(6) Modeling of internal dose from an insoluble cesium

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Abstract–Micrometer-sized particles bearing radioactive cesium were found after the accident of Fukushima Daiichi Nuclear Power Station. The particles were insoluble with high specific activities. If the particle is incorporated into the human body, the radioactive cesium included in the particle will move as a single particulate material without being distributed throughout the body by dissolving to blood or tissue fluid. Commonly applied methods for estimation of the numbers of disintegrations in organs and tissues are designed for the average behavior (i.e. distribution in the body) of countless radioactive nuclei. Therefore, the existing methods are not applicable to the intake of the small number of cesium bearing particles. Then, we developed a method that simulates a stochastic movement of a single particle in the body. This stochastic biokinetic method used a compartment model based on appropriate biokinetic models. Each retention time of the particle is determined by a random number based on the biological half-life of the compartment. If the number of the pathways from the compartment is no less than one, a target compartment of migration of the particle is also determined by a random number based on the proportion of the transfer coefficients from the compartment. In this way, we can track the stochastic movement of the single particle in the body, and obtain the respective numbers of disintegrations of radioactive cesium in the organs and tissues. Subsequently, organ absorbed doses can be evaluated by summation of the products of the numbers of disintegrations and corresponding *S* values. Repetitive execution of this procedure makes it possible to evaluate a probability density function of exposure dose. An improved biokinetic model was also studied for micrometer-sized insoluble particles. When insoluble particles are inhaled into the respiratory tract and deposited there, they are cleared by three main routes to blood by absorption, to alimentary tract by ciliary movement, and to regional lymphatic nodes by action of macrophage. According to the preceding studies, some of the insoluble particulate matters are transferred to lymphatic nodes and retained there, and the others migrate to some organs and tissues and retained, for example, liver, spleen, thymus, and so on. Considering these pathways, we constructed a biokinetic model for the cesium bearing particles based on the experimental data. In this study, the probability density function of the absorbed dose for each target organ was evaluated by combining the stochastic biokinetic method and the biokinetic model for cesium bearing particles. In addition, the 99th percentile, arithmetic mean and median values of the distribution of doses were compared with the dose based on the existing models for inhalation type S which is generally applied to unknown chemical forms. This presentation will describe the approach to modeling of the stochastic biokinetic method and the biokinetic model for internal dosimetry of insoluble particles bearing radioactive cesium. Moreover, we will discuss the uncertainties in the lung doses from the insolubility of particles, and also the difference of doses between our constructed models and the existing cesium models.

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