

ON ELIMINATION THROUGH THE MUCOSA OF THE URINARY BLADDER.*

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In a previous communication (1) it was reported that after intravenous injections of large amounts of dextrose into normal rabbits the intestine contained on the average 1.2 per cent. of the injected dextrose, while through the kidneys about 40 per cent. of the injected dextrose was eliminated. In rabbits whose kidneys were removed previous to the injection of the dextrose, and in which, therefore, nearly one half of the injected quantity was prevented from being eliminated, the dextrose content of the intestine reached the average of 2.2 per cent. In discussing these results we arrived at the conclusion that the elimination of 1.2 per cent. of the dextrose in the intestines of normal rabbits can not be looked upon as an "intestinal diabetes" (MacCallum (2)), nor is it due to an increased permeability of the intestinal epithelium (Fischer (3)), nor can the increase of 1 per cent. in the dextrose in the intestine of nephrectomized rabbits be looked upon as a "vicarious action" (MacCallum). It was assumed that the elimination of 1.2 per cent. in the intestine of the normal, and 2.2 per cent. in the intestine of the nephrectomized rabbit after an intravenous injection of a large quantity of dextrose has no specific secretory character, comparable, for instance, with the elimination of dextrose through the kidney. It was suggested that the intestinal elimination is merely due to the temporary hyperglycemia; and, in consequence of the high sugar content of the blood and lymph, elimination occurs in minute quantities through all mucous membranes. In the intestine, on account of the large surface of its mucosa, the sugar eliminated aggregates to the considerable figures of 1.2 and 2.2 per cent.

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The mucosa of the intestine, however, is studded with numerous glands. While each kind of gland secretes a specific substance, all glands eliminate some fluid in which these substances are suspended. The glands derive that fluid from the blood. It is therefore plausible to assume that in taking out some fluid from the blood the glands may be capable of removing from the blood, in very minute quantities and in an unspecific manner, any substance present in the blood in excess of the normal. All mucous membranes are moist; their moisture they also derive from the lymph and the blood. Are mucous membranes as such, without the assistance of glands, also capable of eliminating from the blood substances present in the blood in excess? To test this question, one must examine the contents of a viscus which is lined with a mucous membrane free from glands. Such a hollow viscus is the urinary bladder; its mucosa is not provided with secreting glands. A series of experiments was therefore carried out to determine whether dextrose, when present in excess in the blood, or a substance foreign to the blood, may be eliminated into the bladder. In the following report we shall describe these experiments very briefly.

The rabbit was the experimental animal used. A double nephrectomy was performed and either later on the same day, or on the next day, cannulas were inserted in the bladder and in the jugular vein. Ether anesthesia was used during all operative procedures. In the bladder was inserted a cannula which was modeled on the Ludwig-Spengler cannula for obtaining blood pressure laterally from an artery, except that both plates were made flat. Care was taken, when inserting the cannula, that the circulation was interfered with as little as possible. The cannula was inserted in the ventral side of the bladder and the abdomen sewed up. Warm 20 or 30 per cent. dextrose solution was injected intravenously, seven to ten grams per kilogram being introduced in from twenty to fifty minutes. The bladder was washed by irrigating with warm 0.9 per cent. sodium chloride several times during and after the dextrose injection; the fluid was ejected by the animal as in normal micturition. The washings were boiled immediately, assembled, and concentrated to a small volume on the water bath and analyzed for sugar, qualitatively with Fehling's and Benedict's (4) solutions, and quanti-

TABLE I.

No. of animal.	Color.	Sex.	Weight in gm.	Time of nephrectomy.	Uranin introduced in mg.	Dextrose introduced.			Duration of dextrose injection in min.	First bladder washing.	Color of bladder washings.	Uranin found in bladder washings.	Dextrose found in bladder washings.
						U	D	S					
DB 2	Gray	F.	1,550	Previous day	0	54	20	7	34	After injection of 22 c.c. dextrose solution	Blood-tinged		0.006
DB 3	Gray	M.	2,400	Same day	0	84	20	7	29	After 42 c.c. dextrose solution	Slightly blood-tinged		0.000
DB 5	Gray	M.	2,020	Previous day	0	70	20	7	20	After 57 c.c. dextrose solution	Colorless		0.000(?)
DB 6	Gray	F.	2,030	Previous day	0	70	20	7	33	After 35 c.c. dextrose solution	Almost colorless		0.007
DB 7	Maltese and white	F.	1,440	Same day	0	50	20 ¹	7	20	After 25 c.c. dextrose solution	Almost colorless to slightly blood-tinged		0.008
DB 11	Gray and white	M.	1,770	Same day ²	0	62	20 ³	7	26	After 31 c.c. dextrose solution	Almost colorless		0.000
DB 12	Gray	M.	2,055	Previous day	0	72	20	7	34	1 hour after end of dextrose and thereafter for 1 hour	Colorless to slightly blood-tinged		0.000
DB 13	Maltese and gray	F.	1,420	Previous day	0	50	20 ⁴	7	31	After 25 c.c. dextrose solution	First very bloody, others almost colorless		0.000
DB 14	Gray	F.	1,740	Same day	20	58	30	10	48	After 5.5 c.c. dextrose solution	Almost colorless	0	0.000(?)
DB 15	Gray	F.	2,140	Same day	100	72.5	30	10	40	After 18 c.c. dextrose solution	Almost colorless to bloody	Trace(?)	0.000(?)
DB 17	Gray	M.	1,625	Same day	100	55	30	10	38	After 11 c.c. dextrose solution	Colorless	0	0.000
DB 18	Gray	M.	1,470	Same day	100	52	30	10	35	After 13 c.c. dextrose solution	Colorless to fluorescent	<0.035 mg.	0.011
DB 19	Gray	M.	1,550	Same day	100	52	30	10	40	After 13.5 c.c. dextrose solution	Colorless to fluorescent	<0.15 mg.	0.000

¹ 50 c.c. $\frac{M}{8}$ magnesium chloride first injected in 21 minutes. Artificial respiration after 18 c.c. had been introduced.

² Only ureters tied.

³ 150 c.c. 0.9 per cent. sodium chloride first injected in 38 minutes.

⁴ 50 c.c. $\frac{M}{8}$ calcium chloride first injected in 34 minutes.

tatively by the Pavy-Ramsden method (5). In some of the experiments uranin, the sodium salt of fluorescëin, in very diffusible dye, was dissolved in the injection fluid. This was estimated in the washings by a rough colorimetric analysis.

The results of all the experiments are given in table I. It will be seen that in nine experiments either no sugar or else indeterminable traces were found, and in four experiments six to eleven milligrams, *i. e.*, 0.05 to 0.08 per cent. of the amount injected, were obtained. In three experiments the injection of magnesium chloride, sodium chloride, and calcium chloride, respectively, in physiological concentration, had no noticeable effect upon the result. In the experiments in which twenty milligrams of uranin were introduced, no trace of the dye could be detected in the washings of the bladder. In four experiments 100 milligrams of uranin were introduced; in two there was not a trace and in the other two there was a barely perceptible trace.

In considering these results stress is to be laid on the following facts: (1) the amount of sugar (and uranin) injected was exceedingly great; (2) the kidneys were not functioning; and (3) the bladder was washed at frequent intervals. Nevertheless either there was no dextrose or uranin discovered in the washings or the amounts discovered were quite insignificant.

The conclusion may therefore be drawn that the bladder is practically impermeable for diffusible substances present in the blood in great excess even in the absence of the kidneys, the chief organs of elimination of the body.

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