# A Multi-state Model for Bone Marrow Transplantation using the `mstate` package

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In this talk I will address two issues arising in multi-state models with covariates. The first has to do with how to obtain parsimony in the modeling of the effect of covariates. The standard way of incorporating covariates in multi-state models is by considering the transitions as separate building blocks, and modeling the effect of covariates for each transition separately, usually through a proportional hazards model for the transition hazard. This typically leads to a large number of regression coefficients to be estimated, and there is a real danger of over-fitting, especially when transitions with few events are present. We propose the use of reduced rank models in order to deal with this issue.

The second issue addressed in this talk concerns the standard errors of the regression coefficients of the reduced rank model. A model-based resampling technique based on repeatedly sampling trajectories through the multi-state model is proposed. The same ideas are also used for estimation of prediction probabilities in general multi-state models, and associated standard errors.

Standard errors can also be obtained analytically. I shall also illustrate how to estimate the covariance matrix of estimated transition probabilities.

During the presentation I will show how to use the `mstate` package for estimating the effect of the covariates, estimation of the cumulative incidence functions, state and transition probabilities. I will also compare results obtained by resampling techniques and exact calculation of all transition probabilities.

# References

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