Diabetic Ketoacidosis:
Evidence based review

Written for the College of Emergency Medicine e-learning programme in collaboration with Doctors.net.uk
Context

Diabetic ketoacidosis (DKA) is a life-threatening condition. It may present in a known patient with diabetes or in a previously undiagnosed patient, and occurs in both adults and children. Acute precipitants of DKA include insufficient or absent insulin administration, and conditions that increase circulating stress hormones, such as infection, myocardial infarction and trauma. It may be the first presentation of diabetes in type 1 diabetic patients.

The main features of the disorder are hyperglycaemia, metabolic acidosis and heavy ketonuria. Fluid depletion is an additional feature and, in severe cases, hypovolaemic shock may occur.

Pathophysiology

DKA is a state of uncontrolled catabolism and insulin deficiency.

Hyperglycaemia

Insulin deficiency leads to a reduction of glucose transfer into the cells. The intracellular hypoglycaemia leads to an increase in stress hormone production (including glucagons, catecholamines, cortisol and growth hormone). These hormones increase gluconeogenesis and glycogenolysis, thereby increasing the blood glucose levels.

Metabolic acidosis and ketonuria

The increase in circulating glucagon and catecholamines stimulate lipolysis, which leads to the breakdown of triglycerides into fatty acids. The fatty acids are oxidised to form ketone bodies; accumulation of these ketone bodies leads to metabolic acidosis and urinary excretion, which produces a heavy ketonuria.

Fluid depletion

Hyperglycaemia leads to an osmotic diuresis with loss of fluid and electrolytes and reduced renal perfusion. In addition, metabolic acidosis leads to vomiting, which exacerbates the dehydrated state.
Clinical features and causes

The acute presentation is of a dehydrated and possibly shocked patient with deep rapid respiration (air hunger/ Kussmaul breathing) and symptoms of ketosis, e.g. nausea and vomiting.

There may be:

- fetor (smell of ketones on the breath) and abdominal pain
- features of an underlying illness, such as acute myocardial infarction or infection
- reduced conscious level and coma

History may determine a reduction in insulin use if the patient is known to have diabetes. It is important to establish the presence (or absence) of hypovolaemic shock and the patient’s state of dehydration as this will guide fluid management. The patient may be tachycardic, have a normal or low blood pressure, and dry mouth and skin.

Management

The management of DKA can be stratified as below:

1. Replace the fluid loss

If the patient is shocked, resuscitation should commence in the standard fashion – oxygen and fluids via wide bore cannulae with monitoring (including cardiac, pulse and blood pressure monitoring). If the patient is not shocked the fluid replacement should be tailored for individual needs. A suitable starting regime is 2 l of 0.9% saline over four hours (500 ml/h). More “traditional” regimes of rapid administration of large volumes of fluid should be avoided because of the risk of precipitating cerebral oedema or renal or cardiac failure. Repeated assessment of fluid status will allow this to be tailored to the individual.

If the patient has high/ rapidly rising sodium levels, which can occur as a consequence of treatment (the water and potassium move into the cells and the sodium moves out), 0.45% saline can be considered.

2. Replace the insulin

An insulin infusion of soluble insulin (e.g. actrapid) is required to control the hyperglycaemia. Some practitioners start with a bolus dose while others start with the infusion. The aim is to reduce the blood glucose by 2–4 mmol/h. If the reduction is too rapid it increases the risk of cerebral oedema. There is variation in practice here and little evidence to support one particular strategy.
3. Monitor/ replace potassium

Fluid and insulin administration will lead to a fall in serum potassium as potassium moves from the extracellular to intracellular compartment. Significant hypokalaemia is a life-threatening complication of DKA management. Potassium replacement should be started after fluids and insulin have been commenced and when the serum level is below the upper limit of normal (usually 5.5 mmol/l).

4. Management of acidosis

Bicarbonate administration should be avoided in DKA; there is no evidence that it is beneficial and is in fact potentially harmful. It can worsen intracellular acidosis, hypokalaemia and arrhythmias and also contributes a high sodium load to the patient. The acidosis will improve as the ketone bodies are removed and the patient is hydrated. It is sometimes given in an intensive care setting if severe acidosis is present and affecting myocardial function.

Close observation and review of the clinical and biochemical state is crucial, along with repeated urea and electrolytes, blood glucose and urine output monitoring. Therapy should be adjusted accordingly and the blood glucose measured hourly.

Glucose should be provided as 5% dextrose once the patient’s blood sugar approaches the normal range (around 15 mmol/l). Insulin needs to be continued until the ketosis has cleared and the pH has normalised.

Abdominal pain may be a feature of DKA. This may be as a result of an additional pathology or a part of the presenting features of the disease itself. Such patients should have a nasogastric tube placed. The mechanism of abdominal pain in DKA is poorly understood but gastric distension, hypovolaemia and electrolyte disturbance may contribute. Symptoms resolve as medical treatment restores the patient to normality. In the event of an underlying surgical problem, the patient's biochemical state should be treated prior to surgical intervention to reduce intra-/ post-operative mortality.

All patients with DKA need education on how to avoid the condition again. It is essential that patients understand how to manage their diabetes if they develop an infection or other illness. Thrombo-prophylaxis is indicated if the patient is likely to be immobile for more than 24 hours, in line with the management of other conditions. It should be considered in all patients with DKA.

Complications of therapy

Cerebral oedema may occur and has a high mortality rate. Avoid excessive use of fluids and rapid reductions in plasma glucose. Hypo-/ hyperkalaemia is avoidable with appropriate monitoring and therapy, as is hypoglycaemia.