

Hyperglycemic Emergencies:

Diabetic Acidosis and the Hyperosmolar State

1. What are the two hyperglycemic emergencies that can affect a person with diabetes?

The two hyperglycemic emergencies that can affect a person with diabetes are:

- diabetic acidosis;
- the hyperosmolar state.

These two conditions are caused by a lack of insulin. Diabetic acidosis is more common in people with type 1 diabetes. Hyperosmolar states occur primarily in people with type 2 diabetes, usually when they are older. It is possible, however, for both conditions to occur simultaneously in people with either type 1 or type 2 diabetes.

2. What is diabetic acidosis?

Diabetic acidosis is caused by a lack of insulin. It is characterized by hyperglycemia and an accumulation of ketone bodies in the blood. The ketone bodies, which are acids, are produced by the breakdown of fats. They make the blood acidic, which can cause **excessive fatigue, abdominal pains, nausea and vomiting**. Diabetic acidosis also gives the breath a fruity odour and causes intense thirst as well as deep and rapid breathing; in some cases, it provokes disorientation and confusion. It can also sometimes result in a **coma**, which can be fatal if not treated.

- 4) **Follow the advice and instructions** of the doctor and dietician concerning the nutrients that should be ingested in both solid and liquid form and the **insulin** doses that should be injected when an illness makes it difficult or impossible to follow a normal diet.
- 5) **Call the doctor or go to the emergency room if any one of the following five situations occurs:**
 - **blood glucose is higher than 20 mmol/L;**
 - **the ketosis level reading (ketone bodies) in the urine is moderate (4 mmol/L) or large (8 mmol/L –16 mmol/L);**
 - **the ketosis level reading from the fingertip is above 3 mmol/L;**
 - **you are vomiting continually and cannot retain liquids;**
 - **the following conditions persist** despite treatment: excessive fatigue, weakness, dizziness, abdominal pains, nausea and vomiting, fruity breath odour, intense thirst, fast and heavy breathing.

6. What is a hyperosmolar state?

A hyperosmolar state usually occurs in people with type 2 diabetes who develop an **increased resistance to insulin**. Insulin resistance prevents **glucose** from entering the cells properly, leading to its **accumulation in the blood**.

If kidney function is slightly impaired, it is more difficult to eliminate excess sugar in the blood through the urine. Sugar can therefore accumulate in the blood until it reaches very high levels (**above 30 mmol/L**), especially if not enough fluids are ingested. The small amount of insulin present in the blood at this point is usually sufficient to prevent the breakdown of fats, however, and diabetic acidosis generally does not develop.

In a hyperosmolar state, blood glucose levels rise and the person feels extremely tired and thirsty (although some elderly people feel no thirst). Frequent and profuse urination also occurs, leading to dehydration. This can be followed by a drop in blood pressure and in some cases disorientation, which can lead to coma and, if left untreated, even death.

Suggested approach to the detection and treatment of diabetic acidosis and/or hyperosmolar states			
Blood glucose (mmol/L)	Ketosis level reading (mmol/L) in urine or blood	Symptoms	Suggested action
13 - 14	None, or trace Urine: 0.5 Blood: less than 0.6	Frequent urination Intense thirst	<ul style="list-style-type: none"> • Drink 250 ml of water every hour • Measure blood glucose levels every 6 hours
14 - 20	Small Urine: 1.5 Blood: 0.6 to 1.5	Frequent urination Intense thirst	<ul style="list-style-type: none"> • Drink 250 ml of water every hour • Measure blood glucose every 4 hours • Adjust insuline doses according to the rules of adjustment • Contact your doctor
14 - 20	Moderate Urine: 4 Blood: 1.5 to 3	Frequent urination Intense thirst Nausea Vomiting Abdominal pain (Diarrhea)	<ul style="list-style-type: none"> • Measure blood glucose and ketone bodies every 4 hours • Immediately adjust the insulin dose to follow the sick day recommendations (see boxed insert, next page) • Contact the doctor or go to the emergency room if there is no improvement
More than 20	Moderate to large Urine: 8 to 13 Blood: more than 3	Nausea Vomiting Abdominal pain (Diarrhea) Fruity breath	<ul style="list-style-type: none"> • Go to the hospital*
More than 30	None or small Urine: 0 to 1.5 Blood: 0 to 0.6	Frequent urination Intense thirst Extreme weakness	<ul style="list-style-type: none"> • Go to the hospital**

* Diabetic acidosis

** Hyperosmolar state

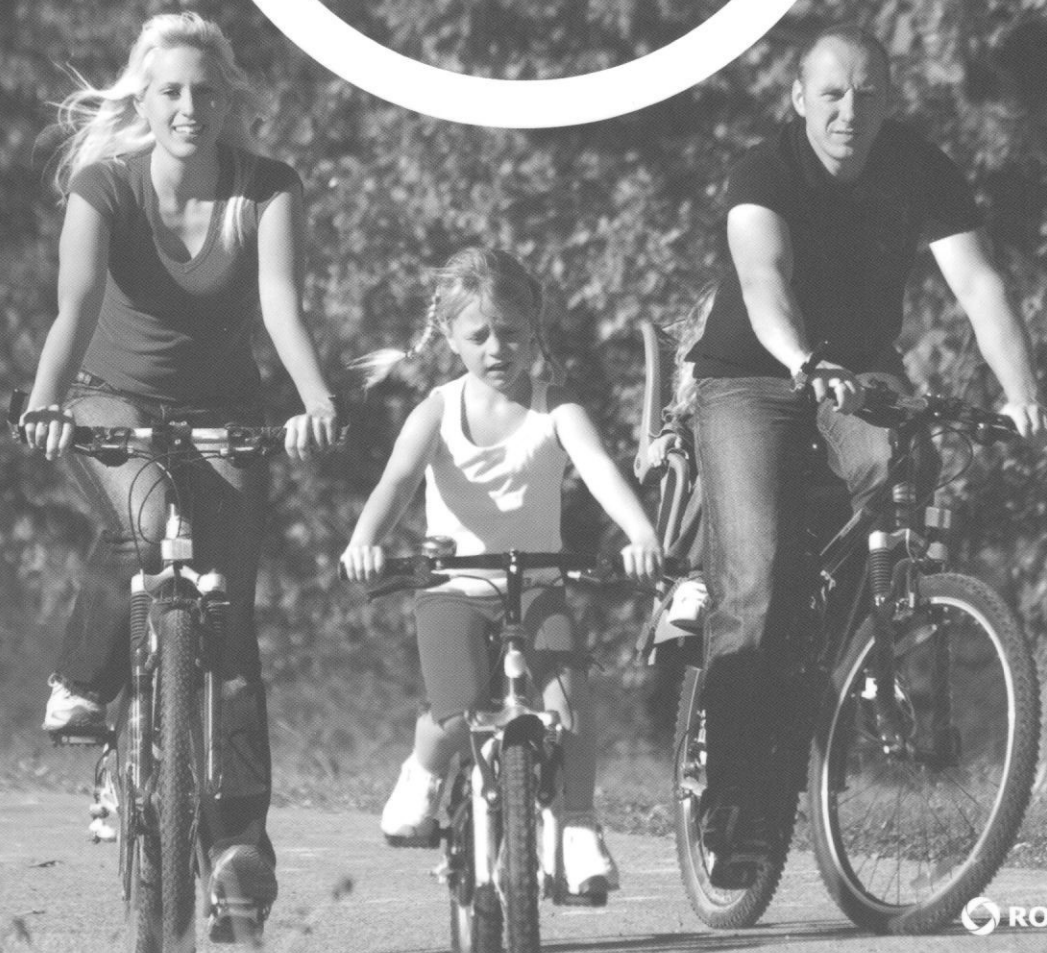
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DR. ROBERT G. JOSSE,
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NEW EDITION 2009

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Diabetic acidosis occurs primarily in people with type 1 diabetes, although it can also occur in people with type 2 diabetes when there are other aggravating factors such as infection, myocardial infarction (heart attack), pancreatitis or stroke.

3. What causes diabetic acidosis?

Diabetic acidosis is always caused by a **shortage of insulin** in the blood. When there is insufficient insulin, glucose cannot enter certain cells of the body and accumulates in the blood at extremely high levels. The body is then forced to draw on its reserves of fat for energy. The **breakdown of fats** causes the liver to produce ketone bodies. The ketone bodies, which are acids, then accumulate in the blood and spill over into the urine.

This complication of diabetes can occur if **insulin injections are skipped or doses miscalculated**.

Diabetic acidosis is sometimes caused by an **increased need for insulin** (this can happen, for example, when a person gets an infection or is under exceptional stress).

4. How is diabetic acidosis detected?

Diabetic acidosis is detected by the **presence of ketone bodies** in the urine or blood; these are accompanied by elevated blood glucose levels, often higher than 20 mmol/L.

5. How can diabetic acidosis be avoided?

Diabetic acidosis can be avoided in most cases by taking the following precautions:

- 1) **Check blood glucose levels regularly.** If necessary, check for ketone bodies in the urine using Ketostix® test strips or determine the level of ketone bodies in a blood sample from the fingertip, using the Precision Xtra® meter. Take these readings **more frequently** when ill, under exceptional stress, and especially if glucose readings are **higher than 14 mmol/L**.
- 2) Follow a **dietician-recommended meal plan**.
- 3) **Take insulin** as prescribed.

- 4) **Follow the advice and instructions** of the doctor and dietician concerning the nutrients that should be ingested in both solid and liquid form and the **insulin** doses that should be injected when an illness makes it difficult or impossible to follow a normal diet.
- 5) **Call the doctor or go to the emergency room if any one of the following five situations occurs:**
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7. What causes a hyperosmolar state?

In all cases, a hyperosmolar state is caused by a **shortage of insulin** in the blood. Because there is not a complete absence of insulin, however, ketone bodies do not form and diabetic acidosis does not develop.

This complication of diabetes can occur if antidiabetic drugs (insulin or pills) are **skipped**.

A hyperosmolar state is sometimes caused by an **increased need for insulin** (for example, in the case of illness, infection or exceptional stress, or when the subject is using certain medications such as cortisone).

Most of the time, a hyperosmolar state occurs in people who **do not feel thirst** or who are unable to hydrate themselves, which is sometimes the case for elderly people or individuals who have lost autonomy.

8. How is a hyperosmolar state detected?

The symptoms of a hyperosmolar state are generally **intense thirst, frequent and increased urination over several days**, and in particular, **blood glucose levels over 30 mmol/L**. There is usually no accumulation of ketone bodies in the blood or urine.

9. How can a hyperosmolar state be avoided?

The following tips can generally help a person avoid a hyperosmolar state.

- 1) **Stay hydrated**; drink 250 mL of water every hour if blood glucose levels are high or if high glucose levels cause an increased amount and frequency of urination.
- 2) **Measure blood glucose levels regularly** during illness or in times of exceptional stress.
- 3) **Follow the meal plan** recommended by the dietician.
- 4) Take antidiabetic **drugs** (pills or insulin) as prescribed.
- 5) **Follow the recommendations** of the doctor and dietician concerning the appropriate **nutrients** to consume in solid and liquid form and the **antidiabetic drug dosages** (pills or insulin) to be taken when illness makes it impossible to follow a normal diet.

Suggested approach to the detection and treatment of diabetic acidosis and/or hyperosmolar states			
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* Diabetic acidosis

** Hyperosmolar state

SLIDING SCALE FOR ADJUSTING INSULIN DOSES ON SICK DAYS

For example, in addition to units calculated for meals, one unit of rapid- or short-acting insulin may be added for each mmol/L above a blood glucose level of 14 mmol/L before each meal, at bedtime or if necessary, at night.

Example: **Lunch:** Carbohydrate content of meal = 60 g
 Ratio = 1.0 unit/10 g of carbohydrates
 Blood glucose = 23 mmol/L
 Ketone bodies = moderate
 If measured in the urine: 4 mmol/L
 If measured in the blood: 1.5 to 3 mmol/L

Inject:

1) **Meal:**

$$\frac{1.0 \text{ unit} \times 60 \text{ g}}{10 \text{ g}} = 6 \text{ units}$$

2) **Adjustment of insulin doses for sick days:**

$$23 \text{ mmol/L} - 14 \text{ mmol/L} = 9 \text{ units for dosage adjustment}$$

3) **total amount to inject:**

$$6 \text{ units for the meal} + 9 \text{ units for dosage adjustment} = 15 \text{ units}$$

SUMMARY

Appropriate action is determined on the basis of:

- 1) blood sugar levels;
- 2) the presence or absence of ketone bodies in the blood or urine;
- 3) the presence of signs and symptoms.