Dietary Treatment of Diabetes Mellitus in the Pre-Insulin Era (1914–1922)

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ABSTRACT Before the discovery of insulin, one of the most common dietary treatments of diabetes mellitus was a high-fat, low-carbohydrate diet. A review of Frederick M. Allen's case histories shows that a 70% fat, 8% carbohydrate diet could eliminate glycosuria among hospitalized patients. A reconsideration of the role of the high-fat, low-carbohydrate diet for the treatment of diabetes mellitus is in order.

The discovery of insulin in the early 1920s ushered in a new era of the treatment of diabetes (Bliss 1982). Insulin made emaciated patients gain weight and diabetic glycosuria disappear. Even the once uniformly fatal condition of diabetic coma could be cured. Insulin was truly a miraculous discovery

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for diabetics who had no endogenous insulin production, and rapid adoption of the use of insulin into clinical practice understandably ensued.

Unfortunately, however, the widespread use of insulin has not allowed individuals with diabetes mellitus to live entirely normal lives. Today, diabetes mellitus is known as a chronic disease with high rates of retinopathy, nephropathy, and vasculopathy (Feudtner 2003). Moreover, the majority of diabetes mellitus today is caused by insulin resistance (type 2 diabetes), not by insulin deficiency (type 1 diabetes). Patients with type 1 and type 2 diabetes are instructed to measure their own blood glucose and to self-administer insulin subcutaneously to achieve normoglycemia. Yet despite intensive management with insulin and oral medications, normoglycemia remains an elusive goal (DCCT 1993; UKPDS 1998).

In hindsight, the rapid adoption of insulin therapy and the hope that insulin would "cure" diabetes mellitus may have led to the premature abandonment of earlier successful treatments for diabetes. In the pre-insulin era, the pharmacological treatment of diabetes mellitus comprised a combination of modalities including alcohol, opioids, arsenic, and potassium bromide. More potent than medication, however, was the high-fat, low-carbohydrate diet (Osler and McCrae1923). This paper reviews the high-fat, low-carbohydrate diets that were tested and popularized by the two leading diabetic specialists of the time, Frederick Madison Allen and Elliott Proctor Joslin.

FREDERICK MADISON ALLEN: UNDERNUTRITION, 70% FAT DIET

Frederick Madison Allen (1914) created a model of diabetes by removing almost all pancreatic tissue in dogs. When these dogs were fed a high carbohydrate diet, they developed glycosuria. If, however, these same animals were fed a high-fat diet, the glycosuria decreased or disappeared entirely.

In the treatment of diabetes mellitus in humans, Allen employed fasting, then a stepwise reintroduction of macronutrients to find the threshold at which glycosuria developed (Allen 1915a 1915b, 1920). First, the patient fasted until glycosuria was no longer present. Then carbohydrates in the form of green vegetables were introduced, starting at 10 g/day and increased until the glycosuria threshold was reached. The carbohydrate intake prior to the appearance of glycosuria was considered the optimal amount of carbohydrate. This level was maintained and then protein was added to the diet, beginning with 1–1.5 g protein/day, to find the glycosuria threshold for the combination of carbohydrate and protein. Finally, fat was added to the diet, to provide calories for weight gain or weight maintenance; fat was observed to have little effect on glycosuria. For some patients, a weekly fast day was recommended.

Review of Allen's Case Histories

Allen published meticulous descriptions of a series of hospitalized diabetic patients treated with his method (Allen, Stillman, and Fitz 1919). To characterize the results of his method, two authors (ECW and WSY) independently abstracted the hospital discharge daily dietary recommendation for these case histories, which had been determined by the method described above. Disagreements were resolved by reviewing the case histories. If several hospitalizations were recorded, only data from the first hospitalization was used. Because height and weight were missing in many cases, body mass index was not available. If only the total calories, carbohydrate grams and protein grams were recorded, fat grams were estimated as:

$$((\text{total kcal}) - (\text{carbohydrate g} \times 4\ \text{kcal/g}) - (\text{protein g} \times 4\ \text{kcal/g})) \,/\, 9\ \text{kcal}$$

The calories from alcohol were calculated as 7 kcal/g (Poehlman and Horton 1999, p. 99).

Seventy-six case histories were available; 10 were excluded because of death, one because the diabetes was infection-induced, and one because the discharge dietary recommendation was not clear. Because the low weight of children created a much more variable range of dietary intake, 17 cases under the age of 18 were excluded. Forty-seven adult case histories were available for the analysis. The mean age was 39.3 years; 23 (49%) were female; ethnicity was not recorded. For the discharge diet recommendation, the mean caloric intake was 1956 kcal/day, the mean carbohydrate intake 38.7 g/day, the mean protein intake 85.3 g/day, and the mean fat intake 156.4 g/day (Table 1). The percentages of daily caloric intake for carbohydrate, protein and fat were 8, 18, and 70%, respectively.

In these case descriptions, Allen observed that too much dietary fat could initiate or worsen diabetic coma. In seven cases alcohol was used as a calorie source to avoid the production of ketone bodies. The long-term diet recommendation was for "undernutrition," or keeping the diabetic in a state of mild starvation. Excerpts from one case illustrate Allen's method:

> Male, unmarried, age 30 yrs. American; electrical engineer. Admitted March 8, 1915.
>
> Family History: One brother died of diabetes at the age of 15.
>
> Present Illness: During 1913, trouble occurred with a wisdom tooth, resulting in an abscess. . . . Thirst, polyuria, and loss of weight were noticed shortly thereafter. . . .
>
> Physical examination: A well developed, moderately emaciated young man with no urgent symptoms
>
> Treatment: The observation diet on Mar. 9 and 10 consisted of 75–80 gm. protein, 3 gm. carbohydrate, and 1670–2300 calories. On Mar. 10, the sugar excre-

TABLE 1 ADULT DISCHARGE DIET RECOMMENDATION FOR DIABETES MELLITUS, 1919

	Mean (sd)	*Minimum*	*Maximum*
Caloric intake (kcal/day)	1,955.7 (584.6)	700	3002
Carbohydrate (g/day)	38.7 (39.3)	0	160
Protein (g/day)	85.3 (23.2)	25	150
Fat (g/day)	156.4 (60.1)	11	276
PERCENT (%) CALORIC INTAKE			
Carbohydrate	8 (8.4)	0	40
Protein	18 (4.7)	7	33
Fat	70 (14.3)	11	87

*n = 47, age > 18 years; sd = standard deviation
Source: Allen, Stillman, and Fitz (1919).

> tion was 14.6 gm. . . . 4 days of fasting with whiskey cleared up the glycosuria . . . Green vegetables were then begun, 20 gm. carbohydrate being thus added to the whiskey on Mar. 15, after which the whiskey was stopped. Increase of vegetables in the form of a carbohydrate test established the tolerance as 175 gm. carbohydrate, this quantity being tolerated on Apr. 3, but causing slight glycosuria on Apr. 4. A mixed diet was then rather rapidly built up, with the usual weekly fasting days. At discharge on July 15 the diet consisted of 80–90 gm. protein, 50 gm. carbohydrate, and 2500 calories (1.6 to 1.8 gm. protein and 50 calories per kg., diminished one-seventh by weekly fast-days). (Case 36; Allen, Stillman, and Fitz 1919)

ELLIOTT PROCTOR JOSLIN: LOW-CARBOHYDRATE, HIGH-FAT DIET

Like Allen, Elliott Proctor Joslin (1893) recommended a high fat, low carbohydrate diet, as shown in the case description of the diabetic patient Mary H.: "Dietetic treatment is of the first importance. The carbohydrates taken in the food are of no use to the body and must be removed by the kidneys thereby entailing polydipsia, polyuria, pruritus and renal disease." Mary H. was put on a stringent diet consisting only of protein and fat. "The beneficial effects were seen at once." She gained five or six pounds, and was advised to "eat all the cream, butter, and fatty food possible."

Joslin's recommendation was similar to that of Allen's, and consisted of a 70% fat, 10% carbohydrate diet. Joslin carefully listed carbohydrate-containing foods by their carbohydrate content, advising patients to eat only vegetables with less than 5% carbohydrate content. In his classification, vegetables with a carbohydrate content from 1 to 3% were lettuce, cucumbers, spinach, asparagus, rhubarb, endive, marrow, sorrel, sauerkraut, beet greens, dandelion greens, swiss chard, celery, and mushrooms. Vegetables with a carbohydrate content from 3 to 5% were tomatoes,

brussels sprouts, watercress, sea kale, okra, cauliflower, eggplant, cabbage, radishes, leeks, canned string beans, broccoli, and canned artichokes (Joslin 1919, 1928).

OTHER DIETS

Several other investigators employed diets similar to the Allen and Joslin diets. One, known as "The Michigan Diet," was developed by Newburgh and Marsh (1920). Their method distinguished itself from Allen's because it did not have a period of fasting, and provided individualization of macronutrient distribution. The initial treatment was 900 to 1,000 kcal/day, with 90 g fat, 10 g protein, and 14 g carbohydrate for one to two weeks until glycosuria resolved. Calories were then increased to 1,400 kcal/day, consisting of 140 g fat, 28 g protein, and 15–20 g carbohydrate.

DISCUSSION

In the early 1900s, prior to the discovery and utilization of insulin therapy, Frederick Allen and other experts recommended a high-fat, low-carbohydrate diet for the treatment of diabetes. A review of the Allen method showed individual differences in carbohydrate tolerance, but at hospital discharge a 70% fat, 8% carbohydrate diet, on average, was prescribed to control glycosuria. In the current era, if an important goal in the treatment of diabetes mellitus is to reduce glucose levels by dietary means, then a high-fat, low-carbohydrate diet needs to be reconsidered.

A diet designed to control fasting and postprandial blood glucose (type 1 diabetes) or blood glucose and subsequent insulin response (type 2 diabetes) would logically avoid foods that elevate blood glucose. The "glycemic index" is a measure of the postprandial serum glucose response to a standard weight of single foods (Holt, Miller, and Petocz 1997). While reducing the consumption of high glycemic index foods leads to improvements in diabetic control, the consumption of a high-carbohydrate, low-glycemic diet has only modest effects on glycemic control in patients with type 2 diabetes (Brand-Miller et al. 2003; Heilbronn, Noakes, and Clifton 2002). As Allen demonstrated, normoglycemia may only be achievable in some patients by avoiding carbohydrate-containing foods altogether. While the Allen method emphasized a high-fat, low-carbohydrate macronutrient composition, other types of calorically restricted diets may also lead to improved diabetic control.

Clearly, the discovery and clinical application of insulin therapy revolutionized the treatment of diabetes mellitus due to insulin deficiency, and no one would question the use of insulin for type 1 diabetes mellitus. For diabetes mellitus related to insulin resistance (type 2 diabetes), however, it is not clear that medication therapy (including insulin) is superior to a high-fat, low-carbohydrate diet for glycemic control and avoidance of long-term complications. Such

a study was never done. This historical review leads us to conclude that a scientific evaluation comparing medication to a high-fat, low-carbohydrate diet for type 2 diabetes is still needed.

Several limitations temper our ability to directly apply this historical information today. Due to the possibility of spectrum bias, it is difficult to ascertain the severity of diabetes that Allen treated; his patients may not be representative of the diabetic population, since individuals with more severe disease are likely to have died. There was also no formal distinction between type 1 and type 2 diabetes at the time, though he noted that children and young adults presented with weight loss (probably type 1), while older patients were often obese (probably type 2). In this sample with a mean age of 40, most of the patients probably had type 2 diabetes. The long-term use of a high-fat diet raises concerns about cardiovascular risk. However, recent studies have shown that high-fat, low-carbohydrate diets used for weight loss do not increase serum lipids over durations of six to 12 months while individuals are losing weight (Foster et al. 2003; Samaha et al. 2003). Furthermore, little is known about the ability of patients to adhere to these diets, or their effects on quality of life.

In conclusion, reconsideration of a high-fat, low-carbohydrate diet for the treatment of diabetes mellitus is in order. Because the effects of this type of diet beyond short-term glycemic control are not well described, further research is needed before such a diet can be recommended.

REFERENCES

Allen, F. M. 1914. Studies concerning diabetes. *JAMA* 63:939–43.

Allen, F. M. 1915a. The treatment of diabetes. *Boston Med Surg J* 172:241–47.

Allen, F. M. 1915b. Prolonged fasting in diabetes. *Trans Assoc Am Physicians* 30:323–29.

Allen, F. M. 1920. Protein diets and undernutrition in treatment of diabetes. *JAMA* 74: 571–77.

Allen, F. M., E. Stillman, and R. Fitz. 1919. *Total dietary regulation in the treatment of diabetes. Monograph No. 11.* New York: Rockefeller Institute for Medical Research.

Bliss, M. 1982. *The discovery of insulin.* Chicago: Univ. of Chicago Press.

Brand-Miller, J., et al. 2003. Low-glycemic index diets in the management of diabetes. *Diabetes Care* 26:2261–67.

The Diabetes Control and Complications Trial Research Group (DCCT). 1993. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med* 329(4):977–86.

Feudtner, C. 2003. *Bittersweet: Diabetes, insulin, and the transformation of illness.* Chapel Hill: Univ. of North Carolina Press.

Foster, G. D., et al. 2003. A randomized trial of a low-carbohydrate diet for obesity. *N Engl J Med* 348:2082–90.

Heilbronn, L. K., M. Noakes, and P. M. Clifton. 2002. The effect of a high- and low-glycemic index energy restricted diets on plasma lipid and glucose profiles in type 2 diabetic subjects with varying glycemic control. *J Am Coll Nutr* 21:120–27.

Holt, S. H., J. C. [Brand-]Miller, and P. Petocz. 1997. An insulin index of foods: The insulin demand generated by 1000-kJ portions of common foods. *Am J Clin Nutr* 66: 1264–76.

Joslin, E. P. 1893. Pathology of diabetes mellitus. Lecture to the Boyleston Medical Society of the Harvard Medical School.

Joslin, E. P. 1919. *A diabetic manual for the mutual use of doctor and patient*. Philadelphia: Lea & Febiger.

Joslin, E. P. 1928. Ideals in the treatment of diabetes and methods for their realization. *N Engl J Med* 198:379–82.

Newburgh, L. H., and P. L. Marsh. 1920. The use of a high fat diet in the treatment of diabetes mellitus: First paper. *Arch Int Med* 26:647–62.

Osler, W., and T. McCrae. 1923. *The principles and practice of medicine*, 9th ed. New York: D. Appleton.

Poehlman, E. T., and E. S. Horton. 1999. Energy needs: Assessment and requirements in humans. In *Modern nutrition in health and disease*, 9th ed., ed. M. E. Shils et al. Baltimore: Williams & Wilkins.

Samaha, F. F., et al. 2003. A low-carbohydrate as compared with a low-fat diet in severe obesity. *N Engl J Med* 348:2074–81.

UK Prospective Diabetes Study Group (UKPDS). 1998. Effect of intensive blood-glucose control with metformin on complications in overweight patients with type II diabetes (UKPDS 34). *Lancet* 352:854–65.