CASE REPORT

Diabetic Ketoacidosis in End Stage Renal Failure Patient On Maintenance Dialysis – Key Challenges in Management

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ABSTRACT

Diabetic ketoacidosis (DKA) is a medical emergency which requires prompt management to prevent mortality. Treatment is complicated in end stage renal failure (ESRF) patients due to their altered physiology in sugar metabolism and fluid haemodynamics. To date, there are only a few case reports illustrating the presentation and management of DKA in ESRF patients and a definite guideline on treatment of DKA in ESRF is seriously lacking. We report here a case of an ESRF patient on maintenance haemodialysis, who develops DKA due to missed insulin, and outline our successful treatment plan. We hope our reported case report research can further contribute to the knowledge of DKA management in ESRF.

Keywords: Diabetic ketoacidosis, End stage renal failure, Management

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INTRODUCTION

Diabetes ketoacidosis (DKA) is an endocrine emergency, defined as a triad of hyperglycemia (blood glucose >11 mmol/L), ketonaemia (serum ketone ≥ 3 mmol/L or ketonuria >2+ on urine dipstick), and acidosis (serum bicarbonate <15 mmol/L and/or venous pH <7.3) (1). In this article, end stage renal failure (ESRF) is defined as dependent on dialysis irregardless of the glomerular filtration rate.

DKA is attributed to insulin deficiency and increase in stressor hormones causing hyperglycaemia. Hyperglycaemia in return, causes osmotic diuresis and dehydration. Fatty tissue breakdown occurs as an alternative metabolism, releasing ketone and acid into the bloodstream. Mortality of 3.9% due to DKA was reported in UK from year 1971 to 1991 (1). The mortality rate of DKA in Malaysia setting is higher at 17.6 % (2).
The mainstay therapy for DKA revolves around adequate fluid replacement, insulin administration, electrolytes correction, and treating the precipitating factor. However, in ESRF, especially aneuric one who depend on regular dialysis, treatment could pose a challenge as they can easily go into fluid overload with fluid replacement, insulin tend to remain longer in body due to reduced renal excretion, and potassium replacement may not be required as per non-dialysis patients. To this day, there is no definite guideline on how to manage DKA in ESRF patients and judicious clinical assessment is required to guide our treatment for this population.

CASE REPORT

A 63-years-old-lady with underlying hypertension, dyslipidaemia, and type 2 diabetes mellitus (T2DM), which was complicated by diabetic retinopathy and nephropathy, had ESRF for almost a year. She had minimal urine output, of less than 200 mL daily. She had been undergoing haemodialysis via right intrajugular catheter regularly three times weekly while awaiting fistula creation. She was prescribed on a strict fluid restriction of 500ml daily. In November 2018, she was admitted for catheter-related blood stream, during which she was incidentally diagnosed to have a right atrial myxoma. Hence, she was referred to the cardiothoracic team for mass excision. On the day she was electively admitted for the atrial myxoma surgery, she experienced reduce appetite and missed three of her usual bolus insulin injection. Her capillary blood sugar revealed high index pre-dinner. On examination she was not lethargic, not tachypnoeic, euvolaemic, afebrile and has no signs of circulatory shock. Her random venous glucose was 55.8 mmol/L. Her venous blood gas showed pH of 7.328, bicarbonate of 13.8 and partial carbon dioxide level of 29 mmHg. She had minimal urine output on catheterization and urinalysis showed the presence of ketone of 2+ and glucose of 3+. Her serum ketone was 5.5 mg/dl (normal ketone <1) and potassium of 4.3 mmol/l. She was diagnosed to have diabetic ketoacidosis. Table 1 summarized her blood

Table I: Summary of blood investigations and treatment regime given to the patient, with an estimated body weight of 60kg

	28/12/18 4pm	28/12/18 9.30pm	29/12/18 2am	29/12/18 6am	29/12/18 2pm	29/12/18 5.10pm	30/12/18 1 am
Urea (mmol/l)	22.7	23	21.6	22.3	22.4	10.4	11.9
Na(mmol/l)	124	127	131	135	133	135	136
K (mmol/l)	4.3	3.6	3.1	3.1	4.2	3	4.2
Cl (mmol/l)	85	89	96	98	101	97	98
Creatinine (µmol/l)	409	417	384		399	191	235
Hb (g/dl)	8.4						7.8
Hct (%)	29.3						24.3
Platlet (x10^9/l)	553						465
WCC (x10^9/l)	18.4						18.6
Urinalysis	Blood trace, urobilinogen trace, ketone 2+, protein 2+, glucose 3+, leu 1+						
Glucose (mmol/l)		55.8	36.5	5.1	19	14	8-11
Blood gas		pH 7.328, HCO3 13.8, BE -8.7	pH 7.315, HCO3 21.1, BE -4.9	pH 7.317, HCO3 21.8, BE -4.3	7.39, HCO3 23.5, BE -1.2	7.372, HCO3 27.4, BE 1.4	
CRP (mg/l)		200					
Insulin regime		S/C Actrapid 36 units bolus and infusion of 11 units for 1 hour, then 4 units per hour	Insulin infusion 4 units per hour	Insulin withheld	Insulin infusion 1 units per hour		Overlap infusion with basal boluses S/C Actrapid 6 units pre-meals and S/C Insulatard 12 units pre-bed
Fluid regime		Normal saline 1L over 1 hour, then 1L over 24 hours	Normal saline 1L over 24 hours	Dextrose 10% 1L over 24 hours	Normal saline 1L over 24 hours		Normal saline 500mL over 24 hours
Potassium replacement		1g KCl over 24 hours	1g KCl over 24 hours	1g KCl over 1 hour			
Hemodialysis					4 hours HD, UF 1.5L		

parameters and her treatment regime. Total fluid given on 28/12/18 was 2L normal saline; on 29/12/18 was 1L in total of a mixture of 700mL normal saline and 300 mL 10% dextrose; and on 30/12/18 was 500mL normal saline. Potassium replacement was given one gram on 28/12/18 and 2g on 29/12/18, as per requirement. Blood culture was taken and she was given intravenous amoxicillin-clavulanate to cover for a possible catheter-related infection. Her blood cultures subsequently came back with no growth and the antibiotic was discontinued after five days.

DISCUSSION

Diabetes mellitus is a common cause of end stage renal failure but it is uncommon for ESRF patients to develop DKA. ESRF patients have increased insulin secretion, lower insulin sensitivity, reduced renal gluconeogenesis, and reduced or absence of urine output precluding dehydration (3). Fluid loss from body is usually not from osmotic diuresis as these patients may have minimal to no urine output. Instead, fluid loss may happen if there is gastrointestinal loss. The altered physiology in patients with terminal renal impairment often leads to minimal symptoms of DKA and eludes early detection. It is due to the same reasons above that it is more difficult to treat DKA in ESRF, as they are more likely to respond to lower doses of insulin, and develop fluid overload state with the regular fluid regime prescribed for DKA, as fluid deficit may not be as much as in non- ESRF patients. There are a few case studies discussing about management of DKA and ESRF patients, but definite guideline is currently lacking (4).

The patient above had her DKA resolved within 24 hours with a fraction of the regular fluid resuscitation volume along with regular monitoring and careful insulin regime. Fluid replacement is recommended to be done in small boluses and with regular clinical fluid assessment to prevent pulmonary oedema and cerebral oedema. Frequent serum potassium monitoring is compulsory and replacement is only recommended with presence of hypokalaemia during pre-haemodialysis. Unlike normal population, maintenance potassium is not required as ESRF patients tend to have hyperkalaemia. Insulin administration is carefully titrated and reduced as soon as hyperglycaemia is controlled and ketonaemia is resolved. Patients undergoing haemodialysis need frequent blood sugar monitoring as they can get hypoglycaemic with haemodialysis. Any stressor or cause of insulin deficiency must be identified immediately and to be corrected as soon as possible.

Frequency of haemodialysis in patients with DKA is determined by the clinical status of the patient, and is affected by the fluid status, acidosis and potassium level. The usage of haemodialysis in the treatment of DKA is controversial and has not been systematically studied in ESRF patients. Traditional urgent indications such as pulmonary edema and hyperkaelemia are the main reasons for acute dialysis in DKA. Carrying out earlier than usual dialysis in patients with DKA without clear indications can cause rapid decrease of serum tonicity, which can thereotically cause cerebral oedema. Administration of sodium bicarbonate in this population is not recommended, as this often leads to hypernatremia, volume expansion and increased osmotic pressure. Gradual reduction of osmolality in DKA patient is the key to reduce the chance of developing cerebral oedema (5). The key management points for managing DKA in ESRF versus normal population is outlined in table II. Although the response to therapy and mortality of DKA in patients with and without ESRF is similar, patients with ESRF were older, presented with more severe hyperglycaemia and had longer hospital admissions, hence a multidisciplinary team effort consist of nephrologist, endocrinologist, physician, primary care doctors and diabetic nurse educator are crucial in ensuring the best clinical outcome.

Table II: Differences in management of DKA patients with ESRF versus normal kidney function

Key differences in management	Normal kidney function patients	ESRF patients
Insulin regime	Insulin infusion at one unit per kg of body weight per hour. After DKA resolves, insulin regime is altered according to sugar reading.	Lower rate of insulin infusion at <1 unit per kg per hour and adjusted according to hourly blood capillary sugar reading. Monitor closely for hypoglycaemia.
Fluid regime	Isotonic fluid boluses (usually normal saline) of one litre for first hour, then one litre for two hours that follows, continued by one litre for four hours. Further fluid regime depends on hydration status of patient, boluses can be repeated as needed. Dextrose fluid can be given if random capillary sugar reduced below normal on insulin infusion, to solve starvation ketosis.	Isotonic fluid boluses at smaller doses, usually 250mL each time, and can be repeated according to fluid status of the patient and individual requirement. Boluses fluid can be given more if patient has residual urine output. Dextrose fluid maintenance can be given if capillary blood sugar reduced with insulin infusion.
Potassium replacement	Maintenance potassium according to daily requirement given routinely, with replacement of boluses of 1-2 g KCl if level falls below 3.5 mmol/L.	Maintenance potassium is not usually given due to hyperkalaemia associated with ESRF. Replacement is only given if it falls below 3.5 mmol/L, and given slowly.
Acidosis	Monitor acidosis closely. For bicarbonate replacement if severe acidosis.	Patient is somewhat accustomed to mild acidosis associated with ESRF. Bicarbonate is not given in anuric patient.

CONCLUSION

Altered physiology in patients with ESRF who develops DKA causes challenges in the management of the endocrine emergency but with judicious use of fluid and insulin, as well as careful correction of electrolytes, the outcome appears to be favorable. Further reviews and analyses are required to develop a guideline on the management of DKA in this population.

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