Study of the global AUC(t) for a multi-state model

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The motivation for my PhD arises from clinical data from the DIVINE project where patients hospitalized due to COVID-19 are followed through several states. One of the aims of this project was to analyze the evolution of those patients and for that a complex multi-state model (MSM) was designed. This MSM allows us to analyze the risk factors for the different events of interest (e.g. non-invasive mechanical ventilation ($NIMV$), invasive mechanical ventilation (IMV), or death) as well as to predict the course of the disease for new patients, but we realized that we didn't know how to analyze its predictive capacity. Therefore, the main objective of my PhD is to evaluate the discriminative ability for MSM, and for that, the area under the time-dependent ROC curve ($AUC(t)$) can be used.

In this work we focus initially in those patients with severe pneumonia who can transition to two competing events: the need for $NIMV$ or IMV; and we propose an estimator for the global $AUC(t)$ for a competing risk model. Under competing risk models, different estimators can be used to estimate the (partial) $AUC(t)$ of each transition ($AUC_k(t), k = 1, 2$). In this work, we propose an estimator $\widehat{AUC}_{CR}(t)$ for the global AUC(t) ($AUC_{CR}(t)$) for a competing risk model as a weighted sum of $\widehat{AUC}_k(t), k = 1, 2$ with each $AUC_k(t)$ being weighted by the probability of experiencing that event k before time t. We have proved that $\widehat{AUC}_{CR}(t)$ is consistent and asymptotically normal.

Keywords: Multi-state models, discriminative ability, time-dependent AUC.