The Diabetic Patient

Objectives

After reading this article, you will be able to:

- Understand carbohydrate metabolism.
- Discuss the long term complications of diabetes.
- Discuss the differences of Type I and Type II diabetes.
- Describe incidence of diabetes and predisposing factors.
- Discuss the pre-hospital treatment for a symptomatic diabetic patient.

Introduction

To understand the pathology of diabetes, it is necessary to understand how endocrine glands function in the body. The body's endocrine system is comprised of ductless glands that produce and secrete hormones. The main endocrine glands are the pituitary, thyroid, adrenal cortex and medulla, the pancreas, ovaries and testes. The hormones are secreted directly into the blood stream and have a regulatory effect on different types of cells, which in turn, affect certain metabolic functions of the body.

The interaction of these hormones with the cells is based on receptors that are found either on the cell's surface or in the interior of the cell. Some hormones produced in the body "open" these receptors to enable the nutrients to enter the cells where they are needed, but when the gland responsible for manufacturing the hormone is not working properly, the hormone and cell will not interact for the effect needed in order for the body to function normally. Hormones will only interact with the cells that contain the appropriate receptors for that particular hormone.

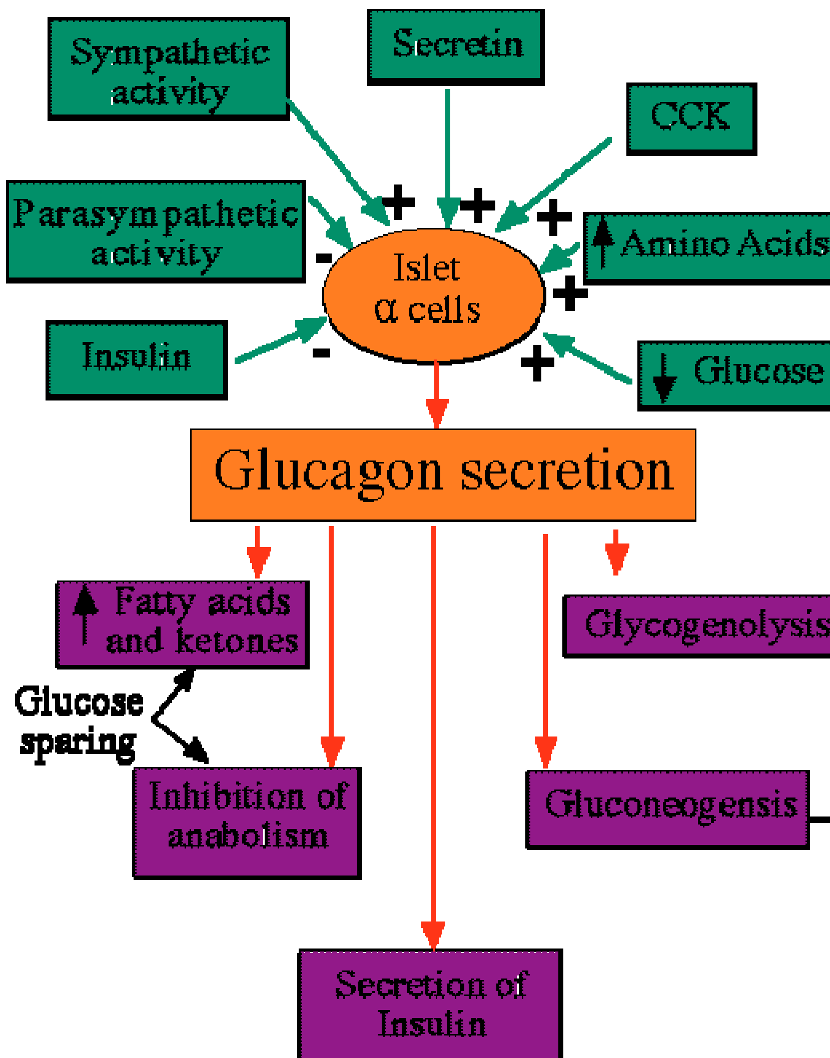
All cells in the body need glucose, or sugar, for energy. There are receptors that allow the glucose to enter and nourish the cell, but insulin is needed to "unlock" the receptors in order for this action to take place. The pancreas is the organ in the body responsible for the production of insulin and when the pancreas is not working properly, the cell receptors remain locked and the cells do not get the glucose they need. This results in the glucose remaining in the blood stream, rather than being absorbed into the cells and the resulting condition is diabetes. The deprivation of energy to the cells is directly responsible for extreme fatigue experienced by the diabetic patient. There is no cure for diabetes, which is a chronic and progressive disease and predisposes the patient to many true medical emergencies. The best a person with diabetes can do is to try and stay one step ahead of the disease.

Diabetes is a systemic disease that leaves patients with many long-term complications, including:

- Blindness (5000 diabetics lose their sight each year)
- Kidney disease that includes end stage kidney failure, requiring dialysis or kidney transplant.
- Peripheral neuropathy, which is damage to the nerves in the hands and feet.
- Increased infections of the feet that are slow to heal

- Autonomic neuropathy that damages nerves controlling voluntary and involuntary functions. This may affect sexual function, bladder and bowel control and the body's ability to control blood pressure.
- Heart disease and stroke
- High blood sugar and fat in the blood contribute to atherosclerosis (hardening of the arteries).
- Peripheral vascular disease, resulting in the need for amputation.

Understanding Glucose Metabolism
There are three main components of food, which are carbohydrates, fats and proteins. Carbohydrates are found in all starchy and sweet foods and contain the simple sugar, glucose. Because they are the first food substance to enter the bloodstream after a meal, they provide quick energy. What is not immediately utilized by the body is either stored in the liver and muscles as glycogen for short-term energy reserve or is turned to fat for a long-term energy reserve.



The secretion of insulin is stimulated by chemical, neural and hormonal means after the intake of carbohydrates. The increase in blood sugar, parasympathetic stimulation and gastrointestinal hormones will trigger the pancreas to secrete insulin.

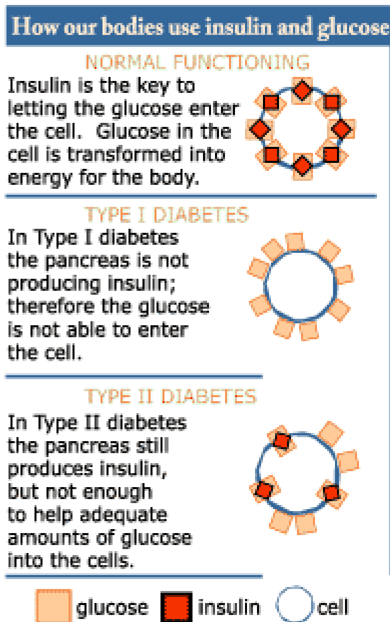
An Organ at Odds With Itself
As mentioned previously, the pancreas releases insulin, which is responsible for unlocking cells to enable glucose to enter and provide the needed energy for the body, but it has other functions as well. Insulin also increases the speed in which glucose is carried to the cells, increases metabolism by the cells, increases levels of glycogen (a form of glucose) in the liver, and it decreases the concentration of sugar in the blood to help maintain a normal level of 60 to 120mg/dL.

In the diabetic patient, the pancreas is not working properly, and the insulin is ineffective in maintaining normal blood sugar levels. When the pancreas senses that the blood sugar levels are dropping, it will secrete a protein called Glucagon, which will stimulate the liver to release some of its stored glucose. The uncontrolled release of insulin can aggravate the effect the liver has on the body's blood sugar level that can lead to hyperglycemia.

Type I Diabetes
Type I Diabetes occurs when the pancreas does not produce an adequate insulin supply to be effective in maintaining blood sugar levels. This type of diabetes can develop anytime after birth, but usually is diagnosed in teenagers and young adults. This condition is typically hereditary and appears to be an autoimmune deficiency resulting from a genetic abnormality or susceptibility that causes the body to attack and destroy its own insulin producing cells. Anyone who has a parent or sibling with this condition has a 10% chance of developing the disease by age 50.

Type I Diabetes requires a life-long regimen of insulin injections, diet regulation and exercise. The symptoms of Type I Diabetes usually appear suddenly and include:

- Polyuria (excessive urination)
- Polydipsia (excessive thirst)
- Polyphagia (excessive hunger)
- Dizziness
- Blurred vision
- Rapid, unexplained weight loss



Type II Diabetes
Type II Diabetes occurs when the pancreas has a decrease of insulin production and a diminished sensitivity to insulin. This type of diabetes is most often seen in patients who are over 40 years of age and are overweight. Obesity predisposes a person to this condition because the demands are higher on the pancreas to produce enough insulin for a larger body. Other people at higher risk for this type of diabetes are Native Americans, Hispanics and African-Americans. Many people with this condition are unaware they are afflicted until more severe symptoms materialize.

Type II Diabetes requires a regimen of oral hypoglycemic medications, dietary regulation and exercise, although a small number of people also require insulin injections. The symptoms of Type II Diabetes include:

- Fatigue (often extreme)
- Changes in appetite
- Tingling, numbness and pain in the extremities
- Itching in the extremities
- Blurred vision
- Slow healing leg/foot wounds

Effects of Diabetes
There are three effects of diabetes that result in decreased levels of insulin in the diabetic patient.

1. A decrease in the cells' use of glucose will lead to higher levels of sugar in the blood.

2. Dramatic increases in the metabolism of fats from fat storage areas may lead to short-term ketoacidosis (accumulation of ketones in the body's tissue) and to long-term atherosclerosis (hardening of the arteries).

3. Depletion of proteins in the body and the wasting of muscle tissue.

Loss of Glucose In The Urine
When the amount of glucose entering the kidneys rises above the normal threshold, the kidneys are unable to reabsorb the excess, which results in the glucose spilling over into the urine. The loss of glucose in the urine has a diuresis effect and leads to frequent urination, which results in dehydration of the extracellular and intracellular spaces.

Acidosis in Diabetes
When carbohydrates change to fat metabolism, the result is the formation of ketone bodies (ketoacids). These acids are strong, constantly produce and eventually overwhelm the kidneys' attempt to clear the acid load, which leads to metabolic acidosis. The body will partially compensate for the overload by a respiratory alkalosis, which presents as deep, rapid respirations (Kussmaul's respirations). Acidosis, along with the severe dehydration of the body's cells, can lead to death.

Diabetic Emergencies
Three life threatening emergencies can arise for the patient with diabetes, which are: hypoglycemia (insulin shock), hyperglycemia (diabetic ketoacidosis) and hyperosmolar hyperglycemic nonketotic coma (HHNK). The condition of HHNK is when the patient is experiencing very high levels of sugar in the blood (levels over 800mg/dL), which causes shifts in the water contained in brain cells. The result is coma and the condition can be fatal or lead to permanent brain damage. Ketoacidosis is not usually present with this condition.

Hypoglycemia
Hypoglycemia occurs when blood sugar levels drop below 80mg/dL. Symptoms will begin to surface when the level drops below 60mg/dL, but, if the fall in glucose has been rapid, symptoms can occur before the levels reach 60mg/dL. This condition is not exclusive to the diabetic patient and can occur as a result of an excessive response to glucose absorption, physical exertion, effects from alcohol or drug use, pregnancy, lactation, or skipping meals. For the diabetic, the most common causes for the development of hypoglycemia are:

- Administration of too much insulin or oral hypoglycemic medications
- Delayed or skipped meals
- Unusual or vigorous physical exertion

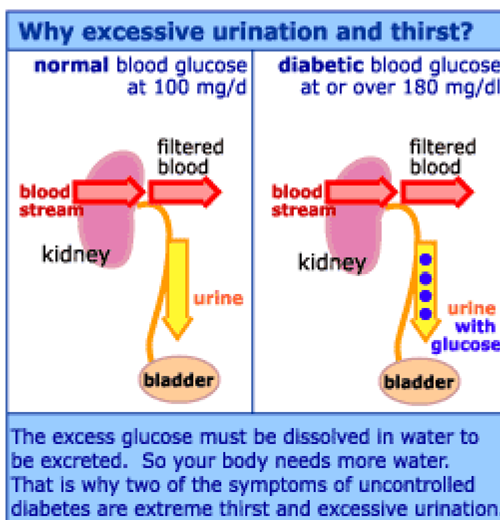
Less common conditions that predispose the diabetic to hypoglycemia include:

- Alcoholism, as alcohol depletes the liver's glycogen stores
- Adrenal gland dysfunction
- Liver disease (hepatic insufficiency or failure)
- Malnutrition
- Pancreatic tumor
- Cancer

- Hypothermia
- Sepsis (systematic infection)
- Administration of cardiac beta blocker medications
- Administration of Anti-inflammatory drugs in infants and children
- Overdose of diabetic medication

The signs and symptoms of hypoglycemia are usually rapidly apparent. Any diabetic patient displaying changes in behavior, confusion or unconsciousness should be treated for hypoglycemia. This condition is a true emergency and if left untreated can lead to permanent brain damage or death. In the early onset of the condition, the patient may complain of extreme hunger and experience one or more of the following symptoms as the condition progresses:

- Nervousness, trembling
- Irritability
- Psychotic and combative behavior
- Weakness
- Appearance of uncoordinated
- Confusion
- Appearance of intoxication
- Weak, rapid pulse
- Cold, clammy skin
- Fatigue
- Seizure
- Coma



Diabetic Ketoacidosis

Diabetic Ketoacidosis occurs when insulin is absent or the level becomes too low to meet the metabolic demands of the body. Because insulin is not available to "unlock" the glucose receptors in the cells, the sugar remains in the blood stream. The cells then become starved for energy and will begin to utilize other sources, principally fat. When fat is metabolized, by-products of fatty acids and glycerol are created. The glycerol will provide the cells with some energy, but the fat is further metabolized and forms ketoacids, leading to acidosis. The unusual levels of acidosis will then increase the transport of potassium from the cells into the blood stream, which leads to a high concentration of potassium in the urine, leaving little for the rest of the body to utilize.

As the levels of sugar in the blood rise, the patient experiences a massive cellular diuresis, which leads to dehydration and shock. The electrolyte imbalances in the body may also cause cardiac dysrhythmias and neurologic alterations causing seizures.

Patients experiencing this condition are rarely comatose. If a diabetic is found unresponsive, they should be assessed for another cause of their presentation. The signs and symptoms of ketoacidosis are:

- Warm, dry skin
- Dry mucus membranes
- Tachycardia with thready pulse
- Postural hypotension (The manifestation of low blood pressure when rising from a lying or sitting position)
- Weight loss
- Excessive urination
- Excessive hunger
- Generalized abdominal pain
- Nausea, Vomiting
- Acetone breath (sweet, fruity odor of the breath)
- Kussmaul's respirations
- Decreased level of consciousness
- Anorexia

Hyperosmolar Hyperglycemic Nonketotic Coma (HHNK)

As mentioned previously, HHNK is a condition when the diabetic patient has blood sugar levels in excess of 800mg/dL. HHNK differs from ketoacidosis in that the insulin may be adequate to prevent the production of ketones and the resulting ketoacidosis, but not enough to permit the use of glucose by peripheral tissues. This condition can lead to CNS dysfunction, severe dehydration and the loss of electrolytes.

Patients predisposed to HHNK include the elderly, those with preexisting cardiac or renal disease, diabetics with inadequate insulin secretion (type II), increase insulin needs brought on by stress, infection, trauma, burns, or myocardial infarction, patients with a feeding tube and certain medicines that are ingested. The signs and symptoms of this condition include:

- Weakness
- Excessive thirst
- Frequent urination
- Weight loss
- Extreme dehydration
- Flushed, dry skin
- Dry mucus membranes
- Decreased skin turgor (skin remains in a "tent" formation after pulling up)

- Postural hypotension (The manifestation of low blood pressure when rising from a lying or sitting position)
- Altered level of consciousness
- Tachycardia
- Hypotension
- Tachypnea

Assessment of the Diabetic Patient
The presentation of a patient experiencing a diabetic emergency may mimic the signs and symptoms of other common illnesses. The pre-hospital caregiver should always carefully consider if the patient may be diabetic. In addition to the appropriate patient assessment procedures, it is important to look for medical alert jewelry, the presence of any diabetic blood testing equipment, syringes and any diabetic medications (insulin is kept in the refrigerator). Specific information that should be gathered from the diabetic patient includes:

- Onset of symptoms
- Food intake
- Insulin or oral hypoglycemic use
- Alcohol or drug consumption
- Recent predisposing events (exercise, illness, stress)

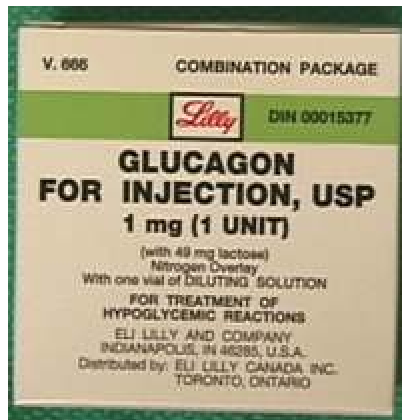
The signs and symptoms of a diabetic emergency and be difficult to differentiate in the pre-hospital setting. The following chart may help as a quick guide to the underlying pathophysiology of the patient's condition.

Management of the Conscious Diabetic Patient
While obtaining a medical history from the patient, the pre-hospital caregiver should assess the patient's breathing and circulation. Medical direction may require drawing a blood sample before the possible administration of glucose. Some local EMS systems use a field blood testing monitor (glucometer), which can provide vital information and direction to the patient's course of treatment. Any patient with a blood sugar level of less than 80mg/dL and are presenting symptoms of hypoglycemia, should be given dextrose. Some patients respond so well to the simple administration of dextrose, that they are released after treatment and transport to the hospital is not necessary. Local protocols vary and the pre-hospital caregiver should be aware of the protocol in their area.

Methods of glucose administration vary according the local protocols and the presentation of the patient. If the patient is alert and able to swallow, food that is high in sugar content may be given orally, such as a candy bar, a glass of orange juice with sugar added, a sweet drink or glucose gel. If nothing is available for the patient to eat, dextrose 50% may be administered slowly via an IV. Note that dextrose 50% should not be administered to infants or young children. If the patient is a known alcoholic, the administration of dextrose 50% can lead to neurological complications. Therefore, thiamine should be administered either before or concurrently with the dextrose.

Thiamine
Thiamine is a vitamin (B1) that the body needs for metabolism, but does not manufacture. Usually, the body will get the thiamine it needs through a normal diet, but chronic alcohol intake

interferes with the absorption and utilization of thiamine, which can lead to neurologic disorder. Any comatose patient, especially those who are suspected to be alcoholic, should receive IV thiamine in addition to D50. The pre-hospital caregiver should be aware of the protocols for thiamine administration in their area.



Management of the Unconscious Diabetic Patient

Pre-hospital treatment of any unconscious patient includes airway management, high-flow O2, ventilatory support as needed and circulatory support. A blood sample should be obtained and, depending upon local protocols, an IV should be established to administer a lactated Ringer's or saline solution to replenish fluids and electrolytes. Dextrose should then be administered, but if alcohol and drug abuse are suspected, thiamine and Narcan should be administered before the dextrose.

If an IV line can not be established, Glucagon may be administered via a subcutaneous or intramuscular injection. Glucagon is helpful in raising blood sugar levels by stimulating the breakdown of glycogen in the liver. Note that Glucagon is not effective in treating the chronic alcoholic and those patients with liver disease. Definitive treatment of ketoacidosis and HHNK requires transport to the hospital where the patient can receive insulin, fluid replacement, electrolyte monitoring and observation.

Naloxone (Narcan)

Naloxone is a medication use to reverse the effects of narcotics that have been ingested by a patient. The results can be dramatic and nearly instantaneous, but the effects of Naloxone begin to wear off after 20 minutes. Subsequent doses may need to be given if the hospital is a distance from the scene. Once admitted, the patient may be placed on an IV drip of Naloxone until the narcotics are no longer present in the patient's system.

Summary

Diabetes can be of the insulin-dependent or non-insulin-dependent variety. IDDM usually causes more significant problems than NIDDM. As food is broken down into glucose, it enters the blood with the help of insulin to be used for energy, or is stored in the liver as glycogen for future energy needs. If insulin is not available, glucose builds up in the blood and results in a complex array of problems. Management is geared toward a balance between diet, insulin or oral medication and exercise.

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