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.

In this report we described of functions and characteristics of two minicomputer systems which designed for data processing in the field of nuclear medicine.

One is the system with TOSBAC-40C (40 kB) as CPU. This consists of magnetic disc unit, magnetic tape unit and graphic display unit, and is connected with scintillation camera on line. So the software "NUMOS" for image data processing is built in this system. Furthermore by adding the software "DOS-40 (E)" and mark card reader, developments of application programs for logic diagnosis and recording of patients are executed. The program for logic diagnosis consists of process filing data and reporting and doing output of diagnosis at real time. Now this program use likelihood method.

Another is the syste with YHP-2100 (48 kB) as CPU. This consists of magnetic disc unit, high speed printer and simple display unit, and is utilized for general purposes. So for image data processing by using this system, magnetic casette tapes are used as data medium and processed off line. Programs for reading casette tape are developed.

A Simple Mathematical Method for the Analysis of Radioimmunoassay Data with A Computer Connected with An Automatic Gamma Counter On Line

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Simple mathematical methods have been used to analyze radioimmunoassay data utilizing a small computer (Olivetti P652) connected on line with an automatic gamma counter (Shimazu AL201). Construction of doseresponse curve, elimination of unreliable data and calculation of concentrations of unknown samples were all automated by this computer. After eliminating data of standard preparations with B/F difference between duplicates larger than 0.2 as erroneous data, first simulation of standard curve was performed either by the rectangular hyperbola or the cubic polynomial: $Y=a_0(\log X)^3+a_1(\log X)^2+a_2(\log X)+a_3$. Taking all data within the range of $Y\pm 0.1Y$ of the simulated equation including the data once omitted, the second fitting of the standard curve was performed with the same equations. We also used a linear polynomial: $Y=a_0 \log X+a_1$ for the second fitting. In the latter case, the standard curve was automatically divided into two or three segments in order to minimize the variance. Standard curve calculated by this method usually showed best fitting with least variance and therefore seems most preferable method.

Transaction of Multipule Pinhole Coded Aperture by Min.-Computer

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By making a few improvements on the Multiple-pinhole Coded Aperture (MPCA) and decoding the obtained shadowgrams either by otpical system or computer, we have tried to solve the problems of restriction on the lateral spatial resolution and its sensitivity, associated with the gamma camera collimetor. Theoretically, lateral spatial resolution depends upon the size of pinhole; the smaller than diameter of pinhole, the sharper than resolution. This shadowgram contains tomographic images from which we are able to obtain the (tomographic) images of the desired depths