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Comparison of blood gas analysis parameters, biochemical tests and hematological parameters in geriatric patients admitted to the emergency department

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Abstract

Aim: The primary aim is to compare blood gas parameters (sodium, potassium, glucose, hemoglobin, hematocrit) with biochemical test and hospital hemogram results and thus to investigate the compatibility of blood gas estimation with other laboratory tests in geriatrics. The secondary aim is to compare the effects of these parameters on patient mortality.

Material and methods: Patients over the age of 65 who applied to the emergency department were included in our retrospective study. Statistical Package for Social Sciences (SPSS Inc., version 20.0; Chicago, IL) was used for statistical analyzes applying to the emergency department. Statistical significance was accepted as $p<0.05$.

Results: 102 patients were included in our study and 51.97% were male. 9.8% of our patients died. The diagnostic test performance analyzes of BG (blood gas) hemoglobin, hemoglobin, BG hematocrit, hematocrit, BG glucose, glucose, BG sodium, sodium, BG potassium, potassium in predicting mortality revealed with the AUC(area under curve) value being calculated as unsuccessful for BG hemoglobin, hemoglobin, BG hematocrit and hematocrit (AUC value: 0.47, 0.45, 0.46, 0.50). AUC (area under curve) value being calculated as weak for BG glucose, glucose and BG sodium (AUC value: 0.64, 0.61, 0.63 respectively). AUC value being calculated as medium for sodium (AUC value: 0.71).

Conclusion: There is no superiority of blood gas parameters over hematological and biochemical parameters in predicting mortality in the geriatric patient group. However, blood gas parameters can be used in patient management as they correlate with other laboratory tests.

Key words: blood gas parameters, geriatrics, sodium, glucose, hemoglobin

Introduction

It makes it easier for us to have information about blood gases, acid-base balance disorders, hypoxia, metabolic disorders, fluid-electrolyte disorders, which we frequently prefer in bedside analyzes [1,2]. Routine electrolyte measurements are made with auto-analyzers in hospital centers. Although it is predicted to give results within 15 minutes, this measurement sometimes takes longer time in terms of hospital conditions and density [3,4].

Adequate equipment and income are required to get results in a shorter time. The usability of blood gas parameters instead of hospital laboratory parameters in the treatment and management phase is not yet clear.

Many studies have been conducted to compare hemoglobin, hematocrit, sodium, potassium and glucose parameters to determine the reliability of blood gas analysis parameters, and it has been discussed in many studies whether hematological parameters and biochemical parameters are compatible with blood gas parameters [5-7].

Although there are studies conducted in patients admitted to the emergency department [1], patients hospitalized in the intensive care unit [6], and pediatric patients [8], there is no study comparing blood gas parameters and hospital laboratory parameters in geriatric patients, to the best of our knowledge.

Aim: The primary aim is to compare blood gas parameters (sodium, potassium, glucose, hemoglobin, hematocrit) with biochemical test and hospital hemogram results and thus to investigate the compatibility of blood gas estimation with other laboratory tests in geriatrics. The secondary aim is to compare the effects of these parameters on patient mortality.

Material and methods

Ethics

The instant study was carried out with the permission of the University of Karamanoglu Mehmetbey, Karaman Education and Research Hospital Ethics Committee (Date: 24/05/2022, Decision No: 2022-KAEK-154/9).

Study design

Patients over the age of 65 who applied to the emergency department of Karaman Education and Research Hospital between 01.03.2022 and 01.09.2022 were included in our retrospective study.

Study population

Patients over 65 years of age, who applied to the emergency department between 01.03.2022 and 01.09.2022, with negative Covid-19 PCR (polymerase chain reaction) were included in the study. All patients under the age of 65, trauma patients over the age of 65, patients who developed cardiac arrest and for whom we have data obtained after cardiopulmonary resuscitation, and patients with missing laboratory data were excluded from the study.

Data collection

Heparinized syringes were used for blood gas samples taken from patients admitted to the emergency department (PICO50 Arterial Blood Sampler – Radiometer Medical ApS, Brønshøj, Denmark). The samples were studied with the blood gas analyzes used by the hospital (Radiometer ABL 700 Blood Gas Analyzer, Radiometer Medical ApS, Brønshøj, Denmark). These blood gas analyzers were calibrated 6 times a day. Hematology analyzer was used for hematological samples (Abbott Cell-Dyn 3700 Hematology Analyzer, IL, USA). For biochemical data, ion selective diluted method was used (ARCHITECT ci4100 Clinical Chemistry Analyzer, IL, USA, using a 2P32 ICT sample diluent kit).

The blood samples for the blood gas parameters, the hematological parameters, and the biochemical parameters were separate blood samples taken simultaneously.

Using hospital system data, demographic characteristics, disease diagnoses, vital signs, saturation, respiratory rate, fever, blood pressure, background information, sodium, potassium and glucose values obtained from blood gas and chemistry laboratory, and hemoglobin and hematocrit values obtained from blood gas and hematology laboratory 30-day mortality was recorded. Length of hospital stay, 30-day mortality rates, intensive care stays, and ward were also recorded. Length of hospital stay and ward and intensive care unit admission rates were recorded using the hospital data system. According to their survival status, the patients were divided into two groups (those who died and survivors) according to the National death notification system in Turkey. The examinations and data of patients who attended the emergency department were used.

Statistical analysis

The categorical data was done using the fisher exact test and chi-square test. Quantitative variables were presented as median and interquartile range (IQR, 25th-75th percentile) values, and the Mann-Whitney test was used in analyzing the paired groups. The normal analysis of continuous data was done using the Shapiro-Wilk test. Spearman correlation analysis was performed for each parameter. During this analysis, the area under the curve (AUC) values were calculated, and the sensitivity, specificity, accuracy, and 95% confidence interval (CI) data were analyzed. The AUC values of the parameters were calculated and tested mutually for significance with the DeLong quality test. Statistical Package for Social Sciences (SPSS Inc., version 20.0; Chicago, IL) was used for statistical analyzes applying to the emergency department. Statistical significance was accepted as $p<0.05$.

Results

Demographic data, comorbidities, symptoms and examination findings

102 patients were included in our study, 51.97% of them were male. 9.8% of our patients died and 80% of the patients who died were women. No statistically significant relationship was found between comorbid diseases and mortality. While applying with the most complaints of fatigue; No statistically significant relationship was found between symptoms and mortality. A statistically significant relationship was found between high fever and low saturation and mortality ($p=0.003$, $p=0.016$, respectively). The relationship of demographic data, comorbidities, and symptoms with mortality is shown in Table 1.

Relationship between laboratory parameters, clinical outcome with 30-day mortality

When the relationship between blood gas parameters and hemogram and biochemical values was evaluated, it was observed that WBC and sodium elevation had a statistically significant relationship with mortality ($p=0.012$, $p=0.028$, respectively). There was no statistically significant correlation between blood gas parameters (BG hemoglobin, BG hematocrit, BG glucose, BG sodium, BG potassium, BG lactate) with mortality ($p=0.727$, $p=0.710$, $p=0.151$, $p=0.190$, $p= 0.365$, $p=0.099$, respectively). While 33.3% of the patients were admitted to the service; 22.5% of them were admitted to the intensive care unit. 43.47% of the patients admitted to the intensive care unit died ($p<0.001$). Laboratory parameters are specified in Table 2.

Correlation between BG parameters, hemogram parameters and biochemical parameters

There was a statistically significant, positive and strong correlation between BG hemoglobin and hemoglobin (Spearman correlation test, $r=-0.95$, $p<0.001$); BG hematocrit and hematocrit (Spearman correlation test, $r=0.93$, $p<0.001$);

Table 1 Demographic data, comorbidities, symptoms, examination findings and 30-day mortality of patients

Dependent: MORTAL	**Survivor**	**Non-Survivor**	**Total**	**p**
Age Median (IQR)	76.0 (70.0 - 82.0)	82.0 (74.2 - 82.8)	76.5 (70.0 - 82.0)	0.255
Gender (n,%)				
Female	41 (44.56)	8 (80.0)	49 (48.03)	0.072
Male	51 (55.44)	2 (20.0)	53 (51.97)	
Comorbidities (n,%)	27 (30.0)	2 (20.0)	29 (29.0)	0.769
Hypertension	63 (70.0)	8 (80.0)	71 (71.0)	
Diabetes Mellitus	27 (30.0)	3 (30.0)	30 (30.0)	
COPD	28 (31.1)	2 (20.0)	30 (30.0)	
CAD	39 (43.3)	2 (20.0)	41 (41.0)	
CHF	9 (10.0)	0 (0.0)	9 (9.0)	
CVD	13 (14.4)	1 (10.0)	14 (14.0)	
CRF	5 (5.6)	1 (10.0)	6 (6.0)	
Malignancy	6 (6.7)	1 (10.0)	7 (7.0)	
DVT	4 (4.4)	0 (0.0)	4 (4.0)	
Use of anticoagulants	50 (55.6)	5 (50.0)	55 (55.0)	
Symptoms	59 (65.6)	3 (30.0)	62 (62.0)	0.064
Breathness	31 (34.4)	7 (70.0)	38 (38.0)	
Chest pain	5 (5.6)	0 (0.0)	5 (5.0)	
Hemoptysis	1 (1.1)	0 (0.0)	1 (1.0)	
Cough	36 (40.0)	6 (60.0)	42 (42.0)	
Sore throat	32 (35.6)	1 (10.0)	33 (33.0)	
Weakness	75 (83.3)	7 (70.0)	82 (82.0)	
Physical examination Median IQR				
Fever	36.5 (36.3-36.8)	37.0 (36.6-37.7)	36.5 (36.3-36.8)	0.003
Heart rate	88.5 (77.0-101.8)	98.5 (93.0-109.0)	89.0 (77.0-103.0)	0.045
Respiratory rate	19.0 (18.0-21.0)	22.0 (20.2-23.5)	19.0 (18.0-22.0)	0.010
Systolic blood pressure	134.0 (115.8-150.8)	122.5 (102.5-149.5)	134.0 (114.0-150.2)	0.364
Diastolic blood pressure	72.0 (66.0-80.8)	66.5 (60.0-77.5)	71.0 (65.0-80.2)	0.152
PH	7.4 (7.4-7.4)	7.4 (7.3-7.4)	7.4 (7.4-7.4)	0.333
Carboxyhemoglobin	0.9 (0.6-1.2)	0.9 (0.8-1.0)	0.9 (0.7-1.2)	0.945
Saturation (%)	93.0 (91.0-95.5)	90.0 (88.5-91.8)	93.0 (91.0-95.0)	0.016

(COPD, chronic obstructive pulmonary disease; CAD, coronary artery disease; CHF, Chronic heart failure; CVD, cerebrovascular disease; CRF, Chronic renal failure; DVT, deep vein thrombosis)

Table 2 Laboratory parameters, clinical outcome and 30-day mortality of patients

Laboratory Parameters Median (IQR)	**Survivor**	**Non-Survivor**	**Total**	**p**
BG Hemoglobin (g/dl)	13.0 (10.9-14.5)	12.6 (11.5-13.6)	12.9 (11.0-14.4)	0.727
BG Hematocrit (%)	38.0 (32.0-43.0)	37.0 (33.5-40.2)	38.0 (32.2-43.0)	0.710
BG glucose (mmol/l)	137.0 (105.8-189.2)	181.5 (137.5-214.2)	142.5 (107.2-194.5)	0.151
BG Sodium (mEq/l)	136.6 (133.2-139.6)	138.0 (135.4-144.1)	136.9 (133.4-139.9)	0.190
BG Potassium (mEq/l)	4.2 (3.9-4.6)	4.2 (3.7-4.4)	4.2 (3.9-4.6)	0.365
BG Lactate	1.7 (1.3-2.1)	2.1 (1.6-2.8)	1.8 (1.3-2.2)	0.099
WBC (103µ/L)	8.6 (6.9-12.7)	12.6 (12.2-15.0)	9.0 (7.1-12.9)	0.012
Lymphocyte (103µ/L)	1.5 (1.0-2.1)	1.1 (0.9-1.2)	1.5 (1.0-2.0)	0.200
Hemoglobin (g/dl)	12.8 (11.1-14.5)	12.3 (11.2-13.4)	12.6 (11.1-14.5)	0.612
Hematocrit (%)	37.8 (32.9-42.4)	36.7 (35.4-43.1)	37.7 (34.0-42.5)	0.982
Glucose (mmol/l)	136.0 (104.0-185.8)	194.5 (127.5- 228.2)	140.5 (104.2-199.0)	0.237
Sodium (mEq/l)	137.0 (134.9-139.3)	140.2 (138.5-141.7)	137.0 (135.0-140.0)	0.028
Potassium (mEq/l)	4.4 (4.1-4.7)	4.4 (4.0-4.5)	4.4 (4.0-4.7)	0.686
C-reactive protein	41.0 (7.4-110.5)	61.0 (11.4-141.2)	41.0 (7.6-110.8)	0.525
Clinical outcome				<0.001
Discharge	45 (48.9)	0 (0.0)	45 (44.1)	
Ward admission	34 (37.0)	0 (0.0)	34 (33.3)	
Intensive Care Unit	13 (14.1)	10 (100.0)	23 (22.5)	
LHOS/day Median (IQR)	2.0 (0.0 - 8.0)	9.0 (6.5 - 10.0)	4.0 (0.0 - 8.0)	0.004

(BG, blood gase; WBC, white blood cell; LHOS, length of hospital stay)

Table 3 ROC analysis for blood gas parameters, hemogram parameters and biochemical parameters for 30-day mortality

Parameters	Cut-off point	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	AUC
BG Hemoglobin(g/dl)	15.3	20%	89.13%	16.67%	91.11%	0.47
Hemoglobin (g/dl)	10.8	90%	22.83%	11.25%	95.45%	0.45
BG Hematocrit (%)	31	90%	18.48%	10.71%	94.44%	0.46
Hematocrit (%)	34.3	90%	27.17%	11.84%	96.15%	0.50
BG Glucose (mmol/l)	169	70%	67.39%	18.92%	95.38%	0.64
Glucose (mmol/l)	174	70%	68.48%	19.44%	95.45%	0.61
BG Sodium (mEq/l)	137.4	70%	59.78%	15.91%	94.83%	0.63
Sodium (mEq/l)	140	70%	75%	23.33%	95.83%	0.71
BG Potassium (mEq/l)	3.36	100%	3.26%	10.1%	100%	0.41
Potassium (mEq/l)	4.45	50%	58.24%	11.63%	91.38%	0.46

(BG, blood gase; PPV, positive predictive value; NPV, negative predictive value; AUC, area under curve)

BG glucose and glucose (Spearman correlation test, r=0.91, p<0.001); BG sodium and sodium (Spearman correlation test, r=0.85, p<0.001) and BG potassium and potassium (Spearman correlation test, r=0.80, p<0.001).

The diagnostic test performance analyzes of BG hemoglobin, hemoglobin, BG hematocrit, hematocrit, BG glucose, glucose, BG sodium, sodium, BG potassium, potassium in predicting mortality revealed with the AUC(area under curve) value being calculated as 0.47(16.67%-91.11%) for BG hemoglobin, with a cut-off value of 15.3; 0.45(11.25%-95.45%) for hemoglobin, with a cut-off value of 10.8; 0.46(10.71%-94.44%) for BG hematocrit, with a cut-off value of 31; 0.50(11.84%-96.15%) for hematocrit, with a cut-off value of 34.3; 0.64(18.92%-95.38%) for BG glucose , with a cut-off value of 169; 0.61(19.44%-95.45%) for glucose , with a cut-off value of 174; 0.63(15.91%-94.83%) for BG sodium, with a cut-off value of 137.4; 0.71(23.33%-95.83%) for sodium, with a cut-off value of 140; 0.41(10.1%-100%) for BG potassium, with a cut-off value of 3.36; 0.46(11.63%-91.38%) for potassium, with a cut-off value of 4.45 (Table 3).

Table 4 Comparison of sodium AUC values (De-Long test) (p=0.145)

	Cut-off point	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	AUC
BG Sodium (mEq/l)	137.4	70%	59.78%	15.91%	94.83%	0.63
Sodium (mEq/l)	140	70%	75%	23.33%	95.83%	0.71

(BG, blood gase; PPV, positive predictive value; NPV, negative predictive value; AUC, area under curve)

When BG sodium and sodium values with high AUC values were compared with the De-Long test, the BG sodium AUC value was 0.63; sodium AUC value was determined as 0.71(p=0.145) (Table 4).

Discussion

In our study, a significant correlation was found between glucose, hemoglobin, hematocrit, sodium and potassium values in blood gas parameters taken in geriatric patients and laboratory analyzes. Considering their relationship with mortality, AUC(area under curve) value being calculated as medium for sodium, weak for BG sodium, glucose and BG glucose.

Our secondary aim was to compare the effects of these values on the prognosis. However, sodium was the only value that had a statistically significant relationship with mortality (p=0.028).

In the literature, different results were obtained in studies on blood gas parameters. In a prospective study by Uysal et al., 1094 patients were examined; Core laboratory analyzes of hemoglobin, hematocrit, sodium, potassium and glucose values and blood gas analyzes were found to be correlated, similar to our study [1]. In another study, laboratory and blood gas analyzes of 11000 patients were examined over a 5-year period; A correlation was found between blood gas calcium, sodium and potassium values and laboratory values [2]. In another study comparing the laboratory autoanalyzer and blood gas analysis, there was no statistically significant correlation between potassium values; there was a statistically significant relationship between sodium values [4]. In our study, BG potassium and laboratory potassium values were correlated. We found that BG sodium and BG glucose values and laboratory sodium and glucose values were associated with mortality.

In the literature, rather than the relationship between blood gas and laboratory parameters and mortality, the correlation of blood gas and laboratory parameters with each other and whether they can guide treatment has been discussed [5,6]. Gavala et al., in their study, suggested that blood gas parameters should not be used instead of hospital laboratory tests in guiding treatment [5]. In a study conducted by Servent et al. in 51 intensive care patients, they stated that treatment can be planned based on blood gas measurements [6]. The correlation of hemoglobin, hematocrit, glucose, sodium and calcium values in blood gas analyzes and laboratory parameters in our study showed that blood gas parameters can be used instead of laboratory tests in geriatrics. In a study with two hundred and nineteen data, no statistical significance was found in the comparison of laboratory hemoglobin values with blood gas hemoglobin values; There was a statistically significant correlation in the comparison of blood gas analyzes of sodium and potassium and hospital laboratory values [7]. In a retrospective study that included 1927 pediatric patients, it was concluded that blood gas parameters such as hemoglobin, hematocrit, sodium, and potassium could not adequately correlate with hospital laboratory parameters, and these parameters should not be used in patient management [8]. In a retrospective study of more than thirty thousand patients, hemoglobin, hematocrit, sodium, potassium, glucose values were compared between blood gas analyzes and hospital laboratory analyzes, similar to our study. A strong correlation was found in glucose, hemoglobin and hematocrit values [9]. We think that the correlation of each blood gas parameter with hospital laboratory analyzes in our study will contribute to the literature.

Limitations

In our study, the examinations obtained at the first application were used. Since the patients who applied to the emergency department were included in the study and not every patient was hospitalized, control tests could not be taken during the hospitalization period of the patients and an evaluation was not made accordingly.

Conclusion

There is no superiority of blood gas parameters over hematological and biochemical parameters in predicting mortality in the geriatric patient group. However, blood gas parameters can be used in patient management as they correlate with other laboratory tests.

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