

The YEAR BOOK of

# Nuclear Medicine

1978

Editor

JAMES L. QUINN, III, M.D.

The YEAR BOOK of

# Nuclear Medicine

1978

Editor

**JAMES L. QUINN, III, M.D.**

*Professor of Radiology and Pathology, Northwestern  
University Medical School; Director of  
Nuclear Medicine, Northwestern Memorial  
Hospital, Chicago*

Associate Editor

**STÉWART M. SPIES, M.D.**

*Assistant in Radiology, Northwestern  
University Medical School; Associate  
Director of Nuclear Medicine, Northwestern  
Memorial Hospital, Chicago*

**YEAR BOOK MEDICAL PUBLISHERS, INC.**  
CHICAGO • LONDON

# Nuclear Medicine

Copyright 1978 by YEAR BOOK MEDICAL PUBLISHERS, INC.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from the publisher.

Printed in U.S.A.

Library of Congress Catalog Card Number: 66-5562

International Standard Book Number: 0-8151-6987-6

Associate Editor

STEWART M. SPIES, M.D.

Assistant in Radiology, Northwestern  
University Medical School, Assistant  
Director of Nuclear Medicine, Northwestern  
Memorial Hospital, Chicago

YEAR BOOK MEDICAL PUBLISHERS, INC.  
CHICAGO • LONDON

# Table of Contents

The material covered in this volume represents literature reviewed up to July, 1977.

CURRENT LITERATURE QUIZ . . . . .	7
INTRODUCTION . . . . .	11
<b>Cost-Effectiveness of Radiopharmaceuticals in</b>	
<b>Medical Imaging by KENNETH R. HETZEL,</b>	
<b>M.S., R.Ph. . . . .</b>	<b>13</b>
RADIATION PHYSICS AND INSTRUMENTATION . . . . .	17
RADIOCHEMISTRY AND RADIOPHARMACOLOGY . . . . .	25
HEALTH PHYSICS AND RADIATION BIOLOGY . . . . .	61
THE ENDOCRINE SYSTEM . . . . .	71
THE HEMATOPOIETIC AND LYMPHATIC SYSTEMS . . . . .	95
THE GENITOURINARY SYSTEM . . . . .	129
THE CENTRAL NERVOUS SYSTEM . . . . .	149
THE GASTROINTESTINAL SYSTEM . . . . .	179
THE HEART AND GREAT VESSELS . . . . .	219
THE PULMONARY SYSTEM . . . . .	291
THE OSSEOUS AND CARTILAGINOUS SYSTEMS . . . . .	321
ANSWERS TO CURRENT LITERATURE QUIZ . . . . .	363

The YEAR BOOK of

# Nuclear Medicine

1978

Editor

JAMES L. QUINN, III, M.D.





The YEAR BOOK of

# Nuclear Medicine

1978

Editor

**JAMES L. QUINN, III, M.D.**

*Professor of Radiology and Pathology, Northwestern  
University Medical School; Director of  
Nuclear Medicine, Northwestern Memorial  
Hospital, Chicago*

Associate Editor

**STÉWART M. SPIES, M.D.**

*Assistant in Radiology, Northwestern  
University Medical School; Associate  
Director of Nuclear Medicine, Northwestern  
Memorial Hospital, Chicago*

**YEAR BOOK MEDICAL PUBLISHERS, INC.**  
CHICAGO • LONDON

# The YEAR BOOK of Nuclear Medicine

Copyright 1978 by YEAR BOOK MEDICAL PUBLISHERS, INC.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from the publisher.

Printed in U.S.A.

Library of Congress Catalog Card Number: 66-5562

International Standard Book Number: 0-8151-6987-6

Associate Editor

STEWART M. SPIES, M.D.

Assistant in Radiology, Northwestern  
University Medical School, Assistant  
Director of Nuclear Medicine, Northwestern  
Memorial Hospital, Chicago

YEAR BOOK MEDICAL PUBLISHERS, INC.  
CHICAGO • LONDON



# Table of Contents

The material covered in this volume represents literature reviewed up to July, 1977.

CURRENT LITERATURE QUIZ . . . . .	7
INTRODUCTION . . . . .	11
<b>Cost-Effectiveness of Radiopharmaceuticals in</b>	
<b>Medical Imaging by KENNETH R. HETZEL,</b>	
<b>M.S., R.Ph. . . . .</b>	<b>13</b>
RADIATION PHYSICS AND INSTRUMENTATION . . . . .	17
RADIOCHEMISTRY AND RADIOPHARMACOLOGY . . . . .	25
HEALTH PHYSICS AND RADIATION BIOLOGY . . . . .	61
THE ENDOCRINE SYSTEM . . . . .	71
THE HEMATOPOIETIC AND LYMPHATIC SYSTEMS . . . . .	95
THE GENITOURINARY SYSTEM . . . . .	129
THE CENTRAL NERVOUS SYSTEM . . . . .	149
THE GASTROINTESTINAL SYSTEM . . . . .	179
THE HEART AND GREAT VESSELS . . . . .	219
THE PULMONARY SYSTEM . . . . .	291
THE OSSEOUS AND CARTILAGINOUS SYSTEMS . . . . .	321
ANSWERS TO CURRENT LITERATURE QUIZ . . . . .	363

# Table of Contents

The material covered in this volume represents literature reviewed up to July, 1977

323	Answers to Current Literature Quiz
321	The Osseous and Cartilaginous Systems
301	The Pulmonary System
219	The Heart and Great Vessels
179	The Gastrointestinal System
149	The Central Nervous System
139	The Genitourinary System
95	The Hematopoietic and Lymphatic Systems
71	The Endocrine System
61	Health Physics and Radiation Biology
25	Radiochemistry and Radiopharmacology
17	Radiation Physics and Instrumentation
13	M.S. R.P.
	Medical Imaging by Kenneth R. Helzlsouer
	Cost Effectiveness of Radiopharmaceuticals in
11	Introduction
7	Current Literature Quiz

## Current Literature Quiz

The significant advances described in this YEAR BOOK introduce new diagnostic and therapeutic procedures useful for treating conditions seen frequently in your practice. The following questionnaire will test your familiarity with the current literature. References to the articles on which the questions are based are given in the back of the book.

1. In addition to improved sensitivity, can the ability of a scintillation camera to handle high (100,000 cps) count rates result in improved spatial resolution?
2. What techniques are currently available for effective quality control of short-lived radiopharmaceuticals?
3. What is one possible explanation for the presence of an area of increased uptake to the right of the sternum seen on a  $^{201}\text{Tl}$  myocardial perfusion image?
4. What are the prognostic implications of a normal  $^{67}\text{Ga}$ -citrate scan in a patient with malignant melanoma?
5. How can a history of recent radiation to the neck affect the interpretation of a  $^{67}\text{Ga}$ -citrate scan in a patient with a history of head and neck carcinoma?
6. Describe the radiopharmaceutical strategy on which the use of liposomes in nuclear imaging is based.
7. What mechanisms can account for poor images obtained after administration of radiopharmaceuticals prepared from kits using stannous ion for reduction?
8. Describe the typical appearance of a  $^{99\text{m}}\text{Tc}$ -pyridoxylidene-glutamate image of the abdomen in a patient with complete obstruction of the common bile duct.
9. What is the appropriate management of a patient with a history of thymic irradiation who presents with a normal physical examination but a suspicious thyroid scan?
10. Discuss the feasibility of performing radioiodine thyroid ablation with doses of less than 30 mCi in patients with thyroid malignancies.
11. What is the probable mechanism for the occasional occurrence of hyperthyroidism in patients with choriocarcinoma?
12. Does radioiodine therapy for Graves' disease alter the subse-

quent response of patients to pharmacologic doses of stable iodide?

13. Discuss the relative contributions of  $^{131}\text{I}$ -iodocholesterol imaging, ultrasound and contrast aortography in the localization of adrenal lesions.
14. What is the value of conventional  $^{51}\text{Cr}$ -erythrocyte sequestration studies done by surface counting in patients with autoimmune hemolytic anemia?
15. What factors justify inclusion of  $^{67}\text{Ga}$ -citrate scanning in the initial evaluation of lymphoma patients?
16. How may  $^{111}\text{In}$  marrow imaging be used to increase the effectiveness of bone marrow biopsy in patients treated with radiation or chemotherapy?
17. What are the limitations of the  $^{125}\text{I}$ -fibrinogen uptake test in patients with hip fractures?
18. Compare the specificity and sensitivity of  $^{125}\text{I}$ -fibrinogen uptake and impedance plethysmography in detection of deep vein thrombosis.
19. Discuss the differential diagnosis of acute testicular torsion versus epididymitis as judged by  $^{99\text{m}}\text{Tc}$ -pertechnetate imaging.
20. What is the significance of renal activity seen on a  $^{67}\text{Ga}$ -citrate image obtained 72 hours after injection?
21. What are the advantages and disadvantages of the use of  $^{99\text{m}}\text{Tc}$ -glucoheptonate as a brain-imaging radiopharmaceutical?
22. In what disease states is combined transmission computerized tomography and radioisotope central nervous system imaging justifiable?
23. Compare the time course for positivity of transmission computerized tomographic scans and radionuclide brain images in patients with cerebrovascular accidents.
24. In children, what underlying disorders generally are associated with the following cerebrovascular disorders: cerebral emboli, intracerebral hemorrhage, veno-occlusive disease?
25. What is the effect of cerebral infarction on regional cerebral blood flow in the asymptomatic hemisphere as determined by  $^{133}\text{Xe}$  washout?
26. What conditions can result in false positive  $^{99\text{m}}\text{TcO}_4$  images when one is searching for Meckel's diverticulum?
27. Discuss the technique for assessing peritoneovenous shunt patency in patients with ascites.
28. What is the significance of lung uptake of  $^{99\text{m}}\text{Tc}$ -sulfur colloid in children?
29. Does liver uptake of  $^{99\text{m}}\text{Tc}$ -pyrophosphate administered for detection of acute myocardial infarction suggest a radiopharmaceutical impurity?

30. What is the current radiopharmaceutical of choice for performing myocardial "hot spot" imaging?
31. What is the appearance of  $^{99m}\text{Tc}$ -pyrophosphate images in patients with myocardial ischemia without infarction?
32. What is the significance of persistent uptake of  $^{99m}\text{Tc}$ -pyrophosphate after acute myocardial infarction?
33. Discuss the role of "hot spot" imaging in evaluating perioperative myocardial infarction.
34. How may  $^{201}\text{Tl}$  be used to evaluate patients with pulmonary hypertension?
35. How does  $^{201}\text{Tl}$  perfusion imaging compare in sensitivity and specificity with stress electrocardiography for detection of ischemic myocardium?
36. Describe the use of exercise-gated blood pool studies to evaluate patients suspected of having coronary artery disease.
37. Discuss the use of short half-life radiogases in the assessment of regional ventilation.
38. What are the advantages of  $^{127}\text{Xe}$  over  $^{133}\text{Xe}$  for ventilation imaging?
39. What is the importance of obtaining posterior oblique views in routine lung perfusion images?
40. Discuss an effective strategy for the use of ventilation and perfusion images in the detection of acute pulmonary embolism.
41. How can  $^{67}\text{Ga}$ -citrate be used as an aid in the differential diagnosis of pulmonary embolism?
42. Compare the use of conventional and large-field gamma cameras for bone imaging.
43. What effect on the quality of bone images can be expected with iron overload in patients?
44. List the indications for bone imaging in patients with breast carcinoma.
45. What is the significance of a single abnormality in a bone image done in a patient with known malignancy?
46. What is the role of bone imaging in patients with stress fractures?
47. Discuss the indications and limitations of bone imaging in patients with lymphoma.
48. Compare the use of conventional x-rays with bone imaging in the evaluation of patients with Paget's disease.
49. How may bone imaging be used to evaluate patients with arthropathies affecting the sacroiliac joints?
50. What role does bone imaging have in patients with hyperparathyroidism?





## Introduction

This year is perhaps best characterized by continued growth in cardiovascular nuclear medicine, nuclear cardiology or whatever you choose to call this area of study. We are seeing the fruition of what was predicted by the Inter-Society Commission for Heart Disease in the 1977 YEAR BOOK. There is an increasing number of satellite nuclear medicine imaging units springing up in hospitals in the coronary care or medical intensive care areas. The World Health Organization published two valuable reports from their "expert" panel that are of import to the field. These are, "The Planning for Nuclear Medicine Facilities," in the technical report series, number 591, and the "Use of Ionizing Radiation and Radionuclides on Human Beings for Medical Research, Training and Nonmedical Purposes," in the technical report series, number 611.

Because of the increasing diversity of the nuclear medicine literature, I have invited my associate, Stewart M. Spies, to join me as Associate Editor of the YEAR BOOK OF NUCLEAR MEDICINE. He will continue in this volume, as he did last year, to formulate the series of questions at the beginning of the book that relate to the selected articles and the editorial comments in this volume.

A review of the YEAR BOOK by E. R. Davies, which appeared in *Nouvelle Presse Medicale (Paris)* in October, 1975, raised the question as to whether or not we should pay more attention to the cost-effectiveness of the radiopharmaceuticals that we are using. I asked our radiopharmacist, Kenneth R. Hetzel, to write the lead article in response to this very proper suggestion. I believe that you will find his article, "Cost-Effectiveness of Radiopharmaceuticals in Medical Imaging," interesting and thought provoking without being tirelessly encyclopedic.

As before, I would like to thank the readers for their encouragement and suggestions. I am glad this volume con-

tinues to be well received by our colleagues throughout the world.

JAMES L. QUINN, III, M.D.

## **COST-EFFECTIVENESS OF RADIOPHARMACEUTICALS IN MEDICAL IMAGING**

**KENNETH R. HETZEL, M.S., R.Ph.**

*Director, Radiopharmaceutical Services,  
Northwestern Memorial Hospital, and  
Assistant Professor of Radiology  
Northwestern University Medical School*

Over the past 20 years, nuclear medicine has made significant contributions to society both in improved patient care and an increased understanding of disease through a combined diagnostic-biomedical research approach. Several current studies<sup>1-3</sup> draw more objective conclusions on the cost-effectiveness of diagnostic nuclear tests. The controversy underlying the cost-effectiveness of computed tomography and advanced ultrasound systems is yet unresolved. Current evidence, however, suggests a favorable position if appropriate utilization is realized.

Many argue that the extensively developed gamma camera-low-energy radionuclide marriage has reached maximal performance capabilities, much the same way as rectilinear scanners did 5-8 years ago. With this maturity and the advent of alternative imaging techniques, nuclear medicine has been directed to a choice of actions, analogous to the words of Frost<sup>4</sup>:

"Two roads diverged in a yellow wood,  
And sorry I could not travel both  
And be one traveler, long I stood  
And looked down one as far as I could  
To where it bent in the undergrowth;

Then took the other, as just as fair,  
And having perhaps the better claim,  
Because it was grassy and wanted wear;