Adult Type 2 Diabetes Mellitus:  
Transition to Insulin  
A Case Study  

by  
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Understanding the Diagnosis and Pathophysiology

1. **What are the standard diagnostic criteria for T2DM? Which are found in Mitch’s medical record?**

   Standard diagnostic criteria for T2DM is a casual plasma glucose greater than 200mg/dL, a fasting blood glucose level greater than 126mg/dL, or an OGTT, oral glucose tolerance test, blood glucose level not greater than 200mg/dL. Because Mitch hadn’t consumed food and only had sips of water for at least 12-24 hours, he could be considered for the fasting blood glucose (FBG) test. Mitch’s serum glucose levels were at 1524mg/dL upon arrival at the ER, and a week later still above all standard testing levels at 475mg/dL.

2. **Mitch was previously diagnosed with T2DM. He admits that he often does not take his medications. What types of medications are metformin and glyburide? Describe their mechanisms as well as their potential side effects/drug-nutrient interactions.**

   **Metformin** is in the class of Biguanides. It decreases hepatic glucose production and increases insulin uptake in muscles. Its’ advantages include weight gain control, low risk of hypoglycemia, helps to control LDL cholesterol levels, and may have cardiovascular benefits. On the other hand, the disadvantages are transient diarrhea, nausea, bloating, anorexia, flatulence, and lactic acidosis (rare). The advantages are all areas that Mitch could use help in, and the disadvantages are probably what Mitch was referring to when he complained of how the medications were making him feel. A patient needs to report if taking any of the following medications if taking previously or while being prescribed Metformin:

   acetazolamide (Diamox); amiloride (Midamor, in Moduretic); angiotensin-converting enzyme (ACE) inhibitors such as benazepril (Lotensin), captopril (Capoten), enalapril (Vasotec), fosinopril (Monopril), lisinopril (Prinivil, Zestril), moexipril (Univasc), perindopril (Aceon), quinapril (Accupril), ramipril (Altace), and trandolapril (Mavik);
   beta-blockers such as atenolol (Tenormin), labetalol (Normodyne), metoprolol (Lopressor, Toprol XL), nadolol (Corgard), and propranolol (Inderal); calcium channel blockers such as amlodipine (Norvasc), diltiazem (Cardizem, Dilacor, Tiazac, others), felodipine (Plendil), isradipine (DynaCirc), nicardipine (Cardene), nifedipine (Adalat, Procardia), nimodipine (Nimotop), nisoldipine (Sular), and verapamil (Calan, Isoptin, Verelan); cimetidine (Tagamet); digoxin (Lanoxin); diuretics ('water pills'); furosemide (Lasix); hormone replacement therapy; insulin or other medications for diabetes; isoniazid; medications for asthma and colds; medications for mental illness and nausea; medications for thyroid disease; morphine (MS Contin, others); niacin; oral contraceptives ('birth control pills'); oral steroids such as dexamethasone (Decadron, Dexeone), methylprednisolone (Medrol), and prednisone (Deltasone); phenytoin (Dilantin, Phenytek); procainamide (Procanbid); quinidine; quinine; ranitidine (Zantac); topiramate (Topamax); triamterene (Dyazide, Maxzide, others); trimethoprim (Primsol); vancomycin
(Vancocin); or zonisamide (Zonegran). Your doctor may need to change the doses of your medications or monitor you carefully for side effects.

**Glyburide** is a second-generation Sulfonylurea agent. It stimulates insulin secretion. Its advantages are that its inexpensive, has long precedence of effectiveness, and only needing daily dosage. On the other hand, its disadvantages are there is a high risk of hypoglycemia.

The combination of Metformin and Glyburide together are primarily used to treat T2DM in patients whose diabetes can’t be controlled by diet and exercise alone. To avoid side effects and possible negative drug interactions, a patient needs to report to their doctor if on any of the following medications:

- mention angiotensin-converting enzyme (ACE) inhibitors such as benazepril (Lotensin), captopril (Capoten), enalapril (Vasotec), fosinopril (Monopril), lisinopril (Prinivil, Zestril), moexipril (Univasc), perindopril, (Aceon), quinapril (Accupril), ramipril (Altace), and trandolapril (Mavik); anticoagulants ('blood thinners') such as warfarin (Coumadin); aspirin and other nonsteroidal anti-inflammatory medications (NSAIDs) such as ibuprofen (Advil, Motrin) and naproxen (Aleve, Naprosyn); beta blockers such as atenolol (Tenormin), labetalol (Normodyne), metoprolol (Lopressor, Toprol XL), nadolol (Corgard), and propranolol (Inderal); calcium channel blockers such as amlodipine (Norvasc), diltiazem (Cardizem, Dilacor, Tiazac, others), felodipine (Plendil), isradipine (DynaCirc), nicardipine (Cardene), nifedipine (Adalat, Procardia), nimodipine (Nimotop), nisoldipine (Sular), and verapamil (Calan, Isoptin, Verelan); chloramphenicol; clarithromycin (Biaxin); cyclosporine (Neoral, Sandimmune); disopyramide (Norpace); diuretics ('water pills'); fluconazole (Diflucan), fluoxetine (Prozac, Sarafem); hormone replacement therapy and hormonal contraceptives (birth control pills, patches, rings, implants, and injections); insulin or other medications to treat high blood sugar or diabetes; isoniazid (INH); MAO inhibitors such as isocarboxazid (Marplan), phenelzine (Nardil), selegiline (Eldepryl, Emsam, Zelapar), and tranylcypromine (Parnate); medications for asthma and colds; medications for mental illness and nausea; miconazole (Monistat); niacin; oral steroids such as dexamethasone (Decadron, Dexam), methylprednisolone (Medrol), and prednisone (Deltasone); phenytoin (Dilantin); probenecid (Benemid); quinolone and fluoroquinolone antibiotics such as cinoxacin (Cinobac), ciprofloxacin (Cipro), enoxacin (Penetrex), gatifloxacin (Tequin), levofloxacin (Levaquin), lomefloxacin (Maxaquin), moxifloxacin (Avelox), nalidixic acid (NegGram), norfloxacin (Noroxin), ofloxacin (Floxin), sparfloxacin (Zagam), trovafloxacin and alatrofloxacin combination (Trovan); rifampin; salicylate pain relievers such as choline magnesium trisalicylate, choline salicylate (Arthrolan), diflunisal (Dolobid), magnesium salicylate (Doan's, others), and salsalate (Argesic, Disalcid, Salgesic); sulfa antibiotics such as co-trimoxazole (Bactrim, Septra); sulfasalazine (Azulfidine); and thyroid medications

- Alcohol can make the side effects from glyburide worse. Consuming alcohol while taking glyburide also rarely may cause symptoms such as flushing (reddening of the face), headache, nausea, vomiting, chest pain, weakness, blurred vision, mental confusion,
sweating, choking, breathing difficulty, and anxiety.

5. HHS and DKA are the common metabolic complications associated with diabetes. Discuss each of these clinical emergencies. Describe the information in Mitch’s chart that supports the diagnosis of HHS.

Diabetic Ketoacidosis (DKA), is a severe form of hyperglycemia as a direct result of insulin deficiency. Although it primarily affects T1DM patients, it is a risk for T2DM patients as well. Symptoms include nausea and/or vomiting, stomach pain, fruity or acetone breath, Kussmaul respirations, and mental status changes.

Hyperglycemic Hyperosmolar Syndrome (HHS), has many of the same symptoms also caused by severe hyperglycemia, yet HHS can happen over time while DKA will happen rather quickly. The reason for this is that with T2DM individuals, they do have some insulin while T1DM individuals don’t produce any. The difference is that T2DM individuals will not likely have significant ketoacidosis. The precipitating factors for HHS are dehydration and infection.

In both cases, hospitalization is required for rehydration; any needed insulin treatments; for HHS, treatment of underlying problems, and for DKA, an assessment of serum electrolytes. Both DKA and HHS can cause fatality without treatment, yet, because HHS can go on for time without being detected, it is fifteen percent higher in mortality rates.

According to Mitch’s chart, the following are indicators of HHS:

- Serum glucose of 1524mg/dL
- Serum osmolality of 360mmol/kg/H2O
- Patient reporting of not taking meds, indicator of insulin deficiency
- Fever of 100.5, indicator of infection, WBC at 13.5
- Dehydration, dry mucous membranes, patient reporting of only consuming sips of water/no food
- Vomiting, poor skin turgor (result of vomiting)
- High specific gravity in urinalysis
- Mental confusion

9. Describe the insulin therapy that was started for Mitch. What is Lispro? What is Glargine? How likely is it that Mitch will need to continue insulin therapy?

Insulin Lispro is fast acting insulin. It allows more flexibility than regular insulin. Patients who use Lispro have a shorter period of time before meals. It works by replacing normally producing insulin in the body and helping move sugar from the blood into tissues where it will be used for energy. Lispro is injected or applied under the skin fifteen minutes before or after meals.
Insulin glargine is a basal insulin analog that has more consistent activity profile comparing to lispro. Insulin glargine is typically given as a single injection prior to bedtime. It is soluble in acidic pH, after injection, it precipitates in the neutral pH subcutaneous tissues, prolonging its systemic absorption.

11. Outline the basic principles for Mitch’s nutritional therapy to assist in control of his DM?

   Weight management: overweight and obesity are strongly associated with developing of type II diabetes. Mr. Mitch is an obese patient with a BMI of 31. Being obese or overweight disables the body to maintain the proper glucose levels. Moreover, hypertension, dyslipidemia, and CVD are major causes of death in those with diabetes; yet the risks of susceptibility to these chronic illnesses are lowered with weight loss and exercise.

   Carbohydrate: Carbohydrates intake is a strong predictor of glycemic response. Monitoring Mr. Mitch’s carbohydrate intake is crucial – the key is to count carbohydrates and adjust insulin accordingly; lowering the glycemic respond is accomplished by either exchanging the source of carbohydrates or carbohydrates counting. From reviewing Mr. Mitch’s 24-hour food intake, a beneficial modification would be to change to whole-wheat bagels instead of white bagels. Moreover, a low-carbohydrates diet is not suggested because the brain and central nervous system have an absolute need for the glucose found in the carbohydrates.

   Protein & fat: Mr. Mitch should also monitor for his protein and fat intake. His protein level should not increase more than 20%. Higher protein consumption increases the risk factor of getting nephropathy. In addition, total fat intake should not exceed 25%-35% of total Kcal, and saturated fat intake should not exceed 7%. Trans fat intake should be minimal.

   Fiber: fruits, vegetables, whole grain products and fiber-rich cereal are recommended. Foods with high amount of gums, beta-glucan, phsyllium, resistant starches and pectin can lower glucose levels by slowly absorbing glucose in the small intestines. Mr. Mitch’s diet should be high in fibers consisting of lots of fruits and vegetables and whole grains products to help him control his blood sugar and loose weight.

12) Assess Mitch’s weight and BMI. What would be a healthy weight range for Mitch?

   Weight: 97.2 kg   140-189   Height: 175.26cm = 1.752 m

   Healthy BMI range:

   Because Mitch is obese at a 31, we calculate his healthy BMI using the Hamwi equation ± 10%.

   IBW: 72.k2 kg ± 7.2   Low: 65.52 kg; High: 79.9 kg.

   *IBW: 106 lbs ÷ 6 lbs (9”) = 160 lbs / 2.2 = 72.72 kg = 160 lbs. Given his ideal body weight is 160 pounds, 125 pounds which is 25% less than his IBW, may not be a safe or healthy weight for Mitch.
13) Identify and discuss any abnormal laboratory values measured upon his admission. How did they change after hydration and initial treatment of his HHS?

Hyperglycemic Hyperosmolar Syndrome (HHS) is a complication of type II diabetes that involves extremely high blood glucose levels >600mg/dL, serum osmolality > 320 mOsm/kg without the presence of ketoacidosis. Infection and dehydration are precipitating factors of HHS.

Mr. Mitch abnormal values upon admission were as follows:

- Low sodium/losses in urine
- Increase d/t dehydration
  - High BUN
  - High creatinine
  - High glucose
- Low phosphate
- High osmolality

After hydration and initial treatments, his laboratory values improved. Hydration enhanced his blood pressure, BUN and circulation. His new laboratory results show that his osmolality and blood sugar levels have dropped significantly, yet still considered high in comparison to a healthy individual.

14. Determine Mitch’s protein and energy requirements for weight maintenance. What energy and protein intake would you recommend to assist with weight loss?

For obese individuals, we use the Hamwi equation to determine energy needs:

- IBW: 106 lbs + 6 lbs (9") = 160 lbs /2.2 =
  
  \[ IBW = 72.72 \text{ kg} \]
- REE: \[ 66.5 + 13.8 (72.72) + 5 (176.26) - 6.6 (53) \]
  
  \[ = 66.5 + 930.8 + 881.3 + 349.8 = 1,589 \text{ cal.} \]

  \[ \text{REE} = 1,589 \text{ cal.} \times 1.2 – 1.3 = 2,067 \text{ kcal} \]

- PRO intake: 10-20% of calories = 223 - 446 cal = 56 - 111 g PRO (or 0.8 – 1g PRO/kg = 58.73 g PRO)

  \[ \text{TEE: 2,451 – 2,674} \]

Energy and protein intake for weight loss:

Given that Mitch’s energy requirements are determined using the Hamwi equation of IBW for obese individuals, his daily energy intake will be less than his current intake. Recommendations for healthy weight loss are based upon losing 1-2 pounds a week. Since, Mitch will already be at a caloric deficit based upon his IBW, it is recommended that Mitch’s daily energy needs for weight lost be calculated based upon 1 pound a week:

- 1 pound a week lost:
  - 1 lb = 3,500 calories, 2 lb = 7,000 calories as 500 to 1,000 daily caloric deficit.
Adult Type 2 Diabetes Mellitus Case Study: Transition to Insulin

- To lose 1 pound per week:
  - 2,451 to 2,674 cal <500 cal/day> = 1,951 to 2,171 daily caloric recommended intake
  - PRO recommendations: 10 – 20 % = 195 to 217 calories daily = 49 to 54 g PRO daily

(Protein: 10-20% of calories
Nephropathy-reduce to 0.8 g/kg/day)

15. Prioritize two nutrition problems and complete a PES statement for each.

1. HHS (Hyperglycemic Hyperosmolar Syndrome)
   - PES: Hyperglycemic hyperosmolar syndrome related to prolonged dehydration and hyperglycemia as evidenced by plasma serum glucose of > 1524 mg/dl (normal = 600 mg/dl). (However, this is a medical dx and is not applicable to RD dx.)

Diabetes Nutrition Knowledge
   - PES: Diabetes food-nutrition knowledge deficit related to lack of previous nutrition education as evidenced by unregulated carbohydrate intake in infrequent intervals through the day and consumption of high glycemic foods choices during meals.

16. Determine Mitch’s initial CHO prescription using his diet history as well as your assessment of his energy requirements.

Recommended CHO intake is to consistently consume CHO at meals and snacks (3 meals, 2-3 snacks a day) and to include:

Initial CHO Rx:
   - General guidelines for diabetes type to are to consume an average of 45-60g CHO at each meal = 180 - 240 calories CHO
     - Based upon consuming 3 meals and 3 snacks a day, he will have consumed 270 - 360 g CHO.
   - Using Mitches ideal body weight, his daily caloric intake of CHO is 1,190 (1,308 would be too high as it’s greater than 60% estimated needs for weight loss) calories CHO a day = 298 g CHO daily (327 g CHO is too high).

Recommendations for CHO consumption:
   - Consume 3 meals and 2-3 snacks a day as breakfast, lunch and dinner.
   - (1 serving = 15 g CHO, minus fiber if > 5g/serv.); 60-70 for larger individuals. In Mitches case, for weight maintenance.
   - CHO = 50-60% of his daily caloric intake.
17. **Identify two initial nutrition goals to assist with weight loss.**
   1. Stabilize CHO intake and minimize calorie restricting, i.e., distribute CHO evenly through the day to maintain balanced blood sugar glucose levels.
   2. Diabetes education to promote better food choices
   3. Modify fat intake: Saturated fat < 7% of daily consumption
   4. Exercise 30-45 min/day of moderate-intense physical activity 3-5 days a week with no more than two consecutive days without exercise.
      - One exercise modality could include resistance training to increase development of lean muscle mass to reduce muscle wasting as a result of gluconeogenesis.

**References**
