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Compatibility of Na and K values measured by biochemistry analyser and blood gas analyser in different clinical situations

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ABSTRACT

Severe disturbances in sodium and potassium are frequently encountered in emergency departments and these are among the most important treatable medical emergencies. In this study we aimed to evaluate the correlation of serum sodium and potassium levels measured with blood gas analyser (BGA) and biochemistry laboratory autoanalyser (BLA) devices in the laboratory.

We conducted a retrospective study between April 1st and 30th, in an emergency department of an university hospital. We screened patients whom had both venous blood gas analysis and serum electrolytes in biochemistry panel. Then we grouped electrolyte levels of patients as hyper-, hypo-, and eu- to compare these groups separately. Pearson correlation coefficients were calculated for determination linear relationships between the variables.

Results: total of 156 patients (age> 18) screened whom had both venous blood gas analysis and serum electrolytes in biochemistry panel at the same emergency appointment. The mean level of sodium in serum samples was 138.7 mmol/l compared to 143.2 mmol/l in venous blood gas. Mean variation between two samples was -4.46 mmol/l (95% CI -5.25, -3.67), ranged from -19 mmol/l to 4 mmol/l. The mean level of potassium in serum samples was 4.34 mmol/l compared to 3.74 mmol/l in venous blood gas. Mean variation between two samples was 0.6 mmol/l (95% CI 0.50, 0.69) ranged from -0.50 mmol/l to 2.6 mmol/l. The correlation coefficient was found r=0.852 for Na, r=0.774 for K and p was <0.001 for both values.

We found positive correlation in sodium and potassium levels in various strength in different clinical situations. As our opinion, blood gas analyses should help and guide physicians especially in emergent conditions.

Key Words: Blood gas analysis, sodium, potassium

Introduction

Severe disturbances in sodium and potassium are frequently encountered in emergency departments and these are among the most important treatable medical emergencies (1).

These disturbances may lead to serious potential clinical situations which threatens patient life in a little while like hyperkalemia.

Therefore rapid knowledge of patient's status is crucial in emergency setting, emergency physicians need blood gas analysis for quick and appropriate determination and treatment due to its quick results. On the other hand, data on the accuracy of blood gas analysers in assessing electrolyte concentrations are limited, with no obvious independent validation being available in the literature other than provided by the manufacturers (2). At this point we need to test reliability of this approach in different clinical situations then facilitate accurate and prompt clinical decision.

Although there are several studies regarding this correlation, the aim of our study was to assess compatibility of serum sodium and potassium levels of blood gas and biochemistry laboratory analysis in different clinical situations like hypernatremia, hypokalemia etc (3,4)

In this study we aimed to evaluate the correlation of serum sodium and potassium levels measured with blood gas analyser (BGA) and biochemistry laboratory autoanalyser (BLA) devices in the laboratory.

Materials and Methods

We conducted a retrospective study between April 1st and 30th, in an emergency department of an university hospital. We screened patients older than 18 years old whom had both venous blood gas analysis and serum electrolytes in biochemistry panel. We attached great importance to make sure that blood samples were drawn from same vein and simultaneously to avoid improper results. The samples were collected from

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Table 1. Mean and mean differences between two analysis

	Biochemistry Laboratory Mean (SD)	Venous blood gas mean (SD)	Mean Difference (SD)	r	p
Sodium	138.73(±7.12)	143.20(±7.93)	-4.46(±4.17)	0.852	<0.001
Potassium	4.34(±0.71)	3.74(±0.71)	0.60(±0.48)	0.774	<0.001

SD: Standart deviation, r= Pearson correlation coefficient, p= probability of hypothesis

Table 2. The estimation of laboratory results from blood gas values by using linear regression analysis

	Regression Equation	R square as determination coefficient
Laboratory Na (mmol/l)	29.138 + 0.765 * Na value in blood gas (mmol/l)	%72.6
Laboratory K (mmol/l)	1.448 + 0.774 * K value in blood gas (mmol/l)	%59.9

same vein consecutively and the blood gas injector flushed thoroughly with 1 ml solution of heparin which was removed completely before drawing of sample. Samples collected in different time frames or from different veins were excluded from the study. And we also excluded the samples which are defined as hemolysed by biochemistry laboratory. Then we grouped electrolyte levels of patients as hyper-, hypo-, and eu- to compare these groups separately. All protocol was approved by the university ethics board.

All blood gas samples were analysed using the "Radiometre abl90 flex" machine, and all venous samples were analysed using "Abbott Architect c16000" laboratory analysers. All machines were calibrated on a timely and regular basis to company specifications.

Statistical Analysis: Descriptive statistics for the continuous variables (characteristics) were presented as mean, standard deviation, while count and percent for the categorical variables. Pearson correlation coefficients were calculated for determination of linear relationships between the variables. In addition to correlation analysis, Linear regression analysis was performed to predict biochemical values from the blood gas values. Patients were classified into three subgroups by considering blood gas and biochemical values of the Na and K. For the agreement between blood gas and biochemical values, kappa coefficient was computed. Statistical significance level was considered as 5% and SPSS (ver: 20) statistical program was used for all statistical computations.

Results

A total of 156 patients (age> 18) screened whom had both venous blood gas analysis and serum electrolytes in biochemistry panel at the same emergency appointment. Then 47 of them were excluded due to inappropriate time of sample collection. We conducted our study on 109 patients and both potassium and sodium levels were accessible in this group. The study group consisted of 58 (53.2%) male and 51 (46.8%) female patients and mean age was 57.0 (std.dev 17.69). The mean level of sodium in serum samples was 138.7 mmol/l compared to 143.2 mmol/l in venous blood gas. Mean variation between two samples was -4.46 mmol/l (95% CI -5.25, -3.67), ranged from -19 mmol/l to 4 mmol/l. The mean level of potassium in serum samples was 4.34 mmol/l compared to 3.74 mmol/l in venous blood gas. Mean variation between two samples was 0.6 mmol/l (95% CI 0.50, 0.69) ranged from -0.50 mmol/l to 2.6 mmol/l. The correlation coefficient was found r=0.852 for Na, r=0.774 for K and p was <0.001 for both values. The mean and mean differences were shown in Table 1. Blood gas analyser tend to measure sodium levels higher than biochemistry autoanalyser. In all study group, blood gas analyser measure sodium levels higher in 96 (88%) patients and lower in 11 (10%) patients, in 2 (2%) patients both tests gave the same result. Blood gas analyser tend to measure potassium levels lower than biochemistry autoanalyser. In all study group, blood gas analyser measure potassium levels lower in 102 (93.5%) patients and higher in 6 (5.5%) patients, in 1 (1%) patient both tests gave the same result. When we make linear regression analysis to predict electrolyte levels in biochemistry panel from blood gas samples we have found equations shown in Table 2.

Sodium Group: In blood gas analysis results; 68 (62.4%) patients were eunatremic, 11 (10.1%) were hyponatremic and 30 (27.5%) were hypernatremic.

Table 3. Crosstabulation of sodium values

			Sodium in biochemistry (BLA)			
			eunatremia	hyponatremia	hypernatremia	Total
Sodium in blood gas (BGA)	eunatremia	Count	61	7	0	68
		% within bloodgas	89.7%	10.3%	.0%	100.0%
		% within biochemistry	76.2%	36.8%	.0%	62.4%
	hyponatremia	Count	0	11	0	11
		% within bloodgas	.0%	100.0%	.0%	100.0%
		% within biochemistry	.0%	57.9%	.0%	10.1%
	hypernatremia	Count	19	1	10	30
		% within bloodgas	63.3%	3.3%	33.3%	100.0%
		% within biochemistry	23.8%	5.3%	100.0%	27.5%
Total		Count	80	19	10	109
		% within bloodgas	73.4%	17.4%	9.2%	100.0%
		% within biochemistry	100.0%	100.0%	100.0%	100.0%

When we compare the blood gas analysis results to biochemistry panel; in eunatremia group 61 (89,7%) of the patients were also eunatremic, 7 (10,3%) of them were hyponatremic and none of them was hypernatremic in biochemistry panel. In hyponatremia group, 11 (100%) of them were also hyponatremic, none of them was either hypernatremic or eunatremic.

In hypernatremia group 10 (33,3%) of them were hypernatremic, 19 (63,3%) of them were eunatremic and 1 (3,3%) of them was hyponatremic. Sodium group cross tabulation given is on Table 3. As a result, blood gas analysis tend to show sodium result higher than biochemistry, so if we see eunatremia or hyponatremia in blood gas analysis it is likely to be confirmed in biochemistry result. On the other hand, if we see hypernatremia in blood gas analysis, it is more likely to fail than other groups (Kappa coefficient = 72,43% p<.001).

Potassium Group: In blood gas analysis results; 60 (55%) patients were eukalemic, 35 (32,1%) were hypokalemic and 14 (12,8%) were hyperkalemic. When we compare the blood gas analysis results to biochemistry panel; in eukalemia group 44 (73,3%) of the patients were also eukalemic, 15 (25%) of them were hyperkalemic and 1 (1,6%) of them was hyperkalemic in biochemistry panel. In hypokalemia group, 27 (77,1%) of them were eukalemic, 6 (17,1%) of them were hypokalemic, 2 (5,7%) of them were hyperkalemic. In hyperkalemia group 12 (85,7%) of them were hyperkalemic, 2 (14,2%) of them were eukalemic and none of them was hypokalemic. Sodium group cross tabulation given is on Table 4. As a result, blood gas analysis tend to show potassium result lower than biochemistry, so if we see eukalemia or hyperkalemia in blood gas analysis it is more likely to be confirmed in biochemistry result than hypokalemia group (Kappa coefficient = 38,5%). Besides kappa coefficient of sodium group is higher than potassium group, 72,43 vs 38,5 consecutively, so blood gas analysis had higher likelihood for sodium levels.

Table 4. Crosstabulation of potassium values

			Potassium in biochemistry (BLA)			
			eukalemia	hypokalemia	hyperkalemia	Total
Potassium in blood gas (BGA)	eukalemia	Count	44	1	15	60
		% within bloodgas	73,3%	1,7%	25,0%	100,0%
		% within biochemistry	60,3%	14,3%	51,7%	55,0%
	hypokalemia	Count	27	6	2	35
		% within bloodgas	77,1%	17,1%	5,7%	100,0%
		% within biochemistry	37,0%	85,7%	6,9%	32,1%
	hyperkalemia	Count	2	0	12	14
		% within bloodgas	14,3%	,0%	85,7%	100,0%
		% within biochemistry	2,7%	,0%	41,4%	12,8%
Total		Count	73	7	29	109
		% within bloodgas	67,0%	6,4%	26,6%	100,0%
		% within biochemistry	100,0%	100,0%	100,0%	100,0%

Discussion

Serum electrolyte levels and early prediction of that levels are seriously important which may cause serious harms and even deaths in emergency setting. Despite other findings such as electrocardiography or mental status of patients make guidance to physicians, blood gas analysis also helps pyhsicians and settles one's decision. We conducted this study to evaluate the concordance with blood gas sample results and standart biochemistry analysis to estimate sodium and potassium levels in a faster way. The US Clinical Laboratory Improvement Amendment (USCLIA) accepts a difference of ±4 mmol/L sodium and ±0.5 mmol/l for potassium for the gold standard calibration results (5). In our study, both of these differences were slightly higher than USCLIA's acceptable range. Several studies found sodium levels higher in biochemistry analysis but in our study blood gas analysis had higher sodium levels (4.6-8). Potassium abnormalities need emergency care more frequently than sodium's. Less accurate compatibility can be tolerated in sodium abnormalities and should be waited for clinical and laboratory confirmation. On the other hand, potassium level alterations may need emergent care but mean variation between two samples was 0.6 mmol/l (maximally 2.6 mmol/l) in potassium levels. Bloom et al. has found 3.36 mmol/l difference for sodium and 0.46 mmol/l difference for potassium between two analysis (9). In another study, Budak et al. found sodium difference as 4.9 mmol/l and potassium difference as 0.25 mmol/l (7). Unlike these studies, Yalçın Solak (10) compared biochemistry analysis and blood gas analysis in terms of Na values as hyponatremia, eunatremia and hypernatremia. He found biochemistry autoanalyser tended to measure serum sodium higher compared with BGA in most patients and mean sodium difference showed an upward trend from hyponatremia to hypernatremia. Opposite to this study, as we found serum sodium value lower in biochemistry laboratory autoanalyser, mean sodium

difference showed a downward trend. In other words; sodium values counted as hyponatremia and eunatremia in BGA were tend to be measured as in the same group in BLA (91.1% n=79). On the other hand, most of hypernatremia results in BGA were in eunatremia group in BLA (63.3% n=30). In our study, we also compared potassium values as hypokalemia, eukalemia and hyperkalemia between two analyses. Mean potassium difference between two analyses showed an upward trend from hypokalemia to eukalemia. In other words, potassium values counted as hyperkalemia and eunkalemia in BGA were tend to be measured as in the same group in BLA (75.6% n=74). On the other hand, most of hypokalemia results in BGA were in eukalemia group in BLA (77.1% n=35). Kozacı et al. met 7.9 mEq/l difference for sodium and 0,5 mEq/l difference for potassium in their study. And they also found sodium value higher in blood gas analysis than biochemistry panel like our study (11). In our study, we found a mean difference between two analysis as -4.46 mmol/l in sodium group and 0.6 mmol/l in potassium group. In term of limitations; only one blood gas analyser and standard biochemistry analyser were used, so aggreement between different machines should be investigated. To sum up, several studies found significant positive correlation of electrolyte values in two different analysis. We also found positive correlation in sodium and potassium levels in various strength in different clinical situations. As our opinion, blood gas analyses should help and guide physicians especially in emergent conditions.

Conflict of Interest: Authors declare that they have no conflict of interest.

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