The effect of prior information on frequentist properties of Bayes test decisions

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In precision medicine a frequent approach is to investigate many treatment strategies for multiple diseases in one trial setting. This situation often leads to small sample sizes in disease-treatment combinations and has fostered the discussion about the benefits of borrowing of external or historical information for decision-making in these trials. In the Bayesian framework, external information is included by construction of an informative prior distribution. Several methods have been proposed that dynamically discount the amount of information borrowed from historical data based on the conformity between historical and current data. Numerous investigations have been performed to characterize the properties of the various borrowing mechanisms with respect to the gain to be expected in the trials. However, there is common understanding that the risk of type I error inflation exists when information is borrowed and many simulation studies are carried out to quantify this effect. We show that if prior information is conditioned upon and a uniformly most powerful test exists, strict control of type I error implies that no power gain is possible under any mechanism of incorporation of prior information, including dynamic borrowing. The basis of the argument is to consider the test decision function as a function of the current data even when external information is included and that external data is given and fixed. We exemplify this finding in the case of a pediatric arm appended to an adult trial and dichotomous outcome for various methods of dynamic borrowing from adult information to the pediatric arm. In conclusion, if use of relevant external data is desired, the requirement of strict type I error control has to be replaced by more appropriate metrics.

Reference:
Kopp-Schneider A, Calderazzo S, Wiesenfarth M. (2020) Power gains by using external information in clinical trials are typically not possible when requiring strict type I error control. Biom J 62(2):361-374. doi: 10.1002/bimj.201800395