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Semiparametric efficient inferences for lifetime regression model with time-dependent covariates

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Abstract Through a threshold equation, we propose a time-transformed accelerated failure time (AFT) model with time-dependent covariate history in survival analysis. This model contains a general class of semiparametric lifetime regression models, including AFT with identical time-scale and a wide spectrum of Cox's hazard regression models and their frailty variants. We first construct the semiparametric efficient statistical inferences on the AFT model with identical time-scale. The theoretical semiparametric Fisher information bound is explicitly derived under right-censored data setting. And the overidentified estimating equation (OEE) approach based on two martingale processes is shown to achieve this semiparametric efficiency bound. Extensions of the semiparametric efficient statistical inferences to the time-transformed AFT versions are also discussed. We also conclude that most log-rank estimating equations would suffer severe information loss primarily caused by wiggling pattern of the baseline hazard function, while the OEE approach can alleviate the damaging effects. A simulated biological life history example is numerically studied.

Keywords Accelerated failure time model · Log-rank estimating equation · Martingale central limit theorem · Overidentified estimating equation (OEE) approach · Transformation model