Lessons from practice

# The risk of ketogenic diets while breastfeeding: severe euglycaemic ketoacidosis

## Clinical record

A 31-year-old Caucasian woman presented to the emergency department with a 1-day history of vomiting and lethargy, but no other symptoms. Her medical history included a normal vaginal delivery 9 weeks before, appendicectomy in 2011, and pyelonephritis in 2010. Her pregnancy was uncomplicated, and she exclusively breastfed her baby every 3 hours. She was not taking any medications. Four days before presentation, she commenced a ketogenic diet and was fasting each day until midday, losing 2.5 kg during these 4 days, having had a normal diet previously. She reported an intake of 7530 kJ per day and was walking for 30 minutes daily. Her diet consisted of animal protein and low carbohydrate vegetables, with the aim of reducing carbohydrate intake below 50 g daily. There was no personal or family history of diabetes, and no recent alcohol or recreational substance use. On examination, she was afebrile and haemodynamically stable with blood pressure of 121/80 mmHg, a heart rate of 116 beats per minute, a respiratory rate of 20 breaths per minute, and oxygen saturation of 99% on room air. Her body mass index was in the mildly overweight range at 26 (normal range, 18.5–24.9). Investigations showed high anion gap acidosis (28 mmol/L; reference interval [RI], 12–20 mmol/L) with a baseline venous pH of 7.08 (RI, 7.30–7.40), a bicarbonate level of 6 mmol/L (RI, 22–32 mmol/L), arterial blood gas base excess of – 24 mmol/L (RI, – 3–3 mmol/L), high levels of serum ketones (7 mmol/L; RI, < 0.8 mmol/L), and normal levels of lactate (0.7 mmol/L; RI, ≤ 2.0 mmol/L) and blood glucose (4.2 mmol/L; RI, 3.5–7.7 mmol/L). Her serum potassium level was 4.2 mmol/L (RI, 3.2–5.0 mmol/L), her creatinine level was 69 µmol/L (RI, 45–90 µmol/L) and estimated glomerular filtration rate was > 90mL/min/1.73m$^2$. Urinalysis did not suggest underlying infection. She was managed with intravenous thiamine, 5% dextrose, Hartmann's solution and potassium supplementation during an overnight admission, in addition to encouraging oral intake of simple carbohydrates such as apple juice. The following morning a venous blood gas sample showed resolution of ketoacidosis, with a pH of 7.36, and levels of bicarbonate (25 mmol/L), ketones (0.2 mmol/L) and blood glucose (6.7 mmol/L) within normal range. She felt well and was discharged home that day, with advice to increase carbohydrate intake, particularly while breastfeeding. At outpatient follow-up, she was progressing well in the community and maintaining a higher carbohydrate intake while breastfeeding.

## Discussion

The most common causes of ketoacidosis include diabetes, starvation, alcohol and inborn errors of metabolism.[1] Ketoacidosis in the context of lactation, a form of starvation ketoacidosis, is a rare phenomenon. However, the number of cases reported has increased in the past 5 years, the precipitant in most of these cases being a very low carbohydrate diet with or without calorie restriction in the context of a breastfeeding mother.[1] When restricting carbohydrate intake to less than 50 g per day, as occurs in a ketogenic diet, glycogen stores deplete and gluconeogenesis becomes the primary mechanism by which glucose is produced. Eventually, glucose availability becomes insufficient and ketone bodies are produced as an alternative energy source. This state of ketosis is considered safe and even desirable in order to maintain the benefits of the ketogenic diet — mainly reduced appetite, increased lipogenesis and increased lipolysis to cause weight loss.[2]

A study found that the increased glucose requirements during 42 hours of fasting in lactating women are met by increased gluconeogenesis and ketosis, with pro-ketogenic glucagon levels rising in lactating women by 30 hours fasting to almost twice the levels found in non-lactating women.[3] Therefore, the increased energy demands of lactation in addition to the increased reliance on hepatic gluconeogenesis during both ketogenic dieting and lactation were believed to be the combination of factors causing ketoacidosis, rather than the physiological state of ketosis in this cohort.[3]

A similar situation occurs in bovine ketoacidosis, a condition seen in lactating cattle, believed to occur as a result of their exclusive dependence on hepatic gluconeogenesis for milk production.[1]

Most cases of lactation ketoacidosis have presented within 3 months post partum, but have been reported as late as 10 months post partum.[4] Ketoacidosis can occur rapidly after significant carbohydrate restriction in lactation; in our patient within 4 days and in others within 10 days.[4] Unlike our case, most other cases have occurred in the context of intercurrent illness,

### Lessons from practice

- Severe life-threatening ketoacidosis can occur in lactating women who severely restrict their intake of carbohydrates and/or calories to lose weight post partum, for example, with a ketogenic diet.
- Health care professionals should strongly advise breastfeeding women against severe carbohydrate and/or calorie restriction in order to prevent ketoacidosis.
- These messages should be a routine part of antenatal and community nurse education programs for pregnant and breastfeeding women.

**Nardeen S Habashy**[1]
**Hwang Tan**[1]
**Emily J Hibbert**[1,2]

**1** Nepean Hospital, Sydney, NSW.
**2** Nepean Clinical School, University of Sydney, Sydney, NSW.

**nardeen.said@health.nsw.gov.au**

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where other insulin counter-regulatory hormone levels are high in addition to glucagon. In most cases, women have been advised to stop breastfeeding. However, our patient was able to safely continue breastfeeding with increased carbohydrate intake.

With the recent increasing popularity of the ketogenic diet, this case highlights the importance of greater awareness by both health care professionals and the general public of this life-threatening condition, its symptoms, and the need to prevent it by encouraging lactating women to maintain a well balanced diet with adequate carbohydrate and energy intake.

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References are available online.

1 Nnodum BN, Oduah E, Albert D, Pettus M. Ketogenic diet-induced severe ketoacidosis in a lactating woman: a case report and review of the literature. *Case Rep Nephrol* 2019; 2019: 1214208.

2 Paoli A, Rubini A, Volek JS, Grimaldi KA. Beyond weight loss: a review of the therapeutic uses of very-low-carbohydrate (ketogenic) diets. *Eur J Clin Nutr* 2013; 67: 789–796.

3 Mohammad MA, Sunehag AL, Chacko SK, et al. Mechanisms to conserve glucose in lactating women during a 42-h fast. *Am J Physiol Endocrinol Metab* 2009; 297: E879–E888.

4 von Geijer L, Ekelund M. Ketoacidosis associated with low-carbohydrate diet in a non-diabetic lactating woman: a case report. *J Med Case Rep* 2015; 9: 224. ■