Minimally invasive thermal therapies deliver heat to tissue in a controlled manner in order to modulate a host of microscopic and macroscopic events in tissue. Irreversible tissue damage from heating is a cumulative process that depends on exposure time as well as temperature and is often an endpoint for thermal therapies, particularly thermal ablation. Models for predicting the extent of damage after exposure to heat have been implemented and investigated in cells and tissue. With respect to rapid, high temperature ablations, the most often used approaches include simple temperature threshold models, Arrhenius rate models, and cumulative equivalent minutes at 43°C (CEM 43°C). While displaying significantly different responses at lower temperatures or long exposure times, these approaches are more closely related at higher temperatures.

In cases where the ability to visualize the spatiotemporal distribution of heat and resulting damage is realizable, comparisons between these models are possible and useful for comparing with results from imaging and/or pathology correlates. Here we provide a review of the different models for high-temperature ablations and use magnetic resonance temperature imaging results of thermal ablations, compared to with post-treatment imaging or histology to illustrate some of the differences between these models when used for predicting outcomes in thermal therapy. Implications for therapy monitoring and guidance are discussed as are future prospects for predicting iso-effects other than tissue destruction in tissue.

Educational Objectives:

(1) Learn basic concepts of thermal dosimetry
(2) Understand current usage and potential limitations of applying current models