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Reliability of blood gas analyzer for the measurement of electrolytes - A comparative study

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Abstract

Background: Electrolyte and blood gas analysis are essential for most patients who are admitted in the casualty. Routinely simultaneous arterial and venous sample would be sent to the laboratory for blood gas analysis and serum electrolytes respectively. Electrolytes can also be measured by the blood gas analyzer. We wanted to find out if these values were reliable.

Methods: This study has been checked and permitted by the hospital ethics committee. We obtained two samples, one venous and one arterial sample from patients in the intensive care unit (ICU) and casualty of Ashwini rural medical college, hospital and research centre, (ARMCH&RC) Kumbhari Solapur.

The arterial blood samples were analyzed on the ABOTT arterial blood gas analyzer (ABG) and venous samples were analyzed on PROLYTE electrolyte autoanalyzer (AA). Both instruments were placed in our biochemistry laboratory.

Results: A total of 200 samples were analyzed. The mean ABG sodium value was 132.0 mmol/L (SD 9.82) and the mean AA sodium (Na^+) was 135.7 mmol/L (SD 9.99). The mean AA sodium value was more than mean ABG sodium but statistically significant difference was not found (p=0.18).

The mean ABG potassium (K^+) value was 3.4 mmol/L (SD 0.68) and the mean AA potassium (K^+) was 3.8 mmol/L (SD 0.79). The mean AA potassium value was more than mean ABG potassium and found statistically significant difference (p=0.02).

Conclusion: We found that there was no significant difference in the sodium values measured by the ABG analyzer and the auto-analyzer. However, there was a significant difference in the potassium values measured by these instruments.

Keywords: Electrolytes; Arterial blood gas analyzer (ABG); Autoanalyzer (AA)

Introduction

Electrolytes form an important part of the complex physiological systems needed to maintain the integrity of the cells. When the patient is admitted, the electrolytes are checked. The changes in these values may be the cause of the condition or a result of it. This condition has to be identified for proper treatment(1).

Our hospital is situated in a rural area. Many of the patients are brought in a critical condition to the casualty. Relatives are not aware of the medical history of the patient. So the diagnosis has to be quick and treatment started immediately. For correction of these imbalances, the electrolyte values are required for guiding therapy.

In this study, we look at whether sodium and potassium ion concentrations measured with ABG analyzer and electrolyte analyzer are equivalent. If the electrolyte values are found to be equivalent, then the ABG analyzer can be used at point-of-care.

Materials and Methods

The study was cleared by the college ethics committee of ARMCH & RC, Kumbhari. Solapur. India. We obtained coupled blood samples from 100 consecutive patients admitted to the ICU of Ashwini rural medical college Hospital & research centre. The study included both male and female patients aged between 40 to 75years. The study started in August 2013 and continued till May 2014. Blood samples were collected at the same time for ABG and AA for electrolyte analysis. All samples were analyzed on the ABOTT blood gas analyzer and the PROLYTE electrolyte analyzer. In ABG, for cartridges, calibration is automatically performed as part of the test cycle on each cartridge. The AA is calibrated yearly by the company.

For the ABG we require a single-use cartridge. In this study we used EG7+ cartridges which measure the electrolytes also. The EG7+ cartridges contain chemically sensitive biosensors on a silicon chip each designed specific to the test. The AA uses ion selective electrodes to measure the electrolytes.

Standardization of the instruments was performed every day. For AA we use the standard provided by the company. The control solution was also run everyday for internal quality control check. The ABG is calibrated electronically. Our laboratory is also enrolled in an external quality control programme.

We included 100 patients in this study. From each patient we obtained an arterial sample and a venous sample for blood gas analyzer and auto-analyzer respectively for electrolyte measurement.

After analyzing the data, paired t test were applied for comparison of values of sodium (Na+) and potassium (K+) obtained from these measurements. Pearson's correlation coefficient value (r) was calculated. A p-value less than 0.05 were considered as significant.

Results

When we analyzed the sodium values (Table 1), we found that the mean sodium measured on the ABG was 132 mmol/L (SD 9.82), and the mean sodium measured by the AA was 135.7 mmol/L (SD 9.99). The mean difference was 3.72 mmol/L. Statistically there was no significant difference between them (p=0.18). The correlation coefficient (r) was 0.596 and found statistically significant at p<0.001. The adjusted r^2 was within a 95% confidence interval from 0.21–0.50. Though the mean difference in the sodium values was 3.72 mmol/L it is in the acceptable range suggested by US CLIA 2006. (The electrolyte values reported to the clinician were obtained from AA and not from ABG).

The mean ABG sodium value was more than mean AA sodium but statistically significant difference was not found (p=0.18).

Table 1: Statistical analysis of sodium samples

Sodium	Mean	SD	Mean difference	95% CI of difference	t-value	P –value
AA	135.7	9.99	3.72	1.8-9.24	1.35	0.18
ABG	132	9.82				

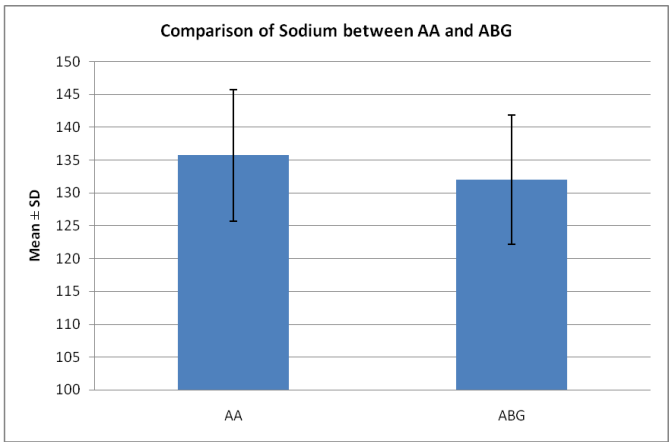

Fig. 1: Comparision of sodium values between AA and ABG

Analysis of the potassium values (Table 2) obtained from the AA and the ABG showed that the mean difference was 0.49 mmolL. There was a statistically significant difference (p = 0.02) between K+ measured by the ABG (3.4 mmol/l, SD 0.68) and AA (mean 3.8mmol/l, SD 0.79). The correlation coefficient (r) was 0.65. The adjusted r^2 was within a 95% confidence interval of 0.27 – 0.56.

Table 2: Statistical analysis of potassium samples

Sodium	Mean	SD	Mean difference	95% CI of difference	t-value	P –value
AA	3.8	0.79	0.49	0.078 - 0.906	2.38	0.02
ABG	3.4	0.68				

Analysis of the potassium measurements showed significant difference between the two values (p = 0.02). But the mean difference between the two instruments was 0.49 mmol/l, which was within the acceptable limit i.e. less than 0.5mmol/l according to the US CLIA 2006.

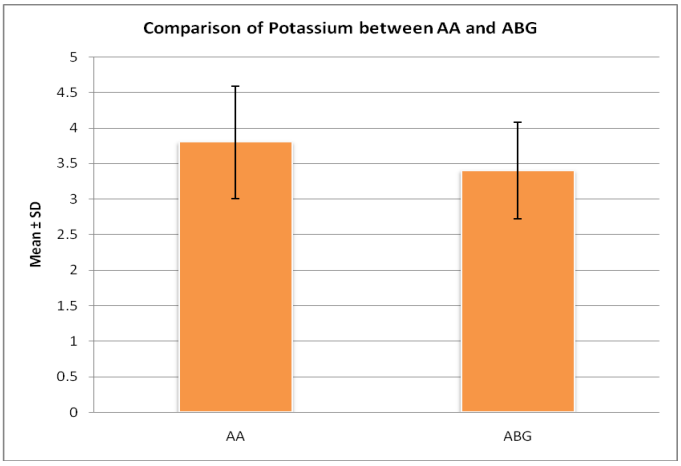

Fig. 2: Comparision of Potassium values between AA and ABG

Discussion

In the lab we often would get request for both ABG analysis and electrolytes. Physician would send an arterial sample for ABG and a venous sample for electrolytes. We had EG7+ cartridges from I-stat Abbott which also measures the electrolytes. After few tests we noted discrepancies in the electrolytes values obtained from ABG when compared to the auto-analyzer. We started this study to check if ABG analyzers can be used as a reliable source for electrolytes.

The advantages if the ABG analyzer was found reliable are:

1. The analysis can be done at point of care.
2. The turnaround time would be shortened. We can avoid delays due to transport and human errors. The ABG uses heparinised arterial blood, so there is no need to prepare the sample before the test. Whereas the venous sample used in AA need plasma to be separated. The attending physician will have the reports immediately. This would guide his further course of treatment.
3. Helps in discussions with other fraternities and pave way for alterations in the treatment regimen at the earliest.

This study shows that, there was no statistically significant differences in Na+ values derived from the AA and the ABG machines. We can suggest that serum Na+ is reliable when obtained on the ABG machine.

Analysis of Na by two different methods revealed no significant difference and also mean measuring difference between two methods is within the range as given by the guidelines of US CLIA 1988[4]. K+ values calculated by the ABG machine are not completely reliable, so we may need to cross check these values by other methods. Though statistically significant, the mean difference in the measured K+ values in patients was within the recommended US CLIA guidelines.

Many studies have been conducted to assess the electrolyte values by different machines. But there are different opinions in the conclusion. Anunaya Jan et al[5] found that there was not much difference between the potassium values measured by the blood gas machine and the auto-analyzer. However, the difference between the measured sodium was found to be significant, whereas Yasemin U Buda et al[6] conclude that the ABG and AA do not yield equivalent Na+ and K+ values. Sunil Kumar Nanda et al[7] observed that sodium and potassium assayed by point of care ABG analyzer were in agreement to the sodium and potassium levels measured in electrolyte analyser. R King et also concluded that the sodium and potassium values measured by ABG analyser and chemistry auto analyser[8] were almost similar. Binila Chacko et al, observed that there was significant difference between arterial and venous sodium levels and arterial and venous potassium levels[9]. The conclusions from other studies are differing as compared to our study. This may be due to

1. Heparin rinsed syringes were used to collect the arterial samples. There may be difference in the amount of residual heparin. If it is more it would dilute the sample or the heparin may itself bind to the electrolytes. Instead if we use dried out heparin syringes[11] the results would be more precise.
2. Our values were not cross checked by another AA and ABG (Details of calibration mentioned in material and methods)

Our study shows the need of determining the agreement of electrolyte values acquired by ABG and those acquired by auto-analyzer. As instrument type and calibration methods may vary among hospitals, it is necessary that each hospital conducts similar studies before the use of ABG at point-of –care.

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