Background

The prevalence of eating disorders among adolescents and adults in western countries has continued to increase since the 1990's (1). This is especially concerning when one considers that anorexia nervosa has the highest mortality rate of any mental disorder (2). Diagnostic criteria for eating disorders has been established by the American Psychiatric Association in the Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV) and is available for anorexia nervosa, bulimia nervosa, eating disorder not otherwise specified (EDNOS), and binge eating disorder (3). The core clinical manifestation of anorexia nervosa is deliberate starvation to the point of emaciation with excessive fear of weight gain. Two diagnostic subtypes exist for anorexia nervosa: binge-purge subtype and restricting subtype. The reported lifetime prevalence of anorexia nervosa in women is 0.3-3.7%, depending on how strictly diagnostic criterion is applied (3). Mortality rates for anorexia nervosa are higher than most other psychiatric conditions, with crude mortality rates ranging from 0-8% across studies, with a cumulative mortality rate of 2.8% (4). Severe physical and clinical side effects of anorexia nervosa include dehydration, electrolyte abnormalities, cachexia, osteoporosis, cardiac arrhythmias, and orthostatic hypotension (3).

An additional estimated 1-3% of women in the United States suffer from bulimia nervosa in their lifetime. Bulimia nervosa is characterized by recurring episodes of bingeing followed by one or more compensatory mechanisms such as self-induced vomiting, laxative abuse, diuretic abuse, excessive exercise, or fasting. Unlike women with anorexia nervosa with binge-purge subtype, women with bulimia nervosa are typically within a normal weight range. Individuals with bulimia nervosa may experience abnormal electrolytes, heart arrhythmias, esophagitis, enamel erosion, and edema (3).

Treatment of eating disorders typically requires an interdisciplinary team approach including psychiatric, medical, psychological, and nutritional interventions in either an inpatient or outpatient setting. Patients will be assessed using anthropometric, biochemical, and clinical data in addition to patient interview and collection of a dietary recall. Patients will be prescribed a diet and will work with the dietitian and other members of the treatment team to normalize eating behaviors, challenge irrational food beliefs, and reduce food restrictions and aversions. Desired outcomes of treatment may include restoration of weight, correction of fluid and electrolyte imbalances, and correction of vitamin and mineral deficiencies (3).
Type 1 Diabetes Mellitus and Eating Disorders

Type 1 Diabetes Mellitus (T1DM) is one of the most common chronic conditions affecting children and adolescents (5), the latter of which is coincidentally the most common time period for initial onset of an eating disorder (3). Research has found that diabetes is associated with an increased risk for development of an eating disorder (6,8), however the prevalence of eating disorders among individuals with T1DM varies among studies (6-9). Approximately 0.3-0.6% of individuals will be diagnosed with T1DM by the age of 20 (10). Management of T1DM is largely reliant on a balanced and consistently-timed diet paired with a corresponding insulin regimen. Coexisting T1DM with an eating disorder is particularly concerning as eating disturbances are associated with impaired metabolic control and poorly managed T1DM can have serious health consequences, including diabetic ketoacidosis and microvascular complications affecting the eyes, kidneys, and peripheral nerves (6).

Diabetes itself associated with an increased risk of development of an eating disorder among young women. A large multi-site case-control study conducted by Rodin et al. found that the prevalence of both eating disorders and sub threshold eating disorders (disordered eating behaviors which did not meet DSM-IV criteria for an eating disorder) were each twice as prevalent among diabetic females aged 12-19 years when compared to their non-diabetic peers (6). Additionally in a four-year follow-up, diabetic patients with persistent eating disorder behaviors had a threefold increase in risk for diabetic retinopathy than those without these behaviors. Not surprisingly, diabetic patients with eating disorders in this study also had significantly higher hemoglobin A1c (HbA1c) levels (9.4% vs. 8.6%). Of those diabetic patients who met the diagnostic criteria for an eating disorder, 42% reported insulin omission, which causes hyperglycemia and glycosuria (7). Medication omission or manipulation is included as a potential compensatory method used for purging purposes in the DSM-IV (8), and insulin omission in this manner could be abused by individuals with anorexia nervosa, bulimia nervosa, or EDNOS. In a study conducted by Rydall et al., 34% of individuals aged 16-22 years with T1DM reported insulin omission or under-dosing of insulin for the purpose of weight loss (9). Other studies conducted with young adults with T1DM found similar estimates of insulin manipulation with 30-40% of participants reporting insulin omission or under-dosing (7,11).

This omission of insulin associated with eating disorders in persons with T1DM strongly increases risk of severe health consequences. In terms of mortality, an 11-year follow-up study conducted by Goebel-Fabbri et al. found that among individuals with T1DM, those who reported insulin omission had a threefold increase for mortality when controlling for body mass index,
age, and HbA1c values. Mean age of death was 45 years for insulin omitters versus mean age of death at 56 years for those reporting appropriate use of insulin (11).

There are many potential factors which may contribute to the increased prevalence of eating disorders among individuals with T1DM in comparison to individuals without diabetes. Treatment of T1DM requires strict dietary control with scheduled meal times that are regulated outside of normal dietary cues of hunger and satiety (9). Additionally, individuals with T1DM may be asked to count carbohydrates which could contribute to a preoccupation with nutritional content of food. Patients may also gain weight or increase in size after initial diagnosis and initiation of treatment for T1DM. These contributing factors in conjunction with the typical timing of diagnosis of T1DM in adolescence when risk for development of an eating disorder is highest could increase risk for development of an eating disorder for individuals with T1DM.

The Case

JD is a 34 year old white female who presented for voluntary admission to the Eating Disorders Unit (EDU) at UNC Hospitals for weight restoration secondary to anorexia nervosa (binge-purge subtype). Her medical state was complicated with a past medical history significant for T1DM (diagnosed at age 19), hypothyroidism, depression, and asthma. JD also had a long-standing history of anorexia nervosa with bulimia nervosa, onset at age 14. JD was suspected to have poorly controlled T1DM as evidenced by a HbA1c of 14.4% and six prior hospitalizations for diabetic ketoacidosis. JD reported that she was previously on an insulin pump for diabetes management but that this was discontinued secondary to anorexia nervosa with subsequent inconsistent caloric and carbohydrate intake. JD was unable to recall her sliding scale insulin regimen prescribed for her use at home, suggesting the possibility of poor adherence. During the admission process, which included a physical exam and labs, JD was found to be bradycardic and hypokalemic with a blood potassium level of 3.1 mEq/L. The medical team concluded that the combination of her poor glucose control and imbalanced electrolytes put her at high risk for refeeding syndrome. Refeeding syndrome is defined as severe electrolyte and fluid shifts associated with metabolic abnormalities in malnourished patients undergoing refeeding (12). As refeeding is initiated, increased blood glucose signals an increase in insulin and decrease in glucagon leading to synthesis of glycogen, fat, and protein. The shift from a catabolic state to an anabolic state requires an influx of electrolytes and fluids into cells, thus further decreasing serum levels of vital electrolytes and fluids. Indicators of

1 Initials have been changed to protect patient's identity
refeeding syndrome include hypophosphatemia, hypokalemia, hypomagnesaemia, and thiamine deficiency (13).

JD was transferred to the Emergency Department where she was started on an IV solution of 5% dextrose in half normal saline to stabilize her poorly controlled blood glucose. She also received sodium and potassium phosphates and magnesium oxide administered orally to stabilize her low potassium and maintain phosphate and magnesium levels within normal limits. She was scheduled to receive point-of-care blood glucose checks at regular intervals to monitor her blood glucose levels.

Endocrinology was consulted soon after admission to the hospital due to the patient’s severely elevated HbA1c and overnight hypoglycemic episodes with blood glucose levels below 40 mg/dL. JD also reported regular episodes of hyperglycemia prior to admission with reported glucose levels above 200-400 mg/dL. Endocrinology initially recommended that JD receive enteral or parenteral nutrition, however, within two days JD was able to increase her oral intake to greater than 25% of the standard hospital diet and thus she did not require nutrition support. As JD began to have improved intake her blood glucose levels rose above 300 mg/dL. She remained hospitalized in General Medicine for eight days until she was deemed to be medically stable, at which point she was admitted to the EDU.

At admission JD was assessed using anthropometric data. She was 62 inches tall and weighed 52 pounds with a BMI of 10.1 kg/m2, classifying her as severely underweight (14). Her weight goals were set at 100 pounds for discharge from the EDU and 109 pounds for weight maintenance. Her discharge goal weight was determined by calculating 80% of her ideal body weight (125 pounds) via the 1983 Met Life Tables for Ideal Height-Weight. Her maintenance weight was calculated as the weight required to maintain a BMI of 20. At admission to the EDU, JD was at 50.2% of her 20 BMI and 43.8% of her ideal body weight. Her recent energy intake was estimated as 950-1,120 calories based on calorie counts collected over the previous three days in the hospital. Her estimated energy needs were calculated using the Harris-Benedict Equation and her total energy expenditure (TEE) was estimated at 1,231 calories per day. Her estimated needs for weight gain were calculated as TEEx1.2-1.4, or 1,477-1,723 calories per day. Based on her recent intake and estimated energy needs, with additional concerns pertaining to over-feeding and triggering of refeeding syndrome, JD was started on a 1,100-calorie diet with plans to advance her diet in 300-calorie increments as clinically indicated for weight restoration.

On the second day of admission the dietitian had an initial consultation with the patient to initiate diet education. The EDU has developed a standard meal planning system referred to
as the exchange system which requires patients to plan a certain number of exchanges from each food group (including milk, fruit, vegetable, starch, protein, fat, and condensed snacks) which correspond to a patient’s calorically-based diet order (prescribed in 100-calorie increments). Based on the standard exchanges, a patient’s meal plan typically includes at least 50-60% of calories from carbohydrates. In addition to teaching the exchange system, the dietitian also initiated education about consistent carbohydrate planning, as this is the generally recommended practice for patients with diabetes (15). JD did not receive a reduced-carbohydrate meal plan, however she was instructed to plan carbohydrates proportionally across all meals and mealtime insulin was prescribed by endocrinology based on her carbohydrate intake.

Within the first two weeks of treatment JD continued to have frequently elevated glucose levels above 200-300 mg/dL. Endocrinology continued to follow the patient weekly and recommended that she continue to plan menus following the standard exchange system without any alteration to proportion of calories from carbohydrates. Endocrinology’s proposed rationale for unrestricted and unregulated carbohydrate intake was that weight restoration was the primary goal for treatment rather than strict diabetes management. Indeed, the proposal for permissive hyperglycemia in the case of early refeeding for patients with concurrent T1DM and anorexia nervosa has been advocated in the literature (16). It is suggested that hyperglycemia is to be expected when reintroducing adequate nutrition to a chronically malnourished diabetic patient and that hyperglycemia is preferable to potential hypoglycemic episodes that may result from overly aggressive insulin regimens. The argument stands that long-term microvascular effects of hyperglycemia accumulate over years, not weeks or months, as is the typical length of the refeeding process. However, it is notable that hyperglycemia in this context is defined as blood glucose levels ranging from 180-240 mg/dL, levels which JD frequently exceeded. Acute episodes of hypoglycemia are considered particularly harmful if not immediately recognized or treated as they can lead to mental confusion, slurred or rambling speech, extreme fatigue, seizures, and unconsciousness (3). Additionally, hypoglycemia is typically treated with the consumption of glucose-dense food items, which may cause psychological distress for an eating disorder patient and may also disrupt the treatment diet regimen that is established.

After the initial two weeks of treatment, JD’s blood glucose levels began to normalize with measurements on average below 200 mg/dL. Endocrinology requested that the dietitian cease monitoring and education related to consistent carbohydrate planning in order to prepare JD for independence in self-managing her diabetes following discharge. As treatment progressed without diabetes management provided by the dietitian, JD required an unusually
high dosage of insulin relative to her body weight for both her pre-meal insulin and long-acting insulin in order to prevent severe episodes of hyperglycemia. As JD’s daytime hyperglycemia began to resolve with aggressive insulin management she began to experience intermittent episodes of hypoglycemia between meals and overnight with blood glucose levels below 60 mg/dL.

JD’s diet continued to advance in 300-calorie increments per treatment protocol with the goal to continue with 1-2 kilograms of weight gain per week for the duration of treatment. After one month of treatment, JD required 2,500 calories per day to continue her weight gain trajectory, and by the end of month two, she required 3,100 calories per day. As JD’s diet advanced, her blood glucose levels began to rise above 200-300 mg/dL despite a steady proportion of carbohydrates prescribed by her diet. Endocrinology struggled to manage the patient’s blood glucose levels and continued to increase the amount of insulin that she received on a weekly basis. Despite poor blood glucose control, endocrinology continued to request that the patient plan meals independently using standard menus for a regular diet without intervention from the dietitian. JD was instructed to continue with consistent carbohydrate meal planning and to track the grams of carbohydrate planned for each meal. It was noted by the dietitian that JD would consistently plan a substantial proportion of her starch exchanges at breakfast and very few starch exchanges at later meals and snacks, however no intervention was made per instructions from endocrinology. JD was notably resistant to discussing her meal planning strategy with the dietitian and refused to share her carbohydrate tracking document with the dietitian when requested.

After nearly two months of treatment, the patient began to convey significant anxiety related to weight gain and began to refuse insulin at multiple meals. Her blood glucose levels rose alarmingly high, with blood glucose measurements recorded above 400 mg/dL. Three days later, endocrinology was consulted for concerns related to refusal of insulin and severe hyperglycemia. On this visit, endocrinology watched the patient administer her own insulin and noted that the patient did so under her clothing and did not leave the needle under the skin for the entire injection. It was discovered that the patient was failing to administer the entire dose of insulin which provided an explanation for why the patient required an exceptionally aggressive insulin regimen. The interdisciplinary care team decided at this time that the patient would no longer retain the right to administer her own insulin. Additionally, as it became apparent that patient was not able to manage her own diabetes in light of her eating disorder, endocrinology requested that the dietitian resume educating JD on consistent carbohydrate meal planning. Immediately following these changes the patient’s blood glucose levels stabilized with a marked
reduction in the number of blood glucose measurements above 180 mg/dL. This improvement in point-of-care blood glucose measurements can be seen in Figure 1 (beginning on day 56 of treatment).

![Graph of patient's daily point-of-care blood glucose measurements (mg/dL) spanning the duration of treatment.](image)

Figure 1: Graph of the patient's daily point-of-care blood glucose measurements (mg/dL) spanning the duration of treatment.

After multiple sessions with both endocrinology and the dietitian, the patient began to demonstrate more mindfulness regarding consistent carbohydrate planning and she was observed tracking grams of carbohydrate for her meals. JD was instructed to plan an equal portion of her carbohydrates at breakfast, lunch, and dinner, with an additional portion of carbohydrates at morning, afternoon, and evening snacks. She continued to make progress with weight restoration and blood glucose levels remained better-managed for nearly a month.

JD reached 90 pounds after 75 days of treatment, which she stated was her personal goal weight. She cited refusal to maintain weight above 90 pounds despite the fact that she remained 10 pounds away from her goal weight for discharge and 19 pounds away from her maintenance goal weight. As seen in Figure 1, the patient's blood glucose measurements also became increasingly elevated around this time. JD's blood glucose levels were consistently measured above 250 mg/dL and she was observed planning a large majority of her carbohydrates at breakfast (70-80 grams), indicating potential manipulation of both insulin and
carbohydrate portioning for the purpose of weight management. The dietitian continued to educate JD on consistent carbohydrate planning and again requested to see the patient's carbohydrate tracking document but she refused. When asked, JD denied that she was manipulating her carbohydrate intake or insulin administration. However it was discovered by nursing on day 82 of treatment that JD was squeezing the skin around the insulin injection site in an attempt to expel the injected insulin. Once this behavior was eliminated by stricter monitoring from staff, the patient's severely elevated blood glucose levels resolved.

On day 96 of treatment, the patient was discharged at 100 pounds, which was 80.3% of her ideal body weight. Despite chronic hyperglycemia during treatment, the patient successfully reduced her HbA1c to 7.6% at discharge, down from 14.4% measured three months prior.

Discussion

This case demonstrates the unique medical and behavioral issues that may arise when treating an individual with anorexia nervosa and concurrent T1DM. Providers should closely monitor patients' blood glucose levels during the refeeding process and anticipate the need for increased insulin as caloric intake increases. Hyperglycemia may be an unavoidable side effect of increased caloric intake in chronically malnourished patients. However, providers should be mindful of monitoring insulin administration and consistent carbohydrate meal planning as these two tools for diabetes management have the potential to be manipulated and abused for the purpose of weight control. Eating disorders patients with T1DM may benefit from stricter management of consistent carbohydrate planning with intervention from a dietitian if noncompliance is noted. Additionally, given the documented practice of withholding insulin for weight management purposes among individuals with T1DM (6-9), insulin administration should be closely monitored by staff for the duration of treatment.

One diabetes management tool that was not utilized with this specific patient is the use of a moderately reduced-carbohydrate diet to manage blood glucose levels. Many hospitalized patients with diabetes will receive a diet order for consistent carbohydrate that contains approximately 40-50% of total calories from carbohydrate. In the case of JD, endocrinology recommended that the patient remain on an unrestricted standard hospital diet for the purpose of weight restoration. However, the patient was noted to plan large proportions of carbohydrates at her breakfast meals despite on-going counseling from both the dietitian and endocrinology on consistent carbohydrate planning. Additionally, the patient was permitted to consume foods high in simple sugars, such as fruit juice and desserts, in large quantities at single meals which likely
contributed to postprandial hyperglycemia. Research has provided mixed results on the long-term effects of high glycemic index foods on blood glucose control, however it is agreed upon that consuming large quantities of carbohydrates in an inconsistent manner will lead to poor blood glucose control (15). While it is important to focus on restoring weight, encouraging normalized eating behaviors, and discouraging food restriction while in treatment, eating disorders patients with T1DM may benefit from receiving more elaborate and individualized education related to diabetes self-management and a meal plan that is specifically tailored for improved blood glucose control. Elaborate diabetes education should not only include consistent carbohydrate education but also provide the patient with education about the importance of maintaining blood glucose within normal limits and to highlight the consequences associated with poor diabetes management.

Conclusions

Treatment and management of coexisting anorexia nervosa and T1DM poses a uniquely challenging situation for both dietitians and endocrinologists. Treatment providers for individuals with T1DM should consider the possibility of insulin omission or under-dosing when patients present with repeated cases of hyperglycemia or significantly elevated HbA1c levels. This may be especially relevant for individuals with known eating disorders or preoccupation with weight management. For patients receiving inpatient treatment for an eating disorder, insulin administration should be either strictly monitored or fully managed by staff. As treatment progresses and the patient has demonstrated improvement in both nutritional and psychological status, the treatment team may wish to allow the patient to resume autonomous insulin administration on a trial basis in preparation for discharge from treatment.

During the refeeding process, the dietitian should work closely with patients with T1DM to plan consistent carbohydrate meals as this may lessen the severity of hyperglycemia associated with refeeding. Encouraging selection of carbohydrate food items which contain fiber and moderating the amount of carbohydrate food items high in simple sugars may contribute to tighter blood glucose management during the refeeding process, although more research is necessary to determine the influence of high glycemic foods on hyperglycemia during the process of refeeding malnourished individuals with T1DM. If a patient experiences repeated episodes of hyperglycemia and is noncompliant with consistent planning of carbohydrates across meals for an extended period of time, loss of autonomous meal planning would be recommended until blood glucose levels stabilize and the patient demonstrates competency and
compliance with consistent carbohydrate meal planning.
References


