Diabetic ketoacidosis (DKA) is the leading cause of death before the age of 30 in people with type 1 diabetes, therefore prompt diagnosis and treatment is vital. This article provides some clinical case studies to illustrate how the presentation of DKA can vary and offers some pointers to aid recognition in patients of all ages.

Diabetic ketoacidosis (DKA) is a condition that all doctors have some familiarity with. In primary care, it is not particularly common. Detailed analysis of the incidence rate of DKA is beyond the scope of this article but we estimate most practices are likely to see at least one case of DKA per year. It is a condition sufficiently well known that GPs are expected to recognise it and admit the patient for treatment in timely fashion.

Both in adult medicine and in paediatrics, the treatment is routine and protocol driven. It is based primarily on fluid replacement with saline, continuous low-dose insulin infusion and the management of electrolytes, particularly potassium. In children, the regimen is modified according to body weight. Young patients are monitored for the serious complication of cerebral oedema. In recent years, successive protocols have employed more conservative approaches to fluid replacement and insulin infusions, although current thinking is that different fluid regimens do not modify the risk of cerebral oedema. Recovery from DKA will generally occur as long as the diagnosis has not been unduly delayed for any reason and the patient is not critically ill before treatment is started.

Failure to make a timely diagnosis can have a catastrophic outcome, made worse by the fact that most patients are children or young adults. In established (previously diagnosed) diabetes, there should be less difficulty in identifying DKA. If the patient is unwell, blood glucose is immediately checked. The wide availability of blood ketone monitors (now preferred to urine testing) aids diagnosis: they measure beta-hydroxybutyrate and values >3mmol/L are strongly suggestive of DKA. A test for ketones is particularly helpful in patients who may have euglycaemic ketoacidosis (e.g. in pregnancy or with the use of SGLT2 inhibitors).

However, serious diagnostic failures can occur in patients known and not known to have diabetes. The aim of this article is to discuss the presentation of DKA in primary care in the
hope that delayed diagnosis can be avoided. We consider both adults and children: there are common features and differences in the presentation. Ultimately, the diagnosis is biochemical where the diagnostic criteria are the same for all ages: generally glucose >16mmol/L, pH<7.3 and beta-hydroxybutyrate >3mmol/L.

**Case studies**

Consider the following cases of DKA.

**Case 1**

A 42-year-old painter and decorator had a history of anxiety and depression but no history of diabetes. He had been working outside in the summer and became thirsty, drinking large quantities of water. His mother thought he had sunstroke. She spoke to a triage nurse at a national GP deputising service and said that he was “muddled and mumbling”, his breathing was erratic and his breath smelled “like pear drops”. The locum GP who visited advised that the patient was depressed and should see his own GP the next day. At Sheffield Crown Court in 2013, the GP admitted causing the man’s death by gross negligence manslaughter and received a two and a half year custodial sentence.³

**Case 2**

A 13-year-old boy (previously well and not known to have diabetes) was unwell with a respiratory infection, probably viral, initially at least. He had a bad cough and also extreme fatigue. He was polyuric and had lost weight. A visiting GP diagnosed a chest infection. The following day, the boy had become very ill. The ambulance paramedic found a high blood glucose value. He was taken to hospital but died despite emergency treatment.

**Case 3**

A 40-year-old woman, not known to have diabetes, asked for a home visit by her GP. She complained of abdominal pain and vomiting. The doctor’s provisional diagnosis was gastroenteritis and he advised an increased oral fluid intake. The patient remained at home. The following day, the doctor returned to assess her progress and found her extremely unwell with signs principally of dehydration and precoma. She was admitted to hospital where a diagnosis of severe DKA was rapidly established. On the standard treatment regimen, her blood glucose gradually reduced to 12mmol/L but she failed to recover movement. Further investigation identified a serum phosphate level of 0.2mmol/L (low serum phosphate can be a consequence of insulin treatment in DKA). With intravenous phosphate and continued insulin, she made a good recovery.

**Case 4**

A middle-aged woman went to see her GP complaining of abdominal pain and vomiting. She was known to have gastroesophageal reflux disease and had previous attended with similar symptoms. She was known to have poorly controlled type 1 diabetes. On examination, there was some epigastric tenderness. She was unable to provide a urine specimen. Her blood glucose was 22mmol/L, which was similar to other results in her monitoring diary. The patient felt her diabetes was not unusually deranged. She was unwilling to go to hospital so, despite the GP’s concerns, she went home. The doctor tried to telephone the patient first thing the following morning to ask about her progress but she had died. At coroner’s autopsy, death due to DKA was recorded.

**Case 5**

It was during my first medical registrar job [JNH]. Adjacent to the District General Hospital where I was working was a large psychiatric hospital with many long-term inpatients. I was asked to see a 60-year-old resident patient. The lady gave no coherent history (because of learning difficulties) but the nursing staff felt she was not her usual self and that she was physically unwell. On examination, she was mildly dyspnoeic at rest in bed. She was not anaemic, there were no abnormal signs in the heart or chest and no obvious lower limb venous thrombosis. A chest X-ray was normal. Although not the only possibility at this stage, it occurred to me that her dyspnoea could be due to metabolic acidosis, most likely DKA. She was transferred to the medical unit where DKA (a new diagnosis of diabetes) was confirmed and she made a good recovery on standard treatment.

**Discussion**

Type 1 diabetes is relatively common in the UK. In children under 15 years of age, data from Wales show an incidence rate of slightly less than 30 new cases of type 1 diabetes per 100,000 children per year.⁴ This is not far behind Scandinavia, which has the highest incidence rate of type 1 diabetes in the world. A survey in Wales by the Brecon Group (Welsh paediatricians with an interest in diabetes and endocrinology) showed approximately 25% of children first present in DKA. The proportion in DKA at first presentation of type 1 diabetes has not reduced over the years despite efforts to improve early diagnosis.⁵ The most recent data show the proportion presenting with DKA has changed little in most countries but is increasing in the USA.⁶ A recent analysis of mortality in type 1 diabetes before the age of 30 years showed that DKA remains the most common cause of death.⁷ Most of this mortality is in established diabetes with a much smaller proportion due to failure to make the diagnosis at first presentation.

The symptoms of DKA are increased thirst, polyuria and polydipsia, tiredness and fatigue, anorexia, abdominal pain, nausea and vomiting, dizziness and dyspnoea. Ketones may be detectable on the breath. Untreated, the condition progresses with features of dehydration, increasing metabolic acidosis, prostration, coma and death. It is overly simplistic to think that polydipsia and polyuria will always be the dominant symptoms and obvious in all cases.

The above case studies are all real cases that illustrate potential causes of a missed diagnosis. A child may be so thirsty that he wants to drink from the tap but thirst and polyuria can be much less obvious, particularly in younger children, although they are usually present if sought. Fatigue, excessive prostration and especially weight loss over time suggest a more chronic component to a presenting complaint of infection. In
these circumstances, underlying new-onset type 1 diabetes should be considered. Abdominal pain and vomiting can lead to a presumed diagnosis of gastroenteritis. These are common symptoms in children with DKA and can result in surgery for supposed appendicitis, a textbook misdiagnosis. Metabolic acidosis from DKA will cause dyspnoea, which may also be the predominant symptom, as described in case 5 above.

The presentation of DKA is more variable than generally appreciated (see Table 1). The age range for first presentation of type 1 diabetes is wide and, albeit rare, may occur in early childhood. Antibody testing has shown us that there is more type 1 diabetes in older people than previously thought. Subsequent reassessment of unclear cases is generally worthwhile. In unwell patients where the diagnosis is not clear, a low threshold for testing blood glucose and ketones is advisable.

The diagnosis is more difficult in children under age five years and more often delayed such that there is more DKA at first presentation in this group. Small children have less buffering capacity, decompensate more rapidly and may have more rapid autoimmune-mediated beta-cell destruction. Listening to the views of the family is often helpful. Repeated episodes of DKA suggest psychological adjustment issues or mental health disturbance: in teenagers, consider eating disorders. In younger children, parental neglect can be a factor, raising safeguarding issues.

It is perhaps surprising that the majority of deaths due to DKA occur in patients already known to have diabetes. Clearly, some patients underestimate the seriousness of their own condition. This may occur on the background of a rather relaxed approach to their own long-term glycaemic control. The potential consequences of missing the diagnosis of DKA are serious, both in newly presenting type 1 diabetes and in established diabetes.

Conclusion

DKA is uncommon in primary care yet when it does occur, the diagnosis must be made or readily preventable death may be the outcome. DKA remains the leading cause of death before 30 years of age in people with type 1 diabetes. The presentation is not always straightforward. We believe the symptoms are more varied than generally appreciated. This article provides clinical examples and suggests pointers that we hope will be helpful.

References


Declarations of interest

None to declare.

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