Clinical Thermology

Subseries Thermotherapy

M. Gautherie (Ed.)

Methods of Hyperthermia Control

With Contributions by
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M. S. Hawley · M. Chive

Foreword by T. C. Cetas

With 125 Figures and 7 Tables

Springer-Verlag Berlin Heidelberg New York
London Paris Tokyo Hong Kong

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ISBN-13: 978-3-642-74638-3 e-ISBN-13: 978-3-642-74636-9
DOI: 10.1007/978-3-642-74636-9

Library of Congress Cataloging-in-Publication Data
Methods of hyperthermia control / M. Gautherie (ed.); with contributions by T.C. Cetas ... [et al.]; foreword by T.C. Cetas. p. cm. – (Clinical thermology. Subseries thermotherapy) Includes bibliographical references.

1. Cancer – Thermotherapy – Standards. 2. Body temperature – Regulation. 3. Thermometers and thermometry, Medical – Standards. I. Gautherie, Michel. II. Cetas, T.C. (Thomas C.) III. Series. [DNLM: 1. Hyperthermia, Induced – methods. 2. Neoplasms – therapy. QZ 266 M5925]
RC271.T5M48 1990 616.99'40632 – dc20 89-26190

Softcover reprint of the hardcover 1st edition 1990

2127/3145-543210 – Printed on acid-free paper

Foreword

The enormous potential that hyperthermia has for benefiting patients with cancer is impressively indicated by biological studies, both in vitro and in vivo, and by comparative clinical studies whenever the heat has been appropriate to the size of the tumor. But hyperthermia, as with any other technologically based medical procedures, requires an extensive development of sophisticated instrumentation and techniques to offer routine clinical benefit. We probably erred in starting clinical trials so soon. We had hoped that by showing the clinical benefits on some superficial tumors quickly, financial support would be stimulated for the required technological developments.

Unfortunately, treating superficial disease adequately was more difficult than we had supposed and regional treatments were less successful than we had wished. The physical reasons are clear and were apparent from the beginning, although in our enthusiasm we ignored them.

Circumstances are different now. We have to treat a wide range of tumors in various sites, but the systems and techniques required are only available in a few laboratories and clinics where they still are undergoing refinement. Thermal dosimetry, as currently practiced in the best centers (Fessenden and Samulski, Part I) is difficult, tedious, and traumatic. In the future, it will be less so (Bolomey and Hawley, Part II) as heating systems are integrated with noninvasive dosimetry (SAR and thermometry). An example of such an approach is given by Chive (Part III), who shows that in clinical practice reduced trauma is possible for superficial tumors. Nevertheless, in research centers striving to address the dose-response relationship in a detailed fashion, the tedious and traumatic procedures outlined in Part I are still required, even for superficial sites.

To quickly review this volume, in Part I "Thermometry in Therapeutic Hyperthermia," Samulski and Fessenden review the status in the clinical setting. An emphasis is placed on techniques for locating thermometer probes and is followed by a review of various types of thermometers. It can be concluded that while further refinements are desirable, the current status of probe thermometry, both instrumentation and practice, is adequate. Quality control is the greatest problem. However, locating the probes in three dimensional coordinate space, along with the heating applicators and target volumes, is excessively laborious. New procedures and probably new devices must be developed so that this "geometrical dosimetry" can become routine for every patient everywhere.

In Part II, "Noninvasive Control of Hyperthermia," Bolomey and Hawley picked up the gauntlet on non-invasive thermometry that I threw down a few years ago. They have reviewed the various approaches by addressing the compromises concerning sensitivities (thermal, spatial, temporal), the problem of noise rejection (i.e., sensitive devices in a noisy environment), the space constraint (heater and imager targeted at the same volume), and the

sensitivity of the thermometric parameter to other physiological variables. They show that the first three of these are merely technical, but nontrivial, and that real solutions are possible, indeed probable as computers get bigger, faster and cheaper. They remind those developing the new methods to consider the sensitivity to physiological variations. If hyperthermia stress changes the parameter under investigation, then that parameter is probably not a good thermometer, but, it may be an excellent indicator of the adequacy of the therapy – a blessing in disguise.
Finally, Part III, "Temperature Measurement by Microwave Radiometry in Hyperthermia Process: Application to Thermal Dosimetry," by Chive describes the development and practical implementation of an integrated heating and noninvasive monitoring system for superficial hyperthermia. The significance is two-fold. First, in its own right, it improves the practice of clinical hyperthermia for superficial disease while reducing trauma to patients. Second, and perhaps more importantly it shows that noninvasive dosimetric devices must be integrated with specific heating approaches for specific sites. An all encompassing heating system probably does not exist, and neither does such a non invasive thermometry system. But several possible systems can be developed in which the patient, the heating approach, and the dosimetry system are all integrated into a totally engineered package.
Overall, this is an impressive volume.

Tucson, January 1990 T. C. CETAS

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