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Comparison of Accuracy of Point of Care Blood Gas Analysis and Laboratory Analysis in Determining Serum Electrolytes Diabetes Mellitus Patients: A Systematic Review

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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 4hours 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. (2tailed)	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

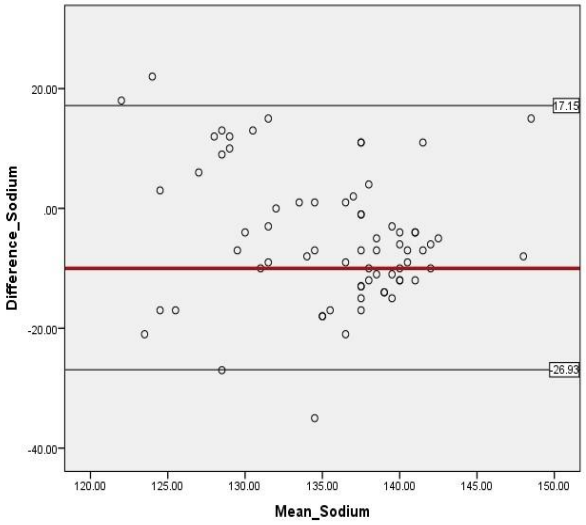
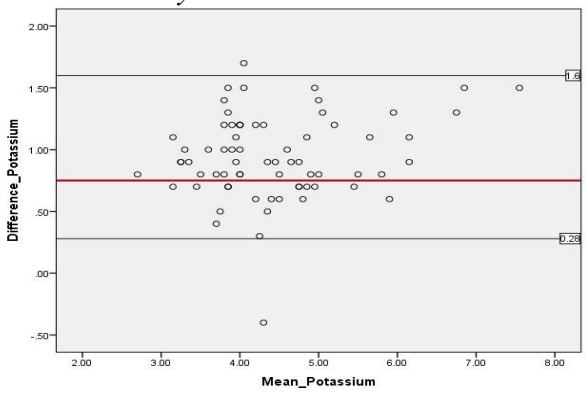


Figure 2

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.

REFERENCES

1. Alanazi, A., Obaidi, A., Al. Enezi, F., AlMutairi, M. K., Aljerian, N., Alsultan, O. A., alharbi, K., & Qureshi, S. (2015). Correlation between the Measurements of Serum and Arterial Blood Gas (ABG) Electrolytes in Patients Admitted to the Intensive Care Unit at King Abdul-Aziz Medical City, Riyadh, Saudi Arabia. *American Journal of Clinical Medicine Research*, *3*(3), 55–59. https://doi.org/10.12691/ajcmr-3-3-5
2. Ayhan, H., Erdogan, M. O., Yigit, Y., Gencer, E. G., Sahin Tuuran, R., Koyuncu Akyol, N., & Karakum, M. (2014). The Reliability of Blood Gas Electrolytes. *Journal of Academic Emergency Medicine*, *13*(2), 49–52. https://doi.org/10.5152/jaem.2014.06978
3. Zhang, J. B., Lin, J., & Zhao, X. D. (2015). Analysis of Bias in Measurements of

Potassium, Sodium and Hemoglobin by an Emergency Department-Based Blood Gas Analyzer Relative to Hospital Laboratory Autoanalyzer Results. *PLOS ONE*, *10*(4), e0122383. https://doi.org/10.1371/journal.pone.0122383

4. Allardet-Servent, J., Lebsir, M., Dubroca, C., Fabrigoule, M., Jordana, S., Signouret, T., Castanier, M., Thomas, G., Soundaravelou, R., Lepidi, A., Delapierre, L., Penaranda, G., Halfon, P., & Seghboyan, J.-M. (2017). Point-of-Care Versus Central Laboratory Measurements of Hemoglobin, Hematocrit, Glucose, Bicarbonate and Electrolytes: A Prospective Observational Study in Critically Ill Patients. *PLOS ONE*, *12*(1), e0169593. https://doi.org/10.1371/journal.pone.0169593
5. Hansda, U., Sahoo, S., Sahoo, J., Singh, N., Guru, S., & Topno, N. (2022). Point-of-care versus central laboratory measurements of electrolytes and hemoglobin: A prospective observational study in critically ill patients in a tertiary care hospital. *International Journal of Critical Illness and Injury Science*, *12*(3), 160–160. https://doi.org/10.4103/ijciis.ijciis_2_22
6. Chacko, B., Peter, J. V., Patole, S., Fleming, J. J., & Selvakumar, R. (2011). Electrolytes assessed by point-of-care testing - Are the values comparable with results obtained from the central laboratory? *Indian Journal of Critical Care Medicine*, *15*(1), 24–29. https://doi.org/10.4103/0972-5229.78219
7. pant, V., Tumbapo, A., & Karki, B. (2017). Inter-instrumental comparison for the measurement of electrolytes in patients admitted to the intensive care unit. *International Journal of General Medicine*, *Volume 10*, 145–149. https://doi.org/10.2147/ijgm.s135788
8. Kapoor, D., Singh, P., & Srivastava, M. (2014). Point of care blood gases with electrolytes and lactates in adult emergencies. *International Journal of Critical Illness and Injury Science*, *4*(3), 216. https://doi.org/10.4103/2229-5151.141411
9. Lee, B., & Park, H. (2022). Performance evaluation of the i-Smart 300E cartridge for point-of-care electrolyte measurement in serum and plasma. *Journal of Clinical Laboratory Analysis*, *36*(4). https://doi.org/10.1002/jcla.24295
10. Gavala, A., & Myrianthefs, P. (2017). Comparison of point-of-care versus central laboratory measurement of hematocrit, hemoglobin, and electrolyte concentrations. *Heart & Lung*, *46*(4), 246–250. https://doi.org/10.1016/j.hrtlng.2017.04.003
11. Jain, A., Subhan, I., & Joshi, M. (2009). Comparison of the point-of-care blood gas analyzer versus the laboratory auto-analyzer for the measurement of electrolytes. *International Journal of Emergency Medicine*, *2*(2), 117–120. https://doi.org/10.1007/s12245-009-0091-1
12. Yılmaz, S., Uysal, H., Avcil, M., Yılmaz, M., Dağlı, B., Bakış, M., & Ömürlü, I. (2016). Comparison of different methods for measurement of electrolytes in patients admitted to the intensive care unit. *Saudi Medical Journal*, *37*(3), 262–267. https://doi.org/10.15537/smj.2016.3.13539
13. Uyanik, M., Sertoglu, E., Kayadibi, H., Tapan, S., Serdar, M. A., Bilgi, C., & Kurt, I. (2014). Comparison of blood gas, electrolyte and metabolite results measured with two different blood gas analyzers and a core laboratory analyzer. *Scandinavian Journal of Clinical and Laboratory Investigation*, *75*(2), 97–105. https://doi.org/10.3109/00365513.2014.981854
14. Solak, Y. (2016). Comparison of serum sodium levels measured by blood gas analyzer and biochemistry autoanalyzer in patients with hyponatremia, eunatremia, and hypernatremia. *The American Journal of Emergency Medicine*, *34*(8), 1473–

1479. https://doi.org/10.1016/j.ajem.2016.04.037

15. Morimatsu, H., Rocktäschel, J., Bellomo, R., Uchino, S., Goldsmith, D., & Gutteridge, G. (2003). Comparison of Point-of-Care Versus Central Laboratory Measurement of Electrolyte Concentrations on Calculations of the Anion Gap and the Strong Ion Difference. *Anesthesiology*, *98*(5), 1077–1084. https://doi.org/10.1097/00000542-200305000-00009

16. Chhapola, V., Kanwal, S. K., Sharma, R., & Kumar, V. (2013). *A Comparative Study on Reliability of Point of Care Sodium and Potassium Estimation in a Pediatric Intensive Care Unit*. *80*(9), 731–735. https://doi.org/10.1007/s12098-013-0977-z

17. Chothia, M. Y., Kassum, P., & Zemlin, A. (2020). A method comparison study of a point-of-care blood gas analyser with a laboratory auto-analyser for the determination of potassium concentrations during hyperkalaemia in patients with kidney disease. *Biochemia Medica*, *30*(3), 432-438. https://hrcak.srce.hr/file/355600