**Case 27: Type 1 Diabetes Mellitus with Diabetic Ketoacidosis**

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*1. There are precipitating factors for diabetic ketoacidosis. List at least seven possible factors.*

Diabetic ketoacidosis (DKA) occurs more often in type 1 diabetics compared to type 2 especially when they have acute illness or when they are insulin deficient. They may show signs of nausea, vomiting, stomach pain, fruity or acetone breath, and mental status change. DKA intensifies during illness, getting an infection, emotional stress, omission of insulin injections and eating poorly (Nelms, 505).

*2. Describe the metabolic events that led to the symptoms associated with DKA.*

Diabetic ketoacidosis (DKA) is a life threatening but reversible complication characterized by severe disturbance in carbohydrate, protein and fat metabolism (Krause, 703). In a patient who has DKA the individual will have elevated blood glucose levels of greater than 250 mg/dL and less than 600 mg/dL and there is a presence of ketones in the blood and urine. The symptoms demonstrated include polyuria, polydipsia, hyperventilation, dehydration and the fruity odor of ketones on the breath, fatigue, nausea, vomiting, stomach pain, and mental status change (Krause, 703) (Nelms, 505). The prevention methods for DKA include self-monitoring blood glucose (SMBG), testing for ketones in the urine, and further medical intervention (Krause, 703). The risk for DKA occurs an individual with type 1 DM is ill, has infection and is experiencing emotional stress such as when a patient is sick and they do not take their insulin (Nelms, 505). When an adequate amount of insulin is not available the glucose production from gluconeogenesis and lipolysis are stimulated to avoid starvation by burning fat instead of carbohydrates. Since lipolysis is activated, and a by-product of burning fat is the accumulation of ketones in the bloodstream, and osmotic diuresis occur which results in dehydration and electrolyte imbalance. When there is large amount so fluid lost the blood becomes concentrated and increases they hyperglycemia (Nelms, 505).

*3. Assess Susan’s physical examination. What is consistent with diabetic ketoacidosis? Give the physiological rationale for each that you identify.*

In Susan’s chart it is noted that she complained of fatigue, nausea, vomiting and intense thirst. It was noted that the physician observed that she was confused, having difficulty breathing and noted the smell of acetone on her breath. Also her urine tests were positive for glycosuria and ketonuria. Additionally, in Susan’s medical exam she looked tired, and had sunken eyes, her nose and ears had dry mucous membranes and had dry flushed skin, experienced Kussmaul’s respirations. Based on the notes in Susan’s chart and her physical exam many of her symptoms demonstrate DKA. Where there is not adequate insulin available the glucose production is stimulated and a by-product is ketones which then accumulate in the bloodstream and result in dehydration and electrolyte balance (Nelms, 505). This is demonstrated by Susan’s signs of having intense thirst, her nose and ears have dry mucous membranes. Also the symptoms of DKA include nausea, vomiting, stomach pain, acetone breath and Kussmaul respirations which Susan have all been reported in Susan’s chart (Nelms, 505).

*4. Examine Susan’s biochemical indices both in the chemistry section and in her ABG report. Which are consistent with DKA? Why?*

Based upon Susan’s biochemical data her levels that are high include potassium, PO4, osmolality, glucose, BUN and creatinine and HbA1C. The one level that is low is her total CO2. The low CO2 levels are consistent with DKA because her metabolism is not functioning properly and therefore results in the reduced production of CO2. A result of DKA is that the total body water decreases and affects potassium, sodium, magnesium and phosphorous that are lost, and this results in the levels of these ions to be normal or elevated from the decreased fluid volume (Nelms, 481). A decreased fluid volume is known as hypovolemia which also causes increased hematocrit, hemoglobin, protein, white blood cell count, creatinine and osmolality which are all demonstrated in Susan’s lab values (Nelms, 482). Because Susan’s serum Bun and creatinine levels are high, this indicates that the function of her kidneys are compromised because of having high long term blood glucose levels (Nelms, 481).

*5. If Susan’s symptoms were left untreated, what would happen?*

If Susan’s symptoms were left untreated this could quickly lead to death (Nelms, 482). It is a concern that Susan’s blood glucose levels remained high for an extended amount of time because of the major complications with DKA, although they can be resolved, eventually it could end in death (Nelms, 482).

*6. Assuming Susan’s SMBG records are correct, what events seem to have precipitated the development of DKA?*

Based on Susan’s self-monitoring blood glucose levels, it appears that her blood glucose levels were normal until Susan started her period on September 20th. On September 20th to September 23th her blood glucose levels were around 150-200, but then when Susan had her volleyball tournament her blood glucose levels increased from 250-300. Also the following day on her birthday her blood glucose levels remained high and therefore further developed DKA.

*7. What, if anything, could Susan have done to avoid DKA?*

For Susan to avoid DKA it would have been important for her to better monitor her blood glucose levels throughout the day. Also Susan should have been carbohydrate counting for each meal and administering the appropriate amount of either short or rapid-acting insulin (Nelms, 490). It is important for Susan to have a good understanding of onset, peak and duration of insulin in relation to the foods she consumes.

*8. While Susan is being stabilized, Tagamet is being given IV piggyback. What does “IV piggyback” mean? What is Tagamet, and why has it been prescribed?*

A piggyback IV is the way in which medications are administered using the primary intravenous line but with a second source of fluid in its separate bag. When administering an IV piggyback it is important to stop the main line temporarily while the piggyback fluid is being administered (Medical Dictionary, 2016). Tagament is the brand name for the generic drug cimetidine which inhibits histamine binding to H2 receptors and efforts to inhibit gastric and pepsin secretions (Drug Bank, 2013). Tagament is used to treat GERD, peptic ulcers, heartburn and indigestion (Drug Bank, 2013). Based on Susan’s lab values it is evident her pH levels were low, indicating there is too much acid present and to help settle her stomach Dr. Green prescribed her Tagament.

*9. The Diabetes Control and Complicaitons Trial was a landmark multicenter trial designed to test the proposition that complications of diabetes mellitus are related to elevation of plasma glucose. It is the longest and largest prospective study showing that lowering blood glucose concentration slows or prevents development of complications common to individuals with diabetes. The trial compared “intensive” insulin therapy (“tight control”) with “conventional” insulin therapy. Define “intensive” insulin therapy. Define “conventional” insulin therapy.*

Intensive insulin therapy is also referred to as flexible insulin is a more common type of insulin administration which requires multiple daily injections of rapid acting insulin before meals, in addition to basal insulin daily (Nelms, 490). This method can use syringes, pens or pumps to deliver the insulin and the insulin will be adjusted depending on what the patient has consumed. It is important when performing physical activity that insulin is injected when appropriate (Nelms, 492). Overall intensive insulin therapy delays onset and slows the progression of complications.

Conventional insulin therapy is also referred to as fixed insulin. Conventional therapy consists of premixed or fixed insulin plan. A prescribed dose of basal or intermediate-actin insulin which is referred to as a mixed dose and the patient may use premixed insulin. For patients using this method, they must synchronize administration of their insulin and food intake to avoid hypoglycemia (Nelms, 490). It is important for patients to keep their regimen consistent from day to day along with not skipping meals and she be aware how physical activity affects their blood sugar and how they can prevent from becoming hypoglycemic (Nelms, 490).

*10. List the microvascular and neurological complications associated with type 1 diabetes.*

Macrovasucular disease involved diseases of large blood vessels while microvascular diseases are ones that involved with small blood vessels and include nephropathy and retinopathy. Diabetic neuropathy is a condition that is characterized by damage of the nerves (Krause, 704). In patients with type 1 and 2 DM nephropathy is seen in 20-40% of the individuals. The first clinical evidence of nephropathy is low and abnormal urine albumin levels called microalbuminuria (Krause, 705). In a type 1 DM when there are chronic high levels of blood glucose this can be associated with never damage. Peripheral neuropathy usually affects the nerves the control sensation in the feet in hands compared to autonomic neuropathy which affect nerve function controlling various organ systems (Krause, 706). Individual who are type 1 DM should be screen yearly if they have had it for more than five years. Although nephropathy cannot be cured it cane be slowed to reduce the risk one’s glucose and blood pressure need to be controlled and both angiotensin-converting enzyme inhibitors or angiotensin receptor blockers should be used. Another microvascular complication that is seen in type 1 diabetics is diabetic retinopathy which is most frequent cause of new cases of blindness among adults who are 20 to 74 years old (Krause, 705). There are further complications that can occur such as glaucoma, cataracts, and other disorders of the eye but there is a screening program that is in place to detect diabetic retinopathy. A type 1 diabetic should have dilated and comprehensive eye examination by an ophthalmologist within 5 years of being diagnosed (Krause, 705).

*11. What are the advantages of intensive insulin therapy?*

The major advantages of intensive insulin therapy is the flexibility the patient has with the way it is administered. Additionally, the patient is able to adjust the insulin dosage based on hyperglycemia, their carbohydrate intake or a change in physical activity. Intensive insulin therapy also slows the progression of complications such as retinopathy, nephropathy, and neuropathy in patients that have type one diabetes. Lastly this method allows the patient to fine-tune the short and rapid acting insulin when their blood glucose levels are not within range (Nelms, 492).

*12. What are the risks of intensive insulin therapy (tight control)?*

The risks associated with intensive insulin therapy is that this method is not meant for everyone and that patients should be reminded that out-of-target blood glucose results should be brought about because of environmental influences. These environmental influences include stress, illness, unpredictable insulin absorption, changes in exercise, Somogyi effect and the honeymoon phase (Nelms, 492).

*13. Dr. Green consults with you, and the two of you decide that Susan would benefit from insulin pump therapy combined with CHO counting for intensive insulin therapy. This will give Susan better glycemic control and more flexibility. What are some of the key characteristics of candidates for intensive insulin therapy?*

The key characteristics of a candidate for intensive insulin therapy is that it is a patient with type one diabetes and they will administer the insulin frequently along with checking their blood sugars often (Nelms, 492). Especially for Susan who is young and has a pretty consistent eating and exercise regimen this would be appropriate for her. For individuals who struggle with severe bouts of low blood glucose, have heart disease, blood vessel disease or severe diabetes complications intensive insulin therapy would not be recommended (Mayo Clinic, 2014). Additionally, this method is not recommended for children or adults.

*14. Explain how an insulin pump works. Is Susan a candidate for an insulin pump?*

An insulin pump is a computerized device that is the size of a pager that allows for regular or rapid-acting insulin that is delivered at a basal rate and then in additional bolus for meals or snacks that the patients has throughout the day (Nelms, 492). The doses of insulin are delivered through a flexible plastic tube that is inserted into the skin in the fatty tissue and taped in place (ADA, 2015). The pump is able to administer insulin in small increments which allows for precise measurements. The pump is also able to continuously monitor the patients blood glucose levels (Nelms, 492). This system overall is very helpful in better control of blood glucose levels

*15. How would you describe CHO counting to Susan and her family?*

Carbohydrate counting has been proven to be the most successful diabetes control. The basic concept is that the carbohydrates found in food is the major macronutrient influencing the blood glucose levels in the blood. These glucose levels then influence the pre-meal insulin requirements that should be administered (Nelms, 501). This approach focuses on the total amount of carbohydrates consumed and eating consistent amount of carbohydrates at meals and snacks can make carbohydrate counting a simpler method to planning meals. Knowing all this information I would provide Susan and her family with an exchange sheet for carbohydrates in certain foods. I would try to go through each category with them but reminding them that they can always refer back to it when preparing meals to ensure they do not get overwhelmed. I would also explain which foods do have carbohydrates in them, and how she would account for an item such as ice-cream and the amount of carbohydrates in it. I would also use Susan’s 24-hour diet recall to ensure that she has the carbohydrate counts of all of her favorite foods so she is not confused when she goes home.

*16. How is CHO counting used with intensive insulin therapy?*

Since Susan is new to counting carbohydrates it would be best to for to learn how to carbohydrate count and learn the exchanges for the foods that she eats most often (Nelms, 501). Based upon the 2014 nutrition from the American Diabetes Association states, “evidence suggest that there is not an ideal percentage of calories from carbohydrate, protein and fat for all people with diabetes; therefore, macronutrient distribution should be based on individual assessment of current eating patterns” (Nelms, 496). Susan’s insulin dosage is determined based upon the amount of carbohydrates that she consumes. It would be necessary to review with Susan what the carbohydrate exchange system. It is good for her to know that one unit of rapid-acting insulin will be administered for one carbohydrate unit which is 10-15 grams of carbohydrates. Using carbohydrate counting and intensive insulin therapy is a great approach to help Susan achieve her target blood glucose levels and ensure they are stabilized.

*17. Estimate Susan’s daily energy needs using the Harris- Benedict equation.*

110 lbs. / 2.2 kg= 50 kg

63 inches x 2.54 cm = 160.02 cm

BMR= 655 + (9.56 x kg) + (1.85 x cm)- (4.68 x yrs) x PAL

BMR= 655 + (9.56 x 50) + (1.85 x 160.02)- (4.68 x 16) x 1.5

BMR= (665 + 478 + 296.04 – 74.88) x 2.0

BMR= 1364.16 x 2.0

BMR= 2,728.32 kcal

**BMR= 2700-2800 kcal**

*18. Using the 1-week food diary from Susan, calculate the average amount of CHO usually consumed each meal and snack.*

|  |  |  |
| --- | --- | --- |
| Monday | AM | 1 ½ c. Rice Krispies, 1 c 2% milk, 1 c orange juice (calcium fortified), 1 med banana (100 grams CHO) |
|  | Lunch | 6-in personal vegetarian pizza, 12 oz. Diet Coke, 1 large apple (75 g CHO) |
|  | Snack | PBJ sandwich: 2 slices whole wheat bread, 2 Tbsp crunchy peanut butter, 1 tsp grape jelly (regular), 12 oz. Diet coke (36 grams CHO) |
|  | Dinner | Spaghetti w/ meat sauce: 3 c cooked spaghetti, ½ c sauce with 2 oz. cooked group beef; large tossed salad w/ diet dressing, 12 oz. 2% milk, 2 stalks cooked broccoli, 6 vanilla wafers (188 gram CHO) |
|  | HS | ½ c vanilla ice cream (Ben & Jerry’s) (16 grams CHO) |
| Tuesday | AM | 1 ½ c. Rice Krispies, 1 c 2% milk, 1 c orange juice (calcium fortified), 1 med banana (100 grams CHO) |
|  | Lunch | Cheeseburger: 1 bun, 1 slice American cheese, 2 oz. beef patty, 1 small bag potato chips (1 oz), 12 oz Diet Mountain Dew, 1 med. Orange (49 grams CHO) |
|  | Snack | 6 saltines, 2 oz Colby cheese, 12 grapes, water (27 grams CHO) |
|  | Dinner | 3 tacos, ¼ cup refried beans, 1 c 2% milk (96 grams CHO) |
|  | HS | ½ orange sherbet (29 grams CHO) |
| Wednesday | AM | 1 ½ c Cap’n Crunch cereal, 1 c 2% milk, 1 c orange juice (calcium fortified) (85 grams CHO) |
|  | Lunch | 4 tacos, 12 oz Diet Coke (102 grams CHO) |
|  | Snack | 6 saltines, 2 Tbsp peanut butter, 12 oz. Diet Coke (19 grams CHO) |
|  | Dinner | 3 oz baked chicken, 1 large baked potato w/ 1 tsp butter & 1 tsp sour cream, 1 c green beans, 2 Fig Newtons (81 grams CHO) |
|  | HS | 1 ½ oz pretzels, 2 tsp mustard, 12 oz caffeine-free Diet coke (34 grams CHO) |
| Thursday | AM | 1 ½ c Rice Krispies, 1 c 2% milk, 1 c orange juice (calcium fortified), 1 med banana (100 grams CHO) |
|  | Lunch | Meatloaf sandwich on 2 slices whole wheat bread (~3 oz. ground beef), 1 c mashed potatoes, ½ c cooked carrots, 1 c 2% milk (83 grams CHO) |
|  | Snack | ½ c cottage cheese, 1 c unsweetened canned peaches (18 grams CHO) |
|  | Dinner | 3 oz. baked pork chop, 1 large baked potato with 2 tsp butter, large tossed salad w/ diet dressing, 12 oz 2% milk, 1 small slice angel food cake (no icing) (111 grams CHO) |
|  | HS | ½ c vanilla ice cream (Ben & Jerry’s) (16 grams CHO) |
| Friday | AM | 1 ½ c Rice Krispies, 1 c 2% milk, 1 c orange juice (calcium fortified), 1 med banana (100 grams CHO) |
|  | Lunch | 6 in personal vegetarian pizza, 12 oz Diet coke, 1 large apple (75 grams CHO) |
|  | Snack | 2 Tbs peanut butter, 1 English muffin, toasted, 1 c 2% milk (43 grams CHO) |
|  | Dinner | Fried fish sandwich- 3 oz. fish, 1 bun, baked French fries, 1 c raw broccoli & cauliflower, low-fat ranch dressing, 12 oz 2% milk, 2 Fig Newtons (98 grams CHO) |
|  | HS | 3 c popcorn (popped), 12 oz caffeine-free Diet Coke (19 grams CHO) |
| Saturday | AM | 3 buttermilk pancakes 2/ 2 Tbsp maple syrup & 2 tsp butter, 3 strips crisp bacon, 1 c 2% milk, 1 c orange juice (calcium fortified) (114 grams CHO) |
|  | Lunch | Chef’s salad: ~ 1 oz. cubed ham, 1 oz cubed cheddar cheese, 1 oz cubed turkey, low-fat ranch dressing; 12 saltine crackers, 1 c 2% milk, 1 large apple (69 grams CHO) |
|  | Snack | 1 c Dairy Queen ice cream (low-fat) in a cone (44 grams CHO) |
|  | Dinner | 1 slice deep pan broccoli-and-Canadian-bacon pizza, 1 dinner salad, 1 tsp low-fat-Italian dressing, 12 oz Diet Coke (35 grams CHO) |
|  | HS | 3 c pooped popcorn w/salt & butter-flavored Pam spray, 6 oz Diet Coke (caffeine-free) (17 grams CHO) |
| Sunday | AM | 1 slice French toast w/ 3 Tbsp maple syrup, 1 c 2% milk, 1 c orange juice (calcium fortified), ½ c sliced strawberries (92 grams CHO) |
|  | Lunch | 3 oz fried chicken, 1 c mashed potatoes w/ 1 Tbsp gravy, 1 c 2% milk, 1 c cooked carrots, 1 small slice angel food cake (105 grams CHO) |
|  | Snack | 1 med banana (27 grams of CHO) |
|  | Dinner | Italian beef sandwich (2 oz sliced beef on 1 hoagie bun), 2 oz WOW potato chips, 1 dill pickle, 12 oz Diet Coke (112 grams CHO) |
|  | HS | 3 c popped popcorn w/ salt & butter-flavored Pam spray, 6 oz Diet Coke (caffeine free) (17 grams CHO) |

*\_153.7\_\_\_gm CHO breakfast*

*\_79.7\_\_\_gm CHO lunch*

*\_30.57\_\_\_gm CHO snack*

*\_103\_\_\_gm CHO dinner*

*\_21.14\_\_\_gm CHO HS*

*19. After you have calculated Susan’s usual CHO intake from her food record, develop a CHO- counting meal plan that she could use. Include menu ideas.*

Based on Susan’s energy needs of 2,000-2,100 kcal/day, her goal is to consume 55% of her calories form carbohydrates, 30% from protein and 25% from fat.

Carbohydrates:2700 kcal x .55= 1,485 kcal/day / 4 kcal/ gram= 371 grams

371 grams/ 15 grams per choice= 24 choices

2800 kcal x .55= 1540 kcal/day / 4 kcal/gram= 385

385 grams/ 15 grams per choice= 26 choices

Protein: 2700 kcal x .3= 810 kcal/day / 4 kcal/ gram= 203 grams

2800 kcal x .3= 840 kcal/day / 4 kcal/ gram= 210 grams

Fat: 2700 kcal x .25 = 675 kcal/ 9 kcal/gram= 75 grams

2800 kcal x .25= 700 grams / 9 kcal/gram= 78 grams

*Daily Total: CHO \_371-385\_\_\_g*

*Protein\_\_203-210\_\_g*

*Fat \_75-78\_\_\_\_g*

*Kcalories \_\_2,700-2,800\_\_*

|  |  |  |
| --- | --- | --- |
| Time | CHO Choice or Grams CHO | Menu Ideas |
| Breakfast | 6 CHO choices | ½ c bran cereal (1 starch)  1 c fat-free milk (1 starch)  1 bagel, 2 oz (2 starch)  2 tsp margarine (2 fat)  1 banana (2 fruit)  coffee |
| Lunch | 6 CHO choices | 1 cup pasta (2 starch) served with ½ cup spaghetti sauce (1 starch, 1 fat)  2 oz meatballs, medium fat  2 Tbs grated parmesan cheese  1 oz garlic bread (1 starch)  1 ½ cup broccoli (1 starch)  17 small grapes (1 starch)  1 cup fat- free milk (1 starch) |
| Snack | 4 CHO choices | 1 fat-free granola bar (2 starch)  2 tbs peanut butter (1 starch)  1 small apple (1 starch) |
| Dinner | 6 CHO choices | 4 oz grilled salmon  2/3 c rice (2 starch)  1 c cooked carrots (1 starch)  ½ cup corn (1 starch)  1 cup mixed green salad  salad dressing with 2 tsp olive oil and wine vinegar  1 c diced cantaloupe (1 starch)  1 cup fat-free milk (1 starch) |
| PM Snack | 4 CHO choices | ½ c low-fat cottage cheese  1 c fruit cocktail (1 starch)  1 small frosted cupcake (1 starch)  3 cup popcorn without added fat (1 starch)  1 cup fat-free milk (1 starch) |

*20. Just before Susan is discharged, her mother asks you, “My friend who owns a health food store told me that Susan should use stevia instead of artificial sweeteners or sugar. What do you think? What will you tell Susan and her mother?*

I would explain to Susan’s mother that this is a common misconception about stevia, artificial sweetener and sugar so this is a great question to ask. Stevia is from the stevia plant also called Reb-A and is several hundred times sweeter than sugar. According to the FDA Reb-A is not one of the six artificial sweeteners, but the FDA has said it is generally recognized as safe to consume (ADA, 2014). In general, most artificial sweeteners such as stevia do not raise blood glucose levels because they are not made of carbohydrates (Mayo Clinic, 2015). In general stevia is a safe product to use, but it would be recommended to use it in small amounts due to its intense sweetness.

Resources

American Diabetes Association (2015). Insulin Pumps. <http://www.diabetes.org/living-with-diabetes/treatment-and-care/medication/insulin/insulin-pumps.html>

American Diabetes Association (2014). Low-Calorie Sweeteners. <http://www.diabetes.org/food-and-fitness/food/what-can-i-eat/understanding-carbohydrates/artificial-sweeteners/>

Drug Bank (2013). Cimetidine. <http://www.drugbank.ca/drugs/DB00501>

Mayo Clinic (2015). Artificial Sweeteners and Other Sugar Substitutes. <http://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/artificial-sweeteners/art-20046936>

Mayo Clinic (2014). Diabetes. <http://www.mayoclinic.org/diseases-conditions/diabetes/in-depth/intensive-insulin-therapy/art-20043866?pg=2>

Medical Dictioinary (2015). Intravenous Infustion. <http://medical-dictionary.thefreedictionary.com/intravenous+infusion>