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Assessment of the correlation between arterial blood gas indices and duration of stay in the emergency department observation unit for pediatric patients aged 0-18 with rotavirus gastroenteritis

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Abstract

Aim: Rotavirus (RV) is the predominant pathogen responsible for the onset of infectious acute gastroenteritis among children younger than five years of age, which is one of the critical public health concerns and one of the childhood gastroenteritis that can cause morbidity and mortality. Although definitive diagnostic methods are essential in such cases, these methods are not always easily accessible. That study aims to investigate the association between blood gas parameters in respondents who have tested positive for RV antigen and their subsequent observation time in the emergency department, as well as the length of their hospitalization.

Materials and Methods: This retrospective analysis encompassed 237 individuals ranging from 0 to 18 years old who sought medical attention at the outpatient clinic or emergency department of Adıyaman University Faculty of Medicine Training and Research Hospital and were found to have a positive RV antigen test. Respondents were segregated into cohorts according to age, gender, blood gas parameters, hemogram, biochemical parameters, duration of stay in the emergency observation room, and duration of stay in the pediatric ward. The respondents were categorized based on various criteria, including age, sex, blood gas readings, complete blood count, biochemical markers, duration of stay in the emergency observation area, and hospitalization period in the pediatric unit. Comprehensive demographic, blood gas, hematologic, and biochemical data were compiled and analyzed employing SPSS version 22.0.

Results: The study identified significant differences in the participants' pH, pO_2, and HCO_3 levels, along with the mean platelet volume (MPV). Notably, a significant correlation was established between the pH levels of blood gases in the emergency room observation space and the observation span for respondents testing positive for RV. In contrast, no significant link was observed between blood gas values and the duration of hospital stay.

Conclusion: The findings suggest that while blood gas analysis outcomes may not predict hospitalization length in cases of Rotavirus gastroenteritis, respondents presenting with lower blood pH levels tend to spend less time in the emergency observation unit. Therefore, it is recommended that blood gas analysis be conducted routinely for respondents presenting with symptoms of Rotavirus gastroenteritis upon their arrival at the emergency medical services.

Introduction

The World Health Organization (WHO) defines diarrhea as three or more stools per day that are softer or waterier than usual or an increase in average stool frequency [1]. Although diarrhea can be seen at any period of life, it is more common before adulthood [2]. Acute diarrhea, defined as diarrhea lasting less than 14 days, may have many causes. Still, the most common cause of diarrhea seen in the period before adulthood, that is, in childhood, is infections, and viruses mainly cause these infections. Viruses that cause diarrhea include Rotavirus (RV), Norovirus, Adenovirus, Astrovirus, and Human Bocavirus. [3]. When respondents who were followed up for acute diarrhea in the first five years of life were examined, it was reported that 40%

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were caused by RVs and 30% by other viruses (Norovirus, Adenovirus). When the stool tests of the affected children were evaluated, it was determined that 20% of the cases were bacterial infectious agents (C. jejuni, Yersinia, Salmonella, Shigella, pathogenic E.coli, or Clostridium difficile). Diarrhea caused by parasites (such as G.Lamblia, Cryptosporidia, and Entamoeba histolytica) is seen in less than 5% [4]. Previous research shows that 8.8 million children under the age of five die every year in the world [5]. When the causes of under-five deaths are analyzed, it is observed that 68% of these deaths are due to infectious diseases. The two most common contagious disease groups causing death are pneumonia (18%, 1.575 million) and diarrhea (15%, 1.336 million) [5,6]. According to the World Health Organization's 2013 data, approximately 500,000 children die every year due to RV diarrhea, and a large proportion of children who die due to this cause or who are affected by RV diarrhea have low socioeconomic living conditions [7]. When the statistical data of our country were evaluated, the prevalence of diarrhea under the age of five was recorded as 25% in 1993 and 23% in 2008 [8]. When the 2014 data of our country were examined, it was determined that there was an increase in the prevalence of diarrhea, and diarrhea ranked second among infections in the 0-6 age group with 33.2% [9]. Moreover, while RV positivity varies between 16.6-36.8% in outpatients in our country, RV positivity is reported to be greater than 50% in hospitalized patients [10,11,12,13].

Materials and Methods

Patient protocol

This study was conducted through a retrospective analysis of patient records at the Pediatric Health and Diseases and Pediatric Emergency Services of Adıyaman University Training and Research Hospital. The study admitted to the ethical standards summarized in the Declaration of Helsinki, and the Adıyaman University Faculty of Medicine's Clinical Research Ethics Committee approved (Protocol No: 2018/2-14, Date: 20.03.2018).

Since the study was carried out on all patients between 01.01.2016 and 01.01.2018, and since the entire population was attempted to be reached, no sample was drawn, and the study was conducted on the entire population.

Between 01.01.2016 and 01.01.2018, respondents aged between 0 months and 18 years who were treated as inpatients in the Pediatric Health and Diseases Service between the dates of 01.01.2016 and 01.01.2018 due to rotavirus infection and who underwent blood gas examination at the beginning of treatment on the day of hospitalization (Group 1), and respondents who were diagnosed with RV in the Pediatric Emergency Department and discharged without hospitalization and underwent blood gas examination in the emergency department (Group 2) were included in the study.

Technique

Along with the demographic data of the patients, blood gas parameters (pH, pCO_2, pO_2, HCO_3-, Na, K, Cl), biochemistry parameters such as Na, K, Cl, and hematologic parameters (white blood cell: WBC), Platelet count (PLT), hemoglobin (Hgb), hematocrit (Hct), Mean erythrocyte volume (MEV), mean erythrocyte count (MEC) and MPV were recorded separately and these parameters were evaluated. The length of stay in the emergency room observation room and the length of hospitalization were calculated in minutes.

Rotavirus antigen: RV gastroenteritis was diagnosed by a positive antigen in the stool. The presence of RV antigen in stool samples was investigated using the qualitative immunochromatographic method. Lungene Rapıd Test brand chromatography kit was used for this purpose.

Statistical analysis

The data collected in our study underwent statistical analysis using the SPSS (Statistical Package for Social Sciences) program version 22.0 (SPSS Inc., Chicago, IL, United States of America). Continuous variables were presented as mean ± standard deviation, median, minimum, maximum, and 25-75 percentiles. Categorical data were compared using the Pearson Chi-square (χ^2) test and Fisher's exact test. The Kolmogorov-Smirnov, Shapiro-Wilk, Skewness, and Kurtosis tests were conducted to assess the normality of continuous variables. Parametric data were compared using the Independent Groups T-Test, and non-parametric data were compared using the Mann-Whitney U Test.

Patients admitted to the ward were divided into three groups (Normal, Acidosis, and Alkalosis) according to blood gas results, and these groups were compared using the non-parametric variance analysis Kruskal-Wallis H Test. Post-hoc tests and pairwise comparisons were used for subgroup comparisons. Spearman Correlation Analysis was used to evaluate the relationship between the blood gas parameters of the patients and the duration of stay in the emergency department observation room and the duration of hospitalization in the pediatric service. Statistical significance was defined as a p-value less than 0.05 in this study.

Results

Patient count: During the period examined in the study (01.01.2016-01.01.2018), 246 respondents were diagnosed with RV in Adıyaman University Training and Research Hospital Pediatrics Department and Pediatric Emergency Department. Despite requests for blood gas analysis, the requisite data were unattainable for nine individuals under consideration, leading to their exclusion from the research. Consequently, the study proceeded with 237 patients confirmed to have RV infection. 153 patients were RV positive and hospitalized (Group 1), and 84 were RV positive and discharged from the emergency department (Group 2). Of the patients who were RV positive and hospitalized, 70 (45%) were female and 83 (55%) were male. Among the patients who were RV positive and discharged from the emergency department, 29 (35%) were female and 55 (65%) were male. There was no statistical difference between Group 1 and Group 2 regarding gender (p=0.094).

The investigation enrolled 237 respondents with a mean age of 20.3 ± 22.8 (1-185) months. In Group 1, the mean age of 153 respondents was 19.06 ± 19.94 (1-146) months,

while in Group 2, the mean age of 84 respondents was 22.46 ± 27.15 (2-185) months. There was no distinction between the two groups concerning age (p=0.271). The mean emergency observation time of 153 patients in Group 1 was 240.55 ± 230.28 min, and the mean emergency observation time of 84 patients in Group 2 was 172 ± 234.56 min. No statistically considerable distinction was observed in the mean duration of emergency observation among the two cohorts. (p=0.548). When the blood gas parameters of 237 respondents included in the study were analyzed, the average pH value in Group 1 was 7.33 (7.12-7.49), while the average pH value in Group 2 was 7.35 (7.13-7.47). When the average pH values of Group 1 and Group 2 were compared, a statistically considerable distinction was found between them (p< 0.001).

The mean HCO_3- of Group 1 patients was 16.9 ± 2.6 (11.3-24.1) mEq/L, while the mean HCO_3- of group 2 patients was 18.6 ± 3.4 (6.3-26.4) mEq/L. There was a statistically considerable difference between the two groups regarding mean HCO_3- (p<0.001). The mean pCO_2 in Group 1 patients was 30.4 ± 5.68 mmHg, while the mean pCO_2 in Group 2 patients was 32.17 ± 6.6 mmHg. The two groups had no statistically meaningful difference regarding mean pCO_2 (p=0.148).

The mean pO_2 of group 1 patients was 47.26 ± 17.96 mmHg, while the mean pO_2 of group 2 patients was 44.75 ± 13.71 mmHg. The two groups had a statistically meaningful difference regarding mean pO_2 (p= 0.018).

The mean Hct in Group 1 patients was 37.57 ± 4.66%, while the mean Hct in Group 2 patients was 39.14 ± 5.7%. The two groups had no statistically meaningful difference regarding mean Hct (p= 0.138).

The mean Na in Group 1 patients was 138.26 ± 4.74 mmol/l, while the mean Na in Group 2 patients was 137.75 ± 3.92 mmol/l. The two groups had no statistically meaningful difference regarding mean Na (p= 0.400).

The mean K in Group 1 patients was 3.93 ± 0.61 mmol/l, while the mean K in Group 2 patients was 3.89 ± 0.42 mmol/l. The two groups had no statistically meaningful difference regarding mean K (p= 0.114).

The mean Cl in Group 1 patients was 110.9 ± 5.78 (99 -137) mmol/l, while the mean Cl in Group 2 patients was 110.28 ± 4.25 mmol/l. The two groups had no statistically meaningful difference regarding mean Cl (p= 0.101) (Table 1).

In group 1 patients, the relationship between pH groups and gender was not statistically meaningful according to the chi-square test (p=0.648). The relationship between pH groups and age (months) was not statistically meaningful according to the one-way ANOVA test (p=0255). The relationship between pH groups and length of hospitalization (minutes) was not statistically meaningful according to the one-way ANOVA test (p=0.847) (Table 2).

The mean length of stay in group 1 patients was calculated as 6635.59±3120.67 (2568- 23520) min. The mean length of stay in the ward was 4.6 days. In addition, acidosis was detected in blood gas in 99 (64.7%) of Group 1 patients. No statistically meaningful discrepancy was observed when we examined the correlation between pH and length of stay in group 1. (p=0.332, r: -0.079) In group 2 patients, when we examined the correlation between pH and duration of observation in the emergency department, no statistically meaningful disparity was detected (p=0.82, r: -0.019) (Table 3).

Table 1. Blood Gas Results and Comparison of Group 1 and Group 2.

	Normal	Group 1 Mean ± SD	Group 2 Mean ± SD	p
pH	7.35- 7.45	7.33 (7.12-7.49)[b]	7.35 (7.13-7.47)	**<0.001***
HCO_3	22-26 mEq/L	16.9 (11.3-24.1)[b]	18.6 (6.3-26.4)	**<0.001***
PCO_2	35 -45 mmHg	30.4 ± 5.68[a]	32.17 ± 6.6	0.148
PO_2	60-80 mmHg	47.26 ± 17.9[a]	44.75 ± 13.7	**0.018***
HCT	35-53.7 %	37.57± 4.66[a]	39.14 ± 5.7	0.138
Na	135 -145 mmol/l	138.2± 4.74[a]	137.75 ± 3.9	0.233
K	3.5 – 5.5mmol/l	3.93 ± 0.6[a]	3.89 ± 0.42	0.114
Cl	95 – 110mmol/l	110.9 ± 5.78[a]	110.28 ± 4.25	0.101

[a]: Independent Student T test mean ± standard deviation; [b]: Man-Whitney median (minimum, maximum); *: p<0.05.

Table 2. Comparison of demographic characteristics of Group 1 patients according to blood gas groups.

	Asidosis	Normal	Alkalose	p
Gender (F/M)[a]	46/53	24/29	0/1	0.648
Age (month)[b]	15.4 ± 10.2 (2-61)	25.8±29.8 (1-146)	13 ± (13-13)	0.255
Hospitalization (minute)[b]	6692.3± 2687.6 (2568-14525)	6396.2± 3970.9 (2780-23520)	7205 ± (7205- 7205)	0.847

[a]: chi-square test; [b]: one-way ANOVA test, mean±SD (minimum-maximum); *: p<0.05

Table 3. Correlation between pH and length of stay in the ward and observation time in the emergency department in patients in Group 1.

	R	P
Length of stay in the ward with pH	-0.079	0.332
Duration of observation in the emergency with pH	-0.019	0.82

According to the test results, at the p<0.05 significance level, there was no statistically significant difference between the 'Acidosis/Alkalosis' variable and the Age (months) variable, whereas there was a statistically significant difference in the Number of Hospitalization Days variable.

Accordingly, as a result of the pairwise comparisons (as a post-hoc test) made for the Number of Hospitalization Days variable, it was concluded that the group responsible for the statistical difference is the "Acidosis" group, and the rank averages of the "Acidosis" group are statistically significantly higher than the rank averages of the other groups.

When we examined the correlation between pH and duration of observation in the emergency department in Group 2 patients included in the study, it was found to be statisti-

Table 4. In Group 2, the result of the correlation between pH and duration of observation in the emergency department.

	R	P
Duration of observation in the emergency with pH	0.331	**0.006***

cally meaningful (p=0.006, r: 0.331) (Table 4). According to the test results, there was a 'low-moderate' positive correlation [R=0.331, p=0.006] between the pH variable and the length of emergency department stay variable at the p<0.05 statistical significance level in Group 2. No correlation was found between other parameters.

To determine whether there was a statistically significant correlation between the continuous variables pH and HCO_3 and the continuous variables 'Number of Days of Hospitalization' and 'Duration of Emergency Department Stay (min)' according to the groups, Spearman correlation analysis was performed on the data set, which was found not to fit the normal distribution. When we examined the correlation between HCO_3- and length of stay in the ward in group 1, no statistically meaningful disparity was detected (p=0.493).

When we examined the correlation between HCO_3- and the duration of observation in the emergency department in Group 1, no statistically meaningful disparity was detected (p=0.380). Among the patients included in the study, a meaningful distinction was not found when we examined the correlation between HCO_3- and the duration of observation in the emergency department in Group 2 on a statistical basis (p=0.166).

Discussion

Upon review of the literature, Inci A et al. conducted a study evaluating 264 patients with acute gastroenteritis (AGE) who tested positive for Rotavirus (RV). They reported that 52% of the cases were male and 48% were female, and no statistically significant disparities were detected concerning gender distribution [14]. Borsa BA et al. demonstrated that 60% of RV-infected patients were male, while 40% were female, as reported in their study [15]. Yasa O et al. emphasized that 54% of the patients admitted to the service due to Rotavirus (RV) infection in one year were male, and 46% were female. The authors found no statistically remarkable difference concerning gender [16]. In alignment with the outcomes documented in existing research, 55% of the 237 patients who tested positive for Rotavirus (RV) were male, while 45% were female. Upon reviewing our study alongside the studies above, it was observed that male gender predominance was evident among RV-positive patients in the Marmara, Central Anatolia, and Southeastern Anatolia regions. However, when comparing the gender distribution among the study groups, no statistically remarkable distinction was found (p=0.061). Balkan ÇE et al. noted that most Rotavirus (RV) infections are seen in children under two. Specifically, RV-positive cases were more prevalent among patients aged 5-24 months when considering various age groups [17]. Konca Ç et al. examined the distribution of patients with positive rotavirus (RV) antigen by different age groups. As reported by the research, the highest positivity rate (19%) was recorded in the 0-24 month age group [18].

Studies conducted outside our country report that the majority of patients with RV are under the age of two. In the study by Tagbo BN et al. [19], the mean age of Rotavirus (RV) positive patients was reported as 9 months, while Mathew A et al. [20] found that 89% of patients admitted due to RV were younger than 23 months. In our research, the mean age of the 237 patients diagnosed with Rotavirus (RV) infection was 20.3 ± 22.8 months, ranging from 1 to 185 months. This age profile is in agreement with data previously published in the literature. However, the analysis did not reveal any statistically remarkable disparities in age distribution among the groups. (p=0.271). Greenberg DE et al. noted that the mean white blood cell count of RV-positive cases was in the normal range and found that 8.6% of the cases had neutropenia [21]. Dalgıç N et al. reported severe neutropenia in 2.5% of hospitalized RV gastroenteritis cases [22].

In our study, despite the absence of a statistically significant discrepancy in the mean white blood cell count between the two groups (p = 0.944), our findings indicate that the white blood cell count frequently falls within the normal range, consistent with the findings of prior referenced studies.

Yorulmaz A et al. evaluated viral, bacterial, and parasitic gastroenteritis cases in Konya province. They found the mean high value as 12.14 ± 1.18 gr/dL in the viral gastroenteritis group (most of this group consisted of RV) [23]. In the investigation carried out by Bucak IH et al. within our region, the average Hgb level for patients testing positive for RV was 11.4±1.1 gr/dL [24]. In our analysis, the average Hgb value for patients in Group 1 was observed to be 11.62±1.29 (7.5-16.4) gr/dl, while for those in Group 2, it was found to be 12.03±1.62 (9.14-19.9) gr/dl. Statistical analysis revealed no significant distinction in Hgb levels among the two groups (p=0.48). The findings from our study align closely with those reported in the existing literature.

Studies in the literature share the blood gas results of RV-positive patients. A survey by Wildi-Runge S et al. found that 84.8% of the patients hospitalized due to RV gastroenteritis had acidosis in blood gas [25]. In the study by Mathew A et al., it was found that the cases of RV gastroenteritis in children younger than 6 months of age reported severe acidosis (pH<7.2) in blood gas in 24.8% and 6.3% of those between 6-23 months [26]. In our study, metabolic acidosis was found in 64.7% of the patients in Group 1. In line with the data, the statistically significant difference between the mean pH and HCO_3- values in blood gas between Group 1 and Group 2 proves that RV gastroenteritis cases with metabolic acidosis are more common in the hospitalized group. Many studies have reported that metabolic acidosis is an essential clinical condition in RV gastroenteritis. The data obtained in our study show that detecting metabolic acidosis in the blood gas does not mean that the patient will be hospitalized for a long time. In Group 2, an inverse relationship was observed between the length of time in the emergency department observa-

tion and blood gas pH. This was interpreted as patients with metabolic acidosis in blood gas were hospitalized earlier, while patients without metabolic acidosis were hospitalized longer in the emergency room observation room.

Conclusion

The findings indicating an association between blood gas parameters and the duration of emergency department stay and hospitalization in children with RV infection may have important implications for clinical practice. In conclusion, A significant diversity was found among the cohorts in the MPV parameter ($p<0.001$). Remarkable differences were found between the groups in pH, HCO_3- and pO_2 parameters. No statistically noteworthy disparity concerning biochemistry parameters was observed among the cohorts (Na, Cl, K). There was no correlation between metabolic acidosis in blood gas and length of hospitalization. In Group 2, a direct relationship was observed between blood gas pH value and duration of stay in the emergency room observation area ($p=0.006$, $r=0.3317$). Therefore, routine blood gas analysis is recommended for patients presenting with symptoms of RV infection upon arrival at the emergency department. These additional insights may help us better understand the relationship between blood gas parameters and the duration of hospital stay and contribute to more effective clinical practices.

Ethical approval

The study admitted ethical clearance from the Scientific Research Ethics Committee of Adıyaman University Faculty of Medicine (number: 2018/2-14).

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