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Variation in pulmonary retention of ^{131}I-macroaggregated albumin[1]

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Counting over the right lung after the intravenous injection of ^{131}I-macroaggregated albumin revealed a wide spread in retention half-times of the radiolabel (7 hours to 31 hours) even among patients having identical preparations. This needs further exploration as to its mechanism and its effect on the calculated radiation exposure of the lungs.

Macroaggregates of human serum albumin labelled with radioiodine (^{131}I) have gained wide use in studies of pulmonary perfusion. While attention has been focused on the distribution of this radioactive material as a diagnostic aid the dynamics of the turnover of the radiolabel have been less well documented. Wagner *et al.* (1964) reported that in four patients the disappearance of ^{131}I-macroaggregate radioactivity from the lungs was approximately exponential, with half-times of from 5 to 10 hours. Quinn and Head (1966) quote values on the disappearance of ^{131}I-macroaggregate radioactivity from the lungs as having two components, the first having a half-time of 3 hours. In order to define the range of pulmonary retention of ^{131}I from radiolabelled macroaggregated albumin, we have followed a number of patients serially after intravenous injection of this substance.

MATERIALS AND METHODS

Patients were given Lugol's solution and the neck was covered by a lead shield before counting over the lungs was begun. Injection (263–358 μCi) of ^{131}I-macroaggregated albumin was made into a vein in the left arm with the patient supine; any small extravasation would then not affect counts over the right lung.

After 5 minutes a 3-inch NaI (T1) cylindrically collimated probe (with scaler and spectrometer) was placed over the right lung. Placement of the probe (with a 35 cm distance bar between the chest wall and the crystal) was at the fourth interspace in the midclavicular line. The same person counted a particular patient at each point in time in order to reduce variations. Left lung counts were not used because of possible radioactivity (free ^{131}I) in the near-by stomach. The start of each count was timed from a central clock. A standard was also counted to ensure against machine drift. Patients returned as many additional times (one to four) as possible.

Counts were plotted on a logarithmic scale versus time on a linear scale. When three or more points were available, the best fitting line was calculated by the method of least squares, using an Olivetti Programma 101 computer. The correlation coefficient was also calculated. From the line obtained in each case an effective half-time of ^{131}I in the lung was calculated.

RESULTS

In the Table patients are grouped according to the batch number of the ^{131}I-macroaggregate used. Thus patients within each group were comparable in that they had received the same preparation of radiolabelled material.

It can be seen that there was wide variability in the effective half-time of retention (from 7 to 31 hours). Within each batch there was also variation. For example, patients given batch 548QL had lung retention half-times of from 7 to 19 hours. Perhaps most striking were the results with batch 548QQ: three patients had nearly identical half-times (11, 11, and 12·5 hours) whereas a fourth patient had a half-time of 31 hours (Figure).

DISCUSSION

This study was designed to determine if there was significant variation between patients in the pulmonary retention of radiolabel after intravenous injection of ^{131}I-macroaggregated albumin. The unexpectedly large differences in retention between patients receiving the same preparation of material has at least two implications.

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TABLE

RESULTS OF RIGHT LUNG COUNTS IN PATIENTS GIVEN ^{131}I-MACROAGGREGATED ALBUMIN

Batch No.	Patient			Dose (μCi)	Retention Effective ($T\frac{1}{2}$ hr)	Comment
	Identification	Age (yr)	Sex			
548QK	71–547	32	F	375	15·0	
	70–649	29	F	276	11·0	E
548QL	71–560	75	M	297	9·0	A
	71–611	76	F	298	19·0	E
	71–575	63	F	310	7·0	
	71–552	79	M	321	9·0	
	71–594	76	F	273	7·0	B, E
	64–159	53	F	301	9·0	
	71–608	44	F	301	14·0	E
	71–605	55	F	301	19·0	
	71–560	75	M	301	15·0	A
548QM	71–594	76	F	358	9·0	B
	71–625	54	F	358	17·0	
	69–156	62	M	358	14·0	E
548QP	71–725	57	M	307	7·5	
	71–608	44	F	292	7·0	E
	71–695	56	M	263	13·5	
	64–159	54	F	312	9·0	
	71–660	42	M	287	9·0	
548QQ	71–790	46	F	284	11·0	
	71–787	84	M	316	11·0	
	71–736	43	F	331	12·5	
	70–1,180	48	M	316	31·0	E

A=two studies performed; B=two studies performed; E=extrapolated (that is, the half-time had not been reached when the study had to be discontinued because of the patient's condition, but points sufficiently far apart had been obtained).

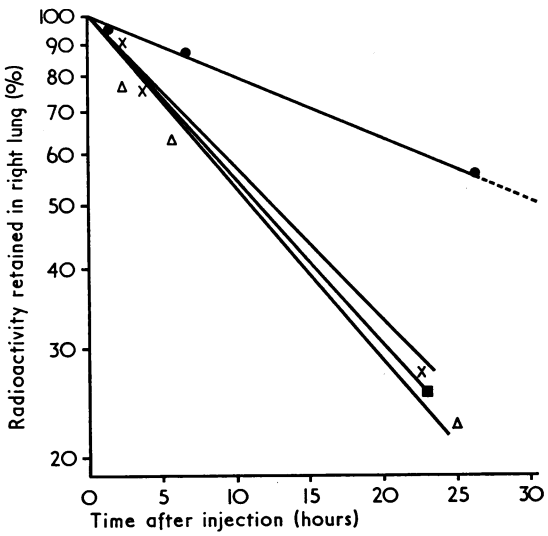

FIGURE. *Retention of radioactivity detected over right lung (log scale) plotted as a function of time. Three of the patients had counts at 4 points in time, while one had only 2 counts for batch 548QQ. Uppermost line (extraplotted to a $T\frac{1}{2}$ of 31 hours) represents case 70–1180. The other lines are for cases 71–736, 71–790, and 71–787 ($T\frac{1}{2}$ of 11 to 12·5 hours). The correlation coefficients for the three lines, of 4 points each, were all over 0·95.*

1. The most important consideration is that changes in retention of radiolabel in the lungs might somehow be related to the progress of the underlying disease. Case 70-1180 ($T\frac{1}{2}$=31 hours), in whom multiple pulmonary embolism had been suspected, had undergone inferior vena cava ligation. Hence there was altered haemodynamics from the vessel ligation as well as the pulmonary vascular lesions. With this background, we are beginning a prospective study of pulmonary retention of the radiolabel as a function of such variables as estimated area of lung embolized, clinical course, return of perfusion (as shown by a follow-up scan), and blood picture changes (white blood cell count, bilirubin, serum aspartate aminotransferase).

2. A less important, but real, consideration is that the radiation exposure of the lungs may vary by a factor of almost 4, due solely to different retention times. Although the radiation dose delivered by microspheres tagged with the short-lived radionuclides ^{99m}Tc or ^{113m}In is, of course, less than that of ^{131}I, the same biological variability may still hold. The intrapulmonary ^{131}I-macroaggregated albumin is degraded and, as long as the thyroid gland has been blocked by Lugol's solution, the critical organ for radiation exposure is the lung. This is because the partially degraded particles (or at least their radioactive component), released from the lungs and taken up by the reticuloendothelial system of the liver or spleen, have but a short residence time in these latter organs.

Owing to the illness of many of the patients it was difficult to obtain multiple counts. Hence such studies may have limited clinical applicability unless a portable probe system can be brought to the patient's bedside. We set up this initial protocol so that it would be easy to perform (that is, the counting procedure resembled that used for thyroid patients). Further refinement could include counting directly over a segment of the lung to rule out the minimal contribution from radioactive particles in the liver.

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