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Effects of Digitalis on Electrolytes of Heart Muscle.*

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The basic mechanism whereby digitalis exerts its specific actions on the heart is not fully known. The changes effected by digitalis are evidenced in the electrocardiogram. These are electrical phenomena which suggest quantitative and distributive changes in the electrolyte pattern of heart muscle. Since it is impossible to determine the electrolyte change as effected by digitalis for one heart beat, it was thought that the total change effected by digitalization could be used as an index of the changes of an individual cycle. It was therefore considered worth while to make a quantitative study of the electrolytes of both auricular and ventricular muscle after maximal digitalization.

Experimental Method. Fifty dogs, anesthetized with pentobarbital sodium, were divided into 3 groups. Nineteen animals were used to determine the normal distribution of electrolytes in both auricular and ventricular muscle. Twenty-one animals received tincture of digitalis intravenously (0.1 cc per kg of body weight) at 5-minute intervals until death. They required an average of 11 doses (range 9-13). To rule out any effect of the alcohol in the tincture of digitalis, 10 addi-

tional dogs were given, in an identical manner, the equivalent amount of alcohol present in a lethal dose of the tincture.

Tissue from each of the 4 chambers was analyzed separately. Chlorides and total nitrogen were determined on fresh tissue. The remainder was dried to constant weight for water determination. One- or 2-g samples of the dried pulverized tissue were ashed at 550°C for 16 hours, and the ash dissolved in 0.5 N HCl (25 or 50 cc respectively). Ca, Fe, Mg, Total P, K and Na were determined from the solution of ash (see ref. 1, 5, 7-11 for methods).

Results. The results of the control group are summarized in Table I, those for the experimental group in Table II, and those for the alcohol group in Table III. Table IV summarizes the changes which were statistically significant.

Discussion. While the water content of both auricular and ventricular muscle was comparable in both the experimental and the control groups, the electrolyte content of ventricular muscle in all 3 groups was much greater than that of auricular muscle. An absolute change in sodium, potassium, and calcium content occurred. There was a significant decrease in potassium and calcium in auricular muscle and a gain in sodium. The gain in sodium did not compensate for the

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TABLE I.
Control (19 Animals).
Electrolytes in mEq. per 1000 g of Dry Tissue.

	R.A.	L.A.	R.V.	L.V.
Calcium	16.6	16.3	11.5	11.2
Chloride	77.8	81.6	87.3	87.8
Iron	7.6	7.6	11.6	12.1
Magnesium	44.4	45.3	75.6	79.0
Phosphorus	180.0	185.0	254.0	261.0
Potassium	137.0	154.0	277.0	279.0
Sodium	96.6	121.0	253.0	255.5
Total Nitrogen %	2.36	2.48	2.90	2.96
Water %	74.6	74.9	77.1	77.4

TABLE II.
Electrolytes in mEq. per 1000 g of Dry Tissue.

	R.A.	L.A.	R.V.	L.V.
Calcium	12.6	12.7	9.0	9.1
Chloride	83.4	86.8	91.5	93.0
Iron	7.2	7.4	12.6	13.8
Magnesium	41.1	43.6	74.8	79.7
Phosphorus	169.0	185.0	248.0	257.0
Potassium	111.0	121.5	268.6	270.0
Sodium	152.2	165.8	306.0	326.0
Total Nitrogen %	2.38	2.53	2.91	2.97
Water %	74.3	75.2	76.9	77.5

TABLE III.
70% Alcohol (10 Animals).
Electrolytes in mEq. per 1000 g of Dry Tissue.

	R.A.	L.A.	R.V.	L.V.
Calcium	16.2	15.9	11.3	11.5
Chloride	80.0	83.4	86.5	87.6
Potassium	141.5	156.6	277.8	277.7
Sodium	102.5	118.6	249.0	260.5
Water %	75.2	75.4	76.7	76.6

loss of potassium and calcium (Table IV). Ventricular muscle showed an absolute increase in sodium in the absence of any other significant changes. The loss of potassium from auricular muscle may be explained on the basis of the vagal component of the action of digitalis, since vagal stimulation causes an outflow of potassium from auricular muscle.^{2,3} The mechanism of an absolute increase in sodium in heart muscle is not understood, but may be related to the poisonous actions of digitalis since an increase in

TABLE IV.
Total Change in Electrolytes.*
(Milli-equivalents per 100 g of dry tissue.)

	R.A.	L.A.	R.V.	L.V.
Control Potassium	137.0	154.0	277.0	279.0
Experimental Potassium	111.0	121.5	268.6	270.0
Loss of Potassium	26.0	33.5	8.4	9.0
Control Sodium	96.6	121.0	253.0	255.5
Experimental Sodium	152.2	156.8	306.0	326.0
Gain in Sodium	55.6	35.8	53.0	70.5
Control Calcium	16.6	16.3	11.5	11.2
Experimental Calcium	12.6	12.7	9.0	9.1
Loss of Calcium	4.0	3.6	2.5	2.1

* From a statistical analysis of the data, only potassium, sodium, and calcium showed P-values not greater than 0.02.

sodium above the physiological ratio of this ion to potassium and calcium produces toxic effects upon the heart.^{4,6}

Summary. 1. Maximal digitalization caused a decrease in the potassium and calcium content of auricular muscle and a gain in sodium which does not appear to compensate for the loss of potassium and calcium. Ventricular muscle showed a gain in sodium which does not appear to compensate for the loss of potassium and calcium. Ventricular muscle showed a gain in sodium in the absence of any other significant changes. 2. The changes in sodium, potassium and calcium following digitalization occurred in the absence of significant changes in the water content of the digitalized heart.

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Effects of Pyribenzamine and Benadryl on Chick Embryo and on Vascular Phenomenon Induced by Normal Serum.

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During the last few years extensive studies have been carried out on the toxic, antihistaminic and antianaphylactic properties of pyribenzamine, benadryl and related compounds. Data on the effects of antihistaminic

drugs on the chick embryo and upon the inverted anaphylactic shock induced by Forssman antibodies are presented in this communication.

Material and Methods. Fertilized chicken