



Original Research Article

Comparative study of electrolyte (sodium and potassium) measurement in severely diseased patient by venous & arterial blood collected at the similar time

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ABSTRACT

Introduction: Purpose of our research study was to sort out differences in levels of Na⁺ and K⁺ in blood sample from venous and arterial system, collected simultaneously in severely diseased patients.

Materials and Methods: In our cross section comparative research study, total 100 patients admitted in intensive care unit were analyzed for measurement of sodium and potassium levels from arterial and venous blood samples collected from femoral artery by heparinised syringe and from median cubital vein by red vacutainer correspondingly at the similar time. ABG Analyzer machine was used for measurement of electrolytes from arterial blood, while ISE Electrolyte analyzer machine was used for measurement of electrolytes from venous blood.

Result: Potassium of venous blood sample (4.49 ± 0.63 mmol/l) was significantly higher as compared to arterial blood sample (4.02 ± 0.59 mmol/l). The mean sodium of venous blood sample (139.86 mmol/L) was significantly higher than arterial blood sample (136.32 mmol/L). The mean Bias for potassium and sodium 0.15 mmol/l and 1.54 mmol/l correspondingly.

Conclusion: Arterial Blood Gas analyzer is not comparable to Electrolyte analyzer machine for measurement of Na⁺ and K⁺ levels. Arterial Blood sample analyzed by Arterial Blood Gas analyzer cannot substitute venous blood sample analyzed by electrolyte analyzer for electrolytes analysis, even if TAT (Turn Around Time) of Arterial Blood Gas analyzer is low.

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1. Introduction

Main reason of morbidity and mortality in severely diseased patients admitted in Intensive Care Unit is electrolytes imbalance.¹ TAT for electrolyte reporting in severely diseased patients should be minimum.² Electrolyte level can be measured by any of the two sample collection method. 1) Serum obtained by centrifugation of venous blood and 2) Whole heparinised blood collected from artery.

Electrolyte level measured from venous blood takes 30 to 40 minutes, whereas electrolytes measured from arterial blood by ABG Analyser takes only 5 minutes. Electrolyte levels are maintained thoroughly in emergency situations by giving intravenous electrolyte infusion. ADH, Aldosterone, Renin Angiotensin system are the main hormonal factors

for regulation of electrolyte levels. Complications affecting cardiovascular system and neurological system are due to electrolyte imbalance. Medical emergencies are common if such complications are not handled within short time.³ Hyponatremia leads to dry mucous membrane, fever, thirst, restlessness, while hyponatremia leads to dehydration, hypotension, lethargy, confusion, tremors and coma.⁴ Major mortality related to abnormality in potassium level is due to cardiac arrest. Hyperkalemia can lead to bradycardia.⁵ So, electrolyte levels should be continuously monitored in severely diseased patients. Turnaround time for the electrolyte measurement should be minimum, so that prompt management of complications of electrolyte imbalance can be done. For that whole blood sample is taken from critically ill patient and sample is analyzed by ABG analyser machine.² This machine analyzes the blood gas level along with electrolyte within 5 minutes.

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In other method venous blood sample should be sent to the laboratory and this takes more time.⁶ Various studies says that there is difference in electrolyte level measured between arterial blood sample and venous blood sample. So, Electrolyte analyzer should be used for exact analysis of electrolyte status of the patient.^{7,8}

2. Materials and Methods

In our cross sectional comparative study, research was carried out among 100 patients admitted to ICU of Geetanjali hospital, Udaipur. The purpose, nature and objectives of this study was clearly made understood to all patients' relatives included in our study. The written informed consent was taken from each patient relative. Two blood samples were collected from severely diseased patients in Intensive C are Unit. Samples were collected with aseptic blood collection method by using sterilized gloves and through disinfection of venipuncture site with 70% ethyl alcohol. One sample was collected from femoral artery by heparinised syringe and immediately analyzed by A BG machine. Another venous blood sample was collected at the similar time from a cubital vein in plain vacutainer and sent to the biochemistry laboratory for analysis by elctrolyte analyser. Arterial blood electrolytes (Na+ & K+) were analyzed by ABG machine by I.S.E. (Ion Selective Method) which is the type of potentiometry in ICU. Venous blood electrolytes were measured by Roche 9180 machine by I.S.E. method in biochemistry lab.

3. Result

The value of 43.4 ± 10.8 years was the mean value for age of patients. Out of 100 patients, there were 63 male and 37 female patients. Mean and SD of K⁺ of blood samples from artery and vein were shown in Table 1. K⁺ of venous blood sample was considerably elevated as compared to arterial blood sample (Venous sample v/s Arterial sample: 4.49 ± 0.63 v/s 4.02 ± 0.59 , $p < 0.01$). The highest discrepancy in potassium value was 3.1 mmol/l, and the lowest discrepancy was 0 mmol/l.

Table 1: Potassium level from venous and arterial blood sample

Sample type	Mean	SD	p value
Venous sample	4.49	0.63	< 0.01
Arterial sample	4.02	0.59	

The mean difference between arterial and venous potassium is 0.15 mmol/l which reflect potassium value from venous sample was overestimated by 0.15 mmol/l as compared to arterial blood sample. The range of 1.96 SD limit of agreement for potassium is -0.20 to + 0.51 This shows that 95 % of the differences noted could be underestimated by 0.20 mmol /l or overestimated by 0.51 mmol/l in venous sample as compared to arterial sample.

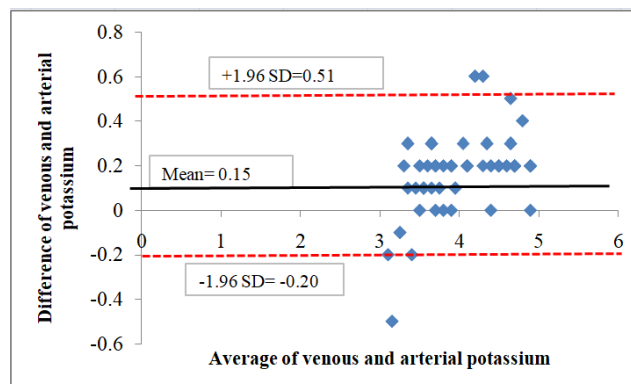


Fig. 1: Bland Altman plot of arterial and venous K level

Table 2: Na+ level of venous and arterial sample

Sample type	Mean	SD	p value
Venous sample	139.86	3.06	< 0.01
Arterial sample	136.32	3.45	

In table number 2, Mean and Standard Deviation value of sodium from venous and arterial blood sample were depicted. The findings are: Mean value for sodium from venous blood sample - 139.86 mmol/L (SD 3.06), whereas the Mean value for sodium from arterial blood sample - 136.32 mmol/L (SD 3.45), which was significantly low as compared to venous blood sample. The maximum difference in Na⁺ level was 15 mmol /l, and the minimum difference was 0 mmol/l.

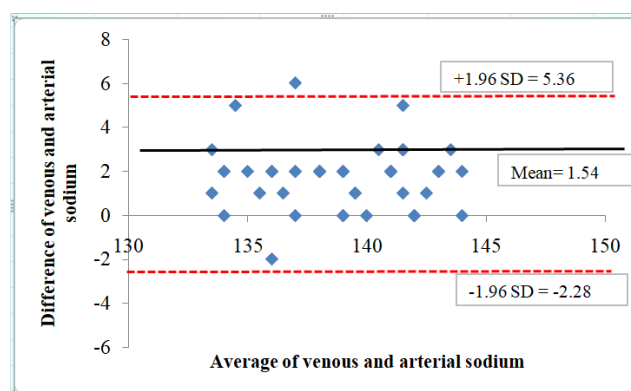


Fig. 2: Bland Altman plot of arterial and venous Na⁺ level

The mean difference between arterial and venous sodium is 1.54 mmol/l which reflect sodium value from venous sample was overestimated by 1.54 mmol /l as compared to arterial blood sample. The range of 1.96 SD limit of agreement for sodium is -2.28 to + 5.36. This shows that 95% of the differences noted could be underestimated by 2.28 mmol/l or overestimated by 5.36 mmol/l in venous sample as compared to arterial sample.

4. Discussion

In the present study, potassium of venous blood sample (4.49 ± 0.63 mmol/l) was significantly higher as compared to arterial blood sample (4.02 ± 0.59 mmol /l). The mean sodium of venous blood sample was 139.86 mmol /L which was also significantly higher than sodium of arterial blood sample (136.32 mmol /L). Mehta V⁹ and S Rajavi¹⁰ detected that potassium and sodium levels were higher in venous blood sample than arterial blood sample. Dilution factor by heparin could be the reason for lower levels in arterial blood samples.¹⁰ Contradictory observation was found in the study of Johnston and Murphy et al. as lower value of potassium in venous blood sample was observed in their study.¹¹

In the present study, potassium level measured from venous sample was overestimated by 0.15 mmol /l in contrast to arterial blood sample level and sodium level measured from venous sample was overestimated by 1.54 mmol /l in contrast to arterial blood sample level. S Nanda reported 0.3 mmol/l and 0.9 mmol /l for potassium and sodium correspondingly.¹² A higher bias was detected in contrast to our research study by Budak YU et al., (4.9 for sodium and 0.25 for potassium). Release of potassium from platelets during the clotting process can lead to high potassium levels, as explained by Budak YU et al.¹³ Chhapola V reported that ABG analyser under estimate sodium and potassium level. Lyophilized container for collection of blood sample can be used to prevent under estimation of electrolytes occurring due to liquid heparin.¹⁴ Fu P also accomplished that arterial potassium could not be used as alternative to serum potassium.¹⁵

5. Conclusion

Arterial blood sample may not substitute venous blood sample for measurement of sodium and potassium in severely diseased patients. Thus, ABG analyzer machine may not be used as an alternative to electrolyte analyzer for measurement of sodium and potassium levels despite of desirable low turnaround time for ABG Analyzer.

6. Source of funding

None.

7. Conflict of interest

None.

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