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Edited by Victor H. Gerbaudo
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Edited by
Victor H. Gerbaudo
Brigham & Women's Hospital
Harvard Medical School



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To Fabiana, Sebastián and Sofia for understanding, patience and support during this demanding journey,

to my mother and father for believing in me,

to my teachers for wisdom, to my patients and students for inspiration, and last, but not least, to my colleagues who share the desire to conquer disease.

Y para vos Lolo, durante este emprendimiento entendí cuan grande es la verdad que una vez albergaron tus palabras, “no hay mejor pan que aquel horneado por uno mismo” y hoy lo comparto con vos. . .



Dr. Victor H. Gerbaudo is the Director of the Nuclear Medicine and Molecular Imaging Program, and the Associate Director of Pulmonary Functional Imaging at the Brigham and Women's Hospital, Harvard Medical School, in Boston, Massachusetts, USA. He is a clinical Nuclear Oncology scientist with 20 years of

experience in the field. His clinical, teaching and research efforts focus on the in-vivo qualitative and quantitative monitoring of tumor biology, imaging, and response to therapy with PET/CT. His teaching integrates the application of basic concepts of tumor pathophysiology and molecular pathology to oncologic imaging and to the interpretation and integration of imaging results into management decisions. Topics of interest include molecular imaging of tumor cell proliferation, perfusion, apoptosis and glycolytic metabolism. His research focuses on the assessment and characterization of tumor

invasion and metastasis with positron imaging of thoracic malignancies (i.e., malignant pleural mesothelioma, lung cancer), as well as esophageal cancer, brain and gastrointestinal tumors. His work in this area has expanded the use of clinical PET/CT for metabolically guided tumor biopsy and ablation, and for metabolic grading and staging of human tumors, as it relates to histological grade, molecular pathology, surgical stage and survival. He has authored numerous original contributions, reviews, clinical communications and abstracts in the imaging and oncologic peer-reviewed literature, and has delivered more than 100 presentations on the role of PET in oncology around the world. Dr. Gerbaudo is a reviewer for numerous radiology and oncology journals, and serves in the Scientific Program Committee of the Society of Nuclear Medicine as subchairman of the Clinical Oncology track, and as the vice chairman of the education and research committee of the New England Chapter of Society of Nuclear Medicine. He is an active member of the Institute for Clinical PET of the Academy of Molecular Imaging, and of the International Mesothelioma Interest Group. Dr Gerbaudo also serves as an ad hoc expert lecturer on PET/CT in Oncology for the International Atomic Energy Agency.

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Contributors

Anthony P. Belanger, PhD

Division of Nuclear Medicine and Molecular Imaging,
 Department of Radiology, Brigham and Women's Hospital
 and Harvard Medical School,
 Boston, MA, USA

Ronald Boellaard, PhD

Department of Nuclear Medicine and PET Research VU
 University Medical Center, Amsterdam, the Netherlands

Scott Britz-Cunningham, MD, PhD

Division of Nuclear Medicine and Molecular Imaging,
 Department of Radiology, Brigham and Women's Hospital
 and Harvard Medical School, Boston, MA, USA

Muhammad A. Chaudhry, MD

Division of Nuclear Medicine, Department of Radiology
 and Radiological Sciences, Johns Hopkins University Hospital,
 Baltimore, MD, USA

Wei Chen, MD, PhD

Department of Molecular and Medical Pharmacology,
 Ahmanson Biological Imaging, David Geffen School of
 Medicine at UCLA, Los Angeles, CA, USA

Hubert H. Chuang, MD

Department of Nuclear Medicine, MD Anderson Cancer
 Center, Houston, TX, USA

Timothy R. DeGrado, PhD

Division of Nuclear Medicine,
 Department of Radiology,
 Mayo Clinic, Rochester, MN, USA

Dominique Delbeke, MD, PhD

Department of Radiology and Radiological Sciences,
 Vanderbilt University School of Medicine,
 Nashville, TN, USA

Laura A. Drubach, MD

Division of Nuclear Medicine and Molecular Imaging,
 Department of Radiology, Children's Hospital of Boston
 and Harvard Medical School, Boston, MA, USA

Einat Even-Sapir, MD, PhD

Department of Nuclear Medicine, Tel Aviv Sourasky Medical
 Center, Tel Aviv, Israel

Kent P. Friedman, MD

Department of Radiology, NYU School of Medicine,
 New York, NY, USA

Victor H. Gerbaudo, PhD

Division of Nuclear Medicine and Molecular Imaging,
 Department of Radiology, Brigham and Women's Hospital
 and Harvard Medical School, Boston, MA, USA

Ritu R. Gill, MBBS

Division of Thoracic Radiology, Department of Radiology,
 Brigham and Women's Hospital and Harvard Medical School,
 Boston, MA, USA

Denis J. Gradinscak, MBB, FRANZCR

Department of Nuclear Medicine, Westmead Hospital,
 Sydney, Australia

Frederick D. Grant, MD

Division of Nuclear Medicine and Molecular Imaging,
 Department of Radiology, Children's Hospital of Boston
 and Harvard Medical School, Boston, MA, USA

Ravinder Grewal, MD

Division of Nuclear Medicine, Department of Radiology,
 Memorial Sloan-Kettering Cancer Center, New York, NY, USA

Jon M. Hainer, BS

Division of Nuclear Medicine and Molecular Imaging,
 Department of Radiology, Brigham and Women's Hospital,
 Boston, MA, USA

Otto S. Hoekstra, MD, PhD

Department of Nuclear Medicine and PET Research, VU
 University Medical Center, Amsterdam, the Netherlands

Laura L. Horky, MD, PhD

Division of Nuclear Medicine and Molecular Imaging,
 Department of Radiology, Brigham and Women's Hospital
 and Harvard Medical School, Boston, MA, USA

List of contributors

Ora Israel, MD

Department of Nuclear Medicine, Rambam Health Care Center, Haifa, Israel

Aaron C. Jessop, MD, PhD

Department of Nuclear Medicine, MD Anderson Cancer Center, Houston, TX, USA

Chun K. Kim, MD

Division of Nuclear Medicine and Molecular Imaging, Department of Radiology, Brigham and Women's Hospital and Harvard Medical School, Boston, MA, USA

Lale Kostakoglu, MD, MPH

Division of Nuclear Medicine, Department of Radiology, Mount Sinai School of Medicine, New York, USA

Homer A. Macapinlac, MD

Department of Nuclear Medicine, MD Anderson Cancer Center, Houston, TX, USA

Stephen C. Moore, PhD

Division of Nuclear Medicine and Molecular Imaging, Department of Radiology, Brigham and Women's Hospital and Harvard Medical School, Boston, MA, USA

Mi-Ae Park, PhD

Division of Nuclear Medicine and Molecular Imaging, Department of Radiology, Brigham and Women's Hospital and Harvard Medical School, Boston, MA, USA

Stephan Probst, MD

Department of Radiology, NYU School of Medicine, New York, NY, USA

Saiyada N. F. Rizvi

Dept. of Nuclear Medicine and PET Research, VU University Medical Center, Amsterdam, the Netherlands

Christiaan Schiepers, MD, PhD

Department of Molecular and Medical Pharmacology, David Geffen School of Medicine at UCLA, Los Angeles, CA, USA

Heiko Schöder, MD

Division of Nuclear Medicine, Department of Radiology, Memorial Sloan-Kettering Cancer Center, New York, NY, USA

Stuart Silverman, MD

Abdominal Imaging and Intervention, Department of Radiology, Brigham and Women's Hospital and Harvard Medical School, Boston, MA, USA

Sigrid Stroobants

Department of Nuclear Medicine, Antwerp University Hospital, Edegem, Belgium

Servet Tatli, MD

Abdominal Imaging and Intervention, Department of Radiology, Brigham and Women's Hospital and Harvard Medical School, Boston, MA, USA

S. Ted Treves, MD

Division of Nuclear Medicine and Molecular Imaging, Department of Radiology, Children's Hospital of Boston and Harvard Medical School, Boston, MA, USA

Richard L. Wahl, MD

Division of Nuclear Medicine, Department of Radiology and Radiological Sciences, Johns Hopkins University Hospital, Baltimore, MD, USA

Katherine A. Zukotynski, MD

Department of Imaging, Dana Farber Cancer Institute and Harvard Medical School, Boston, MA, USA

Foreword

Who could have predicted that the discoveries by Roentgen of X-rays, by Becquerel of radioactivity, by Warburg of the aerobic glycolysis of tumors, and the solution of the Radon problem by Cormack would lead to one of the most powerful medical technologies in the care of cancer patients? But it did and this (not so slim) volume organized by Victor Gerbaudo shows the result.

The development of PET/CT for cancer was mostly a case of technology first – application second. This is in contrast to those technologies where there is a clear need and a technology developed to meet it. Originally concerned in applications to brain imaging, all parts (PET, CT, DG) were adapted to oncology once it was remembered that tumors as well as the brain use glucose as a fuel. After a slow but rapidly progressing start over the past fifteen years, inhibited, in part, by gate-keeping agencies' inability to realize its potential, PET/CT has become central to diagnosis, staging, assessing response to therapy and in the planning of radiation therapy for a host of cancers. This compendium demonstrates how far it has come and points to some uses, such as in image-guided therapy, for the future.

This book should be read by both imagers and oncologists; it should appeal to expert and novice alike. The first part, concerning the sciences and technology basic to PET/CT, not only reviews traditional physics, instrumentation, and radio-pharmaceutical chemistry but adds material on information systems and functional anatomy as well. The second part provides a general background for each organ system followed by case-based exemplars. The expert-authors bring to each chapter a broad experience.

The power of mixing functional imaging with anatomical detail has only begun to be realized. As the systematic variation of genetic components in disease are translated into metabolic/biochemical manifestations and as appropriate radio-labeled agents are developed to reflect them, we can expect new insights into patho-physiology as well as new approaches to nosology and to the planning and monitoring of treatments. Today's FDG-PET/CT in cancer will be the founding example.

S. James Adelstein
Harvard Medical School
Boston, Massachusetts

Preface

Clinical Positron Emission Tomography (PET) with the glucose analog ^{18}F -fluorodeoxyglucose (FDG) has already gained its place as a routine clinical imaging test in today's clinical and surgical practice of oncology. Its inherent ability to interrogate the biologic behavior of neoplastic molecular pathways in one whole-body scan has made it a very important and in some cases indispensable, diagnostic and staging tool for cancer patients. The end result has been its significant impact in the medical management of these patients.

A Case-Based Approach to PET/CT in Oncology applies PET basic and clinical science concepts to the detailed analysis of well-illustrated cases of daily clinical practice. It shows imaging practitioners and clinical and surgical oncologists the important role that PET imaging plays in the care of cancer patients, as it influences management and outcomes.

Part I starts with the physics and instrumentation of PET imaging, followed by a chapter on PET probes that stresses the potential of FDG and other tracers which hopefully soon will be reaching the clinic. A chapter describing the role of information systems in medical imaging and PET/CT in particular introduces the reader to the foundations of the electronic media, so as to be able to recognize the possible pitfalls and to the extent possible, adjust for them to minimize misinterpretation and error. Part I concludes with a chapter describing the basic biodistribution and image patterns observed in the normal FDG-PET image.

Part II is devoted to the oncologic applications of PET imaging. The cancer types discussed per organ system are those in which the published data support good clinical accuracy of the technique. Each chapter starts with an introduction to the general concepts and epidemiology, staging and treatment overview of the cancer type being addressed. This is followed by a thorough description of the role of PET/CT in the diagnosis, initial staging, restaging and monitoring response to therapy; concepts that are applied and exemplified by the cases that follow.

Each case starts with a clinical history, followed by a detailed description of the PET/CT technique employed. The image findings are described as they should appear in the clinical imaging report. The latter unfolds in a detailed discussion of the pathophysiology of the disease, including when appropriate or when known, the molecular basis of radiotracer uptake in the lesion being described. Teaching points highlight the role of FDG and other radiotracers when applicable, in cancer diagnosis, staging, restaging, and monitoring response to treatment, together with its reported accuracy. The additional information provided by fusion imaging is discussed, as it increases confidence during image interpretation for optimal clinical decision making. In addition, the authors elaborate on the PET-driven changes in management, and on the take-home message from each case. A chapter on the methodological aspects of monitoring response to cancer therapy discusses, and exemplifies with everyday cases, the advantages of using tumor metabolic changes as the early predictors of therapeutic sensitivity. The last chapter describes our experience and the complementary role of functional imaging to guide interventional procedures, such as biopsies and ablations. We report on the advantages and limitations of the technique while attempting to minimize sampling errors from cancerous lesions in which metabolic disease precedes morphologic changes.

All chapters, including those on the basic sciences, are clinically oriented, and demonstrate an important clinical application for the practicing radiologist, the nuclear medicine physician, and Residents and Fellows in training. This text attempts to balance practical aspects of anatomic-functional imaging while answering clinical oncology questions, therefore clinical and surgical oncologists and their trainees should also find this book to be a reliable resource for their daily practice.

Victor H. Gerbaudo
Boston, Massachusetts