A Monte Carlo Method for Calculating Bayesian Uncertainties in Internal Dosimetry

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This paper presents a novel Monte Carlo method (WeLMoS, Weighted Likelihood Monte-Carlo sampling method) that has been developed to perform Bayesian analyses of monitoring data. The WeLMoS method randomly samples parameters from continuous prior probability distributions and then weights each vector by its likelihood (i.e. its goodness of fit to the measurement data). Furthermore, in order to quality assure the method, and assess its strengths and weaknesses, a second method (MCMC, Markov chain Monte Carlo) has also been developed. The MCMC method uses the Metropolis algorithm to sample directly from the posterior distribution of parameters. The methods are evaluated and compared using an artificially generated case involving an exposure to a plutonium nitrate aerosol. In addition to calculating the uncertainty on internal dose, the methods can also calculate the probability distribution of model parameter values given the observed data. In other words, the techniques provide a powerful tool to obtain the estimates of parameter values that best fit the data and the associated uncertainty on these estimates. Current applications of the methodology, including the determination of lung solubility parameters, from volunteer and cohort data, are also discussed.

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