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TO STUDY ARTERIAL BLOOD GAS AND VENOUS BLOOD GAS PARAMETERS AND ITS CORRELATION WITH COMPLICATIONS AND TREATMENT OUTCOME IN PATIENTS WITH KETOACIDOSIS CASES OF DIABETES.

Dr Amitabh Lalji Sahoo*

*Senior Specialist Anaesthesia, District Hospital, Bemetara (C.G.),
Email: Sahoo.amitabh220@gmail.com

Abstract-

Introduction- DKA was formerly considered a hallmark of type 1 DM, but it also occurs in individuals with type 2 DM who can sometimes subsequently be treated with oral glucose-lowering agents. Performing a VBG rather than an ABG is particularly convenient in the ICU and in the emergency department, either peripherally or from a central venous line from which venous blood can be quickly drawn.

Aims- The main aim of the study is- To study arterial blood gas and venous blood gas parameters and its correlation with complications and treatment outcome in patients with ketoacidosis cases of diabetes.

Methods and materials- This is a single center observational study was conducted in Department of General Medicine and department of anesthesiology, District Hospital, Bemetara (C.G.) from Jan 2022 – Jun 2024 in 96 patients. In this study, demographic, clinical and laboratory details were studied in patients presenting with diabetic ketoacidosis satisfying the study population criteria and the impact on the outcome was assessed. Written informed consent will be obtained from each diabetic patients enrolled in the study.

All the dates will be entered in a data collection sheet in an Excel format and analysed using SPSS Software. Numerical values will be reported using mean and standard deviation or median. Categorical values will be reported using number and percentages. Probability value (p) value less than 0.05 was considered a statistically significant.

Results- Among the studied 97 patients, 70 were male and 27 were female. Mean age of the study population was 40.53 years with standard deviation of 17.47 years. Most common clinical symptom was vomiting (found in 28.9% patients), followed by altered sensorium (24.7% each). 16 were having associated hypertension and 4 patients were having CAD, while only 2 patients were suffering from hypothyroidism. Type 1 DM patients were 43.3% while 56.7% were Type 2 DM. No any ECG changes, while 50.5% shown sinus tachycardia and only 8.2% shown significant ECG changes with tall T waves in precordial leads. 19.6% expired while 80.4% recovered. The mean value of Arterial pH is 7.24±0.07 and Arterial bicarbonates is 18.74±2.73. while mean Venous pH is 7.26±0.06 and Venous Bicarbonates is 19.58±2.67 in expired patients. The mean value of Arterial pH is 7.25±0.07 and Arterial bicarbonates is 17.07±3.06 while mean Venous pH is 7.25±0.06 and Venous Bicarbonates is 18.07±3.04 in expired patients.

Conclusions- This study suggests that VBG pH values very closely correlate with ABG pH values, which also shows VBG substitution for ABG. Hence venous blood gas might be used as an ideal alternative to arterial blood gas in the initial management of patients in Diabetic Ketoacidosis. It was concluded that venous blood gas analysis has got advantages over arterial blood gas analysis

like safety, fewer number of punctures, easy sampling, less painful, less invasive even though there are some reservations' analysis safer alternative to ABG for determining acid base status reducing the need for frequent invasive arterial sampling.

Keywords: venous blood gas, arterial blood gas, diabetic ketoacidosis, type -2 DM.

Introduction-

Diabetes mellitus is common endocrinopathy. It is a group of common metabolic disorder which share the phenotype of hyperglycemia. Diabetic ketoacidosis (DKA) is an acute, life-threatening complication of DM. DKA occurs predominately in patients with type 1 DM, but unprovoked DKA can occur in newly diagnosed type 2 DM, especially in blacks and Hispanics [1]. A better understanding of pathophysiology and an aggressive, uniform approach to diagnosis and management have reduced mortality to <5% of reported episodes in experienced centres. However, mortality is higher in the elderly due to underlying renal disease or coexisting infection and in the presence of coma or hypotension [2].

DKA is a response to cellular starvation brought on by a relative insulin deficiency and counter regulatory or catabolic hormone excess. Complete or relative absence of insulin and the excess counterregulatory hormones result in hyperglycaemia (due to excess production and underutilization of glucose), osmotic diuresis, prerenal azotemia, ketone formation, and a wide-anion gap metabolic acidosis [2].

The clinical manifestations of DKA are related directly to hyperglycaemia, volume depletion, and acidosis. The metabolic alterations of DKA tend to evolve within 24 h. Osmotic diuresis gradually leads to volume loss in addition to renal losses of sodium, chloride, potassium, phosphorous, calcium, and magnesium. Polyuria and polydipsia are usually the only symptoms until ketonemia and acidosis develop. Abdominal pain and tenderness associated with DKA can be due to gastric dilatation, ileus, or pancreatitis; An elevated serum lipase level is more specific for pancreatitis but it may also be elevated in DKA [3]. Some patients with DKA may present with normal-appearing [HCO_3^-] or even an elevated [HCO_3^-], if coexisting metabolic alkalosis is severe enough to mask the acidosis. In such situations, an elevated anion gap may be the only clue to the presence of an underlying metabolic acidosis [3].

A decreased PCO_2 determination usually reflects respiratory compensation for metabolic acidosis (hyperventilation). If it is lower than explained by the degree of acidosis, as indicated by the [HCO_3^-] a primary respiratory alkalosis exists, which may be an early indication of pulmonary disease (e.g., pneumonia, pulmonary embolus) as a possible trigger of DKA or associated sepsis [4].

Although the actual incidence of hypokalaemia in DKA is not known, two studies report an occurrence of 4%. The decrease in potassium during therapy is reported to be about 1.5 mEq/L, and parallels the drop in glucose and the dose of insulin [5].

Osmotic diuresis leads to excessive renal losses of sodium chloride in the urine. However, the presence of hyperglycaemia tends to artificially lower the serum sodium levels. Standard teaching is that 1.6 mEq should be added to the reported sodium value for every 100 milligrams of glucose >100 milligrams/dL. However, the correction factor is probably 2.4, especially for blood glucose levels >400 milligrams/dL [6]. Haemoconcentration frequently leads to initially elevated levels of these electrolytes in serum. As therapy progresses, lower serum levels of each will be evident. Serum creatinine frequently may be elevated fictitiously if the laboratory assay for creation is interfered with by the nitroprusside assay. Some elevation in creatinine is expected due to prerenal azotemia [7].

Venous pH obtained during routine phlebotomy potentially can be used to avoid ABGs, which are painful and may cause arterial vascular complications. Research has convincingly shown that pH obtained by VBG is equally accurate, easier to obtain, and less painful for patients [8], [9]. In patients who are not in shock, venous pH, bicarbonate and base excess have sufficient agreement to be clinically interchangeable for arterial values [10].

Aims- To study arterial blood gas and venous blood gas parameters and its correlation with complications and treatment outcome in patients with ketoacidosis cases of diabetes.

Materials and methods

This is a single center observational study was conducted in Department of General Medicine and department of anesthesiology, District Hospital, Bemetara (C.G.) from Jan 2022 – Jun 2024 in 96 patients. In this study, demographic, clinical and laboratory details were studied in patients presenting with diabetic ketoacidosis satisfying the study population criteria and the impact on the outcome was assessed.

Inclusion criteria: All diagnosed adult diabetic patients in diabetic ketoacidosis who will be admitted in medical units.

Exclusion criteria:

- Patients with diagnosed systemic causes of renal disease, chronic diarrhoea.
- Pregnant women and children age less than 18 years
- Patients having preexisting respiratory illness.

Clinical assessment and demographic details: The initial clinical details on arrival at emergency department which included symptoms at presentation, vital signs, neurological status were assessed based on Glasgow coma Scale (GCS) and other specific system findings were collected from the case records. Then after establishment of diagnosis of diabetic ketoacidosis demographic history and thorough clinical details were collected from the patient and /or the closest relative. Laboratory assessment (DKA patients): After the initial clinical assessment, blood investigations were taken, which included random blood sugar (RBS), serum electrolytes, renal function tests (RFT), liver function tests (LFT), plasma acetone, arterial blood gas analysis (ABG), complete blood count (CBC). In addition to lipid profile, glycated haemoglobin (HbA1c), urine routine examination and urine acetone were done for all patients included in the study. Other additional investigations which were done included serum amylase, serum lipase, C-Reactive protein (CRP), chest x-ray, blood culture and sensitivity and urine culture and sensitivity based on individual patient requirements.

Data collection

96 diagnosed diabetic patients in DKA will be included in the study. Detailed history – including duration of disease, any past history of and other medications, treatment regimen started. Patients will be examined in detailed for assessing any symptoms and signs of Diabetic ketoacidosis. Blood samples will be taken for ABG and VBG allen test is performed Screen baseline blood glucose, urine samples will be taken for screening baseline urine sugar and urine ketone. Patients will be assessed for blood sugar, urine ketone, urine sugar. Urine routine and blood routine was done.

Statistical analysis:

All the dates will be entered in a data collection sheet in an Excel format and analysed using SPSS Software. Numerical values will be reported using mean and standard deviation or median. Categorical values will be reported using number and percentages. Probability value (p) value less than 0.05 was considered a statistically significant.

Observations and Results

In our study 16.5% of patients were between the age group of <20 years. 34% of them were between 21-40 years, 35.1% of them were between 41-60 years, 14.4% of them were > 60years. Mean Age+/- SD becomes 40.53+/-17.47. Study participants comprising 72.2% male patients and 27.8% Female patients.

Table no-1 presenting complains

Presenting Complaints	Frequency	%
Missed abdominal Pain	22	22.7%
Altered sensorium	24	24.7%
Dizziness	6	6.2%
Shortness of breath	17	17.5%
Vomiting	28	28.9%
Total	97	100%

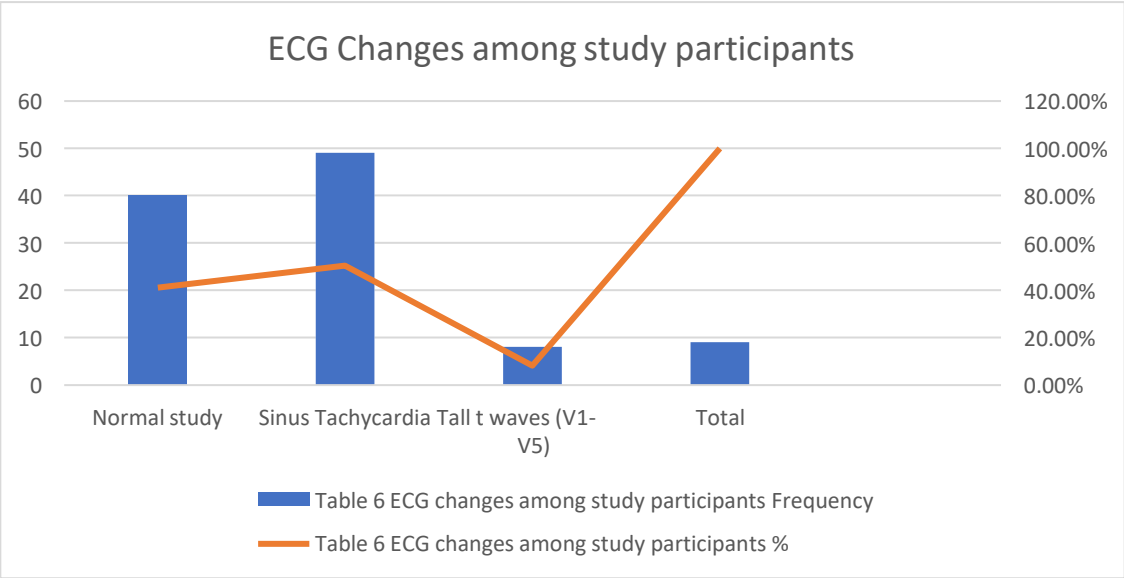
Patients according to presenting Complaints with 28.9% patients presented with vomiting, 22.7% presented with abdominal pain, 24.7% presented with altered sensorium, 17.5% presented with Shortness of breath. 56.7% patients presented with Type 2 diabetes mellitus while 43.3% presented with Type 1 Diabetes Mellitus.

Table 2 Associated illnesses among study participants

Associated illnesses	Frequency	%
CAD	4	4.1%
CVA	1	1%
HTN	16	16.5%
HTN/Hypothyroidism	1	1%
HTN/CAD	3	3.1%
Hypothyroidism	2	2.1%
No	70	72.2%
Total	97	100%

16.5% patients had preexisting hypertension, 4.1% has CAD, 3.1% has both hypertension and CAD 2.1% has Hypothyroidism rest 72.2% has no pre-existing illness.

Almost half (50.5%) of the participants were showing Sinus tachycardia, 41.2% showed normal ECG study while 8.2% showed significant ECG changes with Tall T waves in precordial leads.



48.5% patients presented in DKA has duration of illnesses 1-5 year, 29.9% has duration of illnesses 6-10year, 14.4% has duration of illness 14.4%, while 4.1% patients had duration of illnesses >15years. 80.4% out of all study participants recovered while 19.6% expired. Metabolic Acidosis in

both Arterial and Venous Blood samples.

Table 3 Comparison between arterial and venous Blood Gas analysis variables

Blood Gas Analysis	Arterial	Venous	p Value
pH	7.25±0.07	7.25±0.06	0.65
HCO3	17.39±3.05	18.36±3.02	0.027
PO2	76.95±8.91	36.98±7.33	<0.001
PCO2	39.76±3.4	60.65±10.63	<0.001
Na+	134.32±1.96	134.71±2.67	0.245
K+	4.23±0.59	3.91±0.59	<0.001

Table 4 Comparison between arterial and venous Blood Gas analysis variables among expired study participants

Blood Gas Analysis	Arterial	Venous	p Value
pH	7.24±0.07	7.26±0.06	0.543
HCO3	18.74±2.73	19.58±2.67	0.343
PO2	80.26±9.61	35.47±6.16	<0.001
PCO2	40.68±3.9	57.16±10.28	<0.001
Na+	134.58±1.64	134.89±1.82	0.578
K+	3.93±0.5	4.04±0.6	0.569

Table- 5 Comparison between expired and recovered study participants

Blood Gas Analysis	Type 1 DM	Type 2 DM	p Value
Age	24.17±7.01	53.02±11.77	**<0.001**
RBS	402±88.7	426.45±82.08	**0.164**
Arterial pH	7.24±0.07	7.26±0.06	0.310
Arterial HCO3	16.88±3.32	17.79±2.8	0.149
Arterial PO2	76.07±8.59	77.62±9.17	0.400
Arterial PCO2	39.57±3.34	39.91±3.47	0.631
Arterial Na+	133.96±2.06	134.59±1.85	0.114
Arterial K+	4.25±0.56	4.21±0.62	0.731
Venous pH	7.25±0.06	7.26±0.06	0.434
VenousHCO3	17.88±3.29	18.73±2.77	0.171
VenousPO2	37.33±7.89	36.71±6.94	0.680
VenousPCO2	62.67±9.85	59.11±11.02	0.103
Venous Na+	134.34±2.55	134.99±2.74	0.233
Venous K+	3.89±0.55	3.92±0.63	0.786
Serum Urea	32.33±8.72	35.47±8.85	0.085
Serum Creatinine	1.03±0.35	0.91±0.33	0.087

DISCUSSION

In this study 'To study arterial blood gas and venous blood gas parameters and its correlation with complications and treatment outcome in patients with ketoacidosis cases of diabetes study was done on Department of General Medicine and department of anesthesiology, District Hospital, Bemetara (C.G.) from Jan 2022 – Jun 2024 in 96 patients.

In total of 97 DKA patients studied 19.6% of them had unfavorable outcome. This was near similar to the studies conducted by Oschatz et al. and Agarwal A et al. who showed 29% and 30% mortality in their study in DKA patients. The mortality is rarely due to metabolic complications and is mostly due to underlying precipitating illness. The deaths in study population showed that the individuals who died had, one or other of the accompanied co-morbid illness or complicated precipitating

factor.

In this study, the median age of incidence of DKA was 40.53±17.47 years, with increased incidence in ages less than 40 years of age, and age was not found significant statistically, affecting the outcome. This study was similar to results obtained by Agarwal et al who included a total of 270 patients in the study.9 In international study published in ADA,3stated that most patients with DKA were between the ages of 18 and 44 years (56%) and 45 and 65 years (24%), with only 18% of patients <20 years of age;3 and the prognosis of DKA is worsened with increasing age.

Our study shown male predilection in sex with total of 70 males and 27 females. Females have found to have increased incidence of DKA, whereas Agarwal A et al showed male gender had 7.93-fold more favorable outcome. This finding was more concurrent with a study by Elleman et al., (1984) whereas it was contrary to the findings of Lee et al., (1987) who reported that DKA is more common in females. [11, 12]

In previous studies that two-thirds of diabetic patients presenting with DKA are Type 1 DM and DKA related to Type 2DM has an intractable course and worst outcomes. In this study, patients with Type 1 DM were 43.3% whereas of Type 2 DM were 56.7%. The reason for increased incidence of DKA in Type 2DM can be an indicator of changing profile in Type 2DM due to influence of changing social and environmental factors in developing countries like India, which is required to be scrutinized .DKA mainly occurs in patients with type 1 DM because these patients present with a complete lack of insulin that inhibits gluconeogenesis and glycogenolysis in insulin resistant states (Type 2 DM), the body remains sensitive to the anti-lipolytic effects of insulin. Thus, patients with type 2 DM are rarely affected (Barski et al., 2013; Puttanna et al., 2014)). [13] However, this finding has been challenged in larger number of patients with type 2 DM presenting with DKA. This was seen in a study by Balasubramanian et al, (1999) who reported that 39% of the patients with DKA in their study had Type 2 DM. [14]

In our study 28.9% patient in DKA presented mainly with c/o vomiting, 24.7% in altered sensorium and 17.5% with c/o shortness of breath. Among the studied 97patients, most common co-morbid condition was hypertension (16.5%) followed by CAD (4.1%) and Hypothyroidism (2.1%). Many patients presented in DKA present with hypertension or develop hypertension during treatment. In this study, we documented an association between hypertension and more severe acidosis and hypocapnia (pH and pCO2). Furthermore, we found that hypertension during DKA treatment was associated with alterations in mental status, even after adjusting for factors reflecting DKA severity. Although the number of patients with clinically overt cerebral injury in the study (~1%) was small, precluding meaningful analysis, the frequency of clinically overt cerebral injury in hypertensive patients was higher than in patients without hypertension. Hypertension at presentation was not significantly associated with GCS abnormalities in multivariable models, however, this may have reflected delayed manifestation of mental status. In our study 41.2% among study population showed no ECG changes while 50.5% shown sinus tachycardia and 8.2% shown significant ECG changes with Tall T waves in precordial leads. Acute cardiac complications observed in diabetic ketoacidosis have generally been attributed to electrolyte imbalance.

Hypokalemia, hyperkalemia, hypocalcemia, hypophosphatemia, and hypomagnesemia may develop in diabetic ketoacidosis. Hypokalemia is the most commonly observed electrolyte imbalance and most frequently leads to fatal arrhythmia. Hypokalemia at the time of diagnosis was observed in only four of our patients and the severity of hypokalemia was low. Ventricular premature beat on ECG was found in only one patient who had hypokalemia. ECG assessments were found to be normal in four children who were found to have hypokalemia and in four children whose corrected sodium level was found to be low.

In our study mean Arterial pH were 7.24+0.07, mean arterial bicarbonates were 18.74± 2.73 while mean venous pH was 7.26±0.06 and mean venous bicarbonates were 19.58±2.67 in expired patients. Similarly mean Arterial pH were 7.25+0.07, mean arterial bicarbonates were 17.07±3.06 while mean venous pH was 7.25±0.06 and mean venous bicarbonates were 18.07±3.04 in recovered patients. According to study of 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. [15] 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. [16]

CONCLUSION

Present study comprises of 96 patients of Diabetes Mellitus (newly diagnosed and known cases). It was concluded that venous blood gas analysis has got advantages over arterial blood gas analysis like safety, fewer number of punctures, easy sampling, less painful, less invasive even though there are some reservations analyses safer alternative to ABG for determining acid base status reducing the need for frequent invasive arterial sampling.

This study suggests that VBG pH values very closely correlate with ABG pH values, which also shows VBG substitution for ABG. Hence venous blood gas might be used as an ideal alternative to arterial blood gas in the initial management of patients in Diabetic Ketoacidosis.

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