TABLE I. Effect of Atropine on the Adrenal Ascorbic Acid Response to Eserine.

Treatment	Adrenal ascorbic acid, γ/100 mg
None	468.6 ± 23.2
Eserine*	404.5 ± 29.8
Atropine† ..	318.4 ± 20.9
Eserine + atropine	281.9 ± 10.8

* Eserine (salicylate) 0.03 mg/100 g.
† Atropine (sulphate) 20 mg/100 g.

TABLE II. Effect of Hypophysectomy on the Adrenal Ascorbic Acid Response to Atropine.

Treatment	Adrenal ascorbic acid, γ/100 mg
None	488.4 ± 16.5
Atropine*	286.0 ± 13.8
Hypophysectomy	540.0 ± 15.5
Hypophysectomy + atropine	582.7 ± 17.7

* Atropine (sulphate), 20 mg/100 g.

usual response to atropine was observed under these conditions.

The pituitary-mediated adrenal ascorbic acid depleting effect of atropine as well as its failure to prevent the response to eserine, seem to preclude the possibility of a cholinergic control of ACTH release.

Summary. The adrenal ascorbic acid response to the independent and simultaneous administration of eserine and atropine was studied in the rat. (1) The eserine-induced adrenal ascorbic acid depletion is enhanced by simultaneous administration of atropine. (2) Atropine alone causes a significant fall of the adrenal ascorbic acid concentration. This fall is prevented by hypophysectomy. (3) Our results seem to preclude the possibility of a cholinergic control of ACTH release.

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Comparative Utilization of Fructose and Glucose Given Intravenously.* (18355)

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It has long been known that fructose, despite its slower rate of intestinal absorption (in the rat) is converted to hepatic glycogen more rapidly than glucose(1). *In vitro* experiments using rat liver slices and homogenates(2) have shown that fructose phosphorylation occurred 10 times more readily than glucose phosphorylation. Invert sugar which contains 50% fructose and 50% glucose, when injected into humans has been shown to produce less glycosuria than glucose(3,4). These differences suggest that fructose might be a better sugar for intravenous administration than glucose.

Present study. In each of 10 human subjects two comparative experiments were carried out. The control consisted of the intravenous infusion of 1 liter of 10% glucose. Previously or subsequently 1 liter of 10% fructose was injected at the same or a faster rate. Patients 1, 2, 3, 6 and 8 were patients in their late convalescent period of recovery from abdominal surgery and were relatively normal. The experiments on patients 4, 7, and 10 were performed on their second and third postoperative days and patient 9 was a mild diabetic not on insulin therapy. During and after each injection the urine passed dur-

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TABLE I. Comparative Effects of Intravenous Infusion of One Liter of 10% Glucose and of 10% Fructose.

Patient Age (yr) Sex Wt (kg)	Duration of infusion (hr)	Sugar infused	Whole blood glucose levels (mg %) Initial	Middle	Final	Max. change	Glycosuria g/hr	Glycosuria total g	Fructosuria g/hr	Fructosuria total g	Diuresis cc/hr	Diuresis total cc	Infusion rate, g/kg/hr
1. G.T.	1.5	Glucose	61	295	73†	+234	1.6	10.3	0	0	70	455	1
50 M.	2	Fructose	89	88	81†	— 8	0	0	.2	1.4	26	185	1
64	.8	"	76	99	81†	+ 23	0	0	.6	3.8	37	26	2
2. C.W.	1.5	Glucose	70	260	57†	+203	1.2	8.2	0	0	80	520	1
62 M.	2	Fructose	70	110	101†	+ 40	0	0	.4	3.2	42	300	1
64	.8	"	109	163	138†	+ 54	0	0	.7	4.2	66	385	2
3. H.T.	1.8	Glucose	110	458	247†	+348	1.4	5.6	0	0	46	184	1
62 M	1.8	Fructose	110	126	118†	+ 16	0	0	.9	3.7	43	175	1
53													
4. F.M.	2.25	Glucose	112	334	450†	+338	4.4	17.7	0	0	200	690	.8
64 M.	2.25	Fructose	50	97	—	+ 47	0	0	.7	3.6	72	360	.8
62													
5. S.R.	2	Glucose	87	297	320*	+233	3.8	27.0	0	0	142	1000	1.1
67 F.	1.75	Fructose	90	106	98*	+ 16	0	0	1.1	5.2	155	700	1.2
44													
6. B.V.	1.75	Glucose	72	—	74‡	—	2.3	9.6	0	0	362	1450	.9
60 F.	1.25	Fructose	98	105	78‡	+ 7	0	0	.78	3.1	46	185	1.2
61													
7. J.D.	2.5	Glucose	97	320	334*	+237	1.8	21.4	0	0	43	500	.7
46 M.	2.08	Fructose	182	142	140*	— 42	0	0	.3	5.8	27	500	.8
57													
8. N.A.	2.5	Glucose	67	—	162*	—	.8	3.8	0	0	333	1510	.6
17 M.	2	Fructose	94	105	94*	+ 11	0	0	.2	1.0	172	860	.7
63													
9. E.H.	1.9	Glucose	218	316	342*	+124	4.1	24.9	0	0	380	1900	.7
50 F.	2	Fructose	180	236	216*	+ 56	0	0	.4	2.4	120	720	.7
79													
10. H.E.	2.5	Glucose	96	258	390*	+194	3.6	18.3	0	0	149	745	.8
40 F.	1.5	Fructose	91	112	96*	+ 21	0	0	.9	4.9	190	950	1.4
46													

* 30 min. post infusion.
† 60 min. post infusion.
‡ 120 min. post infusion

ing a period of several hours was collected and analyzed. Whole blood samples were taken at the beginning, at the mid period and at 30, 60 and 120 minutes after the end of the injection. Whole blood and urine glucose was determined by the method of Somogyi(5) and whole blood and urine fructose was determined by a modification of the method of Roe(6).

The 10% fructose solutions were prepared from C. P. fructose (Pfanstiehl) which was dissolved in pyrogen-free water, treated with Norit (activated charcoal), boiled, filtered, passed through a Berkefeld filter and then sterilized at 15 lb pressure for 20 minutes. Aliquots from each batch were analyzed for their fructose content.

Findings. The findings are shown in Tables I and II. It will be noted that the level of whole blood glucose which rose in a characteristic manner following the glucose injection, showed scarcely any increase following the fructose injection. The maximum change in the former was 348 mg % and in the latter case less than 60 mg % (Table I). On the other hand, when the fructose level of the blood was measured following the fructose injections, there was at most a moderate increase which returned almost to zero 60 minutes after the end of the infusion (Table II). Analysis of the urine showed remarkably low values of fructosuria which followed the fructose injection, in contrast to the frequently

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TABLE II. Effect of Intravenous Infusion of One Liter of 10% Fructose on the Level of Whole Blood Fructose.

Patient Age (yr) Sex Wt (kg)	Rate of infusion (g/kg/hr)	Whole blood fructose levels (mg%) Initial	Middle	Final
1. G.T. 50 M. 64	1	0	41	6.5†
	2	0	102	14 †
2. C.W. 62 M. 64	1	0	61	2.7†
	2	0	105	5.6†
3. H.T. 62 M. 53	1	0	123	8.7†
4. F.M. 64 M. 62	.8	0	37	—
5. S.R. 67 F. 44	1.2	0	49	56 *
6. B.V. 60 F. 61	1.2	0	33	0 ‡
7. J.D. 46 M. 57	.8	0	38	65 *
8. N.A. 17 M. 63	.7	0	41	12 †
9. E.H. 50 F. 79	.7	0	46	11 †
10. H.E. 40 F. 45	1.4	0	76	40 *

* 30 min. post infusion.
† 60 min. post infusion.
‡ 120 min. post infusion.

high degrees of glycosuria which followed the glucose injection (Table I). The amount of sugar lost in the latter case was sometimes as much as 25% of that infused, whereas the maximum loss of fructose was 5.8%. The degree of diuresis which accompanied the glucose infusions was not seen following the fructose infusions. Of interest are the findings in the diabetic patient, No. 9. Also of interest are the findings in the patients tested during the immediate postoperative period, who showed a diminution of glucose tolerance.

Discussion. It seems apparent from the present findings that fructose when given intravenously to the human subject, even at rates as rapid as 2 g/kg/hr. leaves the circulation promptly. It does not appear in the urine and is presumably converted just as promptly into glycogen. These findings suggest that fructose is a much better sugar for intravenous feeding than glucose. Not only is less sugar and water lost in the urine but it is likely that the increases of hepatic glycogen which are undoubtedly obtained, have important practical and theoretical implications. For example, the ability of the liver to overcome harmful agents or stresses is undoubtedly increased thereby.

Summary. In 10 experiments on human subjects comparative intravenous injections of 10% glucose and 10% fructose were carried out. Even at rapid rates of infusion very little fructose appeared in the urine as compared to the amount of glucose. Diuresis was also less pronounced with fructose. Moreover, the fructose infusions were not followed by either hyperglycemia nor by an excessive rise in the blood fructose level, thus indicating a more rapid utilization of fructose and presumably more rapid glycogenesis.

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Role of the Thyroid Gland in Urinary Pentose Excretion in the Rat.* (18356)

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Coover, Feinberg, and Roe(1) found that the excretion of urinary pentose in rats was markedly increased by keeping the animals in

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