Exterior exposure estimation using a one-compartment toxicokinetic model with blood sample measurements

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Abstract

Exposure assessment of individuals exposed to certain chemicals plays an important role in occupational as well as environmental health problems. Biological monitoring, as an alternative to direct environmental measurements, may be applied to relate the exterior exposure with the amount of individual intake. In this paper, we estimate individuals' (inhalation) exposure retrospectively from their blood concentrations via a simplified one-compartment toxicokinetic model. Considering stochastic variations to the toxicokinetic model, the solution to the resultant stochastic differential equation (SDE), together with measurement error, is transformed into a dynamic linear state-space model. The unknown model parameters and the mean inhalation concentration are then estimated via the Markov Chain Monte Carlo (MCMC) simulations. We applied the proposed method to the analysis of a styrene data to backward estimate the inhalation concentration assuming it is unknown. The data analysis showed that the internal stochastic variations, often ignored in toxicokinetic model analysis, outweighed in standard deviation almost twice of that of the measurement error. Also, the simulation results showed that the method performed relatively well to the approach considering measurement error only.