ASSESSMENT OF HEMATOLOGICAL PARAMETERS, ACID-BASE STATUS AND ARTERIAL BLOOD GAS TEST BEFORE AND AFTER MANAGEMENT OF ACUTE BRONCHIOLITIS IN CHILDREN

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ABSTRACT

Objective: The purpose of our retrospective study was to investigate the necessity of some laboratory testing in patients with acute bronchiolitis before and after treatment. **Methods:** We have taken blood samples of all children puncturing the cubital vein, and analyzed it using the Colter appliances-automatic counter blood count, for analyzes of some erythrocytes, leukocytes, platelets, differential blood count, Hct, Hb. CRP concentration in serum of patients determined by laser nephelometry with CardioPhase® high sensitivity C-reactive protein (hsCRP). For assessment of acid-base status and arterial blood gas analysis were used ABL5 and ABL700 Radiometer Copenhagen. We monitored the following parameters: pH, pCO_2, HCO_3^-, total CO_2, base excess, pO_2, SpO_2. **Results:** There was a significant improvement of hypoxemia after management of acute bronchiolitis in the form of a significant increase in average values of pO_2 and SpO_2 after treatment of acute bronchiolitis. The mean value of the number of leukocytes and value of CRP in children were significantly decreased before and after management of acute bronchiolitis. There was no significant difference in duration of hospitalization in term and preterm newborns. **Conclusion:** No diagnostic tests are used routinely. However, there is an improvement of hypoxemia after management of acute bronchiolitis in children.

KEYWORDS: Bronchiolitis, Hematological Tests, Acid-Base Balance, Blood Gas Analysis

Introduction

In 2006, a subcommittee of the American Academy of Pediatrics (AAP) together with the European Respiratory Society (ERS) underlined that bronchiolitis is a clinical diagnosis, recognized as "a constellation of clinical symptoms and signs including a viral upper respiratory prodrome followed by increased respiratory effort and wheezing in children less than 2 years of age" [1,2]. Pediatricians can do a review of children with acute bronchiolitis possible when there is some level of diagnostic uncertainty and to make the best decision on further treatment of a child. Testing of blood samples is not routine, nor have clinical value to the guidelines, but in practice, it is the most frequent searches in children with acute bronchiolitis [3-5]. The tests that are done are complete blood counts, C-reactive protein,

DOI:10.5455/ijsm.acute-bronchiolitis
First Received: May 03, 2016
Accepted: May 24, 2016
Manuscript Associate Editor: George Baitchev (BG)
Editor-in Chief: Ivan Inkov (BG)
Reviewers: Gergana Petrova (BG); Piotr Korczynski (PL)
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electrolytes with suspected problems with feeding and signs of dehydration [1,3,6].

Disturbances in total and differential blood count of leukocytes do not foresee a severe bacterial infection in infants and young children hospitalized with a lower respiratory tract infection with a respiratory syncytial virus [1,3,7].

An increase in white blood cells is usually a sign that your body is fighting an infection. A blood test can also determine whether the level of oxygen has decreased in your child's bloodstream [3,7].

There is no agreement on the level of oxygen saturation to be achieved in children with acute bronchiolitis because Scottish national guidelines on acute bronchiolitis from 2006, recommend oxygen saturation 94% or higher while AAP and WHO guidelines recommend a target of 90% SpO_2 [1,2,8].

Some studies have shown that the achievement of 90% oxygen saturation impact on reducing the length of stay in hospital compared to 94% oxygen saturation. AAP guide proposes to reduce the level of monitoring how a baby is improving [2,3].

Management of acute bronchiolitis is supportive, as no medical treatment has shown to improve important clinical outcomes, such as length of hospital stay, use of supportive care or transfer to an intensive care unit [6,8,9].

The purpose of our study was to examine hematological parameters, acid-base status and arterial blood gas analysis in patients with acute bronchiolitis before and after treatment, as the most common medical reason for admission of children to pulmonology department.

MATERIALS AND METHODS

The study was retrospective and included 123 patients with acute bronchiolitis in 2013, treated at the Department of Pulmonology of Paediatric Clinic of University Clinical Center Sarajevo in Bosnia and Herzegovina, where the study was conducted. Criteria for inclusion in the study was the first episode of acute bronchiolitis, clinical diagnosis of bronchiolitis guidelines defined by the American Academy of Paediatric Clinical Practice [2]. Criteria for exclusion from the study are the existence of chronic diseases, the presence of congenital heart disease accompanied by cyanosis; requiring diuretics with or without pulmonary hypertension; pulmonary disease requiring oxygen support with or without the occurrence of pulmonary hypertension presence of neuromuscular diseases, immunodeficiency, hemoglobinopathies.

Blood samples from children were taken penetrating in cubital vein, and it was analyzed using the Colter appliances – automatic counter blood count, for analyzes number of erythrocytes, leukocytes, platelets, differential blood count, MCV, Hct, Hb. All samples were analyzed in the laboratory center at clinical center. Our instruments are regularly tested that the measurements are accurate.(Table 1)

CRP concentration in serum of patients is determined by laser nephelometry (BN II analyzer). As a reagent for this method was used CardioPhase hsCRP (Siemens, Erlangen, Germany), high sensitivity C-reactive protein (CCRP), quantitatively measure CRP levels in human serum and heparinized plasma. All patients have performed a physical examination, chest radiogram, sputum examination, blood gas test.

Blood gas analysis was carried out on appliances ABL 5 (Radiometer, Copenhagen, Denmark) and ABL 700 (Diamond Diagnostics, Holliston, USA). Heparinized capillary blood is used for blood gas analysis.

Table 1 Reference range of parameters used in the study.

Parameter	Referent value	The unit of measurement
Erytrocytes	4.4 – 5.8	x 10^{12}/L
Platelets	150.0 - 400.0	x 10^{9}/L
Leukocytes	9.0-30.0	x 10^{9}/L
Neutrophils	40-70	%
Lymphocytes	30-50	%
Monocytes	2-10	%
Eosinophils	1-6	%
Basophils	0-1	%
pH	7.35 – 7.45	-
pCO_2	4.66 – 6.13	kPa
HCO_3^-	23 - 27	mmol/L
Total CO_2	24 - 30	mmol/L
Base excess (BE)	-2.3 to + 2.3	mmol/L
pO_2	11.06 – 13.3	kPa
O_2 sat.	95 - 100	%
CRP	0-5	mg/L
MCV	72-88	fL
HCT	32-42	%
Hb	10.5-14.0	

Statistical analysis was performed using SPSS (Statistical Package for Social Sciences), version 19.9, and Microsoft Office Excel, version 2013, analyzing the mean (χ^2), standard deviation (SD), minimum (min.) and maximum (max.) value. Categorical variables are presented as numbers, percentage, mean ±, standard deviation (SD). To determine the significance of differences between categorical variables was used chi-square test. Performed calculations are showing normal distribution of data. Student's t-test tested the significance of differences in continuous variables for small independent samples. Values of $p < 0.05$ were considered statistically significant.

Results

Acute bronchiolitis was diagnosed in 123 children, 69 (56.1%) of them were male and 54 (43.9%) were female children. There were 102 (82.8%) term newborns and 21 (17.1%) premature infant. Of the total number of term infants 52 (52.9%) were male and 48 (47.1%) female, while a total number of preterm newborns 15 (71.45%) were male and 6 (28.6%) were female. There was no association between sex and gestation duration ($\chi 2=2.417$; $p=0.120$, $p>0.05$). An average age of children were 3.66±2.14 months (range 1 to 14 months). The average age of boys was 3.86±2.48 months while the average years of girls were 3.14±1.60 months. The most common symptom was caught, in 103 (83.7%) children, while other symptoms were: dyspnea 14 (6.4%), rhinorrhea 74 (60.2%) and fever 17 (22.0%).

The most common form of treatment used in 98 (79.7%) children with acute bronchiolitis was treatment with corticosteroids,

Table 2 Parameters of acid-base status before treatment.

Parameter	Number (n)	Referent value	Increased value	Decreased value
pH	103	85 (82.5)	7 (6.8)	11 (10.7)
pCO_2 (kPa)	102	51 (50.0)	15 (14.7)	36 (35.3)
pO_2 (kPa)	85	-	-	85(100)
Tot CO_2 (mmol/L)	75	41 (54.7)	3 (4.0)	31 (41.3)
HCO_3^- (mmol/L)	98	45 (45.9)	10 (10.2)	43 (43.9)
BE (mmol/L)	101	58 (57.4)	9 (8.9)	34 (33.7)
O_2 sat. (%)	121	39 (32.2)	-	82 (67.8)

Table 3 Parameters of acid-base status before and after treatment.

Parameter	Before treatment	After treatment	p-value
pH	7.39±0.01	7.41±0.01	
pO_2	7.03 ± 0.28	8.56 ± 0.42	p = 0.004; p <0.05
pCO_2 (kPa)	5.30±0.20	5.08±0.18	
Tot CO_2 (mmol/L)	25.23±0.72	25.21±0.95	
HCO_3^- (mmol/L)	23.67±0.61	24.08±0.61	
O_2 sat.	85.10±1.84	91.29±1.09	p=0.006; p<0.05

salbutamol inhalation in 97 (78.9%) children, inhalation of saline solution in 79 (64.2%) children, antibiotic treatment in 56 (45.5%) children and oxygen treatment in 28 (22.8%) children.

The average duration of hospitalization of children with acute bronchiolitis was 5.23±2.34 days, range 2 to 14 days. The mean duration of hospitalization for term newborns was 5.26±2.18 days (range 2-13 days), and for a preterm infant was 5.05±3.04 days (range 2-14 days). There was no significant difference in duration of hospitalization in term and preterm infants (p=0.70; p>0.05).

The values of pO_2 were reduced in 85 children before treatment, and 82 children had a value of saturation of O_2 lower than the lower reference limits. (Table 2)

Application of treatment achieves the increase of pH levels, HCO_3^-, and a decrease of pCO_2 and total CO_2. (Table 3)

Average values of pO_2 in children with bronchiolitis before treatment were significantly lower about the values measured after the administration of therapy. (Table 3)

Average values of O_2 saturation in children with acute bronchiolitis before treatment were significantly lower about the values measured after the administration of therapy. (Table 3)

Table 3 showed a significant increase in mean values of $p0_2$ and CRP after treatment of children with acute bronchiolitis (p<0.05).

By analyzing the values of hematological parameters, we found that the value of CRP, leukocytes count and MCV in most children with bronchiolitis included in our study before treatment were within referent values. In peripheral blood were lower values of erythrocytes, hemoglobin, hematocrit, neutrophils, eosinophils, while values of platelets and leukocytes were increased. (Table 4)

The average value of the number of leukocytes in children with bronchiolitis before treatment was significantly higher compared to the values measured after administration of therapy. (Table 5)

The average value of C-reactive protein in children with bronchiolitis before treatment was significantly higher compared to the values measured after administration of therapy. (Table 5)

No evidence of significant differences in the values of red blood cell count, platelet count, mean cell volume, hemoglobin and hematocrit in children with bronchiolitis before and after administration of appropriate treatment.

Table 5 showed a significant decrease in mean values of leukocytes count and CRP after treatment of children with acute bronchiolitis (p<0.05).

Discussion

Our results are partially in line with the results of other studies regarding gender representation and age. In our retrospective study, most children were term newborns. Premature infants have more severe bronchiolitis in contrast features according to the literature.

According to the Scottish Intercollegiate Guidelines Network leading symptoms a dry cough, dyspnea, and wheezing [1]. The most common symptom in our study was a cough, then dyspnea and fever. The term newborns compared to preterm infants had a higher incidence of dyspnea, fever, and cough, while the frequency of rhinorrhea was higher in preterm compared to term newborns.

Table 4 Hematological parameters before treatment in children with bronchiolitis.

Parameters	Number (n) (%)	Referent value (%)	Increased value (%)	Decreased value (%)
Erytrocytes	119 (100%)	56 (47.1%)	-	63 (52.9%)
Plateletes	119 (100%)	34 (28.6%)	85 (71.4%)	-
Leukocytes	121 (100%)	93 (76.9%)	-	28 (23.1%)
Neutrophils	51 (100%)	18 (35.3%)	2 (3.9%)	31 (60.8%)
Basophils	40 (100%)	40 (100.0%)	-	-
Eosinophils	49 (100%)	18 (36.7%)	3 (6.1%)	28 (57.1 %)
Lymphocytes	51 (100%)	21 (41.2%)	26 (51.0%)	4 (7.8%)
Monocytes	50 (100%)	40 (80.0%)	10 (20.0%)	-
CRP	122 (100%)	88 (72.1%)	34 (27.9%)	-
MCV	114 (100%)	70 (61.4%)	-	44 (38.6%)
Hb	120 (100%)	9 (7.5%)	-	111(92.5%)
Hct	119 (100%)	4 (3.4%)	-	115 (96.6%)
CRP - C-reactive protein, MCV - Mean Cell Volume; Hb - Hemoglobin; Hct - Hematocrit; n - number of patients.				

Table 5 Hematological parameters in children with acute bronchiolitis before and after treatment.

Parameters	Before treatment	After treatment	P - value
Erythrocytes (x 10^{12}/L)	4.54±0.087	4.80±0.13	
Plateles (x 10^{9}/L)	580.69±32.04	630.54±48.21	
Leukocytes (x 10^{9}/L)	15.65±0.93	10.04±0.52	p=0.0001; p<0.05
Neutrophils %	58.34±5.79	51.92±8.22	
Basophils %	0.28±0.04	0.34±0.04	
Eosinophils %	0.66±0.22	1.04±0.41	
Lymphocytes %	30.00±4.71	36.44±5.74	
Monocytes %	8.24±1.43	7.26±1.89	
CRP mg/L	12.44±2.06	2.6±0.27	p=0.0001; p<0.05
MCV (fL)	78.97±1.43	76.23±1.85	
Hb (g/L)	117.33±2.15	121.08±3.49	
Hct %	0.36±0.01	1.78±1.41	
MCV – Mean Cell Volume, Hb - Hemoglobin; Hct – Hematocrit, ± - mean, ± SEM - standard error of the mean, p - the probability; NS - not significant.			

Application of treatment has led to a rise in average values: pH, HCO_3^- as well as a decline in pCO_2 and total CO_2. No evidence of significant differences in the values of pH, pCO_2, the total pCO_2, and HCO_3^- before and after treatment [10,11]. Average values of pO_2 in infants with bronchiolitis before treatment were significantly lower compared to the values measured after administration of the treatment. Average values of O_2 saturation in children with bronchiolitis before treatment were significantly lower compared to the values measured after treatment [10,11].

Complete blood count is not indicated in assessment and management of infants with typical acute bronchiolitis. There has been limited investigation into the role of C-reactive protein (CRP) measurement in distinguishing bacterial from viral lower respiratory tract infections. Existing studies are retrospective or of poor quality and do not provide sufficient evidence upon which to base a recommendation about bronchiolitis [10,12].

Blood gas analysis (capillary or arterial) is not usually indicated in acute bronchiolitis. It may have a role in the assessment of infants with severe respiratory distress or who are tiring and may be entering respiratory failure [10,13].

An observational study attempted to correlate clinical respiratory features, arterial blood gasses and oxygen saturation with illness severity. Oxygen saturation and arterial carbon dioxide tension (pCO_2) best predicted the need for high concentration oxygen therapy. Oxygen tension (pO_2) levels were less useful [10-13].

Studies have shown that small differences in the level of oxygen saturation (92-94%) in children with acute bronchiolitis may significantly affect the admission or discharge patients in emergency departments [11,14,16].

The low level of oxygen saturation on admission can predict the severity of the illness and longer duration of hospitalization. The decision to admit a child with oxygen saturation between 92% and 94% should be supported by detailed clinical examination, stage of disease, the social status of the patient [10,14,16].

Conclusion

No diagnostic tests are used routinely. However, there is an improvement of hypoxemia after management of acute bronchiolitis in children. The basic parameters of inflammation were increased, and pO_2 and O_2 saturation which are indicators of lung function in children.

Authors' Statements

Competing Interests

The authors declare no conflict of interest.

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