Advances in Diabetes Management

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What is Diabetes?
Diabetes affects the ability of our body to convert the food we eat into energy. A condition of altered fuel metabolism.

Body organs involved
- Liver, muscle, fat need insulin to absorb glucose into the cell
- Liver and muscle store glucose into glycogen
- Fat stores glucose into triglycerides
- Brain, nerve, RBC need glucose continuously as they cannot store it and insulin is not needed for glucose to enter these cells

Primary Hormones Secreted Necessary to Keep Glucose in Balance
- **Insulin**: Beta cells in pancreas, decrease BG by increasing the uptake of glucose into cells and inhibits liver glucose output
- **Glucagon**: Alpha cells in pancreas, increases BG by promoting glucose release from the liver
- **Amylin**: Beta cells in pancreas, co-secreted with insulin, decreases glucose by slowing gastric emptying, suppressing glucose secretion and regulating appetite
- **Incretins**: Primarily GLP-1. Secreted in the gut to inhibit post meal glucagon, slow gastric emptying, decrease food consumption and stimulate release of insulin from the beta cell

Normal Physiology Non-fed State
- The liver is responsible to keep glucose stable with the help of glucagon.
- Glucagon enables the liver to convert glycogen to glucose (glycogenolysis)
- As the liver puts glucose into the circulation, the pancreas releases insulin so the liver, muscle and fat can use glucose

Normal Physiology Fed State
- Glucose from our food is used or saved
- Proteins, fats, carbohydrates all important
- Primary source of glucose is carbohydrate
- After our food is broken down in the GI tract, it is absorbed into the portal circulation
- 30-40 mg/dl rise 15 min. after eating due to incretin hormones sending signals to pancreas, liver, brain
Normal Physiology

Fed state continued:
- **1st phase insulin release** from incretin hormones and amylin (co-secreted with insulin) prevents too high of BG after the meal
- Insulin acts on the liver to store some glucose as glycogen (glycogenesis) and stops releasing glucose into the blood until blood levels are back to normal
- **2nd phase insulin release** less dramatic, up to 2 hours after meal, returning BG to normal

Counterregulatory Hormones

- Epinephrine, cortisol, growth hormones have an indirect effect on glucose metabolism
- Work against insulin and increase glycogenesis and decrease cell uptake of glucose
- Operate in stress situations, the normal pancreas increases insulin production

Types of Diabetes

- **Type 1 diabetes**: Autoimmune disease resulting in pancreatic beta cell destruction, usually leads to complete insulin deficiency. Insulin required to live. Usually starts in children and younger adults, about 10% of all diabetes.
- **Type 2 diabetes**: The muscle cells are unable to use insulin efficiently (insulin resistance). The pancreas is unable to produce enough insulin (insulin deficiency). The liver releases too much glucose from storage. Deficient in GLP-1 hormone. About 90% of all diabetes, usually adults, but appearing more in children. Can be related to obesity and inactivity.
- **Gestational diabetes (GDM)**: occurs during pregnancy and usually disappears when the baby is born.

Pre-Diabetes

**Diagnosis:**
- Fasting plasma glucose is 100 – 125 mg/dl (impaired fasting glucose) **or**
- The 2 hour plasma glucose following a 75 g. oral glucose tolerance test (OGTT) is 140 – 199 mg/dl (impaired glucose tolerance) **or**
- Hemoglobin A1c of 5.7%-6.4% - ADA 2010

Recent study, the Diabetes Prevention Program showed that weight loss and exercise helped most people delay or prevent diabetes.

Being diagnosed with pre-diabetes increases the risk for heart attack and stroke by 50 percent.
Diagnostic Criteria for Diabetes

- Fasting plasma glucose 126 mg/dl or greater \( \times 2 \)
- 2 hour plasma glucose \( \geq 200 \) following 75 gram glucose load
- Random plasma glucose 200 mg/dl \( \times 2 \) or once if accompanied by symptoms of diabetes
- Hemoglobin A1c \( \geq 6.5\% \)

(ADA, 2010)

Additional Laboratory Tests

- C-peptide
  - Co-secreted with insulin
  - Measured to determine insulin production
  - Glucose needs to be between 150-250 mg/dl for an accurate result
- Islet cell antibodies
  - GAD-65 – glutamic acid decarboxylase
  - Insulin antibodies

Risk Factors for Type 2 DM

- Family history of type 2 diabetes
- Overweight/obesity
- Sedentary lifestyle
- Hyperlipidemia
- Hypertension
- Previously diagnosed gestational diabetes

Signs and Symptoms of Diabetes (Hyperglycemia) include:

- Frequent urination
- Unusual thirst (especially at night)
- Fatigue
- Sudden weight loss
- Blurred vision
- Slow healing of infections and wounds

Progression of Type 2 Diabetes

- Hypoglycemia: low blood glucose
- DKA: diabetic ketoacidosis
- HHNK: hyperglycemic hyperosmolar nonketotic coma

Acute Complications
Hypoglycemia

Low blood sugar (70 mg/dl or lower) can result from treating diabetes with oral medications (sulfonylureas, like glyburide, glipizide, or glimepiride) and/or insulin.

- **Initial onset**: the patient reports feeling shaky, sweaty, dizzy, hungry, weak, or may experience tachycardia.
- **If left untreated**, the patient may experience vision changes, confusion, changes in behavior, or extreme fatigue.
- **In some cases**, patients with severe hypoglycemia have experienced loss of consciousness and/or seizures.

**Symptoms of hypoglycemia**

**Hypoglycemia Causes**

- Delayed meals
- Inadequate intake
- Extra or intense activity
- Too much medication (insulin stimulating oral agents or insulin)
- Interruption of IV dextrose, TPN, enteral feedings
- Liver or renal dysfunction
- Advanced age
- Alcohol

**Hypoglycemia policies may vary but basic principles:**

- Use glucose to bring blood glucose back into normal range.
- (15 grams of carbohydrate, e.g. ½ cup of juice, or 1 cup of milk, 3 packets sugar, 4 glucose tablets)
- Wait 15-20 minutes, test blood glucose, and if not in desired range yet, repeat treatment.
- NPO status or unresolved hypoglycemia may require IV glucose, or IM or subcutaneous glucagon.

**DKA**

Diabetes Ketoacidosis

**DEFINITION**

- A life threatening, but reversible complication characterized by a severe disturbance in protein, fat, and carbohydrate metabolism resulting from insulin deficiency.
• DKA at onset of diabetes can be prevented by earlier diagnosis.
• After diagnosis of diabetes, DKA is preventable.
• If promptly identified, DKA can almost always be treated successfully.

DIAGNOSIS CRITERIA FOR DKA
• BG >300 mg/dl
• Blood pH≤7.2
• Serum bicarbonate <15mEq/L
• Anion gap>12mmol/L
• Ketonemia and Ketonuria
• Exclusion of other causes

SYMPTOMS
– Thirst and polyuria
– Visual disturbances
– Increasing fatigue
– Nausea and vomiting
– Weakness, loss of appetite
– Weight loss
– Abdominal pain
– Decreased intellectual functioning

SIGNS
– Dry skin; rosy cheeks
– Acetone breath
– Hypothermia
– Kussmaul breathing
– Tachycardia
– Hypotension
– Dehydration
– Impaired consciousness; coma

GOAL OF TREATMENT OF DKA
• Correct the life threatening abnormalities resulting from dehydration, insulin deficiency, potassium deficiency.

PRECIPITATING AND CONTRIBUTING FACTORS FOR DKA
• Inter-current infections
• Emotional stress
• Dehydration
• Physical Stress
  – Acute injuries
  – Cardiovascular and renal disease
  – Surgery
• Non-adherence to therapeutic regimen
• Lack of self-management skills
• Infrequent contact with physician
• Exercise (In poorly controlled patients)
• Insulin pump malfunction or infusion site failure

PRINCIPAL COMPONENTS OF TREATMENT
• Rehydration
• Insulin replacement
• Replacement of electrolyte losses
• Correction of metabolic acidosis
• Supply of adequate calories
HHNK

Hyperglycemic, Hyperosmolar, Nonketotic Coma

**CHARACTERISTIC FEATURES**

- Marked hyperglycemia, often over 600 mg/dl
- Serum osmolar concentrations elevated
- Often no ketones
- Severe dehydration
- Electrolyte depletion, with or without mild acidosis
- Often gradual onset

**TYPICAL PATIENTS EXPERIENCING HHNK**

- Type 2 diabetes
- Elderly with limited mobility and decreased orientation
- Frequently an underlying condition exists (cardiac or renal disease)
- Frequently an underlying precipitating event (acute infection, medication interference)

**TREATMENT**

- INSULIN
- FLUID
- ELECTROLYTE
- Extreme caution with age in relationship cardiovascular status

**Complications**

- **Microvascular**
  - Retinopathy: eye damage
  - Nephropathy: kidney damage
  - Neuropathy: nerve damage
- **Macrovascular**
  - Coronary Heart Disease
  - Cerebrovascular Disease
  - Peripheral Vascular Disease
Complications

- Hyperglycemia causes damage to the heart, blood vessels, kidneys, eyes, nerves and affects one’s ability to fight infection
- Diabetes is the leading cause of blindness
- Two-thirds of people with diabetes get heart disease or stroke
- Diabetes is the 6th leading cause of death in the U.S., probably underreported as the cause of death
- The death rate is 2-4X more in adults with diabetes than without