

sharply, it is useful for a diagnosis of healing of the disease, provided that it is used as one indicator of pulmonary function for follow-up, and can be also useful for understanding of patho-physiological condition of cardiopulmonary diseases.

This method is safe, simple and rapid to perform and results are reproducible. Repeated scans may be done if need be. The application of this technique in evaluating other diseases of the chest is discussed.

Evaluation of Myocardial Blood Flow in Man with Radioactive Rubidium-86 by Means of Precordial Counting Method

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THEORETICAL CONSIDERATION

The present report is concerned with the application of the indicator fractionation technique, proposed by L. A. Sapirstein in 1958, to the measurement of the myocardial blood flow in man. The principle of this method is that the blood flow measurement was made by determining the pattern of distribution of a single mass of injected indicator at a time when the indicator had been delivered to the organs by their arterial supply, but presumably had not yet left any of the organs by way of their venous drainage to a significant extent. At such time the distribution of the indicator can be taken to correspond to the distribution of the cardiac output, if the arterial blood supplying all organs is homogeneous. The radioactive indicator ^{42}KCl or $^{86}\text{RbCl}$ has such a character that its uptake by organs is proportional to their blood flow fraction of the cardiac output with only the exception of the uptake in the brain.

On these grounds, the myocardial blood flow (M.B.F.) can be described as the product of cardiac output and the fractional uptake of indicator in myocardium to the whole body uptake of indicator. While the cardiac output can be described as the total injected indicator divided by integrated, primary arterial concentration curve (A), that is Stewart-Hamilton's equation, and the product of the whole body extraction ratio (E)

for the indicator and the total injected indicator is equal to the whole body uptake of indicator, the myocardial blood flow can be described as follow:

$$\text{M. B. F.} = \frac{\text{Myocardial Uptake of Indicator}}{A \times E}$$

METHOD

After a single intravenous injection of Rb-86, we estimate precordial radioactivity obtaining simultaneously the samples of arterial blood from a brachial artery for a certain time after completion of the first circulation. The precordial activity is made up of an intravascular and an extravascular component. The intravascular component is determined by the intravenous injection of nondiffusible indicator like RIHSA, previously. The extravascular component may then be obtained by subtracting the intravascular component from the precordial activity; it is made up of myocardial activity and the activity in tissues other than myocardium. If the latter is neglected with adequate shielding of scintillation counter, the extravascular component may then be assumed to be equal to myocardial activity.

The whole body extraction ratio is calculated by using RIHSA which exclusively occupies intravascular segment of the body, and using Rb-86 which distributes either tissues and intravascular segments with their constant extraction ratio.

Now we calculate myocardial blood flow per unit mass of myocardium (M) as follow:

$$\text{M. B. F. / M.} = \frac{\text{Precordial Counting Rate due to Myocardial Activity}}{A \text{ (in Radiocardiograph)} \times E}$$

RESULT

We obtained the values of M.B.F. (ml/100gm. min.) in 7 subjects. Their M.B.F. were 92 and 84 in 2 normal subjects, 148 and 104 in 2 subjects with hyperthyroidism, 93 and 53 in 2 subjects with coronary in-

sufficiency, and 82 in one subject with heart failure, respectively.

The method presented in this report is relatively simple and little troublesome to patients, so that its use may prove of interest in the clinical evaluation of myocardial blood flow.

Evaluation of Cardiac Reserve by Means of Externally Monitored Radio Iodinated Serum Albumin in Conjunction with the Master Test

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Estimation of cardiac output from precordial dilution curves following intravenous injection of a radioiodinated human serum albumin was presented.

In 14 cases with hyperthyroidism the values of cardiac output and stroke volume were 87 per cent and 27 per cent higher than those in healthy individuals. The decreases in cardiac output and stroke volume to 45 per cent and to 53 per cent were observed in 6 cases with cardiac failure. Patients with congenital heart diseases showed the decrease in them to 50 per cent and 42 per cent. In many cases of hyperthyroidism, diabetes mellitus and coronary arterial diseases these values remained within normal range.

In an effort to add parameter of cardiac function to the battery of diagnostic methods, the clinical applicability of a cardiac output test in response to exercise was tried. Pulse, blood pressure, electrocardiogram, blood volume and cardiac output were determined before, immediately, 3 minutes and 8 minutes after the standard 2-step exercise test as described by Master.

In 10 normal subjects pulse rate was increased to 19 per cent, 5 per cent and 2 per cent at these times. The increases in cardiac

output at these times after exercise were 67 per cent, 29 per cent and 2 per cent. A stroke volume was increased to 46 per cent, 32 per cent and 4 per cent.

These values rised sharply in the order of 1.5 times the resting level immediately following the end of exercise. At 8 minutes after exercise these values returned approximately to control levels. External cardiac work per stroke and external cardiac work per minute altered similarly after exercise in normal subjects. The 5 patients with positive Master test showed lower response and retarded restoration in these values after exercise.

In 3 cases of 6 hyperthyroidism, 1 case of 3 diabetes mellitus 1 case of 2 hypert, ension and 1 neurocirculatory asthenic patient with negative Master test, lower response to exercise and retarded restoration to control levels which were considered as reduction of cardiac reserve were observed.

The measurement of cardiac output by means of externally monitored radioiodinated serum albumin in conjunctin with the Master test may be useful in clinical evaluation of boundaries of normal and disordered cardiac function.