10a

Diabetes Mellitus

Lecture Presentation
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Diabetes Mellitus

OUTLINE:

- General Characterization and Overall Prevalence
- Type 1 and Type 2 Diabetes
- Gestational Diabetes
- Other Specific Types of Diabetes
General Characterization and Overall Prevalence

- Diabetes mellitus
  - Group of diseases characterized by problems in insulin production or insulin function
    - Result: problems in glucose regulation
  - Major cause of death and disability worldwide
General Characterization and Overall Prevalence

- **Glucose**
  - Monosaccharide
  - Main source of fuel for cells
  - Obtained from the food we eat
  - Absorbed from the digestive tract into the bloodstream
General Characterization and Overall Prevalence

- **Pancreas**
  - Secretes insulin in response to high levels of glucose in the blood (e.g., after a meal)
    - Insulin promotes the movement of glucose into target cells by increasing the number of glucose transport proteins in target cell membranes
  - Unusually high levels of blood glucose occur when
    - There is not enough insulin
    - Target cells do not adequately respond to insulin
Figure 10a.1 *Insulin regulation of glucose levels.*

**Step 1:** Glucose moves from the digestive tract into the bloodstream.

**Step 2:** The pancreas secretes insulin into the bloodstream. In type 1 diabetes, the pancreas produces little or no insulin.

**Step 3:** Insulin promotes uptake of glucose by cells, lowering the amount of glucose in the blood. In type 2 diabetes, body cells fail to adequately respond to insulin.

*Extracellular fluid:*
- Glucose
- Carrier protein
- Plasma membrane
- Cytoplasm
Type 1 and Type 2 Diabetes

- **Type 1 diabetes mellitus**
  - Autoimmune disorder in which the immune system attacks the beta cells of the pancreas, which produce insulin
  - Destruction of beta cells means that insulin must be delivered by injection or pump
  - Represents 5% to 10% of all diagnosed cases
- **Former names**
  - Juvenile-onset diabetes
  - Insulin-dependent diabetes
Type 1 and Type 2 Diabetes

- Type 2 diabetes mellitus
  - Form associated with a lifestyle of overeating, obesity, and inactivity
  - Characterized by insulin resistance
    - Cells of the body fail to adequately respond to insulin
  - Represents 90% to 95% of all diagnosed cases
- Former names
  - Adult-onset diabetes
  - Non-insulin-dependent diabetes
Figure 10a.2 Percentages of people in the United States with diabetes by race and ethnicity, 2007–2009.

<table>
<thead>
<tr>
<th>Race/ethnicity</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Hispanic whites</td>
<td>7.1%</td>
</tr>
<tr>
<td>Asian Americans</td>
<td>8.4%</td>
</tr>
<tr>
<td>Hispanics</td>
<td>11.8%</td>
</tr>
<tr>
<td>Non-Hispanic blacks</td>
<td>12.6%</td>
</tr>
<tr>
<td>American Indians and Alaska Natives</td>
<td>16.1%</td>
</tr>
</tbody>
</table>
Symptoms and Complications

- Type 1
  - Thirst
  - Frequent urination
  - Extreme hunger
  - Unexplained weight loss
  - Fatigue
  - Slow-healing sores

- Type 2
  - Some or none of the symptoms of type 1
Symptoms and Complications

- Acute complications
  - Hyperglycemia (high blood glucose)
  - Hypoglycemia (low blood glucose)
    - Caused by taking too much insulin
    - Insulin shock can be fatal
  - Diabetic ketoacidosis (DKA)
    - Life-threatening biochemical imbalance
    - Much more common in type 1
    - Too little insulin causes energy-starved cells to break down lipids, resulting in the production of ketones (acids) that disrupt blood pH
Symptoms and Complications

- Long-term complications
  - High blood glucose damages blood vessels
    - High blood pressure
    - Atherosclerosis
  - Kidney failure (dialysis may be required)
  - Poor sensation (amputation of lower legs may be required)
  - Blindness
  - Infections of the skin and gums
  - Depression
Diagnosis

- Diagnostic tests that measure glucose in the blood to identify diabetes and prediabetes
  - Fasting blood glucose test
    - Blood collected after overnight fast
  - Random blood glucose test
    - Blood collected at a random (non-fasting) time
  - Glycated hemoglobin A1c test
    - Measures the percentage of hemoglobin molecules that have glucose attached
    - Indicates average blood glucose level for the past 2 or 3 months
Figure 10a.3 A glucometer.
Treatments

- Diet low in fat and calories, but high in nutrition
- Exercise
  - Lowers blood glucose
  - Makes cells more sensitive to insulin
- Hemoglobin A1c testing every few months
Treatments

- Use glucometers to self-monitor blood glucose levels
- Type 1 diabetics and some type 2 diabetics require insulin, which can be delivered by needle, syringe, and vial of insulin, insulin pen, insulin pump
Treatments

- Type 2 diabetics and prediabetics that are at risk of developing type 2 diabetes may take antidiabetic medications to prevent or treat long-term complications, such as cardiovascular disease.
Figure 10a.4 Several methods for self-administering insulin.
Lifestyle Changes and Key Recommendations

- Many lifestyle changes are needed upon diagnosis
  - Self-monitor blood glucose
  - Exercise
  - Plan and eat healthy meals
  - Stop smoking
  - Limit alcohol
  - Lower stress
- Consultation with a diabetic educator
Lifestyle Changes and Key Recommendations

- Have available an emergency kit that contains glucagon (pancreatic hormone that raises blood glucose levels)
- Carry glucose tablets to raise low blood glucose when not an emergency
- Have regular physical, dental, and eye exams
- Wear a diabetic identification tag or bracelet
Figure 10a.5 *It is recommended that diabetics wear a medical ID.*

(a) [Image of a medical ID tag with "DIABETIC" engraved on it.

(b) [Image of a wristband with "I'm diabetic" and "if I pass out call emergency" printed on it.]
Prognoses

- **Type 1**
  - Type 1 diabetes cannot be prevented or cured at this time
  - Can delay or prevent long-term complications through strict control of blood glucose
- **Options being explored**
  - Transplants of pancreas or its insulin-producing cells
  - Artificial pancreas
Prognoses

- Type 2
  - Type 2 diabetes can be prevented or delayed through lifestyle interventions
    - Weight loss
    - Exercise
  - Can delay or prevent long-term complications through strict control of blood glucose and blood pressure
Table 10a.1 A Comparison of Type 1 and Type 2 Diabetes Mellitus

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Type 1</th>
<th>Type 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of all diagnosed cases of diabetes</td>
<td>5–10%</td>
<td>90–95%</td>
</tr>
<tr>
<td>Previous names</td>
<td>Juvenile-onset diabetes</td>
<td>Adult-onset diabetes</td>
</tr>
<tr>
<td></td>
<td>Insulin-dependent diabetes</td>
<td>Non-insulin-dependent diabetes</td>
</tr>
<tr>
<td>Typical age of onset</td>
<td>&lt;25 years</td>
<td>&gt;40 years, but now appearing at younger ages</td>
</tr>
<tr>
<td>Cause</td>
<td>Autoimmune reaction destroys the beta cells of the pancreas</td>
<td>Body cells become resistant to insulin</td>
</tr>
<tr>
<td>Risk factors</td>
<td>Family history</td>
<td>Family history</td>
</tr>
<tr>
<td></td>
<td>Viral infection</td>
<td>Obesity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inactivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Member of a high risk population</td>
</tr>
<tr>
<td>Percentage of patients requiring insulin</td>
<td>100%</td>
<td>~40%</td>
</tr>
<tr>
<td>Development of ketoacidosis</td>
<td>Likely if undiagnosed or if treatment is compromised</td>
<td>Rare</td>
</tr>
<tr>
<td>Treatment</td>
<td>Insulin; management of diet; exercise</td>
<td>Some need insulin; some take oral antidiabetic medications; management of diet; exercise</td>
</tr>
<tr>
<td>Prognosis</td>
<td>Cannot be prevented</td>
<td>Can be delayed or prevented</td>
</tr>
</tbody>
</table>
Gestational Diabetes

- Condition in which a pregnant woman develops diabetes mellitus
  - Occurs in about 7% of pregnancies each year in the United States
- Caused when the placenta produces hormones that make the mother’s cells more resistant to insulin and her production of insulin is insufficient to overcome this resistance
- Typically resolves after delivery of the baby and placenta
Gestational Diabetes

Risk factors

- Having a parent or sibling with type 2 diabetes
- Having gestational diabetes in a previous pregnancy
- Age over 25 years
- Being overweight before pregnancy
- Member of a racial or ethnic group with high prevalence for gestational diabetes
  - African Americans, Hispanic/Latino Americans, American Indians
Gestational Diabetes

- Consequences
  - Health consequences for mothers
    - Some women develop preeclampsia during their pregnancy
      - Life-threatening condition characterized by high blood pressure and fluid retention
    - Difficult deliveries due to large babies
Gestational Diabetes

- Consequences for babies
  - Excessive growth during the prenatal period
    - High levels of glucose in maternal blood pass to fetus via the placenta
    - Maternal insulin cannot cross the placenta
    - By 3 months gestation, the fetal pancreas begins producing insulin, and it responds to the high blood glucose levels by producing excess insulin
    - Glucose moves into fetal cells, promoting excessive growth of the fetus
    - The resulting condition is called macrosomia and is defined as birth weight over 9 pounds
Gestational Diabetes

- Symptoms
  - Women may experience no symptoms or some or all of the symptoms of type 1 and type 2 diabetes

- Diagnosis
  - Glucose challenge test, as part of routine prenatal care
Gestational Diabetes

- **Treatment**
  - Treatment plan typically includes
    - Self-monitoring blood glucose levels
    - Eating a healthy diet
    - Engaging in regular physical activity
Gestational Diabetes

**Treatment**

- If lifestyle changes do not control blood glucose, then treatment plan may include
  - Taking insulin
  - Taking antidiabetic medication
- Annual screening for diabetes after giving birth is recommended
Other Specific Types of Diabetes

- Insulin deficiencies resulting from damage to the pancreas caused by
  - Disease
  - Infection
  - Trauma
  - Drugs
- Represent 1% to 2% of all diagnosed cases of diabetes
You Should Now Be Able To:

- Describe the general characterization and overall prevalence of diabetes type 1 and 2
- Understand the symptoms and consequences
- Understand the different treatments and lifestyle changes
- List the main treatments available
- Compare type 1 and type 2 diabetes
- Describe gestational diabetes
  - Understand the health consequences for the mother and for the baby
- List the other specific types of diabetes