer that is selective for a specific biochemical pathway, an accurate tracer kinetic model, and a dynamic sequence of quantitative images from the PET scanner, it is possible to estimate the absolute rates of biologic processes in that pathway. Examples of such processes that have been successfully measured with PET include regional cerebral and myocardial blood flow, rates of glucose utilization, rates of protein synthesis, cerebral and myocardial oxygen consumption, synthesis of neurotransmitters, enzyme assays, and receptor assays. In summary, some of the distinctive advantages of PET are its exquisite sensitivity, the flexible chemistry, and the better imaging characteristics of PET isotopes. Thus PET provides access to

biological processes that is well beyond the scope of current MR technology.

Although FDG has been successfully and widely employed in oncology, it has not demonstrated significant uptake in some tumors in adults. Some other positron emitter tracers seem to be more promising. Among the many radiopharmaceuticals that show great potential is the serotonin precursor 5-hydroxytryptophan (5-HTP) labeled with ^{11}C , which shows increased uptake in carcinoids. Another radiopharmaceutical in development for PET is ^{11}C L-DOPA, which seems to be useful in visualizing endocrine pancreatic tumors such as Hyperinsulinism (Chapter 26).

PET is now widely used in children in most health care institutions in North America, Europe, and Asia. When an imaging modality is used routinely in children, it usually implies that it has reached a certain maturity, that the modality in question has achieved widespread recognition in the clinical field by peers. Yet there are no PET books available to pediatricians that offer a comprehensive review of diseases and/or issues specific to children. Often those diseases are not reviewed in sufficient details in “adult textbooks,” and issues specific to children not discussed at all (e.g., sedation, dosage). The goal of this text is to fill those gaps. We did a comprehensive review of all clinical and research applications of PET in children and gathered a distinguished cast of authorities from the Americas, Europe, and Australia to summarize their experience with PET and to perform exhaustive reviews of the literature in their areas of interest. Although this book focuses on practical applications, it includes detailed reviews of current and future research applications.

Pediatric PET Imaging offers a comprehensive review of practical issues specific to the pediatric population such as sedation, radiopharmaceutical dosage, approach to imaging children, and “tips” for technologists. For those interested in the research applications of PET, the book also offers practical reviews of regulations, IRB requirements, ethical issues, and biological effects of low level radiation exposure.

The scope of the pathologies reviewed in this work is much wider than what is seen in the typical “adult textbook.” The physiopathology and the imaging findings of the most common cancers afflicting children are scrutinized. Many chapters of this book review non-oncological applications such as neurological and psychiatric diseases, some unique to children, some affecting both children and adults. Some chapters are thorough reviews of inflammation, or variants of it (FUO, IBD, and infection). New applications that appear to have the potential to offer great clinical usefulness, such as imaging of hyperinsulinism, are included. Because the biodistribution of FDG and the “normal variants” are different in children, two imaging atlases are included to allow readers to become familiar with those idiosyncrasies.

The book also reviews principles of operations and instrumentation challenges specific to children. A chapter is dedicated to coincidence imaging, as some of us do not have access to dedicated PET imaging. (One could also foresee similar imaging findings with coincidence imaging and Tc99–glucose scanning, which may become a viable alter-

native to PET imaging in some precise clinical applications.) Finally, there are also expert reviews of multimodality imaging such as PET/CT and PET/MR.

Pediatric PET Imaging addresses typical concerns about imaging children and will be useful to the nuclear medicine physician who sees an occasional pediatric patient in his/her clinical practice. This book may also become a bedside reference for nuclear physicians and radiologists who practice only pediatric imaging. The book is also designed to be useful to all pediatricians, especially oncologists and radiation therapists, clinicians, or researchers looking to learn how the many recent imaging innovations in PET can influence their own areas of interests. Finally, this book offers a comprehensive review of research issues valuable to scientists.

PET will offer many new solutions to current and future problems of medicine. As a scientific community, we need to ensure that the current or proposed uses of PET are evaluated with the greatest accuracy, rigor, and appropriateness within the inherent limits of our current economic infrastructure. One of our many ethical challenges is to choose which pathology should first be scrutinized.

As PET technology continues to mature, we are seeing the beginning of a powerful merger among biology, pharmacology, and imaging, and with it the true birth of in vivo biologic imaging. Because of the flexible chemistry inherent to positron emitting isotopes, PET is vested with tremendous potential to evaluate the physiopathology of pediatric diseases.

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