A latent model approach to define event onset time in the presence of measurement error

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Abstract

For progressive diseases, it is often not so straightforward to define an onset time of certain clinical condition due to the fluctuation of the disease and the variation of clinical measures. When an irreversible disease stage is diagnosed through the first presence of a clinical event which is subject to a large measurement error, such diagnosis method could result in a large false positive rate and is awkward to interpret since patients could be seen to "recover" from the disease condition easily without medical effort. We generalize the traditional event onset time measure through the use of a stochastic process model and a threshold to some prespecified recovery probability. A simulation algorithm is provided for the numerical evaluation of the estimated recovery probability. Bayesian latent residuals are developed for model assessment. This methodology is applied to define a new postural instability onset time measure using data from a Parkinson's disease clinical trial. We show that our latent model not only captures essential clinical properties of a postural instability process, but also outperforms independent probit model and random effects model. A table of estimated recovery probabilities is provided for patients with various disease conditions. This table can help physicians to determine the new postural instability onset time when different thresholds of estimated recovery probability are used in clinical practice.