

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

SECOND PAPER: BLOOD SUGAR

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In a previous communication¹ 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 Male 47 Osteomyelitis of foot 144 lbs.	1	.....	16	100	10	1,000	
		3	0.082					
		6	0.090					
		8	0.070					
		9	.....	30	128	10	1,370	
		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 Male 21 127 lbs.	1	0.300	22	110	10	1,200	
		5	0.211					
		7	0.400					
		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	0.144					
		69	0.111					
3	19-567 Male 49 153 lbs.	1	0.310	16	100	10	1,000	
		11	0.120					
		12	0.080					
		16	0.170					
		17	.....	65	200	10	2,100	
		20	0.095					
		23	0.070					
		27	0.100					
		32	0.090					
		43	0.070					
4	19-264 Female 66 144 lbs.	1	0.325	16	95	10	960	
		5	0.130					
		6	0.120	19	140	10	1,400	
		13	0.150	40	140	10	1,500	
		29	0.210					
		33	0.140					
		37	0.110					
45	0.100					50 gm. bread added to diet one day; glycosuria		
5	19-108 Male, 54 Chronic myocarditis 162 lbs.	1	0.200	16	95	10	960	
		3	0.107	23	140	10	1,425	
		5	0.100					
		6	.....	29	152	10	1,550	
		8	0.107					
		10	0.125					
		16	.....	60	115	40	1,450	
18	0.075							
38	0.100							
6	19-295 Male 53 160 lbs.	1	0.55	16	95	10	960	
		4	0.14					
		6	0.19	9	155	31	1,600	
		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 Male 66 Osteomyelitis of foot 144 lbs.	1	0.550	19	95	10	980		
		7	0.200						
		10	0.110						
		13	.....	25	130	10	1,300	
		17	0.09						
		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 Female 52 181 lbs.	1	.....	16	100	13	1,000	
		7	0.15	23	140	10	1,400		
		12	0.15						
		16	0.13	30	215	11	2,100		
		28	0.14						
9	20-1 Male 60 174 lbs.	..	.....	..	...	..	.....	Diet had been restricted previous to entrance for operation for cataracts
		1	0.19	16	100	10	1,000		
		5	0.15						
		10	0.10						
10	19-130 Male, 31 124 lbs.	1	0.225	16	300	10	1,000		
		6	0.190						
		8	0.145	..	...	..	.....	Left against advice
11	20-458 Male, 65 121 lbs.	1	0.18	27	130	12	1,350	Unexplained hematuria; refused cystoscopy and left	
		7	0.13						
12	20-660 Female 60 114 lbs.	1	0.35	18	90	14	950		
		8	.....	28	130	20	1,400	
		9	0.11						
		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 Female 66 138 lbs.	1	0.33	19	90	10	925		
		3	0.30						
		6	0.153						
		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 Female, 55 135 lbs.	1	0.24	15	100	12	1,000		
		6	0.17						
		9	0.11						
15	19-261 Female 61 151 lbs.	1	0.450	16	95	10	960		
		7	0.125						
		9	0.160	16	140	10	1,400		
		13	0.145	..	...	..	.....	7:00 p. m.
16	21-51 Male 73	1	0.17	16	95	10	960		
		5	0.126	50	235	28	2,400		
		8	0.130						
17	19-163 Male 75 151 lbs.	1	0.275	15	100	10	1,000		
		4	0.145						
		5	.....	55	135	10	1,450	
		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 Female 53 180 lbs.	1	0.30	16	90	14	900		
		4	0.18						
		5	.....	25	135	20	1,400	
		6	.....	30	180	25	1,800	
		7	.....	55	230	30	2,400	
		8	0.13						
		8	0.10						
		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 Male 48 162 lbs.	1	0.35	16	90	14	900					
		4	0.21									
		8	0.14									
		19	0.11									
20	20-558 Male 35 152 lbs.	1	0.37	16	90	14	900					
		5	0.12									
		15	.....						25	135	20	1,400
		17	.....						30	180	25	1,800
		23	0.07									
21	20-653 Male 22 Restricted before entrance 118 lbs.	1	0.16	16	90	14	900					
		3	0.10									
		7	0.11									
		10	.....						30	180	25	1,800
		13	0.08									
		15	.....						55	230	30	2,400
		17	0.11									
		22	0.08									
		31	0.14									
		41	0.07									
22	20-882 Male 63 141 lbs.	1	0.30	16	90	14	900					
		5	0.19									
		13	0.18									
		16	.....						25	135	20	1,400
		18	0.16						30	180	25	1,800
		25	0.11									
		32	0.08									
23	20-738 Female 56 131 lbs.	1	.....	16	90	14	900					
		3	0.19									
		4	0.20									
		6	.....						25	135	20	1,400
		8	0.09						30	180	25	1,800
		12	0.10									
24	20-703 Male 45 168 lbs.	1	.....	16	90	14	900					
		3	0.18									
		5	0.17									
		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 Male 68 153 lbs.	1	.....	16	90	14	900					
		2	0.13									
		4	.....						25	135	14	1,400
		5	0.12									
26	21-8 Male 33 138 lbs.	1	.....	16	90	14	900					
		3	0.267									
		4	0.220									
		5	0.120									
		9	0.180									
		11	.....						25	135	20	1,400
		13	0.120									
		15	0.130									
		18	0.180									
		22	0.150									
		27	0.120									
27	21-9 Female 18 155 lbs.	1	0.220	16	90	14	900					
		4	0.120						25	135	20	1,400
		5	.....								
		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 Female 57 158 lbs.	1	0.27	16	90	14	900					
		5	0.125						25	135	20	1,400
		8	0.16						30	180	25	1,800
		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 Male 47 158 lbs.	1	0.205	16	100	10	1,000	
		3	0.115					
		7	0.092					
		8	0.136	60	150	10	1,700	
		15	0.130					
30	19-438 Female 60 217 lbs.	1	16	95	10	960	
		2	0.190					
		8	0.180					
		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 Female 68 156 lbs.	1	0.380	16	95	10	960	
		3	0.232					
		8	0.150					
		9	.....	45	160	12	1,700
		10	0.150					
		17	0.140					
		21	0.140					
		27	0.135					
		37	0.100					
32	19-56 Female 56 168 lbs.	1	0.18	16	95	10	960	
		3	.....	42	130	10	1,400
		7	0.11					
		9	0.12	..	...	..	.....
33	19-131 Female 60 131 lbs.	1	0.30	16	95	10	960	
		5	.....	42	135	10	1,300
		7	0.145	60	155	10	1,700	
		10	0.145					
		13	0.125					
34	19-84 Female, 51 175 lbs.	1	0.425	16	95	10	960	
		6	0.115	40	110	10	1,200	
		7	0.120					
35	21-19 Male 76 133 lbs.	1	0.30	16	95	14	950	
		5	0.15					
		6	.....	25	135	20	1,400
		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 Male 30 118 lbs.	1	.....	200	185	..	2,075	"Von Noorden" diet
		3	0.275					
		6	0.215					
		8	.....	16	100	10	1,000	High fat diet
		14	.....	52	220	10	2,225	
		17	0.127					
		18	.....	62	315	10	3,100	
37	18-613 Female 35 117 lbs.	20	0.155					
		30	0.113					
		1	.....	200	135	..	2,075	"Von Noorden" diet
		9	0.400					
		10	.....	16	100	10	1,000	High fat diet
		12	0.230					
38	18-657 Female 46	13	.....	30	135	10	1,400	
		16	0.166					
		1	.....	200	135	..	2,075	"Von Noorden" diet
		2	0.214	16	100	10	1,000	High fat diet
		6	.....	42	155	10	1,600	
		10	0.130					
39	19-165 Male 75 180 lbs.	12	.....	200	135	..	2,075	"Von Noorden" diet
		13	0.200					
		16	0.220					
		1	0.273	16	95	10	960	
		3	0.145					
		4	.....	45	160	12	1,700	
40	19-56 Female 53 168 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					
		1	0.500	16	95	10	960	
40	19-56 Female 53 168 lbs.	7	.....	22	100	10	1,025	Urine sugar free after the fifth day
		8	.....	34	110	10	1,150	
		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 Male 18 90 lbs.	1	0.52	16	97	10	1,000	
		4	0.36					
		6	0.29					
		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 Female 54 120 lbs.	1	0.375	16	95	10	960	Far advanced squamous cell carcinoma of uterus Discharged against advice
		5	0.187					
		6	0.168					
		7	0.215	..	...	..	.....
43	20-423 Male 65 81 lbs.	1	.....	16	100	10	1,000	
		4	0.26					
		9	0.16					
		15	.....	28	140	20	1,400	
		23	0.15					
		26	.....	34	160	25	1,700	
28	0.16							
44	19-265 Male 61 149 lbs.	1	0.400	16	95	10	960	
		6	0.120					
		7	.....	16	130	10	1,300	
		11	0.120					
		12	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 Male 40 124 lbs.	1	0.400	16	100	10	1,000	Cerebrospinal syphilis
		3	0.135					
		7	0.160					
		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.