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Diabetic Ketoacidosis

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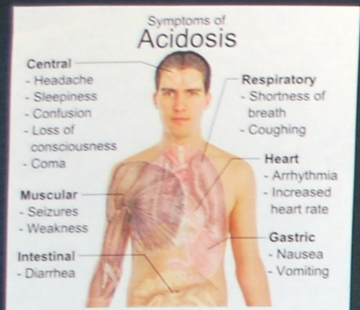
Diabetic Ketoacidosis

Causes and Symptoms



Causes of DKA :

- Alcohol or drug consumption
- An illness or infection (including colds and flus)
- An insulin reaction (low blood glucose)
- Failure to take insulin
- Gastrointestinal (GI) upset
- Heart attack
- High fever
- Not getting enough insulin
- Not getting enough food
- Physical or emotional trauma
- Stress
- Stroke
- Surgery
- Undiagnosed type 1 diabetes

Some common DKA symptoms include :

- Abdominal pain
- Blurred or unclear vision
- Coma
- Confusion
- Dehydration
- Difficulty breathing; rapid, deep breathing; shortness of breath
- Dry mouth
- Excessive thirst
- Fatigue and lethargy
- Flushing
- Frequent urination
- Fruity odor to breath
- High blood sugar levels
- High keytone levels
- Hot, dry skin
- Loss of appetite
- Muscle stiffness or aching
- Nausea
- Perspiration
- Restlessness, discomfort, agitation
- Unconsciousness
- Vomiting
- Weakness

Description

Diabetic Ketoacidosis (DKA) is a dangerous, potentially life-threatening complication of diabetes that many people are unaware of. Also known as diabetic acidosis, DKA is a condition in which the chemical balance of the body (pH) becomes exceedingly acidic, leaving the body vulnerable to a diabetic coma and death. Diabetic ketoacidosis (DKA) is an important hyperglycemic emergency in patients with diabetes mellitus characterized by the biochemical triad of uncontrolled hyperglycemia, metabolic acidosis, and increased ketones. This serious metabolic derangement results from combination of absolute or relative insulin deficiency.

The body must maintain a pH balance of 7 to 7.25. Any reading lower than 7 is too acidic. DKA develops when dangerously high numbers of **ketones** (poisonous acidic chemicals produced by the liver in response to insulin deficiency) accumulate in the body's tissues and fluids, resulting in a loss of water, potassium, ammonium, and sodium.

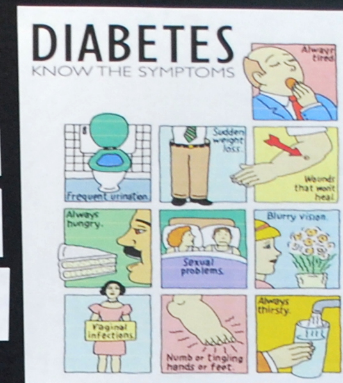
Diabetic ketoacidosis (DKA) always results from a **severe insulin deficiency**. Insulin is the hormone secreted by the body to lower the blood sugar levels when they become too high. **Diabetes mellitus** is the disease resulting from the inability of the body to produce or respond properly to insulin, required by the body to convert glucose to energy.

When there isn't enough insulin present to transport glucose to the body's cells, fat – instead of glucose – is burned to make energy. Ketones are produced during this process, resulting in an abnormal decrease in blood plasma volume, electrolyte imbalance, extremely high blood glucose levels, and the breakdown of free fatty acids.

DKA combines three major features: **hyperglycemia**, meaning excessively high blood sugar levels; **hyperketonemia**, meaning an overproduction of ketones by the body; and **acidosis**, meaning that the blood has become too acidic.

Insulin deficiency is responsible for all three conditions: the body glucose goes largely unused since most cells are unable to transport glucose into the cell without the presence of insulin; this condition makes the body use stored fat as an alternative source instead of the unavailable glucose for energy, a process that produces acidic ketones, which build up because they require insulin to be broken down. The presence of excess ketones in the bloodstream in turn causes the blood to become more acidic than the body tissues, which creates a toxic condition.

DKA is most commonly seen in individuals with type I diabetes, under 19 years of age and is usually caused by the interruption of their insulin treatment or by acute infection or trauma. A small number of people with type II diabetes also experience ketoacidosis, but this is rare given the fact that type II diabetics still produce some insulin naturally. When DKA occurs in type II patients, it is usually caused by a decrease in food intake and an increased insulin deficiency due to hyperglycemia.



Diagnosis

Diagnosis requires the demonstration of hyperglycemia, hyperketonemia, and acidosis. DKA is established if the patient's urine or blood is strongly positive for glucose and ketones. Normal glucose levels in a non-diabetic person on average range from 80-110 mg/dL. A person with diabetes will typically fluctuate outside these parameters. DKA glucose levels exceed 250 mg/dl and can reach 400 to 800 mg/dL. A low serum bicarbonate level (usually below 15 mEq/L) is also present, indicative of acidosis.

The American Diabetes Association categorizes DKA in adults into one of three stages of severity:

- Mild: blood pH mildly decreased to between 7.25 and 7.30 (normal 7.35–7.45); serum bicarbonate decreased to 15–18 mmol/l (normal above 20); the patient is alert
- Moderate: pH 7.00–7.25, bicarbonate 10–15, mild drowsiness may be present
- Severe: pH below 7.00, bicarbonate below 10, stupor or coma may occur

Treatment

DKA is a serious condition that – if left untreated – can lead to illness and death, so it is important to monitor your body for ketones if you have any type of diabetes and are sick, stressed, and/ or pregnant, or your blood glucose level goes above 240 mg/dl (a measure of concentration using milligrams per decilitre).

The main aims in the **treatment** of diabetic ketoacidosis are replacing the lost fluids and electrolytes while suppressing the high blood sugars and ketone production with insulin. Admission to an intensive care unit or similar high-dependency area or ward for close observation may be necessary.

A blood test can also determine the concentration of glucose in your bloodstream.

Your body will try to eliminate excess ketones, so they can be detected and measured in your urine. Commercially available test strips can be submerged into urine to determine the presence and concentration level of ketones.

Ketone test kits come with instructions for using the test strips, but it's also important to ask your health care provider to show you how to keep a record of your blood glucose readings. This will help guide you in knowing how often to test for ketones.

Basic treatment includes:

Fluid replacement

The amount of fluid depends on the estimated degree of dehydration. If dehydration is so severe as to cause shock (severely decreased blood pressure with insufficient blood supply to the body's organs), or a depressed level of consciousness, rapid infusion of saline (1 liter for adults, 10 ml/kg in repeated doses for children) is recommended to restore circulating volume. Slower rehydration based on calculated water and sodium shortage may be possible if the dehydration is moderate, and again saline is the recommended fluid. Very mild ketoacidosis with no associated vomiting and mild dehydration may be treated with oral rehydration and subcutaneous rather than intravenous insulin under observation for signs of deterioration.

A special but unusual consideration is cardiogenic shock, where the blood pressure is decreased not due to dehydration but due to inability of the heart to pump blood through the blood vessels. This situation requires ICU admission, monitoring of the central venous pressure (which requires the insertion of a central venous catheter in a large upper body vein), and the administration of medication that increases the heart pumping action and blood pressure.

Insulin

Some guidelines recommend a bolus (initial large dose) of insulin of 0.1 unit of insulin per kilogram of body weight. This can be administered immediately after the potassium level is known to be higher than 3.3 mmol/l; if the level is any lower, administering insulin could lead to a dangerously low potassium level (see below). Other guidelines recommend delaying the initiation of insulin until fluids have been administered.

In general, insulin is given at 0.1 unit/kg per hour to reduce the blood sugars and suppress ketone production. Guidelines differ as to which dose to use when blood sugar levels start falling; some recommend reducing the dose of insulin once glucose falls below 16.6 mmol/l (300 mg/dl) but other recommend infusing glucose in addition to saline to allow for ongoing infusion of higher doses of insulin.

Potassium

Potassium levels can fluctuate severely during the treatment of DKA, because insulin decreases potassium levels in the blood by redistributing it into cells. A large part of the shifted extracellular potassium would have been lost in urine because of osmotic diuresis. Hypokalemia (low blood potassium concentration) often follows treatment. This increases the risk of dangerous irregularities in the heart rate. Therefore, continuous observation of the heart rate is recommended, as well as repeated measurement of the potassium levels and addition of potassium to the intravenous fluids once levels fall below 5.3 mmol/l. If potassium levels fall below 3.3 mmol/l, insulin administration may need to be interrupted to allow correction of the hypokalemia.

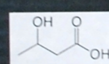
Treatment protocol of patients of mild to moderate diabetic ketacidosis

IV fluids
- 0.9% saline at 500-1000 ml/hour for 2 h
- 0.45% saline at 250-500 ml/hour until blood glucose<250 mg/dl
- Dextrose 5% in 150-250 ml/hour until resolution of DKA

Potassium replacement- S. K >5.5 mmol/l, do not give K
- If S. K 4-5.5 mmol/l add 20 mmol/KCl to each liter of IV fluid
- If S. K 3-4 mmol/l add 40 mmol/l KCl to each liter of IV fluid
- If S. K <3 mmol/l give 10-20 mmol/l KCl per hour until S. K >3 mmol/l, then add 40 mmol/l to each liter of IV fluid

Insulin Therapy
- Group 1-Regular insulin
  - Initial IV bolus 0.1 units/kg body wt. followed by
  - Continuous insulin infusion at 0.1 units/kg/h
  - When blood glucose <250 mg/dl, reduce insulin infusion to 0.05 units/kg/hour to keep blood sugar about 200 mg/dl until resolution of DKA
- Group 2-Insulin Lispro
  - Initial dose- SC 0.3 units/kg followed by
  - SC insulin lispro 0.2 units/kg 1 h later and every 2 hourly
  - When blood glucose <250 mg/dl reduce insulin lispro to 0.1 units/kg every 2 hourly to keep sugar about 200 mg/dl.]

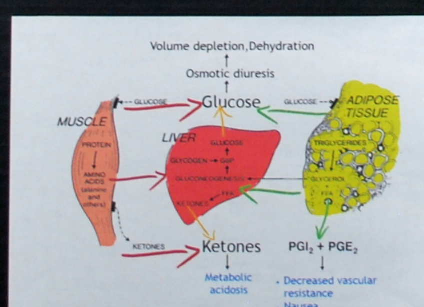
Mechanism



β-hydroxybutyrate

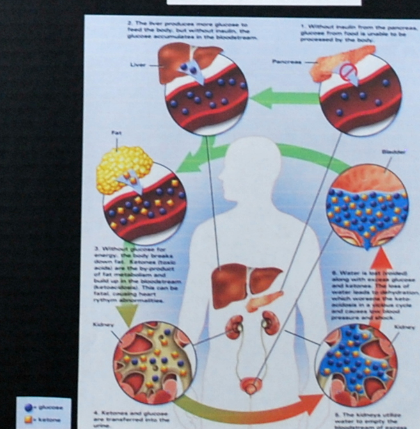
Diabetic ketoacidosis arises because of a lack of insulin in the body. The lack of insulin and corresponding elevation of glucagon leads to increased release of glucose by the liver (a process that is normally suppressed by insulin) from glycogen and through gluconeogenesis. High glucose levels spill over into the urine, taking water and solutes (such as sodium and potassium) along with it in a process known as osmotic diuresis. This leads to polyuria, dehydration, and compensatory thirst and polydipsia. The absence of insulin also leads to the release of free fatty acids from adipose tissue (lipolysis), which are converted, again in the liver, into ketone bodies (acetoacetate and β-hydroxybutyrate). β-Hydroxybutyrate can serve as an energy source in absence of insulin-mediated glucose delivery, and is a protective mechanism in case of starvation.

The ketone bodies, however, have a low **pKa** and therefore turn the blood **acidic** (metabolic acidosis). The body initially buffers the change with the bicarbonate **buffering** system, but this system is quickly overwhelmed and other mechanisms must work to compensate for the acidosis. The **pH buffer systems** are combinations of the body's own naturally occurring weak acids and weak bases. These weak acids and bases exist in balance under normal pH conditions. The pH buffer systems work chemically to minimize changes in the pH of a solution by adjusting the proportion of acid and base. The most important pH buffer system in the blood involves carbonic acid (a weak acid formed from the carbon dioxide dissolved in blood) and bicarbonate ions (the corresponding weak base).



Pathogenesis of Diabetic Ketoacidosis

Mechanism of DKA



Prevention

Once diabetes has been diagnosed, **prevention** measures to avoid DKA include regular monitoring of blood glucose, administration of insulin, and lifestyle maintenance. Glucose monitoring is especially important during periods of stress, infection, and trauma when glucose concentrations typically increase as a response to these situations. Ketone tests should also be performed during these periods or when glucose is elevated.

- Administer and adjust insulin dosage (taking blood sugar levels, nutrition, overall health, stress, and physical activity level into account)
- Be prepared to act quickly – call your health care provider if you have DKA symptoms, or if your blood sugar and/or ketone levels become too high
- Commit to a healthy lifestyle of daily activity and nutritious eating; consider a multi-vitamin to ensure adequate vitamin, mineral, and nutrient intake, and to promote overall health
- Do not exercise when ketone and/or blood glucose levels are high
- Perform careful, regular monitoring of blood sugar levels, especially if you're ill (check every four to six hours when it is higher than 240 mg/dl)
- Undergo regular ketone testing

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Recommended References

Primary literature :

http://medical-dictionary.thefreedictionary.com/Diabetic+ketosis

http://en.wikipedia.org/wiki/Diabetic_ketoacidosis#Mechanism