Robust Design Approaches in Biomedical Research

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Abstract: Researchers often find that nonlinear regression models are more applicable for modelling various biomedical phenomena than are linear ones since they tend to fit the data well and since these models (and model parameters) are more scientifically meaningful. For example, researchers in fields as diverse as toxicology, pharmacology, biometry, and medicine typically fit four-parameter sigmoidal functions and are often in a position of requiring optimal or near-optimal designs for the chosen nonlinear model. A common shortcoming of most optimal designs for nonlinear models used in practical settings, however, is that these designs typically focus only on (first-order) parameter variance or predicted variance, and thus ignore the inherent nonlinear of the assumed model function. Another shortcoming of optimal designs is that they often have only p support points (where p is the number of model parameters), and so cannot be used to test for model adequacy.

This talk reviews and underscores the practical advantages of (generalized and normal-based) nonlinear models, and examines various robust design criteria, including geometric and uniform design strategies given in O'Brien et al (2009) and O'Brien (2016), reflection designs in O'Brien and Silcox (2019), as well as those based on second-order (curvature) considerations. Several key examples are provided to illustrate these ideas using commonly-used software such as SAS and R.