EFFECTS OF THE HIGH CARBOHYDRATE-LOW CALORIE DIET UPON CARBOHYDRATE TOLERANCE IN DIABETES MELLITUS*

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THE purpose of this report is to summarize our experiences with the high carbohydrate-low calorie diet in 50 cases of diabetes where the patients followed treatment carefully for a period of five years. The data, as will presently be shown, clearly indicate that this diet, if followed carefully, leads in the majority of cases to marked improvement in carbohydrate tolerance. The dosages of insulin required eventually in these cases were found to be less than with all other diets which have been used hitherto in the treatment of advanced diabetes mellitus. In 12 cases, an incidence of 24 per cent, the insulin was discontinued entirely.

Our first experiences with the high carbohydrate-low calorie diet, and the conditions which led to its use, were reported in this *Journal*[1] in October, 1930. These observations and subsequent experience[2, 3, 4] make it necessary at least to modify the prevalent conception of the metabolism of diabetes mellitus. Since then a variety of other data, clinical and experimental, have accumulated in the literature which fit in with the experiences with this diet. The various findings will not be dealt with here.† Suffice it to say that it now appears to be fairly well established that carbohydrates improve, whereas fats impair, carbohydrate tolerance; and that carbohydrates increase, whereas fats decrease, the sensitivity of the individual, animal and man, to insulin.

Since the discovery of insulin a number of attempts have been made to use more liberal quantities of carbohydrates in the diet of the diabetic. The first reports were those of Sansum, Blatherwick and Bowden,[5] Adlersberg and Porges[6] and Geyelin[7] in 1926. The experiences with these diets in general fit in with the above-mentioned clinical and laboratory experiments. The data show that prolonged treatment of the diabetic with liberal quantities of carbohydrates is possible with smaller amounts of insulin than were thought possible hitherto, providing the fat content of the diet is reduced. Such diets have at least two advantages. Firstly, the patients feel better, and, secondly, as the diets are much more attractive than those of higher fat and lower carbohydrate content, there is a lesser temptation to break diet. The diabetic is, therefore, less exposed to the dangers of dietary irregularities.

Until recently, no data were available to compare the high carbohydrate-low calorie diet with the above-mentioned high carbohydrate diets. As I shall presently show, though our high carbohydrate-low calorie diet resembles the diets of Geyelin, Adlersberg, Porges and Sansum in that it is liberal with respect to carbohydrates, it differs from these diets in two respects, and it is these differences which account for the different results. Firstly, as I have pointed out before, it should be observed that it is not a high carbohydrate-low fat diet, but a high carbohydrate-*low calorie* diet; that is, treatment with it is still based upon the principle of under-nutrition, except that the term under-nutrition is used somewhat differently than in the days before insulin. Geyelin[8] clearly states that his diet not only provides for normal nutrition, but in some instances there is unavoidable over-nutrition. Caloric intake equal to the normal requirements of the individual is also a feature of the Sansum and Adlersberg and Porges diets.

All authorities agree about the harmful effects of *over-nutrition* in the treatment of diabetes mellitus. In the animal this was clearly shown in the early days of insulin in the late Professor Macleod's laboratory,[9] and in man it now appears to be definitely established that in time over-nutrition decreases the effectiveness of insulin; sooner or later, more insulin is required to keep the urine free of sugar and the blood sugar normal. This alone suggests that mild

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† For details, see Rabinowitch, I. M.: Newer Views and Methods of Treatment of Diabetes Mellitus, Ballin Memorial Lecture, Detroit, 1935.

under-nutrition might be beneficial. Experimentally, this was shown to be so by F. M. Allen as early as 1914. In his recent paper Geyelin[8] states that treatment of the diabetic on the principle of under-nutrition is based upon a fallacious theory; improvement of carbohydrate tolerance due to the operation of under-nutrition, Geyelin states, is comparatively transitory; in children it is "invariably followed by a steadily decreasing tolerance" and even in adults "a permanent increase is not obtainable." The data upon which these statements are based are not given. As I shall presently show, our own data clearly indicate otherwise. Very carefully controlled experiments show that *mild under-nutrition* led to quite marked improvement of carbohydrate tolerance; in time, the majority of patients who required insulin were able to do with lesser quantities, and an appreciable number were eventually able to discontinue its use entirely, in spite of the fact that in some of these cases the carbohydrate content of the diets was increased. That these results were not due to the high carbohydrate or low fat contents of the diets alone is clearly seen from a comparison of our data with those of Geyelin, whose diets are also liberal with respect to carbohydrates, but maintain normal nutrition and at times tend towards over-nutrition.

It is important here again to point out what is meant by the term "under-nutrition" in the treatment with the high carbohydrate-low calorie diet. Prior to the days of insulin under-nutrition meant keeping the diabetic in a physical condition which was incompatible with normal life — the diabetic in spite of treatment was an invalid. By under-nutrition is now meant keeping the diabetic about 5 to 10 pounds under weight according to height, age and sex. This degree of under-nutrition, it should be observed, is very common amongst perfectly normal individuals, and life insurance companies do not rate such people as "sub-standard".

In the above-mentioned paper by Dr. Geyelin[8] are summarized experiences with 150 persons, who were treated with insulin and high carbohydrate-low fat diets, but normal caloric diets. Of this group, 28 patients have been under observation for more than eight years. Experiences with 8 patients only are recorded, but, as they are "representative of the variation of the results obtained in the larger group" it appears justifiable to compare these cases with our own. One difference between Geyelin's diets and our own which is immediately obvious is the large quantities of insulin which are required with the high carbohydrate-normal calorie diets; in 6 of the 8 *representative* cases the daily dosage of insulin *after years of treatment* is more than 50 units, ranging between 54 and 84 units; in one case, the dosage is 46 units per day, and in one case only does the dosage approach that which is commonly required with our high carbohydrate-low calorie diets. In one case, as much as 107 units were required daily in the early stages of treatment. The average dosage of all of these eight representative cases is, at present, 58 units a day.* With the high carbohydrate-low calorie diet we have found that 50 units a day are rarely necessary; very few of our patients have required more than 30 units a day, even in the early stages of treatment; the average dosage in 200 cases selected at random from the private records of the Clinic was found to be 22.8 units. As will presently be shown, the two types of diets contrast still more markedly when their data are made more comparable.

As stated previously, it now appears to be a fairly well established fact that in time carbohydrates improve, whereas, fats impair carbohydrate tolerance, and that carbohydrates increase, whereas, fats decrease the sensitivity to insulin. Since *time* is an important factor, it is obvious that the above-mentioned dosages of insulin required with the two diets are not strictly comparable. The average of 58 units in Dr. Geyelin's cases was calculated from dosages in use after *years* of treatment; whereas, the average 22.8 units with the high carbohydrate-low calorie diet was that of 200 cases *selected at random*, and represents dosages at the beginning and in the early as well as in the later stages of treatment. Since the selection was random, it should also be noted that no consideration was given to the care with which treatment was followed, whereas, the eight cases shown by Dr. Geyelin were carefully selected to exclude dietary irregularities. In order, therefore, to compare the two diets it is necessary to consider not only duration of treatment but also the care with which treatment was followed.

In the following study, in which the above-mentioned variables were considered, an opportunity was afforded to test the value of mild under-nutrition. As will presently be shown, the data clearly show that treatment of the diabetic on the principle of under-nutrition is still sound.

A difficulty which was met with in the attempt to compare Dr. Geyelin's data with our own was the different methods used for determining carbohydrate tolerance with the two types of diet. In order to estimate carbohydrate tolerance, Dr. Geyelin made use of ratios of grams of available glucose in the diet to units of insulin required *without regard to the amounts of glucose which the patients may have been capable of metabolizing without insulin.* Another difficulty in comparing the two diets lay in the different methods of determining insulin requirements at the beginning of treatment. As will presently be shown, the methods employed by Dr. Geyelin do not permit proper estimation of changes of carbohydrate tolerance, nor do they permit proper interpretation of changes of in-

* These data were obtained from a reprint of Dr. Geyelin's paper in which the cases are described in greater detail.

sulin dosage. Stationary dosages of insulin do not necessarily indicate a stationary metabolism, nor do reductions of insulin dosage necessarily indicate improvement of carbohydrate tolerance.

The chief difficulty in such studies as attempted here is the assignment of a definite amount of improvement (or loss) of carbohydrate tolerance to diet alone, when a number of other factors are present. The problem is further complicated when all of the conditions known to be present are not controllable, and still further complicated when, in some instances, conditions known to improve carbohydrate tolerance are not recognizable. As is well known, for example, in spite of a most careful physical examination, an infection, when very mild, may be overlooked; and one of the characteristics of infection in diabetes is the marked disproportion between its clinical signs and symptoms and the disturbance of carbohydrate tolerance which it may cause. Errors of interpretation due to masked infections may be largely reduced by investigating a large number of carefully examined patients and subjecting the data to statistical treatment.

Judging from the literature, the general practice in the great majority of clinics in determining insulin requirements in the uncomplicated diabetic is to estimate firstly the basal caloric requirements of the individual, either directly (basal metabolic rate) or (more frequently) indirectly from standards based upon height, weight, age and sex. Allowance is then made for mild activity and the diet is adjusted accordingly. If, with the diet so determined, the urine cannot be rendered and kept free of sugar, or if the sugar content of the blood cannot be rendered and kept at the normal level, insulin is given in increasing quantities until there is neither hyperglycæmia nor glycosuria. Judging from the above-mentioned report, this is the practice in Dr. Geyelin's clinic. That this method of determining insulin requirements makes it practically impossible to properly interpret subsequent reductions of insulin dosages will be seen from the following observations.

In 1927, I made an attempt to determine whether insulin *per se* does or does not improve carbohydrate tolerance.[10] In this study, the effectiveness of the different methods of rendering the urine free of sugar was observed; "basal" diets were compared with the "ladder" form of treatment, and, I believe, it was clearly shown that the urine is not, as a rule, rendered free of sugar with the "basal" type of diet as readily as with the "ladder" diet. With the "ladder" diet, the patient is given foods and fluids of practically no food value for one to three days; the diet is then gradually increased until it corresponds approximately to the caloric requirements of the individual. *A priori* one would expect that the initial dosages of insulin with this "ladder" diet would be less than with the "basal" diets. Actually, this has been found to be so. The method which we use for determining insulin dosage is another precaution against the use of amounts of insulin larger than those actually required, and, thus, simplifies interpretation of subsequent increases or reductions. This method was reported elsewhere,[3] and will not be described in detail here. Briefly, when it is found by the "ladder" method of treatment that the urine is not rendered free of sugar and that the sugar content of the blood cannot be kept at the normal level the effects of mild exercise are noted (walking about the wards). If mild exercise fails insulin is given, but before the amount is increased an effort is made to determine whether a different distribution of dosage will suffice. With this method of determining insulin requirements we have found that subsequent reductions of insulin were very small when compared with the reductions with the "basal" type of diet. One possible error in the interpretation of insulin dosages with the "basal" diet is, therefore, obvious. A diabetic so treated may, for example, be found to have required 50 units of insulin a day; three months later 25 units only were required. It would thus appear that treatment resulted in improvement of carbohydrate tolerance. However, had the same patient been given the "ladder" form of diet, there would probably have been little or no reduction of insulin dosage, since the initial dosage would have been about 25 units only. By using the "basal" instead of the "ladder" form of treatment it is thus, also, obvious that loss of carbohydrate tolerance is compatible with a stationary insulin dosage.

Working with the same problem daily for years, one cannot but help gain impressions from experiences as they occur repeatedly, and from over 1,000 diabetics who are now being treated with the high carbohydrate-low calorie diet I

have had the impression for some time that this diet leads to rapid and marked improvement of carbohydrate tolerance in an appreciable number of cases; in some cases, the decreases of insulin and the increases of diets without additional insulin have been most striking. The vagaries of the metabolism of the diabetic are, however, many, and an impression is not proof. In order, therefore, to determine the differences, if any, between our old and new diets, and between the latter diets and the high carbohydrate diets of Geyelin, 100 patients were selected for study. The selection was a random one, except for the following.— In every case the patient was carefully examined in order to exclude as much as possible conditions other than diet which are known to influence carbohydrate tolerance and, thus, insulin dosage. Particular attention was paid to infections. Every patient was found to have required insulin at the beginning of treatment according to the above-mentioned method of determining insulin requirements. Every patient had been under observation for five years. In each case, the patient was selected because of the care with which treatment was followed; the records showed that there were very few dietary irregularities. In each case, there were no less than 40 blood sugar and 25 plasma cholesterol determinations.

Fifty of the above-mentioned patients were treated with our old diets and 50 were treated with the high carbohydrate-low calorie diet. In order to avoid errors of interpretation due to vagaries of the individual it was considered more reliable to deal with each group as a whole and subject the data to statistical treatment, rather than to attach any significance to the results in any one case. The combined data are shown in the accompanying Tables. In Table I are recorded the carbohydrate and total available glucose contents of the old and new diets at the beginning of treatment and five years later. It should here be observed, as I have pointed out previously[1] that the fat and protein contents of the old diets were approximately the same in each case, irrespective of carbohydrate content; the fat content ranged between 140 and 150 grams and the protein between 50 and 60 grams. With the new diet the maximum quantity of fat, regardless of carbohydrate content, was 50 grams, the minimum was approximately 35, and the average about 43 grams. It will be noted that the average total available glucose per day with the older diets was 164 grams, whereas with the high carbohydrate-low calorie diets it was 306 grams. It will also be observed that there was very little change in the average amount of total available glucose at the end of five years, though in a number of cases the diets were changed during this period. Interpretation of the averages is thus simplified to some extent, in view of the possible metabolic effects of increase or decrease of diet.

In Table II are recorded the insulin dosages with the old and new diets at the beginning of treatment and five years later. Though there were a number of changes of insulin dosages in individual cases in both groups, it will be observed that the average amount of insulin required per day with the old diets at the end of five years of

TABLE I.

CARBOHYDRATE AND TOTAL AVAILABLE GLUCOSE CONTENTS OF OLD AND NEW DIETS AT BEGINNING OF TREATMENT AND FIVE YEARS LATER

Old Diets				*New Diets*			
Grams COH	*Total G*	*First*	*5 Yrs. Later*	*Grams COH*	*Total G*	*First*	*5 Yrs. Later*
		No.	*No.*			*No.*	*No.*
50	100	4	2	200	260	1	0
75	125	3	1	218	280	4	2
100	150	12	13	236	300	23	8
125	175	23	26	254	320	21	31
150	200	8	8	272	340	1	9
Total Available Glucose		164	168			306	319

TABLE II.

INSULIN DOSAGES WITH OLD AND NEW DIETS AT BEGINNING OF TREATMENT AND FIVE YEARS LATER

Insulin (Units)	*Old Diets*		*New Diets*	
	First	*5 Years Later*	*First*	*5 Years Later*
	No.	*No.*	*No.*	*No.*
-10	3	0	9	13
11-20	8	7	14	18
21-30	11	12	8	5
31-40	11	11	10	2
41-50	14	9	7	0
51-60	1	6	2	0
61-70	2	1	0	0
Total	50	46	50	38
Average insulin (units)	32.2	31.8	24.6	10.6

treatment was not altered appreciably, whereas, with the new diets, there was approximately a 57 per cent reduction; the average amount of insulin required for the group as a whole at the beginning of treatment was 24.6 units per day; at the end of five years, it was 10.6 units only. Other data in these Tables also demonstrate the difference between the old and new diets. It will be observed that, though both groups of cases were equally carefully selected with respect to the care with which treatment was followed, the average dosage of insulin required with the old diets was higher than with the low carbohydrate-high calorie diets. It will also be observed that four only of the patients who were given the old diets were able to discontinue the use of insulin, whereas 12 of the 50 patients who were treated with the new diet were able to discontinue it.

Since the above-mentioned 8 patients who were treated with the high carbohydrate-low fat diet are regarded by Dr. Geyelin as representative of the group as a whole, comparison of his results with our own data appears to be permissible. It will be observed that after five years of treatment with the high carbohydrate-low calorie diet the average daily dose of insulin amongst our 50 patients, all of whom required insulin at the beginning of treatment, was 10.6 units only, whereas in the 8 representative cases treated with the high carbohydrate-low fat diet it was 58 units. Even at the beginning of treatment 2 only of our 50 patients required more than 50 units of insulin a day. Five years later none required more than 40 units; the majority required 20 units or less. It is also of interest to note that none of the 8 representative patients reported by Dr. Geyelin were able to discontinue insulin treatment, whereas, as stated, 12 of our 50 patients treated with the high carbohydrate-low calorie diet were able to do so.

As I have stated, ratios of grams of glucose in the diet to units of insulin used are of very limited significance in studies of carbohydrate tolerance unless consideration is given to the amount of glucose which can be utilized without administering insulin. I have, however, calculated the ratios in our cases, in order to compare them with those reported in Dr. Geyelin's cases. The highest ratio found by Dr. Geyelin in one of his cases after years of treatment was 14.9; the minimum was 5.2 grams, and the average 7.6 grams; whereas, with the high carbohydrate-low calorie diet the average ratio, even at the beginning of treatment, was 12.4 grams; five years later it was 30.1. According to these ratios, therefore; according to the percentage of patients who were able to discontinue insulin; and according to the average reduction of insulin dosage in the group as a whole, it appears reasonable to conclude that the metabolic effects of the high carbohydrate-low calorie diet differ not only from our older diets of lower carbohydrate and higher fat contents but also from the high carbohydrate diets of Geyelin. The data also support the view that treatment of the diabetic on the principle of under-nutrition is still sound practice.

The following data show that the level of blood sugar is more readily controlled with the new diets than with those of lower carbohydrate and higher fat content. This is shown in the Control Index. A brief explanation of this method of estimating the degree of control of diabetes is necessary.

THE CONTROL INDEX

This Control Index was first used in a previous investigation[11] in which it was necessary to find a simple, but a reasonably quantitative, method of determining the average degree of control of the diabetes over a long period of time. Such arbitrary terms as poor control, fair, good, etc., were found to be unsatisfactory, since the same terms in any two clinics may not be, and as a rule are not, strictly comparable. The degree of control of diabetes was rated as follows.

Rating	*Laboratory Findings*
0	Fasting blood sugar higher than 0.18 per cent; glycosuria in the fasting state; acetonuria.
1	Glycosuria in the fasting state; no acetonuria or, in the absence of glycosuria, a fasting blood sugar higher than 0.18 per cent.
2	Fasting blood sugar higher than normal: but less than 0.18 per cent.
3	Fasting blood sugar normal.

It will be observed that, in the 10 examinations in this case, the average Control Index was 1.90. This value, it should be noted, is slightly less than 2.0, according to which there is mild hyperglycæmia (that is, the blood sugar is less than 0.18 per cent) and no glycosuria. With an average Control Index of 1.90, glycosuria must obviously be uncommon and acetonuria *very* uncommon. This, it will be observed, is in

accord, in general, with the actual data in the above-mentioned case. The reliability of this method of expressing control of diabetes was shown in the above-mentioned previous investigation.[11]

The following Table is taken from the first description of the Control Index[11] and is an example of the necessary calculations:—

TABLE III

	Urine sugar	*Urine acetone*	*Blood sugar percentage*	*Control Index*
Jan. 27, 1933	+	0	0.232	1
Mar. 1	0	0	0.166	2
June 14	0	0	0.145	2
Sept. 3	0	0	0.240	1
Dec. 2	0	0	0.108	3
May 4, 1934	0	0	0.087	3
July 8	0	0	0.171	2
Aug. 14	+	Trace	0.263	0
Aug. 21	0	0	0.133	2
Nov. 3	0	0	0.111	3
		Average.....		1.90

TABLE IV.

SUMMARY OF PROGRESS WITH OLD AND NEW DIETS

Remarks	*Old Diets*		*New Diets*	
	First	*5 Yrs. Later*	*First*	*5 Yrs. Later*
Total available glucose.....	164	168	306	319
Number of patients on insulin	50	46	50	38
Average insulin per day (units)	32.2	31.8	24.6	10.6
Control index (average).....		1.92		2.21
Plasma cholesterol (per cent)		0.229		0.184

In Table IV are briefly summarized the differences between the old and new diets, and it will be observed that the average Control Index of the 50 patients treated with the high carbohydrate-low calorie diet was higher than with the old diets of lower carbohydrate and higher fat content. Since in the selection of these 100 patients equal attention was paid in all cases to the care with which the patients followed treatment, it appears reasonable to conclude that the new diets were more effective than the old in controlling the diabetes; and the effects of this control are reflected in the plasma cholesterol data. It will be observed that the average plasma cholesterol of the group of cases in which the new diet was used was definitely lower than that in which the old diets were used. Such results could obviously not have been obtained had the low calorie diets been harmful. The Control Index, therefore, adds further support to the view that treatment on the principle of undernutrition is still sound.

CLINICAL EVIDENCE OF THE EFFECTS OF THE HIGH CARBOHYDRATE-LOW CALORIE DIET

A normal blood sugar and normal plasma cholesterol do not necessarily imply that the person is normal; a diabetic may look and feel very well in spite of a blood sugar of 0.200 per cent or more, and look and feel quite ill with a normal blood sugar. What then are the clinical experiences? The first clinical result with this diet is that the patients feel and look well. They tire less easily than with the high fat diets; and digestive upsets, so commonly met with in the bran muffin era, have disappeared. The increase of energy, I believe, is due to the ease with which nitrogen metabolism is maintained. One of the most difficult problems with the high fat diets was to keep the diabetic in nitrogen equilibrium, whereas, as I have shown previously[2] nitrogen-retention is one of the characteristic features with the high carbohydrate-low calorie diet. Difficulty in maintaining nitrogen equilibrium was, I believe, largely responsible for the stunting of the diabetic child commonly seen in the past. Stunting occurred in spite of the fact that excess skeletal growth is one of the characteristics of the juvenile diabetic prior to treatment.[13, 14] The second result is that, as with all diets which are liberal with respect to carbohydrate, patients follow treatment better; there is, therefore, a lesser tendency to break diet. The diabetic is thus less exposed to the dangers of dietary irregularity. The third result is that the diet is applicable to all forms of diabetes, with one exception, that is, tuberculosis. Tuberculosis still remains the one condition in our Clinic in which very liberal diets are allowed and the food is counterbalanced, if necessary, with large doses of insulin. In our experience at least, whether the urine was free of sugar or not, the well-fed diabetic who suffered from tuberculosis did better than the under-fed diabetic; but he did best when the diet was not only liberal but when the urine was also kept free of sugar and the blood sugar normal or nearly so.[15] The fourth result of this diet is that there has been a marked decrease in the incidence of diabetic coma, and the chief reason, as I believe I shall

show, is that with this diet the diabetic is deprived of that food which is the chief cause of coma, namely, fat. This is shown in Table V which contains a summary of the findings with respect to sugar and acetone in the urines of our diabetics at their last 10,000 visits to the Out-door Clinic for Diabetes. The selection of these cases was random. The data were collected by two of our technicians, Miss Mountford and Miss Holroyde, who at the time had no knowledge of the purport of the investigation. It so happened that when the data were subsequently grouped according to methods of treatment, there was a sufficient number of observations in each group to be reasonably certain of their significance.

TABLE V.

INCIDENCE OF GLYCOSURIA AND ACETONURIA AMONGST 10,725 EXAMINATIONS

Period	No.	Glycosuria		Acetonuria	
		No.	Per cent	No.	Per cent
1923-26	1801	336	18.7	153	9.0
1927-30	3807	805	21.1	129	3.3
1931-34	5117	1251	24.4	93	1.8

It will be noted that the data are divided into three periods, namely, 1923-26, when the diets contained small amounts of carbohydrate, *i.e.*, about 50 grams, and large quantities of fat; the period, 1927-30, when the diets were more liberal with respect to carbohydrates, but still contained large quantities of fat; and, lastly, the period, 1931-34, when the high carbohydrate-low calorie diet was in force. It will be observed that with increase of carbohydrates there was an increase in the incidence of glycosuria. The conditions of the three different periods are, however, not strictly comparable. It will be noted that treatment with the high carbohydrate-low calorie diet corresponded to the period of the general financial depression. During this period, the majority of out-door patients were unable to follow treatment carefully. As will presently be shown, however, the financial depression afforded an opportunity of testing the value of the high carbohydrate-low calorie diet.

It will be noted that, though the incidence of glycosuria was greatest during the period of treatment with the high carbohydrate-low calorie diet, there was a marked decrease in the incidence of acetonuria; when the diets consisted of small quantities of carbohydrates and large amounts of fat 9 per cent of the analyses showed acetonuria; whereas, during the last four years less than 2 per cent showed acetone in the urine. The explanation of these findings appears to be that, though there was an increase of glycosuria, the financial depression deprived our patients of those foods which readily lead to ketonuria (bacon, eggs, butter, cream, etc.). Our out-door patients lived largely on bread, potatoes and other vegetables. That this is the correct explanation is suggested from our experiences recorded in Table VI, in which is shown the relationship found between the Control Index and plasma cholesterol with the old and new diets. For this purpose, 500 records were collected at random from patients treated with the old diets and 500 from those treated with the high carbohydrate-low calorie diets. It will be observed that the old diets of lower carbohydrate and higher fat content caused a more marked disturbance of blood lipoids when the diabetes was under poor control than the high carbohydrate-low calorie diet. This, also, fits in with our experiences with diabetic coma. The latter are shown in Table VII.

TABLE VI.

SHOWING RELATIONSHIP BETWEEN CONTROL INDEX AND PLASMA CHOLESTEROL WITH HIGH CARBOHYDRATE-LOW CALORIE DIET AND WITH LOW CARBOHYDRATE-HIGH FAT DIET

Control Index	N	Plasma cholesterol*	P	PEM	D	PED	D/PED
	High Carbohydrate-Low Calorie Diet						
1	268	0.211	115	4.69			
2	154	0.202	95	5.13	9	6.9	1.3
3	78	0.188	41	3.12	14	6.0	2.3
	Low Carbohydrate-High Fat Diet						
1	207	0.284	114	5.30			
2	190	0.251	99	4.81	33	7.2	4.6
3	103	0.226	52	3.45	25	5.9	4.2

N—Number of observations.
P—Standard Deviation.
PEM—Probable Error of Mean.
D—Difference between Means.
PED—Probable Error of Difference.
*Per cent.

TABLE VII.

INCIDENCE OF CASES OF COMA AND PRE-COMA WITH OLD AND NEW DIETS

Period		*Coma*	*Pre-coma*	*Total*
1928-29	All cases	23	9	32
	New cases	11	3	14
	Treated previously	12	6	18
1933-34	All cases	6	8	14
	New cases	2	3	5
	Treated previously	4	5	9

In Table VII are recorded our experiences during the period 1928-29, when the low carbohydrate-high fat diets were in force, and those during the period 1933-34, when the majority of our patients were on the high carbohydrate-low calorie diets. It will be observed that there was a total number of 32 cases of coma and precoma during 1928-29; 23 patients were definitely in coma. Of these 32 cases, 14 were new patients. These must, therefore, be excluded from the discussion, as they were not influenced by either of our diets, old or new. We are, therefore, left with 18 of our own patients. It will be noted there was a decrease in the number of new admissions for coma and precoma during the period 1933-34. This must be considered in the interpretation of data. It should, however, be observed that, though the number of our own cases of coma and precoma decreased 50 per cent, the number of patients exposed to our method of treatment increased about 100 per cent; over 1,000 patients were added to the Clinic between 1930 and 1934. *In 1934, we had two cases only of coma,* and in one of these cases the coma was precipitated by an infection. The explanation of these findings appears clear. It should be recalled that a body depleted of glycogen and rich in fat is characteristic of diabetic coma. The high carbohydrate-low calorie diet supplies glycogen and tends to prevent accumulation of fat.

In one of our earlier reports[3] I mentioned the beneficial effects of the high carbohydrate-low calorie diet in patients suffering from angina pectoris and advanced heart disease in general. Another result, one which I believe our data show in another report,[11] is that this diet delays the development of arteriosclerosis. In the past, regardless of treatment and control of blood and urine sugar, extremely few diabetics escaped arteriosclerosis after having had diabetes for five years. According to pathological data[16] none escaped. The statement that the high carbohydrate-low calorie diet is delaying the development of arteriosclerosis in our cases is based upon a very carefully controlled investigation. All of the physical examinations before and five years after treatment with the diet were made by the Chiefs of our medical services; every fundus examination was made by our Chief Ophthalmologist, Dr. S. H. McKee. In each case, there was a "six-foot" x-ray plate of the heart, to measure its size, and in each case the large vessels of the extremities were examined by x-rays for calcification of the arteries.

A sixth, and very important result, of this diet is that it simplifies management. I have dealt with our system of education on previous occasions. With extremely few exceptions none of our diabetics now use scales, and none are taught the carbohydrate, fat, protein and caloric values of food materials.

Lastly, and most important, there are morbidity and mortality data. Tuberculosis is an example. In December, 1934, Dr. Russell M. Wilder, of the Mayo Clinic, in a letter to me, asked about the number of our diabetics who have developed tuberculosis since the use of the high carbohydrate-low calorie diet. The answer to date is as follows. Quite a number of patients with tuberculosis have come to our Clinic, but *seven* only of our own patients have developed tuberculosis since 1930. Considering our diabetic population on the high carbohydrate-low calorie diet, I believe this incidence is slightly lower than that found amongst non-diabetic populations in general. It should be observed that this low incidence was found in spite of our routine periodic, physical, and x-ray examinations of the chest. It should also be observed that a person suffering from tuberculosis is more likely to seek advice than one who is suffering from diabetes alone. This would tend to increase rather than decrease the incidence. Our mortality data are equally satisfactory. These are to form the subject-matter of another report.

SUMMARY

I believe that in the data presented here there is incontestable evidence that the high carbohydrate-low calorie diet is more effective in controlling diabetes than all other methods of treatment reported hitherto. It has the advantage of

other diets which are also liberal with respect to carbohydrate in that it is more effective in improving carbohydrate tolerance. Aside from the general well-being of patients, in common with other diets liberal with respect to carbohydrate content, it is, therefore, more economical from the point of view of the cost of insulin. Experiences with this diet in general support the view that under-nutrition is still an important principle in the treatment of diabetes, except that the term "under-nutrition" has a somewhat different meaning now than in the days before insulin. If, in conclusion, any one of the advantages of this diet may be stressed, it is that of simplicity of treatment, and, as I have stated previously[12] the care with which the diabetic will follow treatment will be directly proportional to the simplicity with which it can be carried out.

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EVIDENCE IN FAVOUR OF A MORE ACTIVE PUERPERIUM: A STUDY OF 500 CASES*

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CUSTOM has ordained that the puerperal woman shall not rise from her bed before the tenth day and that during that time she shall remain for the most part physically at rest. In other words, labour itself having become to all intents and purposes a pathological problem the recovery from it stands in the same category. It is probably not our fault that we surround an essentially physiological process with the complete ritual of surgery; nevertheless we cannot be held blameless if we do not call this state of affairs into question from time to time by reviewing sceptically the evidence on which we base our procedure. In this paper I propose to call the traditional handling of the puerperium into such question. I do so with considerable diffidence, since the two classic obstetrical textbooks of this continent are on the side of tradition. Williams[1] states: "Every patient should be kept in bed until the fundus of the uterus has disappeared behind the symphysis pubis . . . . Generally speaking, a two weeks' stay in bed is not excessive." And DeLee[2] "—allows a normal puerpera, after a normal labour, to sit up in bed on the sixth or seventh day, get out of bed into a large chair for an hour on the ninth or tenth day . . . . and before the end of the second week has the freedom of the floor."

I claim no priority in the stand I am taking. Ever since 1773, when Charles White, of Manchester, England, advocated a more active puerperal state there have been those who took a similar stand — Küstner and his followers in Germany, for instance; and on this continent such clinicians as Polak,[3] Watson,[4] Galloway[5, 7] and Parker[6] have advocated greater activity. The claim of those urging greater activity is that it reacts to the patient's benefit. Galloway holds, for instance, that four important factors are accomplished by it, "drainage leading to less infection, better circulation leading to better in-

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