

CHANGES IN TISSUE CLEARANCE OF RADIOACTIVE SODIUM FROM SKIN AND MUSCLE DURING HEATING WITH SHORT-WAVE DIATHERMY; A PRELIMINARY REPORT

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KETY in 1949 first described the use of tissue clearance of radioactive sodium (Na^{24}) as a measure of local circulation. He showed that the Na^{24} remaining at the site of injection decreased along an exponential curve, which when plotted semi-logarithmically against time produced a straight line, the slope of which he called the clearance constant k .

In this paper are reported the results in 46 subjects in whom the circulation in the quadriceps femoris muscle or the overlying skin during heating with short-wave diathermy was studied by a similar technique to that of Kety.

Method

A small quantity of Na^{24} chloride (5 microcuries in 0.1 to 0.2 ml. of isotonic saline solution) was injected at a depth of 2.5 cm. into the quadriceps femoris muscle or into the overlying subcutaneous tissue. A scintillation counter was placed at a fixed distance from the injection site and rates of clearance were recorded at one-minute intervals on a

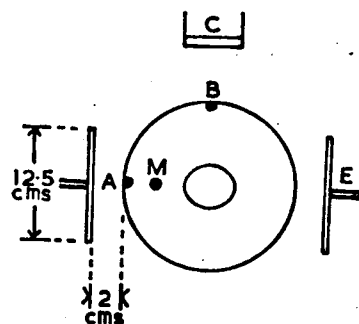


FIG. 1.—Diagram to show technique of short-wave diathermy and injection sites in leg. A and B represent the skin depots of Na^{24} ; A is under an electrode and B is midway between the electrodes. M represents the muscle depot of Na^{24} under an electrode at a depth of 2.5 cm. C is the scintillation counter. E is a Bauwens type condenser electrode. Skin temperature measurements were taken at A and B.

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ratemeter. After a preliminary period of approximately twenty minutes, short-wave diathermy was applied to the site of injection for twenty minutes by means of a Stanley Cox "intertherm" with Bauwens type electrodes tuned to maximum skin-temperature tolerance; the recording was then continued until a final background plateau was reached. Details of technique are shown diagrammatically in Fig. 1.

The subcutaneous tissue overlying the quadriceps muscle was studied at two sites—under one of the electrodes (16 subjects) and midway between them (5 subjects).

The tissue clearance of the opposite leg was recorded at the same time in 19 subjects, as a control.

Skin temperature measurements were recorded over the injection

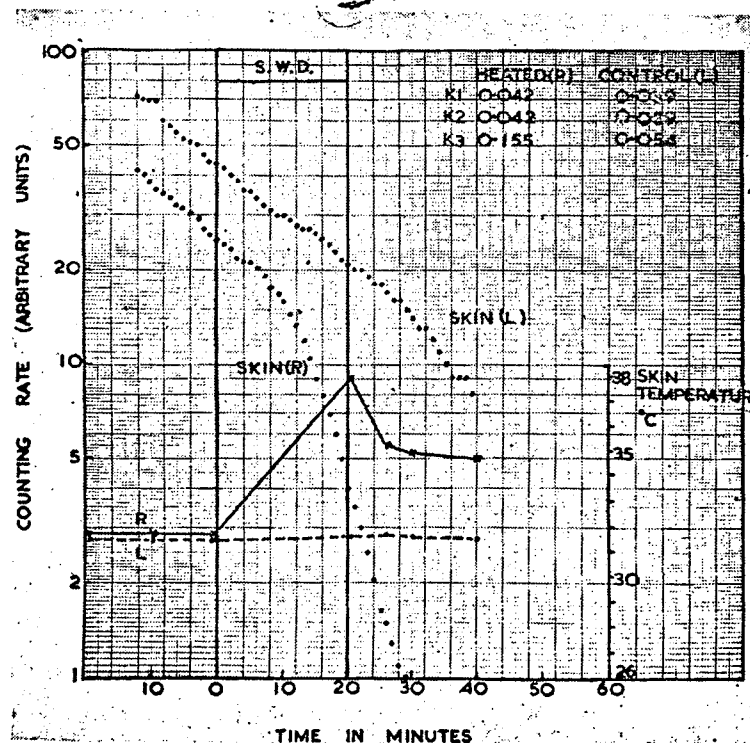


FIG. 2.—Rate of clearance of Na^{24} from skin of both legs measured simultaneously during heating of right leg by short-wave diathermy for twenty minutes (S.W.D.). The skin depot of Na^{24} was at site A in Fig. 1. Skin temperature measurements over the injection site are shown. (To show great increase in rate of clearance from skin of heated leg and slight increase in control leg.)

site with a Cambridge skin thermometer. (See A and B in Fig. 1.)

Deep temperature measurements were made under an electrode, at 2.5 cm. depth, by means of a needle thermocouple, in 6 subjects who were treated but not included in the series. This step was necessary as the introduction of a needle into the muscle during the experiment may cause reflex vascular changes.

The minute-interval recordings, minus background, were plotted semi-logarithmically and the clearance constant k was calculated for the period before, during, and after heating.

Results

The results obtained are shown in Tables I and II.

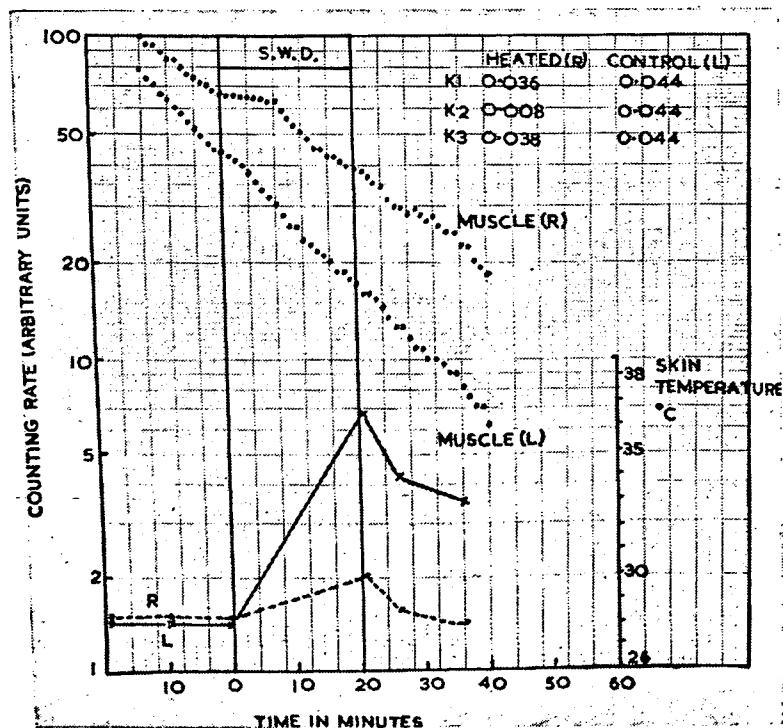


FIG. 3.—Rate of clearance of Na^{24} from quadriceps muscle of both legs measured simultaneously during heating of right leg by short-wave diathermy for twenty minutes (S.W.D.). The muscle depot of Na^{24} was at site M in Fig. 1. Skin temperature measurements over the injection site are shown.

(To show great decrease followed by slight increase in rate of clearance from muscle of heated leg and no change in control leg.)

Circulatory Changes during Short-wave Diathermy

TABLE I
TEST SUBJECTS

	Mean Values of k			Average Rise in Skin Temperature over Injection Site	Remarks
	Before Heating	After Heating	Increase		
Skin clearance: Under an electrode (16 subjects)	0.043 ± 0.014	0.108 ± 0.038	0.065	5.3°C.	All subjects showed an increased clearance rate (see Fig. 2)
Midway between electrodes (5 subjects)	0.044 ± 0.008	0.075 ± 0.032	0.031	1.3°C.	No change in clearance rate in two subjects
Muscle clearance (25 subjects)	0.042 ± 0.013	0.057 ± 0.020	0.015	5.2°C.*	No change in clearance rate in 6 subjects, and a decrease in one subject (see Fig. 3)

* A deep temperature rise of 4.0°C. was noted in six subjects (not included in series).

TABLE II
CONTROL SUBJECTS
(Measurements in opposite leg—not heated)

	Mean Values of k			Average Rise in Skin Temperature over Injection Site	Remarks
	Before Heating	After Heating	Increase		
Skin clearance (6 subjects)	0.057 ± 0.026	0.062 ± 0.023	0.005	1.0°C.	Small decrease in clearance rate in two subjects
Muscle clearance (13 subjects)	0.041 ± 0.013	0.042 ± 0.009	0.001	1.9°C.	No change in clearance rate in five and a decrease in three subjects

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Skin Clearance.—From the table of results it will be seen that under an electrode there was an increase in the skin clearance rate of approximately 150%, and midway between the electrodes one of 70%. The skin clearance in the controls increased by 9%.

Muscle Clearance.—The muscle clearance rates show an increase of 36%. Of the 19 subjects in whom an alteration in clearance rate occurred, one had a decrease of 39%, 3 subjects had a cut-off of 4 to 8 minutes at the onset of heating followed by a return to the previous clearance rate, and 6 subjects had a cut-off of 4 to 5 minutes at the onset of heating followed by an increased clearance rate. The remaining 9 subjects had a gradual increase after heating was started. The muscle clearance rates in the controls show an increase of 2%.

Summary

1. Tissue clearance studies were carried out on 46 subjects to compare the response of the quadriceps muscle and overlying skin to heating with short-wave diathermy.

2. The skin clearance rate showed an average increase of approximately 150%, 19 out of 21 subjects studied showing an increase.

3. The muscle clearance rate showed an average increase of 36%. In approximately one-third of the 25 subjects in this series an increase occurred, in one-third there was little over-all change, and in one-third a decrease followed by an increase.

Acknowledgment

This work was done under the direction of Dr. R. Harris with the aid of a grant from the endowment fund of the Manchester Regional Hospital Board.

REFERENCE

KETY, S. S. (1949) *Amer. Heart J.*, **38**, 321.

CLINICAL REPORTS

DEMONSTRATION OF CASES AT THE LONDON HOSPITAL

A CLINICAL meeting of the Section of Physical Medicine of the Royal Society of Medicine was held in the Department of Physical Medicine, The London Hospital, on March 9, 1955. Cases were presented by Drs. W. S. Tegner, G. O. Storey, and V. L. Steinberg.

As Dr. Tegner said in his introductory remarks, the wide-variety-of cases shown were representative of the clinical material that passes through a Department of Physical Medicine.

Disseminated Lupus Erythematosus with Amyloid Disease

The first case was that of a married woman of 30 with the following history:

In 1940, at the age of 15, she developed rheumatic fever, being confined to her bed for four months. Though the symptoms in the joints rapidly responded to treatment, she remained generally unwell after the attack and attended the out-patient department of a hospital for "debility and anaemia".

In 1944 she had an attack of cerebrospinal meningitis from which she recovered, but shortly afterwards pain, stiffness, and swelling developed in several joints. These symptoms did not remit.

In 1945 (aged 20) she was admitted to the London Hospital with pericarditis complicating rheumatic fever, this diagnosis being supported by typical radiographic and electrocardiographic findings. The arthritis was controlled but not completely cleared up by salicylates, and when this treatment was stopped the symptoms increased in severity.

In 1949, when pregnant for the first time, she had a severe relapse of the arthritis and after delivery became partly bed-ridden. A diagnosis of rheumatoid arthritis was made at this stage. In November, 1952, she was readmitted to the London Hospital with fever, dyspnoea, oedema of the legs, and ascites.

Investigations.—X-ray chest: hilar congestion; heart normal in size. E.C.G.: flat T-waves in all leads. X-ray hands and feet: periarticular osteoporosis, typical of rheumatoid arthritis. Urine: massive albuminuria; maximum specific gravity 1022. Liver function test: alkaline phosphatase, 17.5 units; van den Bergh, 0.2 mg. per 100 ml.; thymol turbidity, 7.5 units; plasma proteins, 5.6 g. per 100 ml. (albumin 3.1 g., globulin 2.5 g.). Congo red test: 90% absorption, none present in urine (diagnostic of amyloid disease). Liver biopsy: changes typical of amyloid disease.