They also observed that in male and female castrates a muscular hypertrophy was produced by administration of testosterone.

It is, therefore, concluded that castration of adult male rats does not alter creatine excretion, that normal and castrated rats react in a similar fashion to exogenous creatine and testosterone propionate as far as creatine excretion and body weight changes are concerned, and that ingested creatine produces an intense creatinuria which is greatly inhibited by testosterone propionate administration.

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Changes in Excretion of Radioactive Na, K and in Carbohydrate Stores Twenty-four Hours following Adrenalectomy.*†

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Serious disturbances in electrolyte excretion and in carbohydrate storage have been observed in adrenal insufficiency. This investigation was undertaken with the hope of determining which of these two mechanisms first showed definite impairment. The findings presented here show that both conditions are altered in the rat 24 hours after the adrenals have been removed.

The altered rates of urinary excretion of radioactive sodium and potassium were interpreted as indicating altered excretion of these electrolytes. Evidence of alteration of carbohydrate metabolism was demonstrated by somewhat lowered values for blood sugar, and by lowered values for liver and muscle glycogen after glucose feeding. Separate groups of rats but of the same sex and approximately the same age, were used for these two studies, since it was not practicable to investigate both conditions in the same set of animals.

In the electrolyte excretion studies, male rats 10 weeks of age with an average weight of 268 g were used. The standardization of conditions for this experiment has been described previously.[1]

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1 Anderson, E., and Joseph, M., PROC. SOC. EXP. BIOL. AND MED., 1939, **40**, 347.

Twenty-four hours before operation, the rats were placed in metabolism cages, and in place of the regular food and drink, they were given, by stomach tube, Locke's solution fortified with 6% glucose in amounts of 10 cc 3 times a day. Three groups of animals were used for the excretion studies of each electrolyte. In Group I both adrenals were removed; in Group II a "mock adrenalectomy" was performed, that is, the adrenals were exposed and handled, but not removed; in Group III no operation was performed. The operative work was done under ether anesthesia, and the anestheic period was not prolonged more than 10 minutes. Immediately following operation, the animals were given 1 cc of an isotonic solution of the radioactive isotope intraperitoneally. Thirty cc of Locke's solution with glucose was continued daily, and the urine was collected in 24-hour samples for 2 days. The amount of radioactive isotope excreted was measured by a Lauritzen electroscope.

In Table I are shown the urinary excretion rates for the radioactive sodium and potassium in the first 24 and 48 hour periods. This is expressed as the per cent of the total amount of radioactive isotope administered. In the first 24-hour period, the adrenalectomized rats showed a slight but significant increase in the excretion of Na^{24} over that of the mock adrenalectomized rats and the normal rats. In this same period the adrenalectomized rats showed a significant amount of K^{42} retention compared with the other 2 groups. The total excretion of Na^{24} and K^{42} for the first 48 hours after adrenalectomy showed the same general trend as in the 24-hour period.

For the study of carbohydrate storage, male rats 64-65 days of age were used. These animals were kept in a constant temperature chamber at 28°C during the experimental period, and for the 2 weeks preceding the experiment. During this time records were kept of the

TABLE I.
Changes in Urinary Excretion of Sodium^{24} and Potassium^{42} During 24- and 48-hour Periods After Adrenalectomy.

	Sodium^{24}			Potassium^{42}		
	No. animals	0-24 hr %*	0-48 hr %*	No. animals	0-24 hr %*	0-48 hr %*
Group I						
24 hr after adrenalectomy	6	16.3 (13.8-17.7)	35.0 (31.9-37.8)	10	2.9 (2.4-3.6)	4.9 (4.3-5.8)
Group II						
24 hr after "mock adrenalectomy"	3	13.4 (11.5-14.3)	30.2 (26.6-32.6)	10	4.5 (3.1-7.5)	9.1 (5.9-12.6)
Group III						
Normal	2	12.3 (11.2-13.4)	27.3 (27.3)	5	4.7 (3.1-5.0)	9.4 (8.7-10.4)

* % of the total amount of radioactive isotope administered.

TABLE II.
Changes in Carbohydrate Stores 24 Hours Following Adrenalectomy.

	No. animals	Body wt g	Glucose absorbed per 100 g body wt per hr	Blood sugar	Liver glycogen		Muscle glycogen, mg %
					mg %	mg per 100 g body wt	
Group I	7	195	128	115	471	15.9	389
24 hr after adrenalectomy			(94-177)*	(90-170)	(141-827)	(5.5-25.6)	(111-549)
Group II	7	196	145	155	1,148	42.0	606
24 hr after "mock adrenalectomy"			(133-172)	(115-185)	(768-1,492)	(28.2-56.5)	(53-941)
Group III	4	195	146	146	2,102	67.3	535
Normal			(134-165)	(120-180)	(1,498-2,862)	(53.3-78.3)	(191-753)
Group IV	3	184		88	62	2.2	395
Normal. Not fed†				(75-100)	(48-71)	(1.9-2.7)	(285-588)

* The figures in parentheses indicate the range of values.
† The total apparent glucose content of the gastrointestinal tract was 7.5 mg, 7.5 mg, and 10 mg respectively.

daily food intake, and the daily variation in body weight. At the time of operation which was 24 hours before sacrificing, the animals were divided into 4 groups carefully matched as to daily food intake and body weight. The adrenalectomized rats (Group I) had had an average daily food intake of 17.8 g for 3 days previously; the "mock adrenalectomized" rats (Group II) 17.8 g; the normal animals (Group III) 15.7 g, and the second group of normal animals (Group IV) 17.3 g. The animals of Groups I, II, and III were fasted 20 hours, given tap water to drink, and then fed 1.2 g glucose (5 cc of a 25% solution), by stomach tube, and sacrificed 4 hours later. Those of Group IV were fasted 24 hours, and sacrificed without feeding. The animals were anesthetized with sodium amytal, the tissues removed immediately, and the following determinations made: intestinal absorption of glucose; blood sugar; liver glycogen, and muscle glycogen. (Liver and muscle glycogen computations of Table II are expressed on a wet tissue weight.)

The results of the carbohydrate study are shown in Table II. After 24 hours the intestinal absorption of glucose is not significantly altered in the adrenalectomized animals as compared with the "mock adrenalectomized" and normal groups. On the other hand, the levels of blood sugar, liver glycogen, and muscle glycogen are significantly reduced 24 hours after adrenalectomy when compared with levels of normal animals. The "mock adrenalectomized" group also showed some lowering of the carbohydrate levels, although they were significantly higher than those of the adrenalectomized group.

It has not been feasible to repeat these 2 sets of experiments using a survival period of less than 24 hours after adrenalectomy. If a difference in time relationship of the onset of electrolyte and carbohydrate disturbances is to be detected, other experimental conditions will have to be set up. However, it appears highly significant that marked derangement in both the electrolyte and carbohydrate mechanism can be detected 24 hours after removal of the adrenals. From these observations one cannot make any assertions as to which disturbance is primary, and which secondary.

Summary. An increased urinary excretion of sodium, and a urinary retention of potassium are detectable in 24 hours after adrenalectomy. Simultaneous with these changes, there is found a lowered blood sugar, and lowered liver, and muscle glycogen values.