



Comparison of Accuracy of Point of Care Blood Gas Analysis and Laboratory Analysis in Determining Serum Electrolytes

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ABSTRACT

Objective: The objective was to investigate the correlation and accuracy between sodium and potassium levels measured by point-of-care blood gas analysis and those obtained through laboratory serum analysis.

Methods: A prospective observational study was carried out on 70 patients presenting to the Emergency Department of Mayo Hospital Lahore. Paired samples were drawn, one of them was used for point of care (POC) blood gas analysis and the other was sent for serum laboratory analysis under standard techniques.

Results: The mean difference between POC blood gas analysis and serum laboratory analysis was 4.9 ± 11.24 (taking 95% CI, $p < 0.001$) for sodium and 0.94 ± 0.07 (taking 95% CI, $p < 0.0001$) for potassium. The Pearson correlation coefficient (r) for POC blood gas analysis and serum laboratory analysis was 0.021 for sodium, showing a weak correlation. This suggests that there is minimal linear relationship between the sodium levels measured by the two analyzers. For potassium, Pearson correlation coefficient (r) was found to be 0.939, showing strong correlation. This indicates that while the methods generally agree within this range, some degree of variability is present.

Conclusion: The difference between the results obtained from both analyzers was found to be statistically significant and therefore, cannot be used interchangeably.

INTRODUCTION

The homeostatic mechanisms of the human body are dependent upon various factors with the electrolytes playing the key role at the gates of each cell of the body monitoring every transport across it (1). The abnormalities in their levels can precipitate life-threatening events. Their frequent measurement is significant in making critical decisions regarding the diagnoses and therapeutic

interventions needed (2). The success of the treatment lies in the rapidity and reliability of these results. Though the biochemistry results from the serum sample from the laboratory are considered as a standard but usually it takes 2 to 4 hours before we access the results, confounded by many factors like lack of a rapid transport delivery or the overwhelmed system (3, 4). In busy tertiary care

emergency setups, it is very difficult to wait for such long hours and delay the interventions required at the bedside. This not only increases their length of stay but also impacts the outcomes unfavourably (5). In contrast to that, electrolyte levels obtained via point-of-care blood gas analysis are received without any hustle or delay but there are discrepancies in their accuracy (6).

In our tertiary care emergency setup, blood gas analysis results are accessible in no time and many critical care interventions are done based on their results. However, there are concerns regarding the accuracy and reliability of point-of-care devices, hence their reported electrolytes cannot be effectively translated into the decisions of therapeutics. Previous studies have yielded conflicting results. Some research indicated significant differences in plasma sodium and chloride concentrations, while others found notable discrepancies in potassium levels (5, 7). In our study, we aimed to assess sodium (Na⁺) and potassium (K⁺) levels through blood gas analysis and compare these measurements with those obtained from standard laboratory tests.

MATERIALS & METHODS

This prospective observational study was conducted from February 2024 to April 2024 at the Emergency Department of Mayo Hospital Lahore. Participants were selected through convenience sampling, and informed consent was obtained from each participant. The study received approval from the Institutional Review Board (IRB).

Our inclusion criteria was patients above 14 years of age, presenting to emergency, with the complaints requiring routine biochemistry along with the blood gas analysis. For laboratory analysis, 3 ml of venous blood was drawn through venipuncture under aseptic measures and sent to the emergency laboratory in serum vials. For blood gas analysis, 2 ml arterial blood was drawn and sent in the plastic syringe, which was priorly heparinized, and the solution was completely removed before the sample was drawn.

Samples received for blood gas analysis were processed immediately for electrolytes, with an ABG analyzer MEDICA Easy Stat. Biochemistry samples received in serum vials were centrifuged within 4 hours after collection. The measurement of electrolytes were done with BECKMAN

COULTER AU5800. Both machines employ the principle of ISE (ion selective electrodes with few differences like ABG analyzer uses Arterial blood sample (plasma) instead of venous blood sample (serum) which is used in Serum Biochemistry analyzer. Another difference is that the ABG analyzer uses ISE without using reagents whereas the Serum Biochemistry analyzer uses ISE with reagents. Principle of technique in ABG analyzer is Arterial gas whereas in Serum Biochemistry analyzer its spectrophotometry technique). The ranges for potassium and sodium, as a reference, were taken as 3.5–5.2 mmol/L and 135–145 mmol/L, respectively.

Statistical analysis was done using SPSS 20. A sample size of 70 was calculated by taking a confidence level of 95%, absolute power of beta as 80%, expected mean in the biochemistry group as 140.1 & blood gas analyzer as 144.6 with a standard deviation as 7.5 (6).

RESULTS

Our study included 70 patients, comprising 30 females and 40 males, with a mean age of 50.39 ± 17 years.

In ABGs and laboratory analysis, the mean sodium (Na⁺) level was 138±8.8 mg/dL and 133±7.2 mg/dL, respectively. The average variation in sodium levels between the two analysers was determined to be 4.9±1.6 mg/dL, a statistically significant difference (p<0.001). This result led to the rejection of the hypothesis that there was no difference between the two measurement methods. The Pearson correlation coefficient was $r = 0.021$, a value near to zero, indicating a weak correlation. A Bland-Altman analysis of sodium measurements from both methods revealed limits of agreement ranging from 17.15 to -26.93 mg/dL as illustrated in Figure 1. The wide limits of agreement (2SD) indicate a clinically unacceptable level of agreement between the two methods, suggesting that the two methods do not agree closely and are not interchangeable for clinical purposes

The average potassium (K⁺) levels measured using ABGs (Arterial Blood Gases) and laboratory analysis were 3.97±0.92 mg/dL & 4.91±0.99 mg/dL, respectively. The mean difference between these two measurement methods was 0.94±0.07 mg/dL which is statistically significant (p<0.0001).

This result led to the rejection of the null hypothesis that posited no difference between the two methods. The Pearson correlation coefficient was $r: 0.939$, with a significance level of ($p < 0.01$), indicating a strong and statistically significant correlation between the potassium levels obtained from the two methods. The Bland-Altman analysis, which compares the laboratory measurements with the blood gas analysis for potassium, shows limits of agreement ranging from 0.28 to 1.6 mg/dL, as illustrated in Figure 2. This indicates that while the methods generally agree within this range, some degree of variability is present.

Table 1
Descriptive Statistics

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---------------------------|----|---------|---------|--------|----------------|
| Sodium levels in ABGS | 70 | 113 | 152 | 137.97 | 8.820 |
| Sodium levels in serum | 70 | 113 | 156 | 133.07 | 7.165 |
| Potassium levels in serum | 70 | 3.1 | 8.3 | 4.910 | .9900 |
| Potassium levels in ABGS | 70 | 2.3 | 6.8 | 3.970 | .9238 |
| Valid N (listwise) | 70 | | | | |

Table 2
One-Sample Test

| | t | df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
|----------------------|--------|----|-----------------|-----------------|---|---------|
| | | | | | Lower | Upper |
| Difference_Sodium | -3.646 | 69 | .001 | -4.90000 | -7.5812 | -2.2188 |
| Difference_Potassium | 23.114 | 69 | .000 | .94000 | .8589 | 1.0211 |

Table 3

Correlations of Sodium by both analyzers

| | | Sodium levels in ABGS | Sodium levels in serum |
|------------------------|---------------------|-----------------------|------------------------|
| Sodium levels in ABGS | Pearson Correlation | 1 | 0.021 |
| | Sig. (2-tailed) | | 0.861 |
| | N | 70 | 70 |
| Sodium levels in serum | Pearson Correlation | .021 | 1 |
| | Sig. (2-tailed) | .861 | |
| | N | 70 | 70 |

Table 3
Correlations of Potassium by both analyzers

| | | Potassium levels in serum | Potassium levels in ABGS |
|---------------------------|---------------------|---------------------------|--------------------------|
| Potassium levels in serum | Pearson Correlation | 1 | .939** |
| | Sig. (2-tailed) | | .000 |
| | N | 70 | 70 |
| Potassium levels in ABGS | Pearson Correlation | .939** | 1 |
| | Sig. (2-tailed) | .000 | |
| | N | 70 | 70 |

** . Correlation is significant at the 0.01 level (2-tailed).

Figure 1
Bland-Altman Plot showing Difference versus Mean Sodium by Laboratory and Point of Care Blood Gas Analysis

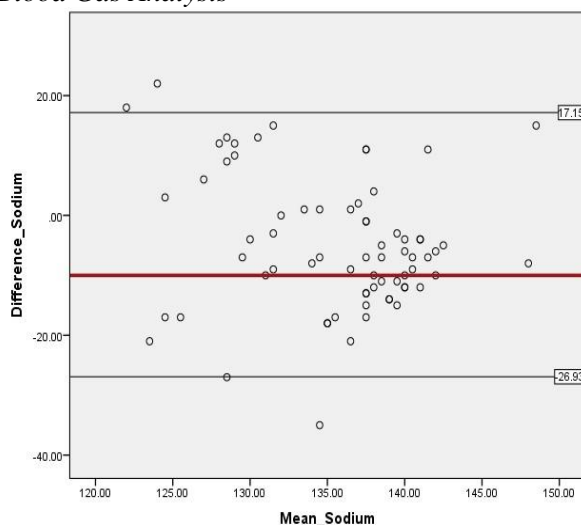
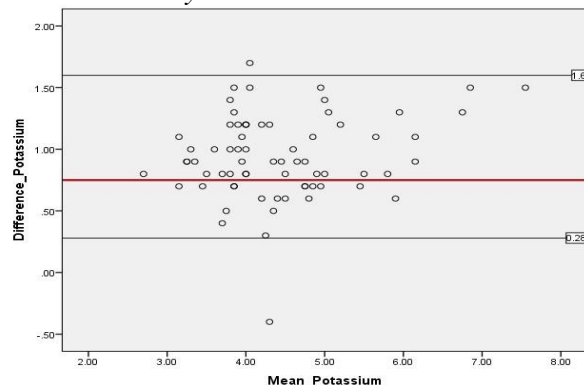


Figure 2

Bland-Altman Plot showing Difference versus Mean Potassium by Laboratory and Point of Care Blood Gas Analysis



DISCUSSION

Electrolyte imbalances frequently occur in critical care and emergency settings and can lead to serious complications. Accurate measurement of electrolytes is essential for effective treatment (8). Point-of-care (POC) arterial blood-gas analyzers are widely used for rapid clinical decision-making and cost-effective electrolyte measurement (9). Despite their ease of accessibility and affordability, previous studies have demonstrated a significant difference in electrolyte levels measured by arterial blood-gas analyzers and chemistry auto-analyzers (10). It is crucial to consider this discrepancy when making clinical decisions based on electrolyte measurements. Possible explanations for this difference include the dilution of the sample with heparin, which might lower electrolyte concentrations, or the potential binding of electrolytes to heparin, which could also reduce their measured levels (11).

Our study sought to determine if sodium and potassium measurements from two different methods were consistent, comparable, and

interchangeable. We discovered that the results from these methods were not comparable, with statistically significant differences in the levels of both sodium and potassium. This indicates that in scenarios where rapid results are essential and critical decisions rely on serum electrolyte levels, the values obtained from arterial blood gases (ABGs) may not be reliable and hence waiting for the serum lab reports found to be necessary. We hope our findings will support better decision-making and improve patient care.

Yilmaz et al (12) conducted the study a similar study on ICU patients and found that sodium levels cannot be used interchangeably but potassium levels are comparable. This study was almost consistent with our results. Similar results were found in the study of Uanik et al (13), which stated potassium can be used reliably but there are consistent differences in the sodium and calcium levels in both methods. Similar results in Yalsin Solak et al (14) and Hiroshi et al (15). Chappola et al (16) conducted the study in PICU and found a statistically significant difference in both Na & K measured by both techniques.

Chothia et al (17) conducted a study on potassium levels only and found consistent results of using blood gas analyzer as a substitute for serum laboratory analysis.

CONCLUSION

There is a statistically significant difference among the values obtained from the point of care blood gas analyzer and serum laboratory analysis for the sodium and potassium levels. Therefore, it is imperative that these results are not used interchangeably.

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