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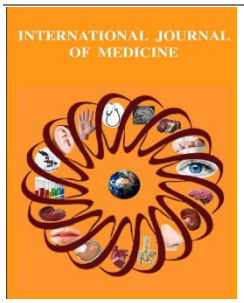

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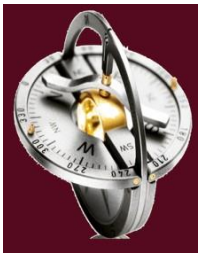

Review Article

Comparative Study of Arterial and Venous Blood Gas Values in The Initial Evaluation of Patients with Diabetic Ketoacidosis

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Abstract

Introduction: Diabetic ketoacidosis (DKA) is a life-threatening complication of diabetes mellitus, requiring prompt evaluation and treatment. Arterial blood gas (ABG) analysis is crucial for diagnosis, but venous blood gas (VBG) analysis may be a less invasive alternative. DKA is a medical emergency necessitating prompt intervention, as it may result in life-threatening consequences including cerebral edema, acute respiratory distress syndrome, and sepsis. ***Objectives***: To investigate the reliability of VBG values as a substitute for ABG values in evaluating patients with suspected DKA, and to analyze the correlation between ABG and VBG findings. ***Methods***: A comparative prospective study was conducted among 90 pediatric patients with DKA, comparing arterial and venous blood gas values, including pH, pCO_2 bicarbonate, and base excess, to determine the reliability of VBG as a substitute for ABG. Patients were included if they had clinical signs of DKA, random blood glucose ≥200 mg/dl, positive urine ketonuria, and parental consent. Those with blood glucose <200 mg/dl, absent ketonuria, unstable conditions, or lack of parental consent were excluded. ***Results***: The mean age was 11.01 years, with 55.6% males and 44.4% females. Key biochemical parameters showed significant acidosis, with a mean arterial pH of 7.11±0.10 and a mean venous pH of 7.07±0.11. The descriptive statistics indicated a statistically significant correlation ($P<0.001$) and close agreement between the mean values of pH, HCO_3, CO_2 level, and anion gap in the ABG and VBG samples. ***Conclusion*:** The study concludes that venous blood gas values can be a reliable substitute for arterial blood gas values in the initial evaluation of pediatric patients with diabetic ketoacidosis, given the significant correlation between ABG and VBG parameters. This finding can help reduce the need for invasive arterial sampling and facilitate timely diagnosis and treatment of DKA.

Keywords: Diabetic ketoacidosis, Arterial blood gas, Venous blood gas

Introduction:

Diabetic ketoacidosis is a critical acute metabolic consequence of diabetes mellitus, marked by hyperglycemia, hyperketonemia, and metabolic acidosis. Diabetic ketoacidosis (DKA) is a medical emergency necessitating prompt intervention, as it may result in life-threatening consequences including cerebral edema, acute respiratory distress syndrome, and sepsis.1 The worldwide prevalence of DKA ranges from 13% to 80%, with a clinical fatality rate of approximately 20%.2 DKA continues to represent 14% of all hospital admissions for this population and 16% of all diabetes-related fatalities. DKA frequently occurs in individuals with type 1 diabetes, with approximately 3% of these patients presenting with DKA at diagnosis; the frequency is two episodes per 100 patient- years of diabetes. Patients with type 2 diabetes may also develop it, although this occurrence is less common.3,4

DKA is biochemically defined by hyperglycemia (blood glucose > 200 mg/dL), a blood pH < 7.30, and a bicarbonate (HCO3) concentration ≤ 18 mmol/L. It can be classified as mild (pH 7.25–7.30, HCO3 15–18 mmol/L), moderate (pH 7–7.24, HCO3 <10 mmol/L), or severe (pH <7, HCO3 <10 mmol/L).5,6 Ketone levels can now be determined using finger-prick testing, with findings available in 30 seconds.7

Blood gas analysis is a crucial approach for assessing the acid-base balance and pulmonary gas exchange capacity in patients, playing a vital role in the diagnosis and evaluation of the therapeutic efficacy of DKA.8 Arterial blood gas analysis (ABGA), which quantifies blood pH, partial pressure of CO2 (pCO2), and bicarbonate (HCO3) concentrations, is a crucial diagnostic procedure for patients with suspected DKA.9

Venous blood gas (VBG) sample is simpler to acquire and offers a less invasive approach for evaluating acid-base status, hence reducing the dangers linked to arterial punctures.10 Venous specimens may be suitable for acquiring pH, pCO2 and HCO3 measurements. The drawback of VBG is that PO2 levels are insufficiently comparable to ABG values. Moreover, arterial PO2 is typically 36.9 mmHg greater than venous PO2, demonstrating a significant range (95% confidence interval from 27.2 to 46.6 mm Hg).11 Venous base excess exhibits a robust connection with arterial base excess in critically ill, mechanically ventilated trauma patients and individuals with acute trauma. It also demonstrated that venous base excess more precisely represents overall tissue perfusion and functions as a dependable predictor of shock severity and mortality.

OBJECTIVES:

The aim of this study is to investigate the reliability of venous blood gas (VBG) values as a substitute for arterial blood gas (ABG) values in

the initial emergency department evaluation of patients with suspected diabetic ketoacidosis. To analyze the changes in ABG and VBG in pediatric diabetic ketoacidosis, establish a correlation between ABG and VBG findings, and determine the outcome in terms of patient recovery and mortality.

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Methodology

A comparative prospective study was conducted at the Department of Paediatrics, JLN Medical College & Associated Group of Hospitals, Ajmer, to determine if venous blood gas values can replace arterial gas values in evaluating patients with suspected diabetic ketoacidosis. The study included 90 patients with DKA, selected through purposive sampling, who met the inclusion criteria: clinical signs of DKA, random blood glucose ≥200 mg/dl, urine ketonuria positive and parental consent. Exclusion criteria included blood glucose <200 mg/dl, absent urine ketonuria, unstable patients, and lack of parental consent. The study aimed to compare arterial and venous blood gas values in the initial evaluation of DKA patients. The study's data collection was conducted after obtaining Ethical Committee permission. Patients were recruited through interviews using a questionnaire, with written informed consent obtained.

Laboratory investigations included blood gas analyses of both arterial and venous samples using an automated analyzer. Parameters measured included pH, pCO_2, bicarbonate, and base excess. Additionally, serum ketones were evaluated using Ketostix Reagent Strips on urine samples, and fingerstick capillary blood glucose readings were documented at admission.

Observations:

In our study, we have enrolled total 90 children of DKA through purposive sampling to determine whether venous blood gas analysis can reliably substitute for arterial sampling during the early assessment of DKA.

Table 1 : Age and Sex Distribution

	Number (%)
Age group (Years)	
Less than 5 years of age (Pre school)	8 (8.9%)
5-10 years (School Age)	32 (35.6%)
11-18 years (Adolescent)	50 (55.6%)
Mean+SD (years)	11.01+3.17
Sex	
Female	40 (44.4%)
Male	50 (55.6%)

Table 2 :

	Number (%)
Urine Ketone	
3+	21 (23.3%)
4+	69 (76.7%)
Urine sugar	
1+	27 (30%)
2+	31 (34.4%)
3+	14 (15.6%)
0	18 (20%)

Table 3 : Distribution of Children According to Severity of DKA

Severity	Number
Mild	19 (21.1%)
Moderate	29 (32.2%)
Severe	42 (46.7%)

Table 4 : Descriptive Statistics (ABG and VBG)

	Mean	r	P value
pH			
ABG	7.11+0.1	0.365	<0.001 (S)
VBG	7.07+0.11		
HCO3			
ABG	9.2+3.03	0.42	<0.001 (S)
VBG	9.65+3.32		
Anion Gap			
ABG	21.87+6.07	0.793	<0.001 (S)
VBG	23.22+5.67		
CO2 level			
ABG	21.11+6.62	0.51	<0.001 (S)
VBG	22.15+5.77		
Sodium			
ABG	144.68+5.63	0.244	0.020 (S)
VBG	146.96+5.13		

Potassium			
ABG	4.34+0.49	0.33	0.001 (S)
VBG	4.55+0.49		
Chloride			
ABG	113.17+3.63	0.292	0.005 (S)
VBG	114.25+3.93		

DISCUSSION

This hospital-based, cross-sectional, prospective observational study was conducted in the Department of Paediatrics at JLN Medical College, Ajmer, Rajasthan. A total of 90 children diagnosed with diabetic ketoacidosis (DKA) were included using purposive sampling. Children presenting with clinical signs of DKA, random capillary blood glucose ≥200 mg/dL, positive urine ketones (+1 or more), and parental consent were included in the study.

The mean age of participants was 11.01±3.17 years, supporting the observation that DKA tends to occur more frequently in the later years of childhood. Sahoo AL et al (2025)12 reported that the average age of the study population was 40.53+17.47 years. A slight male predominance was observed, with 55.6% of the patients being male and 44.4% female.

Severe ketonuria was also a prominent finding, with 76.7% of patients having a urine ketone score of 4+ and 23.3% showing 3+. The high ketone levels indicate significant metabolic stress and are often associated with worsening acidosis. Urine sugar levels varied among patients, with 34.4% showing 2+, 30% having 1+, 15.6% presenting with 3+, and 20% having no detectable sugar in the urine.

DKA remains one of the most serious acute complications of diabetes in children and adolescents, characterized by hyperglycemia, ketosis, and metabolic acidosis. If not promptly diagnosed and managed, it can result in multiple complications including electrolyte imbalance, cerebral edema, and even mortality13,14.

The present study compared arterial and venous blood gas values in patients with diabetic ketoacidosis (DKA). The results showed significant acidosis, with a mean arterial pH (ABG) of 7.11 ± 0.10 and a mean venous pH (VBG) of 7.07 ± 0.11. The mean bicarbonate (HCO_3^-) levels were markedly reduced, consistent with metabolic acidosis, with ABG showing 9.2 ± 3.03 mEq/L and VBG showing 9.65 ± 3.32 mEq/L. The study's findings are consistent with previous research. Sahoo AL et al (2025)12 reported arterial pH of 7.24 ± 0.07 and venous pH of 7.26±0.06 in expired patients. Pathak J et al15 found a mean arterial pH of 7.09 ± 0.24 and a mean venous pH of 7.20 ± 0.178. Riyani G et al16 reported a mean arterial pH of 7.124±0.093 and a mean venous pH of 7.137±0.092. The study also found that the mean anion gap was elevated in both ABG (21.87±6.07 mmol/L) and VBG (23.22±5.67 mmol/L). The average carbon dioxide (CO_2) levels were 21.11±6.62 mmol/L on ABG and 22.15±5.77 mmol/L on VBG. Electrolyte analysis showed mildly elevated sodium levels, with ABG reporting 144.68±5.63 mEq/L and VBG showing 146.96±5.13 mEq/L. MA Brandenburg et al17 reported a mean arterial pH of 7.20±0.14 and a mean venous pH of 7.17 ± 0.13. Their study also found a mean arterial HCO_3^- of 11.0±6.0 mmol/L and a mean venous HCO_3^- of 12.8 ± 5.5 mmol/L.

Overall, the present study and previous research suggest that venous blood gas analysis can be a reliable alternative to arterial blood gas analysis for evaluating acid-base status in patients with DKA[1]

Conclusion

The study found that diabetic ketoacidosis (DKA) was more prevalent in older children with a slight male predominance. The majority presented with severe DKA, marked by hyperglycemia, ketonuria, and metabolic acidosis. Mean values of key biochemical parameters including pH, HCO_3 , CO_2, sodium, potassium, chloride and anion gap showed close agreement between ABG and VBG samples, suggesting that venous blood gas analysis can be a reliable, less invasive alternative to arterial blood gas analysis for evaluating acid-base status in children with DKA.

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