

Relapse of diabetic ketoacidosis secondary to insulin pump malfunction diagnosed by capillary blood 3-hydroxybutyrate

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Citation

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Abstract

A 14 year old female with type 1 diabetes mellitus and a subcutaneous insulin pump was treated for diabetic ketoacidosis presumed secondary to dietary indiscretion, and then restarted her subcutaneous insulin pump after exchanging the tubing. An hour later, nursing review determined that she was using outdated insulin in the pump, and it was exchanged. However, 5 hours later relapse was suggested by a rise in capillary blood 3-hydroxybutyrate, in spite of a normal serum anion gap and a minimal increase in serum [bicarbonate]. Insulin pump failure was suspected, and the patient was treated for relapse of diabetic ketoacidosis. Following resolution, her insulin pump was replaced (due to malfunction) without further complications. Capillary blood levels of 3-hydroxybutyrate may be sensitive, early indicators of relapse of diabetic ketoacidosis, and are easily obtained.

INTRODUCTION

A capillary blood assay for 3-hydroxybutyrate (BHB) has been used at home[1], in hospital emergency departments[2, 3], and during hospitalization[4-7] to diagnose and help manage patients with diabetic ketoacidosis (DKA). Capillary blood BHB tests have been used to document the persistence of ketones even while the urine nitroprusside test for ketones showed their clearance during therapy for DKA[8], and one might predict that these capillary blood BHB tests would have utility in detecting relapse following therapy for DKA. Nevertheless, capillary blood BHB testing is not yet routinely available in all children's hospitals, though such testing is "a useful adjunct to laboratory-based determinations"[9].

An adolescent with a subcutaneous insulin pump and DKA is reported with an early relapse due to insulin pump malfunction, diagnosed by an increase in capillary blood BHB prior to any increase in the anion gap or decline in serum [bicarbonate]. This case provides further support for the need to monitor capillary blood BHB during therapy for pediatric DKA.

CASE REPORT

A 14 year old female with type 1 diabetes mellitus and therapy with a subcutaneous insulin pump for a year, was admitted with severe[9] DKA (arterial blood gas pH 6.96),

with serum [glucose]: 816 mg/dL, PaCO₂: 17 mm Hg, serum anion gap: 38, and 3+ ketones on serum nitroprusside test. She noted dietary indiscretion. After written informed consent and with IRB approval (University Hospital, University of Medicine and Dentistry of New Jersey in Newark, New Jersey), hourly testing of capillary blood BHB (using the Precision Xtra System for BHB; Abbott Laboratories, MediSense Products Inc; Bedford, MA) was performed concurrently with glucose (fingerstick) testing (Figure). Her insulin pump was discontinued, and she received a continuous infusion of intravenous insulin (0.1 to 0.14 units/kg/hr) and rehydration. The serum anion gap and capillary blood BHB fell to normal levels (<12 and <0.5 mmol/L, respectively) at 14 hours. Due to persistent metabolic acidosis, the insulin infusion was continued for a total of 42 hours, when serum [bicarbonate] was 18 mmol/L. She felt much better and resumed her regular diet and therapy with her subcutaneous insulin pump (after changing all pump tubing) at the suggestion of her endocrinologist.

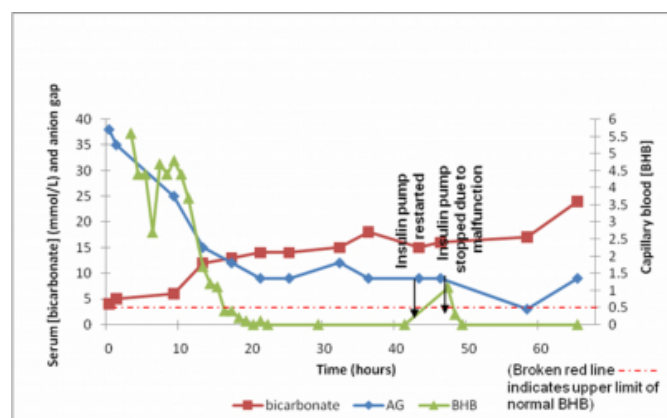
Serum [bicarbonate] fell to 15 mmol/L while serum [chloride] increased to 116 mmol/L (serum anion gap: 9) less than 1 hour later: this was attributed to excessive chloride repletion. Subsequently, she had a meal as well as a snack. Within an hour of restarting the insulin pump, nursing staff determined that the patient had been using outdated insulin, and this was rectified. She was given several extra

doses of subcutaneous (regular) insulin over the next 4 hours. Five hours after discontinuation of the intravenous insulin infusion, serum [bicarbonate] rose slightly to 16 mmol/L and the anion gap was 9, though hyperglycemia recurred (serum glucose: 501 mg/dL).

Simultaneously, capillary blood BHB rose to 1.1 mmol/L. The insulin pump was again stopped and the patient received 20 more hours of intravenous insulin infusion and hydration; her serum [bicarbonate] was then 24 mmol/L with euglycemia. The pump was then replaced due to a malfunction, and the patient was discharged home without further complications.

Figure 1

Figure: Serum [bicarbonate] and anion gap (AG) with capillary blood BHB in patient with DKA and subcutaneous insulin pump.



DISCUSSION

An episode of DKA in a patient with a subcutaneous insulin pump mandates a detailed review to discover the cause: in this patient, a dietary indiscretion was initially suspected, though outdated insulin was subsequently noted and exchanged. However, mechanical pump failure complicated this case, and was responsible for relapse shortly following resumption of a normal diet.

At the time relapse was diagnosed, the serum [bicarbonate] had increased slightly, the anion gap was within normal limits, and postprandial hyperglycemia was noted. Hyperchloremic metabolic acidosis associated with saline replacement of fluid deficits was suspected until the capillary blood BHB was tested. In spite of recent supplemental doses of insulin, the capillary blood BHB level in our patient confirmed relapse of DKA[10], secondary to subcutaneous insulin pump malfunction. It is likely that

supplemental doses of regular insulin blunted the degree of hyperketonemia and associated metabolic acidosis, such that diagnosis of a relapse might have been delayed in the absence of capillary blood BHB testing.

Multiple etiologies for DKA may be present in patients treated with a subcutaneous insulin pump, as in this patient. Capillary blood BHB may be particularly helpful in detecting relapse: a fingerstick BHB level is easily obtained at the bedside in conjunction with a glucose level and does not entail significant delays in processing. Further research regarding the potential utility of capillary blood BHB in this setting is indicated. Capillary blood BHB levels may be particularly helpful for monitoring children hospitalized with a subcutaneous insulin pump[11].

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