Case Study 3
Adult Type 2 Diabetes Mellitus: Transition to Insulin – Case 17

4/29/2014
Professor Charny – FNES 366
Written by Kimberly Tierney
I. Understanding the Disease and Pathophysiology

1. What are the standard diagnostic criteria for T2DM? Cite the ADA Standards of Medical Care – 2014. Which are found in Mitch’s medical record? (5)

Individuals with type 2 diabetes mellitus (T2DM) do produce insulin, however, they are considered to be either insulin deficient or resistant due to the metabolic defect of tissue resistance of insulin or defective insulin secretion. The result to the metabolic defect is the body’s attempt to supply insulin increases the secretion from the pancreas so that in a higher concentration of insulin, adequate amounts may aid is the transition of glucose to fuel. Extended and increased insulin production eventually causes the pancreas to lose the ability of producing any insulin or enough for the body to perform adequate glucose processing.

The standard diagnostic criteria for T2DM according to the American Diabetes Association (ADA) Standard’s of Medical Care in Diabetes, whereby two of the following criteria, or repeat concordance and similarity of test results in cases such as hyperglycemic crisis to confirm a diagnosis of T2DM:

1. A hemoglobin A1C (A1C) of greater than or equal to 6.5% as certified and standardized testing assay
2. A fasting plasma glucose (FPG) of greater than or equal to 126 mg/dL (7.0 mmol/L) with non-per os (NPO) as an 8 hour fasting prior to testing
3. Two-hour plasma glucose (PG) of greater than or equal to 200 mg/dL (11.1 mmol/L) during an oral glucose tolerance test (OGTT) of 75 g anhydrous glucose in water solution, also known as glucose load.
4. A random plasma glucose of greater than or equal to 200 mg/dL (11.1 mmol/L) in cases whereby hyperglycemia or hyperglycemic crisis symptoms present

As stated in Professor Charny’s lecture, “MNT for Diabetes”, confirmation can also include the criteria of observed symptoms plus a casual glucose of greater than 200 mg/dL for diabetes mellitus (DM). In consonance with the ADA, the FPG or two-hour PG result following an OGTT are usually utilized in diagnosis formed on PG standards while maintaining the A1C as another option.

Risk factors which increase the likelihood of T2DM diagnoses as reported in Krause’s Food & the Nutrition Care Process include a body mass index (BMI) equal to or greater than 25 kg/m², high risk populations as African American, Latino, Native American, and Asian-American, low physical activity. immediate relatives with prior diagnosis of DM, hypertension as equal to or greater than 140/90 mm Hg, biochemical assay status in high-density lipoprotein cholesterol of or less than 35 mg/dL and/or a triglyceride level of greater than 250 mg/dL, and cardiovascular ailments such as cardiovascular disease (CVD).

Mitch’s medical record denote that he was ordered a Stat bedside glucose, or random plasma glucose in hyperglycemic crisis, of 1524 mg/dL on 4/12, as well as a hemoglobin A1c of 15.2%, and a FPG on 4/13 of 475 mg/dL. In comparison with the ADA Standard’s of Medical Care in Diabetes criteria, Mitch’s results indicate a definitively severe elevation in all diagnostics indicating a diagnosis of T2DM as follows:

<table>
<thead>
<tr>
<th>Test</th>
<th>Diagnostic Criteria</th>
<th>Initial on 4/12</th>
<th>Repeat on 4/13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random plasma glucose in hyperglycemic crisis</td>
<td>≥ 200 mg/dL</td>
<td>1524 mg/dL</td>
<td>---</td>
</tr>
<tr>
<td>Hemoglobin A1c</td>
<td>≥ 6.5%</td>
<td>15.2%</td>
<td>---</td>
</tr>
<tr>
<td>FPG</td>
<td>≥ 126 mg/dL</td>
<td>---</td>
<td>475 mg/dL</td>
</tr>
</tbody>
</table>

Mitch is also considered a high risk individual whereby he has a medical history of hypertension (HTN) and hyperlipidemia for which he is taking the medications Lipitor and dyazide, his mother was diagnosed with T2DM, and father was diagnosed hypertension and coronary artery diseases (CAD). The medical records also state his general appearance described as mildly obese with an obese abdominal appearance.

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2. **Mitch was previously diagnosed with T2DM. His admits that he often does not take his medications. For each of his diabetes pills, metformin and glyburide, state the class of medication and mechanism of action; list potential drug side effects (i.e nausea, etc) and drug-nutrient interactions (i.e. foods or nutrients to be added or avoided) for each drug. (6)**

<table>
<thead>
<tr>
<th>Medication</th>
<th>Metformin (aka trade name glucophage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medication class</td>
<td>Biguanides</td>
</tr>
<tr>
<td>Mechanism of action</td>
<td>Maintains and stabilizes blood glucose levels via decreasing glucose produced by the liver as well as increases muscular insulin uptake</td>
</tr>
<tr>
<td>Potential drug side effects</td>
<td>Transient diarrhea, nausea, bloating, anorexia, flatulence, rarely lactic acidosis</td>
</tr>
</tbody>
</table>
| Drug-nutrient interactions | • To decrease risk of gastrointestinal stress, medication should be taken with a meal  
• To decrease the risk of lactic acidosis, patient should avoid alcohol while on medication  
• Medication decreases absorption of folate and vitamin B₁₂ |

<table>
<thead>
<tr>
<th>Medication</th>
<th>Glyburide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medication class</td>
<td>Second generation sulfonylurea agent</td>
</tr>
<tr>
<td>Mechanism of action</td>
<td>Stimulates and promotes insulin secretion; insulin secretagogues</td>
</tr>
<tr>
<td>Potential drug side effects</td>
<td>Hypoglycemia</td>
</tr>
<tr>
<td>Drug-nutrient interactions</td>
<td>• Alcohol should be avoided</td>
</tr>
</tbody>
</table>


3. **Mitch also takes other medications, Dyazide and Lipitor. List their mechanisms, potential side effects and drug-nutrient interactions. He is beginning insulin. For insulin, state type; time of onset, peak, duration; potential side-effect. (5)**

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dyazide (combination of hydrochlorothiazide &amp; triamterene)</th>
</tr>
</thead>
</table>
| Mechanism of action    | • Utilized in treatment of edema and hypertension  
• Hydrochlorothiazide is a thiazide diuretic which prevents surplus absorption of salt which may lead to edema or fluid retention |
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<table>
<thead>
<tr>
<th>Table Title</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triamterene</td>
<td>Triamterene is a diuretic which acts with the same purpose as hydrochlorothiazide in limiting salt absorption, however, it is also potassium-sparing in that the medication maintains levels of potassium to adequacy or preventing of deficiency.</td>
</tr>
</tbody>
</table>

### Potential drug side effects

- Visual impairments and pain, bradycardia, tachycardia, or cardiac arrhythmia, lightheaded, rapid weight gain, decreased or absent urine production, anorexia, fainting, difficulty with memory and concentration, headaches, decrease respiration, weakness, abnormal potassium levels, nausea, vomiting, petechia and abnormal bleeding, jaundice, fever, sore throat, diarrhea, constipation, xerostomia, and skin rash.

### Drug-nutrient interactions

- High dietary salt content should be avoided to prevent water retention and maintain effectiveness of medication.
- Patient may necessitate monitoring of dietary lipid and potassium intakes.
- Potassium supplements, salt substitutes and/or low-sodium milk should be avoided.
- Alcohol should be avoided due to decreasing the patient’s blood pressure, as well as a risk of experience greater medication side effects.

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### Medication

**Lipitor (aka atorvastatin)**

| Mechanism of action | Utilized as statin in cholesterol and lipid lowering via a rate-limiting or reductase inhibiting step in the process of building, or synthesizing, cholesterol at the conversion of 3-hydroxy-3-methylglutaryl-coenzyme A (HMG-CoA) to mevalonate. |

### Potential drug side effects

- Arthralgia, myalgia, lethargy, weakness, muscle pain or tenderness, memory impairment as loss or confusion, headache, GI stress as diarrhea, constipation and flatulence, nausea, anorexia or inappetite, abnormal bleeding or bruising, URQ abdominal pain, jaundice, dark-colored urine, rash, increased respiratory efforts, difficulty swallowing, angina, flu-like symptoms.

### Drug-nutrient interactions

- Avoid grapefruit and similar citrus.
- To avoid increased risk of myopathy, take precaution when concurrently administrated with fibrates, high doses of niacin, and cytochrome P450 3A4 inhibitors, such as clarithromycin, HIV protease inhibitors, and itraconazole.
- May significantly decrease or reduce Coenzyme Q<sub>10</sub>.

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### Insulin type

**Lispro rapid-acting (aka Humulin)**

<table>
<thead>
<tr>
<th>Time of onset</th>
<th>&lt; 15 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak</td>
<td>1 – 2 hours</td>
</tr>
<tr>
<td>Duration</td>
<td>3 – 4 hours</td>
</tr>
</tbody>
</table>

### Potential side-effect

- Due to the initial inclusion of insulin, possible reversible ophthalmic refraction disorder, diabetic retinopathy may progress, and acute peripheral neuropathy may ensue.
- An abnormal condition of adipose tissue at the insulin injection site called lipodystrophy including lipohypertrophy, as thickening tissue, and lipatrophy as thinning tissue; may affect absorption of insulin at repeated injection sites.
- Weight gain due to insulin anabolic effect.
- Peripheral edema due to sodium retention.
- Local and systemic allergic reactions, including anaphylaxis.
- Anxiety, ametropia (blurred vision), confusion, disorientation, difficulty thinking, seizures, cold sweat, fever, chills, tachycardia, irritability, dysuria, tingling in hands, feet, lips, and/or tongue, depression, dizziness, and unconsciousness.
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<table>
<thead>
<tr>
<th>Insulin type</th>
<th>Glargine (aka lantus)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of onset</td>
<td>2 – 4 hours</td>
</tr>
<tr>
<td>Peak</td>
<td>Peakless</td>
</tr>
<tr>
<td>Duration</td>
<td>20 – 24 hours</td>
</tr>
<tr>
<td>Potential side-effect</td>
<td>Seizures, unconsciousness, hypoglycemia observed with increased appetite, weakness, increased respiratory rate, tachycardia, fainting, seizure, diaphoresis, headache, difficulty concentrating, tremors, and irritability</td>
</tr>
</tbody>
</table>


4. Mitch experienced symptoms and subsequent admission to the ER with the diagnosis of uncontrolled T2DM with HHS.  
Describe what led to his severe hyperglycemia.  
State Mitch’s signs and symptoms of dehydration.  
Define HHS, its etiology and symptoms.  
State Mitch’s signs and symptoms of HHS.  

Within the medical records, it is stated that Mitch confirms he has not been controlling his T2DM via prescribed medications which he does not take regularly. He explains that he does not follow and has never learned a diet conducive to diabetics, therefore only refrains from consumption of high-sugar foods. His dietary recall confirms a diet uneducated in glucose regulatory contents, therefore it is likely that the most recently consumed meal prior to onset of hyperglycemic symptoms increased Mitch’s blood glucose (BG) levels above the normal parameters of 70 to 100 mg/dL due to the metabolic disease of T2DM metabolizing the body fuels, including carbohydrates, fats, and proteins in an abnormal process; this possibly achieved a status of hyperglycemia identified as a BG of greater than 250 mg/dL or initiating the development of hyperglycemia.
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The abnormal insulin action attributed to T2DM ensues following consumption of meal, also known as post-prandial, originating with inadequate insulin secretion of pancreatic beta-cells. At the cellular level, the defective cell receptors are then unable to adequately utilize the insulin to take up glucose from the blood to be utilized as fuel because receptor uptake responsiveness is decreased and displaying insulin tissue resistance therefore blood glucose levels cannot be corrected or normalized leading to an increased concentration of glucose remaining in the bloodstream post-prandial. Due to the tissue resistance inhibiting normal insulin actions and glucose is not converted to body fuel, but rather remains in the blood, the liver responds in attempts to compensate and create body fuel by proceeding with glycogenolysis and gluconeogenesis accompanying defective insulin secretory response creating greater excesses of blood glucose. This attempt to compensate and insulin resistance is further compounded with abnormal insulin response whereby alpha-cell glucagon secretion is inadequately suppressed; the glucagon hypersecretion also increases the production of glucose from the liver.

The compensations of increased hepatic glucose production is the ensuing fasting hyperglycemia which further aggravated by Mitch’s emesis within the previous 12 to 24 hours and abstinence from any dietary consumption. The combination of post-prandial glucose and pre-prandial fasting blood glucose will cause hyperglycemia and possible glucotoxicity. To further exacerbate Mitch’s unregulated BG, his coworkers discover that he has not shown up to his morning work shift which may suggest that Mitch has experienced the dawn phenomenon whereby the liver released increased levels of glucose in the morning hours in response to hormones.

Therefore, the aggregation of post-prandial and pre-prandial blood glucose, insulin tissue resistance and secretory defect, hepatic glucose compensation via gluconeogenesis, and the dawn phenomenon combine to exacerbate Mitch’s unregulated blood glucose concentrations resulting in severe hyperglycemia.

Mitch’s medical records denote that he has displayed signs and symptoms of dehydration as dry mucous membranes, pale skin, diaphoresis and possible hyperhidrosis, decreased fluid or urine output describing dark colored urine, inability to retain dietary consumption without feeling of nausea, emesis, lethargy and changes in consciousness and mental state, hypotension as a blood pressure decrease as 90/70 mmHg which increasingly progressed to 129/92 mmHg, tachycardia as 105 bpm which progressively normalized to eucardia as 83 bpm. His laboratory results display elevated BUN and creatinine above normal limits, and the electrolytes within the chemistry panel regarding serum sodium and potassium as hyponatremia resulting from sodium loss due to emesis, loss of body fluids, and possibly initial polyuria, as well as decreasing serum levels of potassium approaching hypokalemia, and within the urinalysis an increased specific gravity above normal limits.

Hyperglycemic Hyperosmolar State (HHS) is a metabolic complication associated with diabetes, often with T2DM, in combination of hyperglycemia and dehydration which manifests with signs and symptoms of elevated blood glucose ranging from 400 to 2800 mg/dL, averaging 1000 mg/dL, the absence of ketones or significant ketoacidosis due to prevention of lipolysis via limited production of insulin in T2DM, altered mental status which may include coma and hallucinations, and considerable dehydration status as a serum osmolality of greater than 320 mOsm/kg of water. Other symptoms observed with HHS include seizures or convulsions, fever higher than 100.4 °F, initial polyuria at onset of HHS, lethargy, nausea, weakness, weight loss, altered motility and muscle function, tachycardia, and low systolic blood pressure.

The etiology of HHS with extremely high BG levels, extreme dehydration, decreased consciousness, and possible occurrence of mild ketoacidosis is due to dehydration, kidneys are unable to filter out or excrete glucose via urination to maintain normal blood glucose levels, thereby resulting in an accumulation of extremely high glucose levels in the blood. Due to the extremely high blood glucose concentrations, the blood then becomes hyperosmolar, or containing a high concentration of substance such as sodium or glucose and leading to an increased movement of water into the blood. The water which is drawn into the bloodstream is drawn from the body’s muscles and organs leading to dehydration. The precipitating factors of HHS are infection and dehydration. Hydration is utilized to treat dehydration and insulin is utilized to normalizing BG and correct hyperglycemia.

Mitch’s serum osmolality remains elevated above the normal parameters of 285 to 295 mmol/kg/H₂O is 360 mmol/kg/H₂O on 4/12 and 304 mmol/kg/H₂O on 4/13, however HHS is determined by a serum osmolality of greater than 320 mOsm/kg of water as per Nutrition Therapy and Pathophysiology Mitch displays signs of dehydration as stated above, and a severe status of hyperglycemia at 1524 mg/dL stat bedside BG whereby hyperglycemia is identified as a BG of greater than 250 mg/dL.
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5. **HHS and DKA are metabolic complications associated with diabetes. Define DKA, its precipitating factors and signs /symptoms. What characteristics of Mitch’s condition indicate HHS as opposed to DKA?**

Diabetic ketoacidosis (DKA) is a complication of diabetes individual in which the condition occurs due to an improper, deficient, lack, or inadequate utilization of insulin causing an inability of glucose utilization as the fuel source for the body; the body’s fuel source then resorts to the breakdown of fat to provide a fuel source, however, in the breakdown of fat, ketone bodies are produced accumulating within the blood and urine. An accumulation of high ketone levels, or ketoacidosis, may be life-threatening. In type 2 diabetes mellitus, unregulated or uncontrolled blood glucose, as well as an illness, can lead to ketoacidosis.

DKA presents with signs and symptoms as a blood glucose of greater than 250 mg/dL, positive glucose and ketones within the urinalysis, acetone breath which is sometimes described as sweet or fruity, kussmaul respirations, and dehydration. Signs and symptoms can be observed as dyspneic breathing, xerostomia, dry skin, decreased alertness, flushed skin, initial polyuria at onset of condition, nausea, vomiting, stomach pain, and arthralgia.

Although Mitch’s urinalysis denotes positive presence of ketones and glucose in his urine, HHS can display with mild ketosis as well. The characteristics which indicate an opposition to the condition of DKA are the absence of symptoms such as dyspneic or kussmaul respirations, abdominal pain, arthralgia, and acetone breath. The signs and symptoms indicative of HHS include severe hyperglycemia, decreased blood pressure, significant dehydration observed in serum osmolality, altered mental status as drowsy and confused, fever higher than 100.4 °F, lethargy, nausea, tachycardia, and low systolic blood pressure. The serum osmolality recorded as greater than 320 mOsm/kg and severity of the hyperglycemia as greater than 600 mg/dL strongly indicated HHS as opposed to DKA which includes plasma BG of greater than 250 mg/dL and variable serum osmolality.


6. **Mitch was started on normal saline with potassium as well as an insulin drip. Why are these fluids a component of his rehydration and correction of the HHS?**

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The characteristics of HHS include severe hyperglycemia and dehydration, therefore a correction of BG and hydration status will resolve the HHS. These fluid components are important components in the correction of the HHS because saline contains sodium to correct the hyponatremia and dehydration, potassium will prevent further decrease and approach towards hyperkalemia as well as aid in rehydration, and intravenous insulin will correct blood glucose regulation slowing the excesses hepatic production in correlation with fasting and NPO orders. The correction of dehydration will aid in normalizing blood pressure, cardiac rate, BUN, creatinine, and urinary outputs.


7. Describe the insulin therapy that was started for Mitch. When would a patient be started on insulin, based on the recommendations of the ADA? How likely is it that Mitch will need to continue insulin therapy? (3)

The insulin therapy orders which were started for Mitch began following rehydration via 1 liter stat bolus of saline. Regular insulin was provided through an intravenous drip at 1 unit/kg/h along with continuous infused rate of 500 mL/hr saline with potassium-chloride additive for the duration of 3 hours. The fluid rate, insulin and potassium concentrations were then decreased, and a gradually increasing infusion of insulin was provided. The doctor’s plans were noted to eventually change the rehydration fluids to saline containing 5% dextrose and introduce rapid-acting Lispro insulin at 2 hour increments progressing to an ICR 1:15 in combination with initiating glargine insulin while monitoring BG within the parameters of 80 to 200 mg/dL.

Based on the recommendations of the ADA, a patient should be started on insulin with T2DM if a patient’s A1C does maintain within normal limits for 3 months through mono-mediated oral therapy at upper-limits of dosage, followed by a secondary oral medication failure to regulate; it is at this point in which discussions of glucose regulation via insulin therapy should be discussed with the inclusion of patient’s preference and considering cost, self-monitoring and hypoglycemia, possible side-effects and weight gain, comorbidity, safety, and effectiveness in prevention of cardiovascular events. Eventual failure of the liver to produce and secrete insulin to sustain normal BG status in addition to oral medications will occur in the progression of T2DM will decidedly include the need for Mitch to continue insulin therapy, however the duration in which Mitch can regulate and prevent the absolute inclusion of insulin depends upon therapeutic lifestyle changes such as diet, exercise and weight loss, progression of the diabetes, and self-monitoring of blood glucose.


II. Nutrition Assessment

8. Assess Mitch’s desirable body weight and BMI. What would be a healthy weight range for Mitch? (3)

53 yo M T2DM, 5’ 9”, 214#

Calculations of patient’s BMI:

Actual/current weight = 214 lbs
Height = 5 ft., 9 in. = 69 in.

\[ \text{BMI} = \left( \frac{\text{weight (lb)}}{\text{height (in)}^2} \right) \times 703 \]

\[ \text{BMI} = \left( \frac{249 \text{ lb}}{(69 \text{ in})^2} \right) \times 703 \]

\[ \text{BMI} = 36.77 \% = \text{grade II, class II obesity weight between 35.0 and 39.9\%} \]

Calculations of patient’s desirable body weight (DBW) utilizing Hamwi:
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Males: 106# for 5’ + 6# for each inch > 60”

$$DBW = 106# + (6# \times 9") = 160#$$

**DBW range:** 160 +/- 10% = 144# to 176#

Calculations of patient’s desirable body weight percent (DBW%);

$$\%DBW = (ABW / DBW) \times 100$$

$$\%DBW = (214# / 160#) \times 100 = 133.75\%; > 120\% IBW indicates possible nutritional risk$$

A healthy weight range for Mitch would be between 144 and 176 pounds within the desirable body weight range.


9. **For each lab value, state its abnormal value upon admission and what the value means / indicates.**

   **How did glucose, sodium, phosphate and osmolality change - state the changed value and why it changed.** *(16)*

Initial lab values:

- **Glucose:** ↑ 1524 mg/dL  
  Reference Range: 70-110 mg/dL  
  Indication / meaning: patient displays severe hyperglycemia in combination with dehydration indicating HHS and unregulated blood glucose with T2DM

- **Creatinine:** ↑ 1.9 mg/dL  
  Reference Range: 0.6-1.2 mg/dL  
  Indication / meaning: indicates poor kidney function in response to dehydration

- **Sodium:** ↓ 132 mEq/L  
  Reference Range: 136-145 mEq/L  
  Indication / meaning: decreased sodium and potassium electrolytes indicate poor cellular uptake and losses through excretory voids; electrolytes can change in response to physiological changes such as hormonal response, acid-base balance, organ function, and osmolality in hydration status; indicates patient is dehydrated, possibly from fluid losses in voids

- **Phosphate:** ↓ 1.8 mg/dL  
  Reference Range: 2.3-4.7 mg/dL  
  Indication / meaning: may indicate poor renal function due to dehydration and absence of urination, prescription medications can affect phosphate levels if there is binding,

- **Cholesterol:** ↑ 205 mg/dL  
  Reference Range: 120-199 mg/dL  
  Indication / meaning: can be used as a fasting test to determine if fat is being broken down and cholesterol released from cholesterol esters; patient’s status may indicate a borderline risk for CVD

- **HbA1c:** ↑ 15.2%  
  Reference Range: 3.9-5.2%  
  Indication / meaning: a record or assessment of chronic diabetic control for prior 3 months as mean glycemic blood status; patient’s level indicates severely poor DM regulation and HHS

- **C-peptide:** WNL 1.10 ng/mL
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Reference Range: 0.51-2.72 ng/mL
Indication / meaning: may indicate that in newly diagnosed DM, production of insulin remains

- Osmolality: ↑ 360 mmol/kg/H2O
  Reference Range: 285-295 mmol/kg/H2O
  Indication / meaning: indicates hydration status and solute load, elevated levels in presence of dehydration show patient’s displaying severely concentrated solutes, status increases with dehydration, diabetic coma, and DKA

- Specific gravity: ↑ 1.045
  Reference Range: 1.003-1.030
  Indication / meaning: indicates hydration status and electrolyte and particle concentration in urine, patient’s value displays dehydration, higher concentrations can be observed with darker urine color

- BUN: ↑ 31 mg/dL
  Reference Range: 8-18 mg/dL
  Indication / meaning: elevated BUN indicated poor or damaged kidney function in events of stress, protein catabolism, and dehydration

- Glucose in urine: ↑ +
  Reference Range: Negative
  Indication / meaning: glucosuria due to exceeding high concentration of glucose within the blood during hyperglycemia and unregulated DM, indicates kidney is filtering excess glucose

- Protein in urine: ↑ +
  Reference Range: Negative
  Indication / meaning: indicates positive albumin presence in urine or proteinuria, indicates kidney dysfunction, possibly due to dehydration and filtration

Changed values:
- Glucose: ↑ 475 mg/dL
  Previous Value: ↑ 1524 mg/dL
  Reason for change: patient is receiving rapid-acting insulin to correct hyperglycemia indicated with severely high pervious value of glucose, as well as fluids to correct hydration; in conjunction, hydration and glucose normalization indicates relief of HHS

- Osmolality: ↑ 304 mmol/kg/H2O
  Previous Value: ↑ 360 mmol/kg/H2O
  Reason for change: decreased value indicates correction with intravenous fluid therapy and normalization of hydration status from severe dehydration leading to HHS

- Sodium: ↓ 134 mEq/L
  Previous Value: ↓ 132 mEq/L
  Reason for change: patient receiving saline intravenous fluids which contain sodium, hydration status maintaining

- Phosphate: ↓ 2.1 mg/dL
  Previous Value: ↓ 1.8 mg/dL
  Reason for change: improved hydration status following rehydration via intravenous fluids, also indicates improved kidney function

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10. **Determine Mitch’s energy requirements for weight maintenance using Mifflin St. Jeor equation.**  
Determine Mitch’s protein requirements.  
What daily energy intake would you recommend for an appropriate rate of weight loss? Justify your recommendation. (3)

53 yo M T2DM, 5’ 9”, 214#

Estimated Energy Requirements (EER) utilizing Mifflin-St. Jeor Equations for adult males:

Mifflin-St. Jeor Equation: kcal/day = 10 (wt) + 6.25 (ht) – 5 (age) + 5

Weight = actual body weight in kilograms  
Height = centimeters  
Age = years  
Patient’s values:  
Weight = 214 lbs / 2.2 kg = 97.27 kg  
Height = 69 inches = 175.26 centimeters  
Age = 53 years  
Kcal/day = 10 (97.27 kg) + 6.25 (175.26 cm) – 5 (53 yoa) + 5  
EER of Mifflin-St. Jeor = 1808.08 kcal/day

Including a range of PAL of 1.0 – 1.39 of a sedentary lifestyle and possible benefits of weight loss, the EER range will be:

EER = 1808.08 kcal/day x 1.39 = 2513.23 kcal/day

**Mitch’s energy requirements range: 1808.08 kcal/day - 2513.23 kcal/day**

Patient’s with T2DM have an increased risk of nephropathy and should not exceed 20% of total daily energy intake in protein, therefore the patient’s protein requirements should be equal to or less than 0.8 g/kg or about 10% kcal/day.

Protein: ≥0.8 g/kg/d  
(0.8 g/kg/d) x (97.27 kg) = 77.82 g/d

**Mitch’s protein requirements: ≥ 77.82 g/d**

For patients with T2DM, slow and gradual weight loss will provide the safest and long-term outcome in combination with following dietary guidelines, understanding the glycemic actions of foods, and including a consistent exercise regimen. Mitch should maintain total daily energy intake close to the lower value of his energy requirements of about 1800 to 2000 kcal/day; the exclusion of 500 kcal/day will total 3500 kcal per week, or the equivalence of one pound per week, while maintaining adequate energy to sustain optimal health concurrent with T2DM treatments. Weight loss should be monitored regularly, as well as BG during exercise to prevent hypoglycemic or hyperglycemic events.


III. Understanding the Nutrition Therapy

11. Mitch was NPO when admitted to the hospital. Why? What does this mean? When will Mitch be ready to eat? What foods would be recommended immediately following NPO, before initiating a diet for diabetes? (4)

Mitch was ordered NPO, meaning non per os or nothing administered through oral intake, due to emesis preceding admit of 12 to 24 hours, accompanied by unregulated blood glucose following a diagnosis of T2DM and severe hyperglycemia and dehydration with a current diagnosis of HHS. Mitch will be ordered to abstain from foods and drinks to normalize his blood glucose and hydration status without the addition of glucose from oral consumption affecting his glycemic response so that the insulin and dextrose administered through intravenous fluids, followed by the introduction of lispro and glargine, can produce effective glucose regulation to a homeostatic point. Mitch will be ready for a slow and gradual re-introduction to food, and removal of the NPO order, once his BG has been normalized and monitoring of BG test results display repeated consistency within normal limits. Initial recommendations for oral consumption following NPO before initiation a diabetes diet would be as ordered in the medical records including clear liquids then advanced to a consistent carbohydrate diet prior to meeting for consultation with a dietitian; it should also be recommended to include foods which will not agitate or cause gastrointestinal stresses following the lack of gastric movements with NPO orders and emesis.


12. Mitch was prescribed and initial ICR 1:15. Explain what this means. Outline the general principles for nutrition therapy, to assist in control of DM, for: meals and snacks, carbohydrate, sugar substitutes, fats and weight reduction. Cite the ADA’s Clinical Practice Recommendations for Medical Nutrition Therapy – 2014. (5)

An ICR 1:15 is the ratio of insulin to carbohydrate consumption as part of carbohydrate counting; this means 1 unit of fast-acting insulin is needed to meet the target range of glucose goals for each 15 grams on consistent carbohydrate consumption at meals.

Slow and gradual weight reduction, management and maintenance include permanent changes to dietary behavior and choices via regular consistent meals at consistent times containing lower fat food types, and the inclusion of regular and maintain physical activity. As per the ADA Standards of Medical Care in Diabetes - 2014, “macronutrient distribution should be based on individualized assessment of current eating patterns, preferences, and metabolic goals and a variety of eating patterns are acceptable” which should incorporate the patient’s metabolic goals as well as their personal preference. Regarding carbohydrates, the patient should be educated in portioning and identifying what portions encompass, initial weighing of dietary content may aid in learning portion sizes, followed by carbohydrate counting whereby each portion contains 15 grams of carbohydrate, how to understand and apply the exchange list, glycemic index, glycemic load, and glycemic responses to foods, and discourages low-carbohydrate diet but educates as to more beneficial selections of carbohydrates. Sugar substitutes, or otherwise known as sweeteners, may encourage greater intake of unhealthy food under the illusion of calorie reduction, however this may reduce the selection of healthier alternatives, and sucrose should be substituted with an alternative carbohydrate or incorporated in consideration of glucose-lowering medications and/or insulin administration. Dietary fat recommendations include total fat parameters within 25 to 35% of total daily energy intake with less than 7% as saturated fat, avoidance or limiting trans fat, and the inclusion of 2 to 3 grams per day of plant sterol and stanol esters, as well as omega-3 PUFA.


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IV. Nutrition Diagnosis

13. Write 2 priority nutrition diagnoses, each in PES format. (6)

1) Inadequate fluid intake related to T2DM and HHS as evidenced by previous diagnosis of T2DM, current diagnosis of HHS, diaphoresis, usual dietary recall, fluid intake and output, and laboratory results of sodium, potassium, BUN, creatinine. NI – 3.1

2) Self-monitoring deficit related to undesirable food choices and consistency of medication as evidenced by patient’s confirmation of irregular medication administration, severe hyperglycemia, usual dietary recall, obesity, predicted excessive energy intake, and diagnosis of HHS. NB – 1.4


V. Nutrition Intervention

14. Determine Mitch’s initial CHO prescription using his diet history as well as your assessment of his energy requirements for weight loss: State daily kcal intake, percent kcal from CHO, g CHO, number of CHO choices per day; Suggest the number of CHO choices you would recommend for 3 meals and 2 snacks based on his diet history. (5)

Daily kcal intake range: 1800 – 2000 kcal/d as estimated energy requirement (EER) for weight loss

Step 1: Percent kcal from CHO range: (1800 kcal/d to 2000 kcal/d) x 55% CHO = 990 kcal/d to 1100 kcal/d from CHO

Step 2: (990 kcal/d to 1100 kcal/d from CHO)/ 4 kcal/g = 248 g to 275 g of CHO

Step 3: Number range of CHO choices per day: (248 g to 275 g of CHO) / 15 g per choice = 17 to 18 choices of CHO per 24-hour period

Recommended number of CHO choices based on 18 CHO choices for Mitch’s diet history:
AM Snack: 2 CHO choices due to dawn phenomenon
Midmorning meal: 3 CHO choices
Lunch meal: 5 CHO choices
Midafternoon or after dinner snack: 3 CHO choices
Dinner meal: 5 CHO choices to decrease FPG


15. Identify two initial nutrition goals to assist with weight-loss. (4)

1) Goal setting regarding general healthful diet inclusion, achieving modifications of amounts of food, type, and total daily intake, self-regulation of dietary content to promote weight control, inclusion of physical activities, and target weight loss via gradual reduction in energy intake, smaller more frequent meals, and energy expenditure. C – 2.2

2) Self-monitoring as regarding therapeutic lifestyle changes through modification of eating behavior, physical activity level, desirable food choices, gradual weight loss, total daily energy intake to ensure gradual, maintained
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weight loss, improve overall health, prevent relapse of HHS, and regulate and improve BG, HTN, and hyperlipidemia. C – 2.3


16. Mitch also has hypertension and high cholesterol levels. State the recommendations for the lipid profile, LDL, HDL, Cholesterol and Triglycerides for people with diabetes. (4)

Describe nutrition recommendations for fiber, types of fat and sodium for Mitch and why.

A desirable lipid profile is a cholesterol of < 200 mg/dL, HDL-cholesterol of > 40 mg/dL, an LDL of < 130 mg/dL, and triglycerides of < 150 mg/dL. To maintain an optimal lipid profile it is recommended to limit simple and added sugars to regulate triglycerides, reduce intake of dietary content which contains high fat, saturated fat, and cholesterol which will negatively affect lipoproteins reflecting high LDL and low HDL, and reduce fat intake via animal sources which reflects negatively in cholesterol. All lipid indices will benefit from increased physical activity and exercise and triglycerides will positively reflect healthier selections of carbohydrates, such as complex carbohydrate items.

Recommendations of fiber for individuals with T2DM are the same as general public recommendations of 14 grams fiber per 1000 kcal dietary consumption as a variety of foods with less than or equal to 5 grams per serving, however research results are mixed and foods which a noted to have the greatest benefit towards serum glucose are selections containing high amounts of gums, beta-glucans, psyllium, resistant starches, and pectin. Beneficial fiber-containing selections aid in the regulation of blood glucose by slowing the absorption via the small intestine.

Nutritional fat recommendations follow recommendations of individuals which have cardiovascular disease or conditions include limiting of avoiding or limiting trans fat, and consuming no more than 25 to 35 percent of total daily energy as fat with saturated fats limited to less than 7%; however, the DASH diet recommends that total fat percentage includes 27% of total calories limiting saturated fat to 6% total calories. According to the DASH Goals for Hypertension, sodium should not exceed either 1.5 grams per day.


VI. Nutrition Monitoring and Evaluation

17. Write an ADIME/SOAP note for your initial nutrition assessment.
**A - Assessment**

**S - Subjective**

**Chief Complaint:** “I had a lot of vomiting that I thought at first was food poisoning but I just kept getting worse.” When questioned about medications, patient admits that he has not taken medications for the diabetes regularly—“I hate how they make me feel but I almost always take my other medications for blood pressure and cholesterol.”

<table>
<thead>
<tr>
<th>UBW: NA</th>
<th>Nutritional supplement: none</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight change: gain / loss; NA</td>
<td>Vitamins / herbs: none</td>
</tr>
<tr>
<td>Appetite: normal prior to symptom onset; has not eaten previous 12-24 hours, had sips of water</td>
<td>Food preparation: Cooks sometimes at home, often meets with friends for dinner at restaurants</td>
</tr>
<tr>
<td>Chewing / swallowing problem / sore mouth</td>
<td>Factors affecting food intake: 12-24 hours emesis, +/- HTN, +/- hyperlipidemia</td>
</tr>
<tr>
<td><strong>Nausea / vomiting / diarrhea / constipation:</strong> vomiting ~12-24 hours</td>
<td>Social / cultural / religious / financial: single; 16 years education; retired military – works 8-5 daily; lives alone, religion NA</td>
</tr>
<tr>
<td>Food intolerance / allergies: NA</td>
<td>Other: Tobacco use: 1 ppd x 20 years—now quit</td>
</tr>
<tr>
<td>Diet prior to admit: normal, does not add salt, tries to avoid high-cholesterol foods, stays away from high-sugar desserts, likes to try ethnic foods</td>
<td>Alcohol use: 3–4 drinks per week</td>
</tr>
<tr>
<td></td>
<td>Occupation: retired military; consultant to military equipment company</td>
</tr>
</tbody>
</table>

**O - Objective**

- **Current Diet Order:** NPO except for ice chips and medications. After 12 hours, clear liquids if stable. Then, advance to consistent-carbohydrate diet. Consult dietitian for advancement, total carbohydrate Rx, and distribution

<table>
<thead>
<tr>
<th>Medical Diagnosis: Type 2 DM uncontrolled with HHS</th>
<th>Pertinent Medical History: Type 2 DM x 1 year; HTN; hyperlipidemia; gout</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>prescribed glyburide and metformin but admits that he has not taken the medications regularly; regularly takes blood pressure &amp; cholesterol medication</td>
</tr>
<tr>
<td></td>
<td>Family history: Father—HTN, CAD; mother—type 2 DM</td>
</tr>
</tbody>
</table>

**Nutrition Focused Physical Signs & Symptoms:** admitted with acute hyperglycemia

- Admitting 4/12: BP: 90/70 mm Hg, Temp: 100.5; Pulse: 105 bpm; Throat: Dry mucous membranes; Neurologic: Alert but previously drowsy with mild confusion; Skin: Warm and dry; poor turgor; Chest/lungs: Respirations are rapid; Skin temp: DI


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<table>
<thead>
<tr>
<th>% UBW: NA</th>
<th>% wt Δ: NA</th>
<th>% DBW: 133.75%</th>
<th>Other:</th>
</tr>
</thead>
</table>

Nutritionally Relevant Laboratory Data:

Initial lab values: Glucose: ↑ 1524 mg/dL; Creatinine: ↑ 1.9 mg/dL; Sodium: ↓ 132 mEq/L; Phosphate: ↓ 1.8 mg/dL; Cholesterol: ↑ 205 mg/dL; HbA1c: ↑ 15.2%; C-peptide: WNL 1.10 ng/mL; Osmolality: ↑ 360 mmol/kg/H2O; Specific gravity: ↑ 1.045; BUN: ↑ 31 mg/dL; Glucose in urine: ↑ +; Protein in urine: ↑ +

Changed values: Glucose: ↑ 475 mg/dL; Osmolality: ↑ 304 mmol/kg/H2O; Sodium: ↓ 134 mEq/L; Phosphate: ↓ 2.1 mg/dL

Drug Nutrient Interaction: Glyburide 20 mg PO SID; 500 mg metformin PO BID; Dyazide PO SID (25 mg hydrochlorothiazide & 37.5 mg triamterene); Lipitor 20 mg PO SID

Dyazide interactions: Avoid high dietary salt, possible monitoring of dietary lipid & potassium, avoid potassium supplements, salt substitutes, alcohol and/or low-sodium milk

Lipitor interactions: Avoid grapefruit & similar citrus, precaution with fibrates, high doses of niacin, and cytochrome P450 3A4 inhibitors (clarithromycin, HIV protease inhibitors, itraconazole), possible reduction in Coenzyme Q10

In hospital; Lispro using ICR 1:15, glargine 19 u

Estimated Energy Need:

\[
\text{Estimated Energy Need: } 1808.08 - 2513.23 \text{ kcal / day}
\]

Based on: 18 – 26 kcal/kg/d

Estimated Protein Need:

\[
\text{Estimated Protein Need: } \geq 77.82 \text{ g/day}
\]

Based on: \( \geq 0.8 \text{ g/kg/d in prevention of nephropathy} \)

Estimated Fluid Need:

\[
\text{Estimated Fluid Need: } 2000 – 2500 \text{ mL after rehydration ml / day}
\]

Based on: 20 – 26 mL/kg/d per orders

Nutrition Diagnosis (D)

A - Assessment (A)

State no more than 2 priority Nutrition Diagnosis statements in PES Format. Use Nutrition Diagnosis Terminology sheet

ND Term (Problem) related to (Etiology) as evidenced by (Signs and Symptoms):

1. Inadequate fluid intake related to T2DM and HHS as evidenced by previous diagnosis of T2DM, current diagnosis of HHS, diaphoresis, usual dietary recall, fluid intake and output, and laboratory results of sodium, potassium, BUN, creatinine. NI – 3.1

2. Self-monitoring deficit related to undesirable food choices and consistency of medication as evidenced by patient’s confirmation of irregular medication administration, severe hyperglycemia, usual dietary recall, obesity, predicted excessive energy intake, and diagnosis of HHS. NB – 1.4

Nutrition Intervention (I)

P - Plan

List Nutrition Interventions. Use Nutrition Intervention Terminology sheet. (The intervention(s) must address the problems (diagnoses).

Implemented interventions with general and healthful diet, modify distribution, type and amount of food within meals at specified times, goal-setting, self-monitoring, and relapse prevention. (ND-1.1, ND-1.2, C-2.2, C-2.3, C-2.9)

Goal(s):

1) Goal setting regarding general healthful diet inclusion, achieving modifications of amounts of food, type, and total daily intake, self-regulation of dietary content to promote weight control, inclusion of physical activities, and target weight loss via gradual reduction in energy intake, smaller more frequent meals, and energy expenditure. C – 2.2

2) Self-monitoring as regarding therapeutic lifestyle changes through modification of eating behavior, physical activity level, desirable food choices, gradual weight loss, total daily energy intake to ensure gradual, maintained weight loss, improve overall health, prevent relapse of HHS, and regulate and improve BG, HTN, and hyperlipidemia. C – 2.3

Plan for Monitoring and Evaluation (M E)

List indicators for monitoring and evaluation. Use Nutrition Assessment and Monitoring & Evaluation sheets. (Upon follow-up, the plan for
monitoring would indicate if interventions are addressing the problems).

Monitoring and evaluation for adequacy and effectiveness upon follow-up will be by observation and recording of the patient’s total energy intake, amount of food, types of foods/meals, meal/snack pattern, total carbohydrate, glycemic index and load, insulin-to-carbohydrate ratio, self-monitoring at agreed upon rate, BMI, and glucose profile. (FH-1.1.1.1, FH-1.2.2.1, FH-1.2.2.2, FH-1.2.2.3, FH-1.5.3.1, FH-1.5.3.3, FH-1.5.3.4, FH-1.5.3.7, FH-5.1.4, AD-1.1.5, BD-1.5)


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