Science & Technology

A 'new' and very old therapy for cancer

by James W. Frazer, Ph.D.

The following article by Dr. James Frazer of the M.D. Anderson Tumor Institute in Houston, Texas, describes how an old therapy for cancer has become much more effective as a result of information generated in research on the effects of microwaves and radiofrequency waves on humans and animals. This knowledge, combined with the precise imaging possible with Nuclear Magnetic Resonance Scanning, is leading to more effective therapy of cancer with fewer side effects. At the same time, our understanding of the biology of cancer as a disorder of tissue growth is increasing.

Nuclear Magnetic Resonance (NMR) scanning has led to a revolution in our understanding of the structure of the living cell in health and disease, overturning many concepts based on examination of artifacts in dead cells. It enables us to evaluate the state of living tissues without resort to surgery.

The combination of the localization possible with NMR with the ability to focus microwaves on the target area enables a highly selective destruction of tumor cells, while sparing normal tissue, including the immune system which is frequently affected by chemotherapy. In this light, the observation of regression of distant metastases following destruction of the primary tumor implies that cancer may actively inhibit the immune system.

Hyperthermia—therapeutic treatment by means of artificially induced fever—has long been one of the means of treating human ills. It was used in pre-Columbian Peru in the form of cautery, in Chinese medicine in the form of hot paper treatments, in 19th-century medicine and European folk medicine in the form of "packs," "steepes," or other hot applications. D'Arsonval is said to have built one of the earliest radio transmitters to use inductive heating on a number of communicable diseases.

Development of the concepts of Ehrlich's "magic bullets," culminating in rationally developed antibiotics, shifted emphasis from such physical methods because the antibiotics were much more effective, less labor intensive, and much more comfortable for the patient.

But some diseases do not yet have the chemical armamentarium that can be applied to communicable diseases, and cancer (the collection of diseases resulting from inappropriate growth of particular types of the victim's own cells), is one of these kinds of diseases.

Early attempts to use hyperthermia on different tumors were sometimes successful, sometimes not, and a wide variety of methods for inducing hyperthermia have been used. In the late 1930s, methods such as hot-tub baths or intentional infection with pyretic diseases such as malaria were sometimes utilized, often in conjuction with radiation therapy. One of the lacking findings has been that hyperthermia seems to make radiation therapy of tumors more effective.

Whole body hyperthermia, using circulating hot fluids, electric blankets, and baths, has been found to increase the effectiveness of certain forms of chemotherapy as well as having some anti-tumor action of its own. Unfortunately, tumor recurrences often may occur, and ways of best utilizing this potentiality are still being investigated. The cardiovascular stress and endocrine response to whole-body hyperthermia impose a requirement for patient selection automatically excluding a large part of the population requiring treatment.

For some time, it was thought that tumors in general might be more sensitive to heat than surrounding tissues, and this led to the idea that local or focal hyperthermia might be of use. It is indeed true that many localized tumors are more sensitive to heat, but it now appears that this is not a property of the tumor cell but rather a property of the decreased circulation and the accumulation of acidic metabolic products in many tumors that have grown faster than their own vascular bed. This may also be part of the story in radiation sensitivity. The implications in drug therapy are somewhat unclear.

Because tumor cells are generally no more sensitive to heat than normal tissues, the idea that focal heat might be effective becomes even more attractive as a means of decreasing tissue damage due to hyperthermia, increasing responsiveness to radiotherapy, and potentiating the effects of anti-tumor drugs locally.

A variety of thermal probes, microwave applicators, and temperature-measuring probes that can be used in strong radiowave or microwave fields have been developed at several institutions in the United States, Italy, the U.S.S.R., Japan, Sweden, Denmark, and France. Other groups are constantly starting work.

Experiments with micro-wave heating

Perhaps the greatest early impetus to studying the localization of microwave and radio-frequency fields in the bodies of experimental animals and humans came from the work on radio-frequency bio-effects as part of a U.S. national and international program aimed at determining hazard levels associated with electronic products, radio or T.V. transmitters, and radar transmitters. This program has been active through several federal agencies for some 30 years, though much of the modeling work of present use was done in the

1960s and 1970s. In the late 1960s, serious work with microwave heating in the treatment of human melanoma (black-pigmented tumors) began, and soon other groups were making use of a wide variety of radio-frequency and microwave applicators, at first in treatment of surface tumors, including those in cattle as well as humans. Later attempts have been focusing on deeper tumors.

The ability to focus radio and microwave fields repeatably in internal structures while determining the distribution of local temperatures simultaneously has proved quite a technological challenge. Most radio or microwave applicators generate considerable heat at the skin or other dielectric interfaces which can be diminished by interposing bags of water between the source and the skin, but poses problems in deeper structures. Simultaneous temperature measurement requires indwelling probes (either fiberoptic or high impedance probes), so that knowledge of internal temperature excursions is spotty at best.

Applicators in experimental use for deep tumors include annular phased-array antennae, magnetic induction rings, a variety of capacitors, and indwelling probes acting as the tip of antennae. Ultrasound generators are used for superficial tumors and breast carcinoma. Work is just beginning using nuclear-magnetic-imaging apparatus to drive internal probes and detect alterations in local temperature, but it will be some time before this can be used in experimental animals or humans.

To date, with most cases restricted to surface tumors of the breast, skin, or other superficial structures, human tumors whose temperatures are increased to about 40° centigrade regress quite nicely, which is encouraging since many of those tumors have already failed to respond to the full spectrum of chemotherapy and radiotherapy. In many cases, radiation necrosis of the skin was significantly improved. These tumors do, however, tend to recur when heat alone is the treatment modality. When given in combination with anti-tumor drugs, a much greater response is elicited, though time only will tell how many of these are complete remissions. Therapy is limited by pain which can occur when bony structures are heated, by uncertainty of temperature in deeper structures, and by relationship of thermal distribution to major blood vessels and nerves. In experimental animals, it is not uncommon to have permanent regression of local tumors with heat alone. At the same time, there are occasional regressions of distant metastasis. The latter is still an interesting observation deserving further attention.

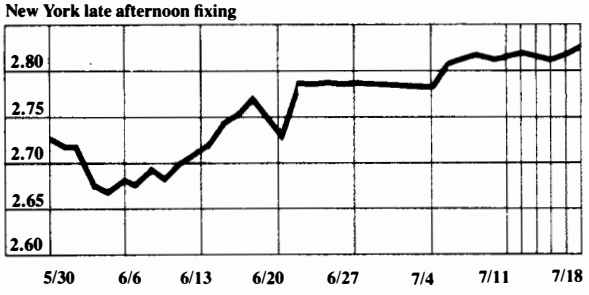
On an experimental level, uses of changes in tissue refractive index or dielectric for temperature measurement are being studied quite intensively. Perhaps the most hopeful studies are those using the radio-frequency of nuclear-magnetic-resonance-imaging equipment in conjunction with indwelling probes while performing imaging analysis for temperature changes.

Hyperthermia, adequately used and controlled, is a valuable therapeutic adjunct to other forms of cancer therapy.

Currency Rates

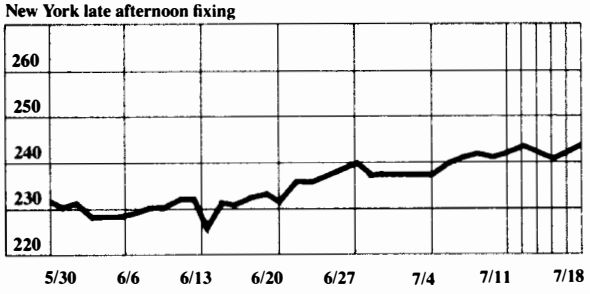
The dollar in deutschemarks

New York late afternoon fixing



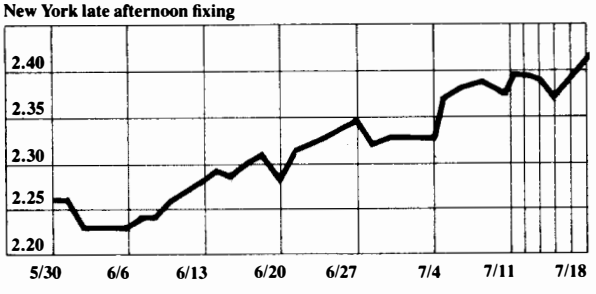
The dollar in yen

New York late afternoon fixing



The dollar in Swiss francs

New York late afternoon fixing



The British pound in dollars

New York late afternoon fixing