

Original Research Article

# Comparative study on arterial and venous blood gas values in the initial evaluation of patients with diabetic ketoacidosis who are visiting the Emergency Department of Rajamutaiah Medical College and Hospital

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## Abstract

**Background:** DKA is the most common serious and life-threatening acute complication of diabetes. The mortality rate is currently estimated at 2% to 10% for patients hospitalized with DKA. Mortality is predominantly due to underlying morbidities, such as sepsis or acute myocardial infarction, but deaths also occur as a result of hypokalemia induced arrhythmias and cerebral edema.

**Aim of the study:** To compare arterial and venous blood gas values in the initial evaluation of patients with Diabetic Ketoacidosis (DKA).

**Materials and methods:** The study was conducted in the division of emergency medicine at Rajah Muthiah Medical College and Hospital, Chidambaram in the year 2017 August to February 2018. Totally 61 patients were included in the study. Both sex in the age group of 14 to 70 years whose Capillary Blood Glucose equal to or greater than 250 mg/dl, Urine ketonuria (+) were included in the study.

**Results:** 37% of patients had >12 urine ketone levels of the patients of patients were 2+ (15 mg/dl) which was 41.0%. 39.3% of patients were 1+ (5 mg/dl) and 19.7% of patients were 3+ (40 mg/dl). All

patients were ketone positive. ABG pH value in which 60.7% of patients were between the level of 7.01 – 7.4, 39.3% of them were from 6.7 – 7.0. ABG PCO<sub>2</sub> value in which 44.3% of patients had values from 16-25, 21.3% of patients had values between 5-15 as well as 26-35 and 13.1% of patients had values from 36-45. In which about 65.7% of patients had HCO<sub>3</sub> levels between 12.01-17, 15.2% of patients had HCO<sub>3</sub> levels between 7.01-12 14.1 % of patients had levels between 17.01 – 18 and 5% of them between 2-7. VBG pH in DKA, in which, 57.4% were in between 7.01 – 7.41. 41% of patients had a pH from 6.7 – 7.0 and 1.6% were between 6.03 - 6.6. VBG HCO<sub>3</sub> in which, 62.3% of patients had HCO<sub>3</sub> levels from 12.01-17, 24.6% had from 7.01 – 12, 11.5% were in between 2-7 and 1.6% were showing levels in between 17.01-18.

**Conclusion:** Venous blood gas measurements accurately and fairly demonstrate the degree of acidosis in the initial evaluation of patients with Diabetic Ketoacidosis in the Emergency Department in comparison with Arterial blood gas values.

### Key words

Arterial Blood Gas, Venous Blood Gas, Metabolic Disturbance, Diabetes Mellitus.

### Introduction

Diabetic Ketoacidosis (DKA) is an acute and potentially fatal complication of diabetes typically characterized by hyperglycemia, ketone body formation, and metabolic acidosis [1]. Over the past 20 years, there has been no reported reduction in mortality rates, which remain between 3.4 and 4.6%. Mortality is predominantly due to underlying morbidities, such as sepsis or acute myocardial infarction, but deaths also occur as a result of hypokalemia induced arrhythmias and cerebral edema. The incidence of DKA is difficult to ascertain, as definitive criteria for the diagnosis have not been agreed, and there is no national register for recording cases [2]. The diagnosis is based on the clinical features of uncontrolled diabetes in the presence of ketosis and acidosis (i.e. arterial blood pH <7.3), although in practice patients with a bicarbonate <15 mmol/l in the presence of a normal pH are often classified as having ketoacidosis. The presence of ketones can now be established by finger-prick testing, results being available within 30 sec [3]. We review the advantages of using such a system in the diagnosis and management of decompensated diabetes. Ketoacidosis is a potentially life-threatening metabolic complication of diabetes mellitus. Although it is commonly associated with type 1 diabetes, it can also occur in patients with type 2 disease during catabolic periods of

stress [4]. In contrast, with the widespread belief, diabetic ketoacidosis (DKA) is more common in adults than in children. In spite of impressive advances in its understanding and management, DKA still has a mortality of 2 - 5%. It is the most frequent cause of death in children and adolescents with type-1 diabetes and accounts for more than half of all deaths in diabetics younger than 24 years of age [5]. In a small percentage of cases of DKA, the glucose levels are not elevated at presentation euglycemic DKA. This usually occurs in association with excessive vomiting and continued insulin administration [6]. The role of monitoring  $\beta$ -OHB is particularly valuable in euglycemic. DKA, as the relatively low blood glucose levels in this state, are a poor guide for the underlying metabolic derangement and can result in inadequate insulin replacement. Euglycemic DKA has been reported to occur in 10% of cases of DKA complicating pregnancy. Although there is no increase in maternal mortality in DKA during pregnancy, fetal mortality is high and is reported to be in the region of 35% [7].

### Materials and methods

The study was conducted in the division of emergency medicine at Rajah Muthiah Medical College and Hospital, Chidambaram. Totally 61 patients were included in the study. This study was carried in both sexes in the age group of 14

to 70 years whose Capillary Blood Glucose equal to or greater than 250 mg/dl, Urine ketonuria (+). Inclusion Criteria: Anyone Clinical signs of DKA (Kussmaul breathing, dehydration, Tachycardia, etc..) Capillary Blood Glucose equal to or greater than 250 mg/dl. Urine ketonuria (+) Exclusion Criteria: Patient refusal, Blood glucose less than 250 mg/dl, Previous history of Renal artery stenosis. Investigation: 1. Arterial blood gases (ABG) 2. Venous blood gases (VBG) 3. Urine ketones. Measures: Patients had capillary blood glucose, venous blood gas (VBG), Arterial Blood Gas (ABG) samples and urine ketones obtained before IV fluid or insulin administration. The study protocol specified that ABG, and VBG samples be drawn simultaneously within 10 minutes of the patient's arrival. The patients were managed according to the ABG and venous pH and HCO<sub>3</sub> levels [8, 9].

### Statistical Analysis

Data was collected on predesigned proforma for each individual case. Descriptive statistics were done for all data. Suitable statistical tests of comparison were done. The data was analyzed using SPSS version 16 was used for statistical analysis. Categorical variables were analyzed with the Chi-Square Test.

### Results

**Table - 1** shows the demographic profile of patients with DKA. 31.1% of patients were between the age group of 51-60 years. 26% of them were between 30-50 years, 18% of patients were in the age group in between 61-65 year, 11.5% of them were between 14-29 years, 13.2% of them between 66-70 years.

**Table - 2** shows the related conditions and risk factors for our study. 81.9% of patients had a previous history of diabetes and (39.3%) of patients had hypertension (9%) of patients had IHD and (21.3%) of patients had Obesity.

**Table - 3** shows the demographic profile urine ketone levels of the patients. 41.0% of patients were 2+ (15mg/dl), 39.3% of patients were 1+ (5

mg/dl) and 19.7% of patients were 3+ (40 mg/dl). All patients are ketone positive.

**Table - 1:** Age wise distribution.

Age (in years)	Frequency	Percent
14-29	7	11.5
30-50	16	26.2
51-60	19	31.1
61-65	11	18.0
66-70	8	13.2
Total	61	100.0

**Table - 2:** Co-morbid conditions.

Illness	Frequency	Percent
Previous history of Diabetic Mellitus	50	81.9
Hypertension	24	39.3
IHD	6	9
Obesity	13	21.3

**Table - 3:** Urine ketone levels.

Urine Ketone Levels	Frequency	Percent
1+(5mg/dl)	24	39.3
2+(15mg/dl)	25	41.0
3+(40mg/dl)	12	19.7
Total	61	100.0

**Table - 4:** ABG pH.

pH	Frequency	Percent
6.7 – 7.0	24	39.3
7.01 – 7.4	37	60.7
Total	61	100.0

**Table - 5:** ABG pCO<sub>2</sub>.

pCO <sub>2</sub> mmHg	Frequency	Percent
5 – 15	13	21.3
16 – 25	27	44.3
26 – 35	13	21.3
36 – 45	8	13.1
Total	61	100.0

**Table - 6:** ABG HCO<sub>3</sub>.

HCO <sub>3</sub> mmol /L	Frequency	Percent
2 – 7	4	5%
7.01 – 12	9	15.2%
12.01 – 17	39	65.7%
17.01 - 18	9	14.1%
Total	61	100.0

**Table - 7:** VBG pH.

	Frequency	Percent
6.03 - 6.6	1	1.6
6.7 - 7.0	25	41%
7.01 - 7.4	35	57.4
Total	61	100.0

**Table - 8:** VBG pCO<sub>2</sub>.

pCO <sub>2</sub> mmHg	Frequency	Percent
5 - 15	12	19.7
16 - 25	28	45.9
26 - 35	14	23.0
36 - 45	7	11.5
Total	61	100.0

**Table - 9:** VBG HCO<sub>3</sub>.

HCO <sub>3</sub> mmol /L	Frequency	Percent
2 - 7	7	11.5
7.01 - 12	15	24.6
12.01 - 17	38	62.3
17.01-18	1	1.6
Total	61	100.0

**Table - 4** shows the demographic profile of patients ABG pH. 60.7% of patients were between the level of 7.01 - 7.4, 39.3% of them were in between 6.7 - 7.0.

**Table - 5** shows the ABG PCO<sub>2</sub> value in which 44.3% of patients had values in between 16-25, 21.3% of patients had values between 5-15 as well as 26-35 and 13.1% of patients had values between 36-45.

**Table - 6** shows the ABG HCO<sub>3</sub> levels. In which about 65.7% of patients had HCO<sub>3</sub> levels between 12.01-17, 15.2% of patients had HCO<sub>3</sub> levels between 7.01-12 14.1 % of patients had levels between 17.01 - 18 and 5% of them between 2-7.

**Table - 7** shows the VBG pH in DKA, in which 57.4% were between 7.01 - 7.41. 41% of patients had a pH in between 6.7 - 7.0 and 1.6% were between 6.03 - 6.6.

**Table - 8** shows the VBG PCO<sub>2</sub> levels, in which 45.9% of patients were between 16-25, 23.0%

were between 26-35, 19.7% were between 5-15 and 11.5% were between 36-45.

**Table - 9** shows VBG HCO<sub>3</sub> in which, 62.3% of patients had HCO<sub>3</sub> levels between 12.01-17, 24.6% had between 7.01 - 12, 11.5% were between 2-7 and 1.6% were showing levels between 17.01-18.

## Discussion

Our study compares peripheral venous blood gas values with arterial blood gas values in patients with DKA. Our goal was to determine whether the pH measurements in ABG and VBG agree sufficiently to allow anyone (ABG or VBG) to be substituted for the other in patients with DKA [10]. Louse C.F., et al. study showed age group ranging from 55 ± 2 years is more prone to DKA. In that 85% of patients had a history of diabetic mellitus, 30% of patients had hypertension and 7% of patients had obesity. Similarly, our study also showed the range of 45 ± 15 years is more prone to DKA. In that 81.9% of patients had a history of the previous history of diabetic mellitus, 39.3% of patients had hypertension, and 9% of patients had obesity [11]. Richarasanov SK, et al. also found that arterial venous pH, Bicarbonate levels were strongly correlated and they concluded that venous blood gas samples were a reliable indicator in patients with DKA and so venous puncture is an easy procedure compared to repeated arterial puncture [12]. Hatice Dulber G, et al. in their study showed the mean difference between arterial and venous bicarbonate level is 1.88 ± 0.4. Similarly, our study showed the mean difference between arterial and venous bicarbonate level of 1.7 ± 0.5 [13]. Similarly in our study also showed that 88.5% patient has admitted ICU, 7% patients were admitted in the emergency ward. A potential disadvantage of the use of the venous blood gas values in DKA is that it may be more difficult to determine when mixed acid-base disorders are present [14]. Kety KH, et al. in his study mentioned that patients with DKA often have conditions such as vomiting, diarrhea, dehydration, and hyperventilation that may cause

mixed acid-base disturbances. ABG values are more relevant in mixed acid-base disorders than VBG values. So in our study, the patients with mixed acid-base disorder were treated with ABG values. In our study, the costs of arterial and venous blood gas analysis were the same however, it should be noted that arterial blood gas sampling is more cumbersome and painful to patients and sometimes requires multiple attempts. Arterial puncture is more time consuming and labor intensive when compared with venipuncture, which must be performed anyway to measure serum electrolytes and glucose levels, as well as to establish intravenous access for fluid resuscitation and insulin administration for DKA patients [15]. A potential disadvantage of the use of the venous blood gas values in DKA is that it may be more difficult to determine when mixed acid-base disorders are present. Derran J, et al. in his study mentioned that patients with DKA often have conditions such as vomiting, diarrhea, dehydration, and hyperventilation that may cause mixed acid-base disturbances [16]. Nemat Bilan, et al. studied the use of ABG in patients with DKA in whom a mixed acid-base disorder is suspected, ABG values are more relevant in mixed acid-base disorders than VBG values. So in our study, the patients with mixed acid-base disorder were treated with ABG values [17]. In our study, the costs of arterial and venous blood gas analysis were the same however, it should be noted that arterial blood gas sampling is more cumbersome and painful to patients and sometimes requires multiple attempts [18]. Arterial puncture is more time consuming and labor intensive when compared with venipuncture, which must be performed anyway to measure serum electrolytes and glucose levels, as well as to establish intravenous access for fluid resuscitation and insulin administration for DKA patients [19, 20].

## Conclusion

Venous blood gas measurements accurately and fairly demonstrate the degree of acidosis in the initial evaluation of patients with Diabetic Ketoacidosis in the Emergency Department in

comparison with Arterial blood gas values. Venous blood gas analysis is a simple procedure and it can be done in emergency room setting while dealing with acutely ill patients. Repeat evaluation of blood gas analysis is also possible with venous blood gas analysis.

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