THE USE OF A HIGH FAT DIET IN THE TREATMENT OF DIABETES MELLITUS *

SECOND PAPER: BLOOD SUGAR

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In a previous communication [1] we discussed in outline the advantages of the use of a high fat diet in the treatment of diabetes mellitus. We reported briefly the results of an investigation of the effect of a diet whose energy came largely from fat, to which was added sufficient protein to maintain nitrogen balance and the minimal carbohydrate necessitated in making up a diet that a human being can eat over a long period of time. It was shown that with such a diet, glycosuria was avoided in severe diabetics, and that acidosis was not produced.

The first paper stated the method employed and, in a general way, the results obtained. Freedom from glycosuria, however, does not necessarily mean normal glycemia. In this communication we shall deal with the effect of this type of diet on the blood sugar.

Blood sugar determinations, sufficiently numerous to permit drawing conclusions concerning the effect of the diet on glycemia, are available in forty-five cases. We include in this group every case in which such a series of determinations has been made, and have omitted only those whose blood sugar determinations have been too few to be of significance. A few patients left the hospital on higher diets than those shown in the tables, but as corresponding blood sugar determinations are not available, the tables for such individuals stop with the last blood sugar reading.

These cases are presented in four groups. The first three groups (Tables 1, 2 and 3), consisting of forty cases, show a satisfactory response of the blood sugar to the treatment. The fourth group (Table 4) comprises the five cases in which blood sugars did not reach a desirably low percentage. Of the forty satisfactory cases, those complicated by chronic nephritis have been brought together in Table 2, and those in which diets varied at times from our standard are presented in Table 3.

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1. Newburgh, L. H., and Marsh, P. L.: The Use of a High Fat Diet in the Treatment of Diabetes Mellitus: First Paper, Arch. Int. Med. **26**:657 (July) 1920.

TABLE 1.—Cases Showing Satisfactory Response of Blood Sugar to Treatment

No.	Case	Day	Blood Sugar per Cent.	Protein, Gm.	Fat, Gm.	Carbohydrate, Gm.	Calories	Remarks
1	19-391	1	.....	16	100	10	1,000	
	Male	3	0.082					
	47	6	0.090					
	Osteomyelitis	8	0.070					
	of foot	9	.....	30	128	10	1,370	
	144 lbs.	11	0.130					
		14	0.109					
		16	.....	40	225	13	2,350	
		19	0.100	54	240	13	2,400	
		21	0.100					
		23	0.120					
2	19-537	1	0.300	22	110	10	1,200	
	Male	5	0.211					
	21	7	0.400					
	127 lbs.	9	0.176					
		12	.....	29	135	8	1,475	
		20	0.175					
		27	.....	38	135	8	1,500	
		31	0.140					
		36	.....	15	42	10	500	
		40	0.176					
		43	.....	29	135	8	1,475	
		45	0.187					
		55	0.125					
		59	.....	30	165	8	1,700	
		62	0.140					
		69	0.111					
3	19-567	1	0.310	16	100	10	1,000	
	Male	11	0.120					
	49	12	0.080					
	153 lbs.	16	0.100					
		17	.....	65	200	10	2,100	
		20	0.095					
		23	0.070					
		27	0.100					
		32	0.080					
		43	0.070					
4	19-264	1	0.325	16	95	10	960	
	Female	5	0.130					
	66	6	0.120	19	140	10	1,400	
	144 lbs.	13	0.150	40	140	10	1,500	
		29	0.210					50 gm. bread added to diet one day; glycosuria
		33	0.140					
		37	0.110					
		45	0.100					
5	19-108	1	0.200	16	95	10	960	
	Male, 54	3	0.107	23	140	10	1,425	
	Chronic	5	0.100					
	myocarditis	6	.....	29	152	10	1,550	
	162 lbs.	8	0.107					
		10	0.125					
		16	.....	60	115	40	1,450	
		18	0.075					
		38	0.100					
6	19-295	1	0.55	16	95	10	960	
	Male	4	0.14					
	53	6	0.19	9	155	31	1,600	
	160 lbs.	12	0.235					
		14	.....	..	...	..	.....	Starvation 24 hours
		15	0.14	16	100	13	1,025	
		20	0.17					
		28	0.083					
		30	.....	..	...	..	.....	Left hospital and did not adhere strictly to diet
		43	0.25	16	100	13	1,025	
		45	0.09					
		50	0.107					
		52	0.09					
		53	0.075					
		55	.....	18	125	7	1,150	
		57	0.095	34	160	8	1,600	
		62	.....	34	170	7	1,700	
		70	0.100					

TABLE 1.—Cases Showing Satisfactory Response of Blood Sugar to Treatment—(*Continued*)

No.	Case	Day	Blood Sugar per Cent.	Protein, Gm.	Fat, Gm.	Carbohydrate, Gm.	Calories	Remarks
7	19-306	1	0.550	19	95	10	980	
	Male	7	0.200					
	66	10	0.110					
	Osteomyelitis	13	.....	25	130	10	1,300	
	of foot	17	0.09					
	144 lbs.	23	0.190					
		24	0.187	19	95	10	980	
		28	0.140					
		33	0.100	16	100	10	1,000	
		34	0.140					
		35	.....	36	220	11	2,230	
		38	0.120					
		42	.....	42	245	15	2,400	
		44	0.110	47	255	12	2,660	
		49	0.100					
		50	.....	100	250	13	2,800	
		58	0.100					
8	19-467	1	.....	16	100	10	1,000	
	Female	7	0.15	23	140	10	1,400	
	52	12	0.15					
	181 lbs.	16	0.13	30	215	11	2,100	
		28	0.14					
9	20-1	..	.....	..	...	..	.....	Diet had been restricted previous to entrance for operation for cataracts
	Male	1	0.19	16	100	10	1,000	
	60	5	0.15					
	174 lbs.	10	0.10					
10	19-130	1	0.225	16	100	10	1,000	
	Male, 31	6	0.190					
	124 lbs.	8	0.145	..	...	..	.....	Left against advice
11	20-458	1	0.18	27	130	12	1,350	Unexplained hematuria; refused cystoscopy and left
	Male, 65	7	0.13					
	121 lbs.							
12	20-660	1	0.35	18	90	14	950	
	Female	8	.....	28	130	20	1,400	
	60	9	0.11					
	114 lbs.	13	0.10					
		17	....	34	170	25	1,800	
		18	0.10					
		19	.....	55	210	35	2,200	
		30	0.14	..	...	..	.....	30 min. after meal
13	19-355	1	0.33	19	90	10	925	
	Female	3	0.30					
	66	6	0.153					
	138 lbs.	8	.....	32	145	14	1,500	
		9	0.136					
		11	0.125	38	200	11	2,000	
		15	0.270	..	...	..	.....	Dietetic error
		17	0.136					
14	20-376	1	0.24	15	100	12	1,000	
	Female, 55	6	0.17					
	135 lbs.	9	0.11					
15	19-261	1	0.450	16	95	10	960	
	Female	7	0.125					
	61	9	0.160	16	140	10	1,400	
	151 lbs.	13	0.145	..	...	..	.....	7:00 p. m.
16	21-51	1	0.17	16	95	10	960	
	Male	5	0.136	50	235	28	2,400	
	73	8	0.130					
17	19-163	1	0.275	15	100	10	1,000	
	Male	4	0.145					
	75	5	.....	55	135	10	1,450	
	151 lbs.	6	0.130					
		7	.....	65	150	10	1,650	
		9	0.180	..	...	..	.....	Ate candy
		11	0.160					
		17	0.140	45	210	30	2,200	
		41	0.120					
18	20-753	1	0.30	16	90	14	900	
	Female	4	0.18					
	53	5	.....	25	135	20	1,400	
	180 lbs.	6	.....	30	180	25	1,800	
		7	.....	55	230	30	2,400	
		8	0.13					
		9	0.10					

TABLE 1.—Cases Showing Satisfactory Response of Blood Sugar to Treatment—(*Continued*)

No.	Case	Day	Blood Sugar per Cent.	Protein, Gm.	Fat, Gm.	Carbohydrate, Gm.	Calories	Remarks
19	20-759	1	0.35	16	90	14	900	
	Male	4	0.21					
	48	8	0.14					
	162 lbs.	19	0.11					
20	20-558	1	0.37	16	90	14	900	
	Male	5	0.12					
	35	15	.....	25	135	20	1,400	
	152 lbs.	17	.....	30	180	25	1,800	
		23	0.07					
21	20-653	1	0.16	16	90	14	900	
	Male	3	0.10					
	22	7	0.11					
	Restricted	10	.....	30	180	25	1,800	
	before	13	0.08					
	entrance	15	.....	55	230	30	2,400	
	118 lbs.	17	0.11					
		22	0.08					
		31	0.14					
		41	0.07					
		43	0.13					
		114	0.12					
22	20-882	1	0.30	16	90	14	900	
	Male	5	0.19					
	63	13	0.18					
	141 lbs.	16	.....	25	135	20	1,400	
		18	0.16	30	180	25	1,800	
		25	0.11					
		32	0.08					
23	20-738	1	.....	16	90	14	900	
	Female	3	0.19					
	56	4	0.20					
	131 lbs.	6	.....	25	135	20	1,400	
		8	0.09	30	180	25	1,800	
		12	0.10					
24	20-703	1	.....	16	90	14	900	
	Male	3	0.18					
	46	5	0.17					
	168 lbs.	7	.....	25	135	20	1,400	
		9	0.09	30	180	25	1,800	
		12	.....	55	230	30	2,400	
		15	0.06					
25	20-688	1	.....	16	90	14	900	
	Male	2	0.13					
	68	4	.....	25	135	14	1,400	
	153 lbs.	5	0.12					
26	21-8	1	.....	16	90	14	900	
	Male	3	0.267					
	33	4	0.220					
	138 lbs.	5	0.120					
		9	0.180	..	...	..	.....	Dietetic error
		11	.....	25	135	20	1,400	
		13	0.120					
		15	0.130					
		18	0.180	..	...	..	.....	Drank 2 glasses milk without permission
		22	0.150					
		27	0.120					
27	21-9	1	0.220	16	90	14	900	
	Female	4	0.120	25	135	20	1,400	
	18	5	.....	..	...	..	.....	Menstruation
	155 lbs.	8	0.420					
		10	0.17					
		14	0.13					
		17	.....	30	180	25	1,900	
		19	0.14	45	180	10	1,900	
		23	0.13					
28	21-31	1	0.27	16	90	14	900	
	Female	5	0.125	25	135	20	1,400	
	57	8	0.16	30	180	25	1,800	
	158 lbs.	12	0.12					

The twenty-eight cases contained in Table 1 show that a high fat diet such as we have used is capable of bringing the blood sugar down to normal and keeping it at that level during the period of observation.

TABLE 2.—Response to Treatment of Blood Sugar in Diabetics with Marked Nephritis

No.	Case	Day	Blood Sugar per Cent.	Protein, Gm.	Fat, Gm.	Carbohydrate, Gm.	Calories	Remarks
29	19-371	1	0.205	16	100	10	1,000	
	Male	3	0.115					
	47	7	0.092					
	158 lbs.	8	0.136	60	150	10	1,700	
		15	0.130					
30	19-438	1	.....	16	95	10	960	
	Female	2	0.190					
	60	8	0.180					
	217 lbs.	12	0.125					
		13	.....	25	150	10	1,500	
		18	0.200					
		19	0.185					
		22	0.200					
		23	.....	30	205	10	2,000	
		26	0.125					
		37	0.130					
31	19-218	1	0.380	16	95	10	960	
	Female	3	0.232					
	68	8	0.150					
	156 lbs.	9	.....	45	160	12	1,700	
		10	0.150					
		17	0.140					
		21	0.140					
		27	0.135					
		37	0.100					
32	19-56	1	0.18	16	95	10	960	
	Female	3	.....	42	130	10	1,400	
	56	7	0.11					
	168 lbs.	9	0.12	..	...	..	.....	25 gm. bread added later caused glycosuria
33	19-131	1	0.30	16	95	10	960	
	Female	5	.....	42	135	10	1,300	
	60	7	0.145	60	155	10	1,700	
	131 lbs.	10	0.145					
		13	0.125					
34	19-84	1	0.425	16	95	10	960	
	Female, 51	6	0.115	40	110	10	1,200	
	175 lbs.	7	0.120					
35	21-19	1	0.30	16	95	14	950	
	Male	5	0.15					
	76	6	.....	25	135	20	1,400	
	133 lbs.	9	0.22					
		10	0.20	30	180	25	1,900	
		14	.....	35	230	30	2,400	
		18	0.18					
		28	0.125					

The seven cases presented in Table 2 are separated from the rest because of the well known fact that chronic nephritis in diabetics tends to keep the blood sugar at an abnormally high level.[2] These patients

2. Meyers, V. C., and Bailey, C. V.: The Lewis and Benedict Method for the Estimation of Blood Sugar, with Some Observations Obtained in Disease, J. Biol. Chem. **24**:147, 1916. Bing, H. J., and Jakolson, B.: Blutuntersuchungen unter normalen u. einigen pathologische Verhältnissen, Deutsch. Arch. f. klin. Med. **113**:571, 1914. Hopkins, A. R.: Studies in the Concentration of Blood Sugar in Health and Disease as Determined by Bang's Micromethod, Am. J. Med. Sc. **149**:254, 1915.

all had a severe nephritis as shown by decreased output of phenolsulphonephthalein, hypertension, high blood urea and the persistence of albumin and casts in the urine days after the disappearance of the glycosuria. It is of special interest to note that the blood sugar of each of these individuals is brought to a point well within normal limits.

The six cases in Table 3 show well the occurrence of hyperglycemia resulting from diets high in protein and the reduction of the blood sugar

TABLE 3.—PATIENTS TREATED BY VARYING REGIMÉS

No.	Case	Day	Blood Sugar per Cent.	Protein, Gm.	Fat, Gm.	Carbohydrate, Gm.	Calories	Remarks
36	18-382	1	.....	200	135	..	2,075	"Von Noorden" diet
	Male	3	0.275					
	30	6	0.215					
	118 lbs.	8	.....	16	100	10	1,000	High fat diet
		14	.....	52	220	10	2,225	
		17	0.127					
		18	.....	62	315	10	3,100	
		20	0.155					
		30	0.113					
37	18-613	1	.....	200	135	..	2,075	"Von Noorden" diet
	Female	9	0.400					
	35	10	.....	16	100	10	1,000	High fat diet
	117 lbs.	12	0.230					
		13	.....	30	135	10	1,400	
		16	0.166					
38	18-657	1	.....	200	135	..	2,075	"Von Noorden" diet
	Female	2	0.214	16	100	10	1,000	High fat diet
	46	6	.....	42	155	10	1,600	
		10	0.130					
		12	.....	200	135	..	2,075	"Von Noorden" diet
		13	0.200					
		16	0.220					
39	19-165	1	0.273	16	95	10	960	
	Male	3	0.145					
	75	4	.....	45	160	12	1,700	
	180 lbs.	5	0.130					
		6	.....	70	160	12	1,800	The excess of protein caused a hyperglycemia
		7	0.180					
		9	0.160					
		15	0.140					
40	19-56	1	0.500	16	95	10	960	
	Female	7	.....	22	100	10	1,025	Urine sugar free after the fifth day
	53	8	.....	34	110	10	1,150	
	168 lbs.	11	.....	37	130	23	1,400	
		13	0.135					
		14	.....	50	120	22	1,375	
		15	0.195					
		16	.....	37	130	23	1,400	
		18	0.130	50	120	22	1,375	
		19	0.190	50	120	35	1,400	
		23	0.170					
		24	0.185					

to within normal limits subsequent to the use of a diet low in protein and high in fat. Case 40 is especially instructive in this respect. After four days on a diet containing 37 gm. protein and 1,400 calories, the blood sugar was 0.135 per cent.; after an increase of the protein to 50 gm., with a slight decrease in carbohydrate and total calories, a hyperglycemia of 0.195 per cent. is noted. A return to the former diet

brought the blood sugar down to 0.130 per cent. while the substitution of the second diet again produced a hyperglycemia of 0.190 per cent.

The five cases in Table 4 are those in which response to treatment was not satisfactory. Two of these (Cases 42 and 45) had severe

TABLE 4.—PATIENTS NOT RESPONDING SATISFACTORILY TO TREATMENT

No.	Case	Day	Blood Sugar per Cent.	Protein, Gm.	Fat, Gm.	Carbohydrate, Gm.	Calories	Remarks
41	19-440	1	0.52	16	97	10	1,000	
	Male	4	0.36					
	18	6	0.29					
	90 lbs.	8	0.24					
		11	0.20					
		12	.....	..	...	..	.....	Broke diet
		13	0.42					
		18	0.23					
		21	0.15					
		26	.....	25	140	10	1,400	
		28	0.16					
		33	0.15	..	...	..	.....	Patient in N balance; left the hospital in excellent condition
		38	0.13	37	190	10	1,900	
		39	0.15					
		41	0.18					
		50	0.15					
		51	.....	37	165	10	1,675	
		57	0.15					
		61	.....	28	160	10	1,600	
		64	0.15					
42	19-229	1	0.375	16	95	10	960	Far advanced squamous cell carcinoma of uterus
	Female	5	0.187					
	54	6	0.166					
	120 lbs.	7	0.215	..	...	..	.....	Discharged against advice
43	20-423	1	.....	16	100	10	1,000	
	Male	4	0.26					
	63	9	0.16					
	81 lbs.	15	.....	28	140	20	1,400	
		23	0.15					
		26	.....	34	160	25	1,700	
		28	0.16					
44	19-265	1	0.400	16	95	10	960	
	Male	6	0.120					
	61	7	.....	16	130	10	1,300	
	149 lbs.	11	0.120					
		13	0.275	..	...	..	.....	Urine sugar free
		15	.....	30	200	21	2,000	
		21	0.225	..	...	..	.....	Urine sugar free
		27	.....	9	155	31	1,600	
		29	0.150	..	...	..	.....	Left hosp. against advice
		34	0.200					
45	20-311	1	0.400	16	100	10	1,000	Cerebrospinal syphilis
	Male	3	0.135					
	40	7	0.160					
	124 lbs.	8	.....	21	156	11	1,500	
		9	0.125					
		15	0.140					
		18	.....	48	240	15	2,500	
		20	0.170					
		29	0.160					

complicating diseases. We suspected but could not prove that one patient (Case 44) was not adhering to his diet; we can give no other explanation for the rise in his blood sugar from 0.120 to 0.275 per cent. between the eleventh and thirteenth days, in the absence of any change in diet on our part.