THERMOREGULATION IN THE CANCER THERAPY REGIONAL HYPERTHERMIA

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Regional hyperthermia is a still not fully established promising cancer therapy based on local heating of tumor tissue to above a threshold value of about 42° C. At present, this therapy is applied in combination with chemo- or radiotherapy or both. The underlying therapeutic idea is that heated tumor cells are more sensitive to extinction by either rays or drugs. The local heating is done via radiowave antennas placed around the patient. The task is to tune the antenna parameters such that the individual patient's tumor is heated, but healthy tissue outside is saved. The thermoregulation within the patient's body is mathematically described by the harmonic Maxwell's equations for the antenna input and by a parabolic PDE describing the physiological heat transport.

The talk will survey the long established collaboration of the speaker's Numerical Analysis and Modelling as well as his Scientific Visualization group with oncoradiologists and oncosurgeons at Charité, Berlin. Generally speaking, the basic paradigm of computational medicine consists of three steps: (a) by means of medical imaging, produce a sufficiently precise grid model of the individual patient in the computer, the so-called virtual patient, (b) solve the therapy planning problem at this virtual patient, which here includes the adaptive multilevel solution of PDEs (harmonic Maxwell's equations in an interesting wavelength regime and some thermoregulation model) and an optimization problem, (c) implant these results in the clinical situation of the real patient. In regional hyperthermia, this paradigm is realized in the integrated software environment HYPERPLAN, a predecessor of the widespread package AMIRA. Illustrative clinical results from the collaboration will be presented.

Rather recently, the project has gained new mathematical life in the following two aspects: (I) The up to now applied simple heat transport model known as the bio-heat transfer equation (BHT), has been revised by the author and R. Hochmuth using homogenization techniques: the result is a similar, but not identical microvascular model. (II) The up to now applied L^2-optimization with penalty terms included is being replaced by appropriate L^∞-models, which have been derived on the basis of some infinite dimensional interior point method derived and pursued in the hyperthermia context by M. Weiser. First results in these two directions will be included.