Abstract

"Optimizing Thermal Medicine with Recent Engineering Tools: from Multiphysics Parametric Modeling to Photothermally-Enhanced Immunotherapy" Dr. Paolo Maccariny, Ph.D.

Temperature is a fundamental parameter in human physiology and strongly affects the treatment of a variety of diseases. From rapid brain cooling after traumatic brain injury to hyperthermic/ablation treatments for cancer therapy, thermal medicine has the potential to dramatically improve patients' lives. However, the widespread use of temperature-based diagnostics and therapies has been hindered by the unavailability of inexpensive, convenient and reliable thermal medicine devices. Fortunately the recent advances in microwave and ultrasound technologies, multiphysics modeling and machine learning, are offering engineers and clinicians novel tools to exploit the numerous benefits of temperature. After reviewing some of the temperature-based clinical applications, I will focus the talk on two recent technologies developed to enhance cancer treatments. The antitumor benefits of immune-blockade inhibitors can be enhanced dramatically by thermally ablate the primary tumor. This synergy is optimally enhanced with the use of nanostar-mediated photothermal therapy: the precise thermal ablation triggers a strong immune response now freed from blockades, while the hyperthermic region boost the immune memory, resulting in both eradication of metastases and long-term vaccination. Maximum benefits require optimal delivery of thermal dose and this can be achieved by accurately controlling temperature distribution in real-time. We will show that thermal profiles in deep tissues can be reconstructed in real-time from noninvasive radiometric measurements, normally used to quantify temperature of distant stars by combining multiphysics simulations with machine learning. We will conclude the presentation with some of the promising technologies coming soon to the clinic, including intelligent thermoacoustic imaging.