B. Measurement I

Optimal Sampling Condition in RI Tracer Kinetic Studies

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Compartmental analysis is frequently used for radio-active kinetic studies to analyse dynamic distribution of fluid in the human body. In this study we gave the logical limit for the experimnetal precision in applying the compartmental analysis to RI tracer kinetic study and obtained the optimal sampling condition.

Method

The output (observation) of the tracer kinetic process is usually expressed by a sum of decaying exponentials:

$$q(t) = \sum_{i=1}^{p} A_i exp\,(-\alpha_i t)$$

In order to investigate the optimal time scale interval (τ) and sample size (m) (the number of equidistant points of observations) for determination of the pertinent parameters (A_i and α_i) as well as the number of exponentials, the best unbiased estimators of the parameters were calculated in the following RI tracer kinetic model:

$$<n_j> = \int_{tj-1}^{tj} \sum_{i=1}^{p} Aiexp\,(-\alpha_i t)\,dt$$

where $<n_j>$ is the expectation value in the j-th observation.

To estimate the unbiased parameters (A_i and α_i), the Fisher information and Cramér-Rao inequality were applied to the density function (L) which is obtained from the product of the probability density of the counts as follows:

$$L = exp\,(-\sum_{j=1}^{m} <n_j>) \frac{<n_1>n^1 <n_2>n^2 \cdots <n_m>n^m}{n_1!\, n_2! \cdots n_m!}$$

Results

Analysis of the effect of sample size, the time scale interval (τ) and the number of exponentials (p) on the variance of A_i and α_i by numerical examples revealed the following results:

(1) For a fixed sample size, there is an optimal time scale interval which increases with sample size. (2) For a fixed time scale interval, the variance of each parameter decreases with the sample size, but it converges to an certain level for a large sample size. (3) The allowable limit on τ as the optimal time scale interval decreases with increasing the number of exponentials. (4) Recommended observation time is 15–20 minutes for the study of the cerebral circulation and 3–5 minutes for the study of the pulmonary circulation and ventilation using ^{133}Xe.

System Configuration of Minicomputer and Its Performance for Data Processing

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Recently minicomputers are utilized in many nuclear medicine laboratories for image data processing and other data processing. However performances of data processing are due to the system configuration and software system of the minicomputer. Construction of computer is decided with memory capacities of central processing unit and kinds of peripheral equipments.