Case Report

Ketoacidosis can Be alcohol in origin: A case report

May Zaw Soe a, Kuan Ming Ching b, Kai Ming Teah c, Chew Har Lim b, Jabraan Jamil d, Boon Tat Yeap c, *

a Department of Medical Education, Faculty of Medicine and Health Sciences, Universiti Malaysia Sabah, 88400, Kota Kinabalu, Sabah, Malaysia
b Department of Anaesthesiology and Intensive Care, Penang General Hospital, 10990, Georgetown, Penang, Malaysia
c Department of Anaesthesia and Intensive Care, Faculty of Medicine and Health Sciences, Universiti Malaysia Sabah, 88400, Kota Kinabalu, Sabah, Malaysia
d Department of Anaesthesiology and Intensive Care, Hospital Queen Elizabeth 2, 88586, Kota Kinabalu, Sabah, Malaysia

ARTICLE INFO

Keywords:
Alcoholic ketoacidosis (AKA)
Diabetic ketoacidosis (DKA)
Hyperketonaemia
High anion gap metabolic acidosis (HAGMA)
Thiamine

ABSTRACT

Background: Alcoholic ketoacidosis (AKA) is a common reversible biochemical pathology arising from hyperketonaemia in patients with a history of chronic alcohol consumption. It is typically fatal when there is a delay in early recognition and management. A further complicating factor is that this condition is frequently confused with diabetic ketoacidosis (DKA).

Case presentation: This report presents the case study of an elderly Chinese man with a 40-year history of alcohol consumption. The patient presented with acute shortness of breath, generalised abdominal pain, and vomiting. Blood gas analysis indicated severe high anion gap metabolic acidosis (HAGMA) with elevated serum ketones and modest hyperglycaemia which was initially treated as diabetic ketoacidosis (DKA). A diagnosis of AKA was later made after obtaining a thorough history of his binge drinking. The patient subsequently responded well to thiamine and aggressive fluid resuscitation. This case highlights the importance of a well-documented patient history and in-depth knowledge of ketoacidosis.

Discussion: AKA must be suspected in patients with a history of chronic alcohol consumption and dependence. The symptoms are non-specific such as abdominal pain, nausea, vomiting and diarrhoea. The latter two result in malnutrition and starvation subsequently leading to hyperketonaemia, hypovolaemia and HAGMA. AKA should be clearly differentiated from DKA to prevent mismanagement. The mainstay of management of AKA is thiamine, fluid resuscitation and good sugar control to prevent Wernicke’s encephalopathy.

Conclusion: A precise patient’s medical history is crucial to prevent misdiagnosis. A non-diabetic patient with a history of chronic alcohol consumption who presents with severe HAGMA, hyperketonaemia and dysglycaemia should raise a clinical suspicion of AKA. Thiamine and judicious fluid resuscitation as well as electrolytes and malnutrition correction should be promptly initiated in patients with AKA. Good family, social support and rehabilitation programs are crucial to help patients with alcohol abuse.

1. Introduction

Alcoholic ketoacidosis (AKA) is a reversible metabolic emergency that occurs commonly in malnourished patients with chronic alcohol dependency. Although this diagnosis is frequently missed by clinicians in Western Europe due to unfamiliarity with the condition, it is also not common in countries such as Malaysia [1]. AKA is often presented as high anion gap metabolic acidosis (HAGMA) with concurrent ketone bodies accumulation, electrolyte imbalances and dysglycaemia. In view of the recent increase in alcohol-related medical disorders, this report highlights the importance of early recognition of AKA in emergency settings and outlines suggestions for its successful management. This work has been reported in line with the SCARE criteria [2].

2. Case report

A 66-year-old Chinese male (body mass index, BMI of 23kg/m²) with co-morbidity of well-controlled hypertension was admitted to the Emergency Department (ED) with a six-hour history of generalised abdominal pain, distension, and intermittent vomiting. He denied having diabetes mellitus (DM) or engaged in any substance abuse. Upon examination, he was alert, conscious, and lucid but suffered from...
generalised abdominal tenderness. His lips were dry but the capillary refill time (CRT) was <2 seconds. His initial blood pressure (BP) was recorded as 125/72 mmHg, pulse rate (PR) 90 beats per minute, and oxygen saturation (SpO2) was 97% under room air. He was tachypnoeic at 28 breaths per minute with deep laboured breathing (Kussmaul’s breathing). After one hour, he became more tachypnoeic and desaturated to 88% under face mask with 50% oxygen. Since he was observed to be hypotensive and tachycardic, his trachea was immediately intubated for airway support and fluid resuscitation commenced with 20 ml/kg of normal saline 0.9%. Infusion of noradrenaline up to 0.7 mcg/kg/min was necessary to achieve mean arterial pressure (MAP) of >70 mmHg.

Arterial blood gas (ABG) analysis prior to intubation showed severe decompensated HAGMA with a pH of 6.78, pCO2 of 17 mmHg, bicarbonate (HCO3-) of 4 mmol/L and base excess (BE) of −32.6 mmol/L. The calculated anion gap (AG) was 41 mmol/l while the delta ratio (delta AG divided by delta HCO3-) was at 1.45, showing uncomplicated HAGMA (Table 1). Furthermore, the patient had a raised random plasma glucose level of 11.3 mmol/l (normal values: 6–10 mmol/l), hyperlactatemia at 1.6 mmol/l (normal values: < 1.0 mmol/l), and hyperketonaemia of 4.8 mmol/l (normal values: 0.1–0.2 mmol/l) (Table 2). Additionally, a computed tomography (CT) scan of abdomen and pelvis showed acute interstitial pancreatitis with minimal peripancreatic fluid collection (Fig. 1).

The provisional diagnosis was acute pancreatitis complicated by DKA and sepsis. Differential diagnoses include AKA and starvation ketosis. The patient was immediately admitted to the Intensive Care Unit (ICU) where he underwent fluid resuscitation with 20 ml/kg of normal saline 0.9%. However, as his mean arterial pressure (MAP) was 65 mmHg with the addition of noradrenaline infusion of up to 0.5 mcg/kg/30-minute period. The MAP improved slightly and was well above 65 mmHg with the addition of noradrenaline infusion of up to 0.5 mcg/kg/min. Insulin infusion of 0.05 U/kg/hour was initiated to achieve blood glucose levels in the range of 6–10 mmol/l. This was discontinued after 3 h when the levels normalised. He was adequately sedated with infusion of dexmedetomidine at the rate of 0.3–0.5 mcg/kg/hour.

During this period, due to the persistence of HAGMA with hyperketonaemia and normalised sugar levels, our senior intensivist decided to revisit the patient’s case history and consider other possible diagnoses. An interview with the patient’s son provided us with an overview of his father’s active alcohol consumption over the previous 30 years. We learnt that the patient had retired from work six years earlier and had been spending most of his time social drinking with his friends. He consumed alcohol in the form of liquor, whisky, beer and Chinese wine (with up to 40% alcohol concentration) in quantities of about 300–500 ml every 2–3 days. However, he had never developed any alcohol withdrawal symptoms such as anxiety, tremor, diaphoresis or delirium tremens syndrome previously. According to the son, his father had consumed about 750 ml of local compounded hard liquor (Chinese wine with 40% alcohol content) approximately 18–20 hours prior to developing his current acute condition. His last meal was a small portion of rice and chicken, consumed approximately 6 hours before he vomiting.

The patient had an irregular diet and often missed his meals. He normally consumed 1–3 small meals per day comprising fish, chicken, vegetables and rice.

This vital patient information, combined with the clinical context of persistent HAGMA, hyperketonaemia, a stable range of plasma sugar values and HbA1C levels, supported a diagnosis of AKA rather than DKA. Consequently, 600 mg of thiamine was administered intravenously three times a day for 3 days and Ryle’s tube feeding commenced based on a regime of 15 kcal/kg/day. In addition, fluid boluses of Sterofundin® crystalloids of 200 ml were administered every two to 3 h. The patient also received broad spectrum intravenous (IV) antibiotics cover of cefepime due to his ongoing sepsis and pancreatitis. The patient’s serum ethanol level returned as elevated at 3.12 mmol/l the next day. The patient’s haemodynamic status and metabolic acidosis gradually responded to treatment. The noradrenaline infusion was subsequently tapered off and completely withdrawn about 8 h after his admission when the MAP achieved ≥65 mmHg.

The patient was extubated two days later after his ABG fully normalised and serum ketone lowered into the range of 0.1–0.2 mmol/l. He was discharged two days after his pancreatitis resolved with strict advice against any future excessive consumption of alcohol. The patient promised to abide by this advice and has been alcohol-free since his discharge.

3. Discussion

This case highlights several notable issues, which are extremely interesting. Firstly, a thorough and concise overview of patient’s history, focusing on social behaviour such as alcohol consumption, is crucial in the initial assessment. This practice ensures that a diagnosis of AKA will not be overlooked in patients presenting severe HAGMA and hyperketonaemia. Our patient also had pancreatitis - a common complication of chronic alcoholism - which was the most likely cause of the AKA. Secondly, clinicians should understand that DKA alone may not be the sole factor of severe HAGMA and dysglycaemia since an elevated anion gap may present with modest elevations of serum glucose due to an underlying catecholamine-related stress response [3,4]. Thirdly, thiamine administration may prevent Wernicke’s encephalopathy in cases of chronic alcoholism.

AKA must be suspected in any patient with a history of chronic alcohol consumption, dependency and recent history of binge drinking [5]. The symptoms will usually be non-specific such as abdominal pain, nausea, vomiting and diarrhoea [3]. The latter two result in malnutrition and starvation subsequently leading to hyperketonaemia, hypovolaemia, intracellular dehydration, electrolyte imbalances and hyperlactatemia.

In AKA, increased oxidation of ethanol after an alcohol binge will precipitate increased acetate levels due to the action of the enzymes, alcohol dehydrogenase and aldehyde dehydrogenase [6,7]. This will then cause increased synthesis of acetoacetate and beta-hydroxybutyrate ketone bodies [8]. Subsequently, alcohol withdrawal following binge drinking causes acute starvation and reduction in serum insulin levels.

Table 1
Serial ABG and clinical management of the patient during his stay in the ICU.

|                  | Day 1 (Pre-Intubation) | Day 2                  | Day 3 (Pre-Extubation)                  |
|------------------|------------------------|------------------------|----------------------------------------|
| **FI02 (Fraction of Inspired Oxygen)** | Face Mask 50% Oxygen | Synchronised Intermittent Mechanical Ventilation (SIMV) with FI02 0.4 | Continuous Positive Airway Pressure (CPAP) with FI02 0.4 |
| **pH**           | 6.78                   | 7.34                   | 7.39                                   |
| **pCO2 (mmHg)**  | 17                     | 30                     | 35                                     |
| **HCO3- (mmol/l)** | 4                      | 17.3                   | 21.2                                   |
| **Lactate (mmol/l)** | 1.6                    | 1.4                    | 0.8                                    |
| **Sugar (mmol/l)** | 11.3                   | 6.1                    | 6.0                                    |
| **ABG Interpretation** | HAGMA                 | Compensating metabolic acidosis | Compensated metabolic acidosis |
| **Mode of Therapy** | Fluid resuscitation and insulin infusion | Fluid resuscitation, IV thiamine 600mg 3 times per day, and initiation of regular Ryle’s tube feeding of up to 15 kcal/kg/day | Extubated an hour later |
with reflex increase in glucagon, growth hormone, cortisol and catecholamines levels [9]. This in turn enhances hepatic lipolysis and ketogenesis. Since ketone bodies are acidic in nature, they contribute to the pathogenesis of metabolic acidosis. This is further compounded by intravascular hypovolaemia which is most commonly secondary to reduced oral intake. Ultimately, these metabolic and fluid disturbances bring about intracellular hypoxia, hyperlactatemia and reduced renal excretion of ketones that lead to haemodynamic instability (Fig. 2).

It is important to differentiate between AKA and DKA as the inappropriate commencement of an insulin regime will lead to unnecessary hypoglycaemia and the acceleration of alcoholic brain disease [10,11] (Table 3). In-depth assessment of the patient’s history of alcohol consumption prior to the clinical condition is key to a precise diagnosis of AKA. The serum ethanol level may be normal or reduced in AKA while it is absent in DKA [11]. The mainstay of AKA treatment is judicious isotonic fluid therapy to improve cellular hydration, increase renal perfusion, reduce hyperlactatemia and hasten elimination of ketones from the body [12]. Glucose containing solutions are essential to stimulate release of serum insulin and thus break the cycle of ketogenesis. In addition, good sedation in patients at risk of seizure following alcohol withdrawal and allow precise Glasgow Coma Scale (GCS) assessment. In our patient, we chose dexmedetomidine as it possesses excellent anxiolytic and sedative properties [12,13]. Chronic alcohol consumption leads to thiamine deficiency by way of decreased absorption of thiamine from the gastrointestinal tract (GIT) and impaired cellular utilisation [14]. IV thiamine is therefore crucial to prevent Wernicke’s encephalopathy and cardiovascular impairment.

Patients with chronic alcohol consumption, especially those with multiple co-morbidities, do benefit from good social and family support. These may be in the form of psychological, spiritual and morale assistance to enable the patients to abstain from pro-drinking lifestyles [15]. Alyssa et al., in 2017 mentioned that it may be beneficial to help people choose environment, their social contexts and network that are necessary to guide patients with alcohol use disorders (AUD) [16].

The clinical presentation of our patient was similar to the one reported by Noor et al. [4]. However, it is worth noting that our patient was diagnosed with acute pancreatitis as the cause of his generalised

| Table 2: Serum alcohol and ketone levels of the patient during his ICU stay. |

| Normal Ranges | Day 1 (Pre-Intubation) | Day 2 (Post-Intubation Upon Admission To ICU) | Day 3 (At ICU) | Day 4 (Pre-Extubation At ICU) | Day 5 (Post-Extubation) |
|---------------|------------------------|---------------------------------------------|----------------|----------------------------|------------------------|
| Serum Alcohol level (mmol/L) | 0.3 | NA | 3.12 | NA | NA |
| Serum Ketone level (mmol/L) | 0.5 | 4.8 | 1.1 | <0.1 | <0.1 | NA |

Fig. 1. CT abdomen showing peripancreatic fluid accumulation (arrow).

Fig. 2. Relationships between excessive alcohol intake, hyperketonaemia, and severe metabolic acidosis.
abdominal pain, which is a common complication of AKA. The CT findings may indicate early pancreatic inflammatory changes due to alcoholism. Should it not be treated early, it may precipitate into severe sepsis.

4. Conclusion

Precise, and complete documentation of the patient’s medical history is crucial to prevent misdiagnosis. A thorough assessment of patients with a history of chronic alcohol consumption, binge drinking without a background of DM presenting with severe HAGMA, hyperketonaemia and dysglycaemia should immediately raise a clinical suspicion of AKA. Once an AKA diagnosis is established, thiamine and judicious fluid resuscitation as well as electrolytes and malnutrition correction should be promptly initiated. Good family, social support and rehabilitation programs are crucial to help patients with alcohol abuse.

**Patient’s perspective**

I am grateful to the team of anaesthetists and intensivists for their prompt diagnosis of me in the acute condition. I was told by my son that I was critically ill and at the near end of death. I am fortunate to be given a second chance to be alive now. I will repent and avoid alcohol from now onwards. I promise myself and family to lead a healthy normal life.

**Provenance and peer review**

Not commissioned, externally peer-reviewed.

**Sources of funding for your research**

There are no funds received for this manuscript.

**Ethical approval**

This case report does not need any ethical approvals.

**Consent**

Informed and written consents were obtained from the patient and parents involved.

**Author contribution**

Dr Kuan Ming Tan and Dr Chew Har Lim were the clinicians involved in the management of the patient. They are the co-authors for this manuscript as well with Dr Boon Tat Yeap, Kai Ming Teah and May Zaw Soe.

**Registration of research studies**

Not related.

1. Name of the registry:
2. Unique Identifying number or registration ID:
3. Hyperlink to your specific registration (must be publicly accessible and will be checked):

**Guarantor**

Boon tat yeap.

**Declaration of competing interest**

The authors declare that no relevant or material financial interests exist.

**Acknowledgement**

We would like to thank the Director General of Health Malaysia for his permission to publish this article as a case report.

**References**

[1] A. Morton, Ketoacidosis in the emergency department, Emerg. Med. Australasia (EMA) 32 (3) (2020 Jun) 371–376.
[2] R.A. Agha, T. Franchi, C. Sohrabi, G. Mathew, for the SCARE Group, The SCARE 2020 guideline: updating consensus surgical Case Report (SCARE) guidelines, Int. J. Surg. 84 (2020) 226–230.
[3] Wrenn, C. Slovis, G. Minion, R. Rutkowski, The syndrome of alcoholic ketoacidosis, Am. J. Med. 91 (2) (1991) 119–128.
[4] N.M. Noor, K. Basavaraju, D. Sharpstone, Alcoholic ketoacidosis: a case report and review of the literature, Oxford. med. case rep. 2016 (3) (2016 Mar 1) 31–33.
[5] B. Long, S. Lentz, M. Gottlieb, Alcoholic ketoacidosis: etiologies, evaluation, and management, J. Emerg. Med. 61 (6) (2021 Dec 1) 658–665.
[6] M.G. Allison, M.T. McCardy, Alcoholic metabolic emergencies, Emerg. Med. Clin. 32 (2) (2014 May 1) 293–301.
[7] T. Ngatchu, A. Sangwaiya, A. Dabiri, A. Dhar, I. McNeil, J. Arnold, Alcoholic ketoacidosis with multiple complications: a case report, Emerg. Med. J. 24 (11) (2007) 776–777.

[8] R. Ylikahri, M. Huttunen, M. Härkönen, Hormonal changes during alcohol intoxication and withdrawal, Pharmacol. Biochem. Behav. 13 (1) (1980) 131–137.

[9] American Diabetes Association, Hyperglycemic crises in diabetes, Diabetes Care 27 (suppl.1) (2004 Jan 1) e94–102.

[10] T. Matsuzaki, W. Shiraishi, Y. Iwanaga, A. Yamamoto, A case of alcoholic ketoacidosis accompanied with severe hypoglycemia, J. UOEH 37 (1) (2015) 43–47.

[11] L. McGuire, A. Cruickshank, P. Munro, Alcoholic ketoacidosis, Emerg. Med. J. 23 (6) (2006) 417–420.

[12] M.K. Teah, G.K. Chan, M.T.F. Wong, T.B. Yeap, Treatment of benzodiazepine withdrawal syndrome in a severe traumatic brain injury patient, BMJ Case Rep. 14 (1) (2021 Jan 8), e238318.

[13] M.K. Teah, E.H.R. Liew, M.T.F. Wong, T.B. Yeap, Secrets to a successful awake fibreoptic intubation (AFOI) on a patient with odontogenic abscess, BMJ Case Rep. 14 (2) (2021 Feb 19), e238600.

[14] P.R. Martin, C.K. Singleton, S. Hiller-Sturmfels, The role of thiamine deficiency in alcoholic brain disease, Alcohol Res. Health 27 (2) (2003) 134.

[15] J.F. Kelly, R.L. Stout, M. Magill, J.S. Tonigan, The role of Alcoholics Anonymous in mobilizing adaptive social network changes: a prospective lagged mediational analysis, Drug Alcohol Depend. 114 (2–3) (2011 Apr 1) 119–126.

[16] A.T. Brooks, M.M. Lopez, A. Ranucci, M. Krumlauf, G.R. Wallen, A qualitative exploration of social support during treatment for severe alcohol use disorder and recovery, Addict. behav. rep. 6 (2017 Dec 1) 76–82.