International Alliance for Biological Standardization

11th Annual Statistics Workshop:
Big Tent Statistics - Conveying the Importance of Statistical Contributions

October 20-23, 2025
Virtual Meeting

Case Study: Bayesian Methods for Qualification of Flow Cytometry Method for Cell Therapies

Flow cytometry methods are critical in characterizing and assessing the quality of cell therapies. Manufacturing cell therapies is a complex process by which the cells are engineered to perform certain functions, while still being tolerated by the patient. This can be achieved by modifying a patient's own cells (autologous therapies) or universal donor cells (allogenic therapies). These processes intend to alter the phenotype of individual cells to fit a target protein expression profile for the intended function and treatment. Verification that the cells express proteins in alignment with the intended phenotype and protein expression profile is crucial and flow cytometry methods offer a solution to directly measuring individual cells. The nature of these single-cell measurements and the relationship between proteins complicates the analytical profile of these methods, even for seemingly simple immunophenotyping measurements. These complex analytical profiles often pose unique statistical challenges to estimating the analytical performance characteristics described in ICH Q2R2.

Bayesian methods offer a practical solution to these unique challenges, easily estimating the accuracy and precision of methods with complex analytical profiles. Three case studies utilizing Bayesian methods for analyzing flow cytometry method qualifications for both simple and complex flow cytometry responses are discussed here. These case studies include methods with independent responses, multivariate responses, and responses with non-normal likelihood distributions, such as the Poisson distribution. Analyses are performed with accessibility to assay scientists in mind, using only functions available in SAS version 9.4 and highlighting the use of prior knowledge to analogous parts of the analytical method lifecycle. The advantages of Bayesian estimates for repeatability, reproducibility, intermediate precision, and accuracy are discussed, with a focus on preparing methods for method validation under the Quality by Design paradigm.