To Study Arterial And Venous Blood Gas Sample For Diagnosis Of Acid Base Abnormality In Patient With Diabetes Ketoacidosis

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Abstract: Background: To study the values of Arterial Blood Gas (ABG) and Venous Blood Gas (VBG) sample for comparison of pH, HCO3 and pCO2 values in patients presenting with Diabetic KetoAcidosis. To determine Degree of Agreement between these values in such patient. To assess whether VBG analysis can replace ABG analysis in initial evaluation of patients presenting with DKA. Material & Methods: The observational comparative study was carried out on 38 patients above the age of 17 years presenting with Diabetic ketoacidosis admitted in Emergency Ward (EW) of medicine department at Tertiary Health Center, South Gujarat. Results: Strong linear correlation was found between Arterial and Venous pH, HCO3 and CO2 values and Venous pH and HCO3 is almost equivalent to that of Arterial, but according to the Degree of agreement Venous pCO2 is not equivalent to Arterial pCO2; so Venous pH and HCO3 can be used in place of Arterial pH and HCO3 in initial evaluation of DKA patient but not Venous pCO2. Conclusion: For initial evaluation of DKA patients (for pH and HCO3 determination), we can use VBGA in place of ABGA, as ABGA is technically more difficult, more painful, and carries higher incidence of complications. [Riyani G Natl J Integr Res Med, 2020; 11(6):33-37]

Key Words: Platelet , Prothrombin time , Partial Thromboplastin Time

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Introduction: Diabetic ketoacidosis (DKA) is a metabolic derangement consisting of high blood glucose concentration, measurable ketone bodies in blood and/or urine, and metabolic acidosis. DKA mainly occurs in patients with type 1 diabetes, but it is not uncommon in patients with type2 diabetes[1].

DKA is defined as an increase in the serum concentration of ketones greater than 5 mEq/L, a blood glucose level greater than 250mg/dl (although it is usually much higher), and a blood (usually arterial) pH less than 7.3.

Ketonemia and ketonuria are characteristic, as is a serum bicarbonate level of 18 mEq/L or less (less than 5 mEq/L is indicative of severe DKA). These biochemical changes are frequently associated with increased anion gap, increased serum osmolarity and increased serum uric acid.[2,3]

Arterial blood gas analysis (ABGA) is indicated for identification of respiratory, metabolic, and mixed acid-base disorders, with or without physiologic compensation, by means of pH, pCO2 level, pO2 level, and HCO3 level.[1]

Determination of arterial blood gas (ABG) values is currently considered essential for evaluation of patients with suspected DKA. Sampling of arterial blood is a painful, sometimes technically difficult procedure that must be done in addition to the sampling of venous blood for testing for electrolytes, ketones, and other parameters.

ABG sampling may also be complicated with local Hemorrhage/ hematoma, arterial occlusion, air/thrombus embolism, infection at puncture site, needle stick injury to health care personnel, etc.

Several authors have recommended the use of venous pH in place of arterial pH in the evaluation of DKA. The correlation between arterial and venous pH measurements is well established. However, this relationship has not been established in DKA.

If venous pH, HCO3 and pCO2 values were found to be highly correlated and show a high level of agreement with arterial pH, HCO3 and pCO2 values in patients who present with DKA, then it might be possible to eliminate arterial blood sampling in the initial diagnosis and evaluation of DKA.[1,2]

The purpose of this study was to determine whether venous blood gas values are correlated and show a high level of agreement with arterial blood gas values in the initial evaluation of patients with DKA and whether venous blood gas analysis can replace arterial blood gas analysis in DKA patients.

Material & Methods: The present study was carried out on 38 patients above the age of 17 years presenting with Diabetic ketoacidosis admitted in Emergency Ward (EW) of medicine department at Tertiary Health Center, South Gujarat.

The patients were selected randomly and both males and females were included in the present study. A detailed clinical history and detailed clinical examination was done. Patients were suspected to have DKA on basis of detailed history, clinical symptoms/signs; and then patient's bedside finger stick Random blood sugar (RBS) test was done with glucometer, and if it was >250 mg/dl, patient's samples for S.Acetone test, Urine for ketones, ABGA, and VBGA were taken.

A sample of arterial blood (.5 to 1.0 mL) for ABGA was obtained from the radial artery of the patient. A sample of venous blood (.5 to 1.0 mL) for VBGA was obtained from peripheral vein at the time of vein puncture for other laboratory reports. The two blood gas samples were obtained as temporally close to each other as possible and before the initiation of treatment, and were immediately sent to the laboratory.

The arterial and venous blood gas determinations were performed with Arterial blood gas analyser with ID- LSCHABJMC/HITECH/ABG- E-3, Model-Combiline, Sr. no.CL0495, manufactured by M/S Eschweiler GmbH & Co., Germany. Serum Acetone was measured in the hospital laboratory qualitatively by using Acetone powder (ammonium sulphate/sodium nitroprusside/ sodium carbonate) graded into Mild (+) light pink color; Moderate (++) light purple color; and Severe (+++) dark purple color. Urinary ketones were tested by using Multiple reagent strip and graded as (+), (++), and (+++) by color code method.

Demographic and laboratory data were recorded on a database form and then they were entered into a computer using Microsoft Excel (Windows version 8.0) for statistical analysis. The strength of association (linear correlation) between arterial and venous pH, arterial and venous HCO_3–, and arterial and venous pCO^2 results was assessed with Pearson's Correlation Coefficient (r). The Coefficient of Determination (r^2) was used to measure the proportion of the variance in arterial levels that could be accounted by the venous levels using a linear model. The degree of agreement between the arterial and venous pH measurements, arterial and venous HCO_3– values, and the arterial pCO^2 and venous pCO^2 values was evaluated on Bland and Altman graph in which the difference between the paired determinations was plotted against the mean of any two determinations, as described by Bland and Altman. This type of plot is bounded by limits of agreement, defined as the mean of the arteriovenous differences ±2 SD.

Results: In present study, 38 patients of DKA above the age of 17 years admitted at Emergency Ward of Medicine department of our institute from January 2018 to October 2019 were included. Maximum number of patients 11 (28.9%) belong to age group 17-24 years; while 9 (23.7%) patients in age group 25-34 years; 6 (15.8%) patients in age group 35-44 years; 3 (7.9%) patients in age group 55-64 years; while none of patients belong to age group >70 years.

Out of 38 (100%) patients, 23 (60.5%) patients were males and 15 (39.5%) patients were females. Out of 38 (100%) patients, 29 (76.3%) patients were having Type 1 DM, and 9 (23.7%) patients having Type 2 DM. Out of 38 (100%) patients, 10 (26.3%) patients were newly detected cases of DM, and all of them were having Type 1 DM; while 28 (73.7%) patients were k/c/o DM, out of which 19 (50%) were having Type 1 DM and 9 (23.7%) were having Type 2 DM.

Mean RBS was 605.58 with SD of 31.62 (Range 546-678) The mean Arterial pH was 7.124 with SD of 0.093 (Range 6.9-7.29) The mean Venous pH was 7.137 with SD of 0.092 (Range 6.9-7.3).

The mean difference between arterial and venous pH values was 0.13. Mean Arterial HCO3 (mmol/L) was 8.686 with SD of 3.375 (Range- 2.7-15.3). Mean Venous HCO3 (mmol/L) was 8.992 with SD of 3.324 (Range- 3-15.9). The mean difference between arterial and venous pHCO3 values was 0.30. Mean of Arterial pCO2 (mmol/L) was 17.25 with SD of 4.80 (Range- 8.2-28.7).

Mean of Venous pCO2 was 20.65 with SD of 3.35 (Range 11-32.8). The mean difference between arterial and venous pCO2 values was 4.17. Regression plot of Arterial and Venous pH

measurements had following results : Coefficient of correlation r =0.9058, Coefficient of determination r^2=0.815, p value <.0001; suggesting strong linear correlation between Arterial and Venous pH values. The Degree of agreement for Arterial and Venous pH measurements (Bland and Altman plot) was >95% ; suggesting that Venous pH is almost equivalent to Arterial pH; and Venous pH can be used in place of Arterial pH in initial evaluation of DKA patient.

Regression plot of Arterial and Venous HCO3 measurements had following results: Coefficient of correlation r =0.9680, Coefficient of determination r^2=0.994, p value <.0001; suggesting strong linear correlation between Arterial and Venous HCO3 values. The Degree of agreement for Arterial and Venous HCO3 measurements (Bland and Altman plot) was >95% ; suggesting that Venous HCO3 is almost equivalent to Arterial HCO3; and Venous HCO3 can be used in place of Arterial HCO3 in initial evaluation of DKA patient.

Regression plot of Arterial and Venous pCO2 measurements had following results : Coefficient of correlation r =0.9639, Coefficient of determination r^2=0.873, p value <.0001; suggesting strong linear correlation between Arterial and Venous pCO2 values. The Degree of agreement for Arterial and Venous pCO2 measurements (Bland and Altman plot) was <95% ; suggesting that Venous pCO2 is not equivalent to Arterial pCO2; and Venous pCO2 cannot be used in place of Arterial pCO2 in evaluation of DKA patient.

Discussion: In present study, maximum number of patients 11 (28.9%) belong to age group 17-24 years; while 9 (23.7%) patients in age group 25-34 years; 6(15.8%) patients in age group 35-44 years; 3 (7.9%) patients in age group 55-64 years; while none of patients belong to age group >70 years.

Out of 38 (100%) patients, 23 (60.5%) patients were males and 15 (39.5%) patients were females. In present study, out of 38 (100%) patients, 29 (76.3%) patients were having Type 1 DM, and 9 (23.7%) patients were having Type 2 DM. Out of 38 (100%) patients, 10 (26.3%) patients were newly detected cases of DM, and all of them were having Type 1 DM; while 28 (73.7%) patients were k/c/o DM, out of which 19 (50%) were having Type 1 DM and 9 (23.7%) were having Type 2 DM. These findings are quite similar to the study done by Christopher A. Newton, in which incidence of Type 1 DM and Type 2 DM were 78.27% and 21.73% respectively.

He found 19.9% patients with newly detected DM, and all of them having Type 1 DM. Above findings suggest that incidence of DKA is more common in Type 1 DM than Type 2 DM; and Type 1 DM is diagnosed more commonly in patients of DKA with no past history of DM.

Figure 1: Figure.1 pH Range

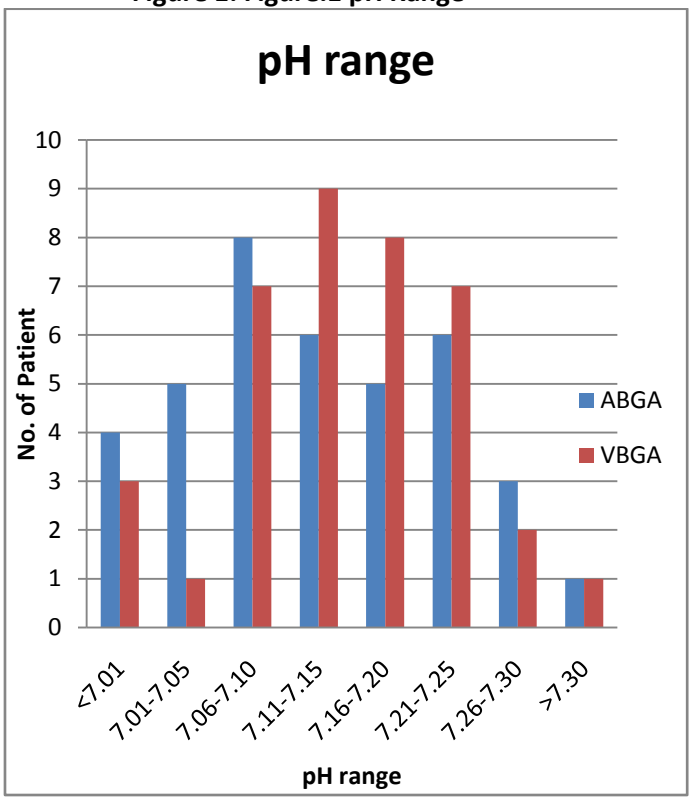


Figure 2: HCO_3 Range

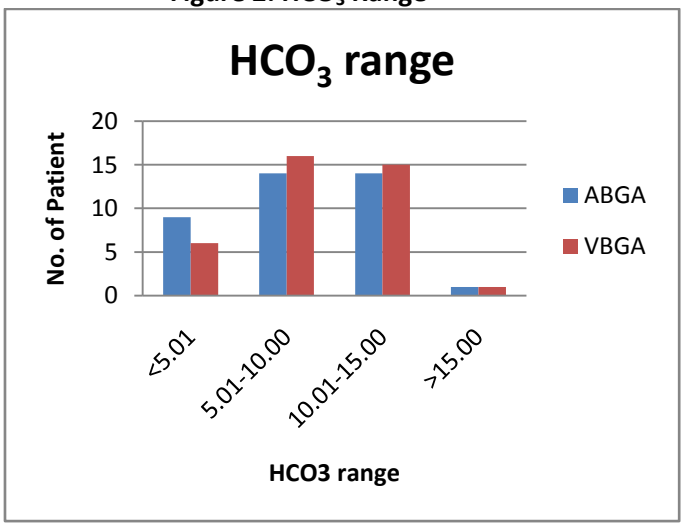
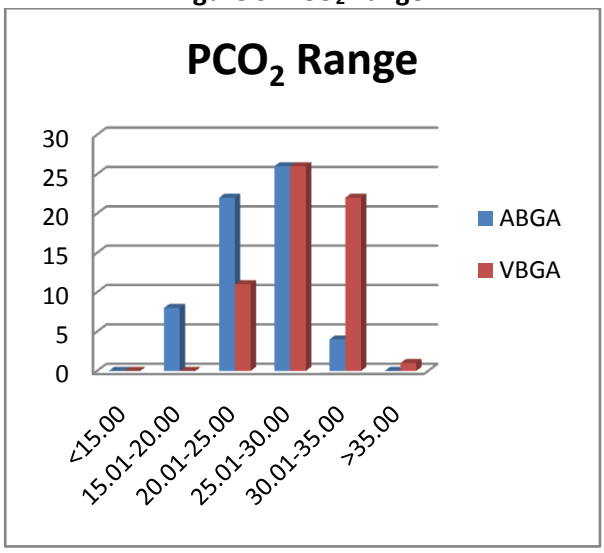


Figure 3: PCO_2 Range



Descriptive statistics of present study: In present study, mean RBS was 605.58 with SD of 31.62 (Range 546-678) The mean Arterial pH was 7.124 with SD of 0.093 (Range 6.9-7.29). The mean Venous pH was 7.137 with SD of 0.092 (Range 6.9-7.3). The mean difference between arterial and venous pH values was 0.13. Mean Arterial HCO3 (mmol/L) was 8.686 with SD of 3.375 (Range- 2.7- 15.3).

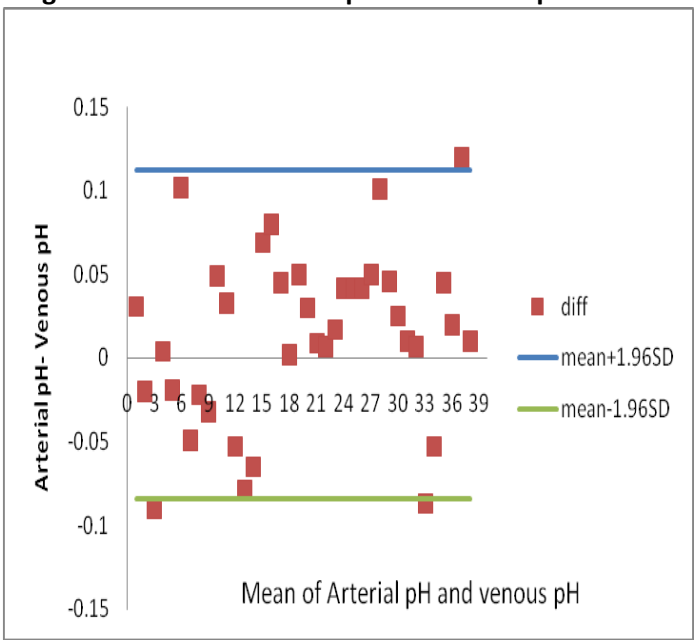
Mean Venous HCO3 (mmol/L) was 8.992 with SD of 3.324 (Range- 3-15.9). The mean difference between arterial and venous pHCO3 values was 0.30. Mean of Arterial pCO2 (mmol/L) was 17.25 with SD of 4.80 (Range- 8.2-28.7). Mean of Venous pCO2 was 20.65 with SD of 3.35 (Range 11-32.8).

In 1996, Mark A Brandenburg and Daniel J Dire did the study of comparison of Arterial and Venous Blood Gas Values in the Initial Emergency Department Evaluation of Patients With Diabetic Ketoacidosis.

Descriptive statistics of study of Mark A Brandenburg and Daniel J Dire: In their study, mean RBS was 609.9 with SD of 288 (Range 250-1464) The mean Arterial pH was 7.20 with SD of 0.14 (Range 6.78-7.39) The mean Venous pH was 7.170 with SD of 0.13 (Range 6.99-7.38). The mean difference between arterial and venous pH values was 0.03. Mean Arterial HCO3 (mmol/L) was 11.0 with SD of 6.0 (Range- 2-23). Mean Venous HCO3 (mmol/L) was 12.8 with SD of 5.5 (Range- 3-24). The mean difference between arterial and venous pHCO3 values was 1.80. Mean of serum CO2 (mmol/L) was 11.8 with SD of 5.0 (Range- 2-24).

Figure 4: Differences between arterial and venous pH measurements on the vertical axis are plotted against the corresponding means on the horizontal axis. (Bland Altman plot)

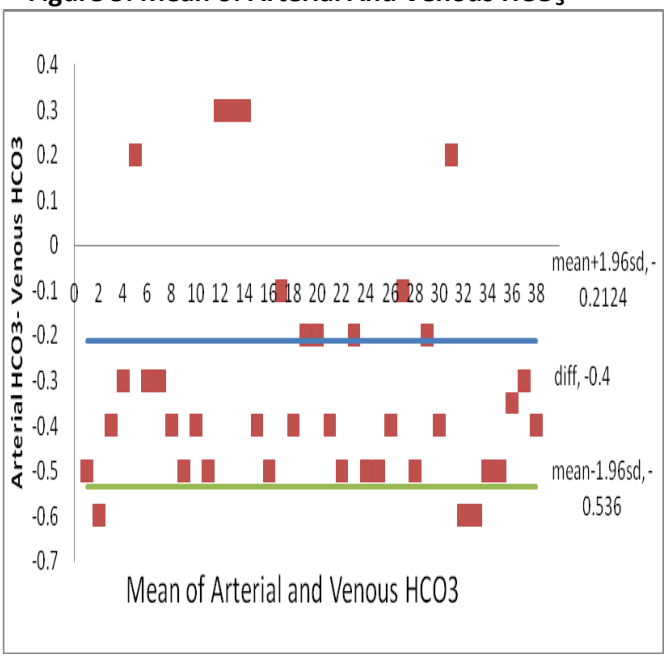
Figure 4: Mean Of Arterial pH and Venous pH



This suggests that Venous pH is almost equivalent to Arterial pH; and Venous pH can be used in place of Arterial pH in initial evaluation of DKA patient.

Figure 5: Differences between arterial and venous HCO– measurements (mmol/L) on the vertical axis are plotted against the corres-ponding means on the horizontal axis. (Bland Altman plot)

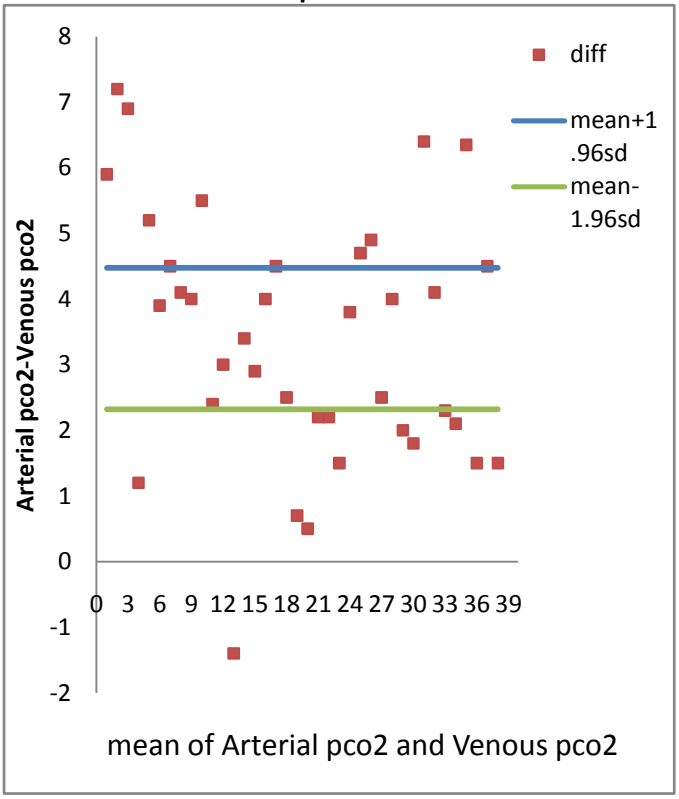
Figure 5: Mean of Arterial And Venous HCO_3



This suggests that Venous HCO3 is almost equivalent to Arterial HCO3; and Venous HCO3 can be used in place of Arterial HCO3 in initial evaluation of DKA patient.

Figure 6: Differences between arterial and venous pCO2measurements (mmol/L) on the vertical axis are plotted against the corresponding means on the horizontal axis. (Bland Altman plot)

Figure 6: mean of Arterial pco2 and Venous pco2



This suggests that Venous pCO2 is not equivalent to Arterial pCO2; and Venous pCO2 cannot be used in place of Arterial pCO2 in evaluation of DKA patient.

Conclusion: Strong linear correlation was found between Arterial and Venous pH, HCO3 and CO2 values and Venous pH and HCO3 is almost equivalent to that of Arterial, but according to the Degree of agreement Venous pCO2 is not equivalent to Arterial pCO2; so Venous pH and HCO3 can be used in place of Arterial pH and HCO3 in initial evaluation of DKA patient but not Venous pCO2.

So, For initial evaluation of DKA patients (for pH and HCO3 determination), we can use VBGA in place of ABGA, as ABGA is technically more difficult, more painful, and carries higher incidence of complications.

References:

1. Diabetes Mellitus: Management and Therapies | Harrison's Principles of Internal Medicine, 20e | AccessMedicine | McGraw-Hill Medical [Internet]. Accessmedicine. mhmedical.com. 2020 [cited 15October2020]. Availablefrom:http://accessmedicine. mhmedical. com/content. aspx? Bookid =2129 &sectionid=192288412
2. DE T. Diabetic ketoacidosis [Internet]. PubMed. 2020 [cited 15 October 2020]. Availablefrom:https://pubmed.ncbi.nlm.nih.gov/15887449
3. Menon R, Sperling M. Diabetic Ketoacidosis [Internet]. SpringerLink. 2020 [cited 15 October 2020]. Available from: https://link.springer.com/chapter/10.1007/978-1-59259-310-1_9#citeas
4. Knott D. Arterial Blood Gases - Indications and Interpretation. Patient [Internet]. Patient.info. 2020 [cited 15 October 2020]. Available from: https://patient.info/doctor/arterial-blood-gases-indications-and-interpretation
5. Brooks D, Wynn V. USE OF VENOUS BLOOD FOR pH AND CARBON-DIOXIDE STUDIES. The Lancet. 1959;273(7066):227-230.
6. H. V. Forster, J. A. Dempsey, J. Thomson, E. Vidruk, and G. A. DoPico. Estimation of arterial PO2, PCO2, pH, and lactate from arterialized venous blood | Journal of Applied Physiology [Internet]. Journals.physiology.org. 2020 [cited 15 October 2020]. Available from: https://journals.physiology.org/doi/abs/10.1152/jappl.1972.32.1.134

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