

lung was divided into 3 regions (upper, middle, lower). In ventilation studies, peak heights after a single breath obtained for each region are thought to represent regional ventilation. Regional ventilation (V) were calculated from the values of minute ventilation volume obtained by spirometry technique and the regional percentage of ventilation volume. In the same way, perfusion peaks for pulmonary blood flow obtained for each region represented regional perfusion (Q) which were calculated from the cardiac output obtained by ^{99m}Tc -Albumin technique and regional percentage of blood flow.

In this way, regional V/Q could be obtained but this method has some problems because breath-holding is unphysiologic and it is doubtful

that peak heights after inhalation represented the regional ventilation.

Therefore, regional washout curves which have many informations about ventilation were analyzed using compartment analysis technique. The compartment model of the lung consists of six compartments which have the pulmonary functions and a dead space compartment. Regional ventilation per unit volume (rate constant K_i) were obtained by fitting method using an analogue computer. Several experiments were performed on the compartment model: The effect of K_i on the washout curves in region i and the other regions. The effects of initial concentration and volume of dead space on each regional washout curve, etc.

Measurement of Pulmonary Blood Flow and Mean Transit Time by using Radiopharmaceutical

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The radioactive ^{99m}Tc -albumin method for the measurement of cardiac output and the transpulmonary blood volume and the transpulmonary mean transit time was used.

The experiments were carried out in six patients with cardiac and/or pulmonary diseases and in three subjects without any disorders of heart and lung.

With the patient in the supine (or sitting) position the detecting head of a scintillation camera was placed close over the heart. Data were recorded on magnetic tape for computer evaluation at various intervals after rapid injection of 4 mCi of ^{99m}Tc -albumin into an antecubital vein. A magnetic tape controller transferred data from the memory system onto the magnetic tape.

By using time-lapse curves concerned with radioactive counts from areas of interest of the

pulmonary artery and the left ventricle and/or the left atrium, peak to peak times and mean transit times calculated by deconvolution method were measured.

Cardiac output was measured by the Stewart-Hamilton method with monoexponential extrapolation of the downslopes.

In three out of six cases whose peak to peak times and mean transit times were simultaneously measured, the two values were almost equal. Although the measurement of peak to peak times is simple and convenient, the caution must be needed against experimental errors.

Each lung was divided into three areas such as the upper, the middle and the lower one. Lung transport functions (distributions of circulatory transit times across each area of the lung) were obtained from lung-input and lung-out dilution curves using a lumped-parameter model and

an iterative convolution technique. A time lag of these lung transport functions was one or two

seconds and the distributions of the functions were in a narrow range.

Measurement of Circulating Blood Volume, Heart Volume, Pulmonary Blood Volume and Blood Volume of Body by Analog Simulation of Radiocardiogram

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Radiocardiograms were performed in 34 normal subjects, 130 patients with cardiac valvular diseases, 11 with obstructive lung disease and 18 with other cardiac diseases. Radiocardiograms were analyzed using an analog computer simulation circuit which represents the mathematical models of the whole circulatory system. Circulating blood volume (CBV) was determined by means of a well-scintillation counter using I^{131} -RIHSA and blood volumes of heart, lung and body were calculated as a product of respective mean transit time (sec) and cardiac output (ml/sec/m²) obtained by analog analysis of radiocardiogram.

In normal subjects, CBV was 2496 ± 241 ml/m² (mean + SD) and blood volume of heart, lung and body was 268 ± 43 ml/m², 272 ± 45 ml/m² and 1955 ± 199 ml/m², respectively, and the ratio of them to the CBV was $10.8 \pm 1.8\%$,

$10.9 \pm 1.1\%$ and $78.3 \pm 2.3\%$, respectively, In patients with mitral and aortic valvular diseases, CBV and heart volume increased in proportion to the severity of the disease classified by the criteria of New York Heart Association, but blood volume of body was almost kept constant and the only exception was the case combined with right heart failure in which blood volume of body was also increased. In patients with lung disease, cases with right heart failure showed the increase of CBV and blood volume of body, however, cases without right heart failure showed no increase of them. These results suggest that in patients with mitral and aortic valvular diseases, increased CBV is caused by the increased heart volume but in the case combined with right heart failure increased blood volume of body also contributes to the increased CBV.

The Determination of Cardiac Output by Radiocardiogram

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In measurements of cardiac output from radiocardiogram, attention must be paid on the following points:

(1) Identical mixing pool both during the primary circulation and at the time of calibration.