ACTA MICROBIOLOGICA BULGARICA Volume 39 / 4 (2023)

Viral Bronchiolitis Findings in Children at the Pediatric Clinic of Clinical Center of the University of Sarajevo

Amina Selimović[1], Haris Čampara[2], Ermina Mujičić[3], Mufida Aljičević[4*], Emina Hadžimuratović[5], Armin Šljivo[5], Velma Rebić[4]

[1]*Pediatric Clinic, Clinical Center University of Sarajevo, Bosnia and Herzegovina*
[2]*Department of Pathology, Hospital Travnik, Bosnia and Herzegovina*
[3]*Cardio-surgery clinic, Clinical Center University of Sarajevo, Bosnia and Herzegovina*
[4]*Department of Microbiology, Faculty of Medicine, University of Sarajevo, Bosnia and Herzegovina*
[5]*Department of Neonatology, Pediatric Clinic, Clinical Center University of Sarajevo, Bosnia and Herzegovina*
[6]*Emergency Medicine Center Sarajevo, Bosnia and Herzegovina*

Abstract

Bronchiolitis is a relatively common respiratory condition, usually presenting in the first two years of life. It is followed by audible phenomena, due to inflammatory airway obstruction. Common symptoms are nasal discharge, cough, tachypnoea, fever, and cyanosis. The cause is viral, most commonly respiratory syncytial virus. Bronchitis leads to respiratory acidosis and leads to accumulation of carbon dioxide. We analyzed 83 patients with a diagnosis of bronchiolitis at the discharge from the Pediatric clinic of the Clinical Center of the University of Sarajevo. We observed the relationships between acid-base status parameters, blood work parameters, age, and weight and placed them into groups based on whether they had any comorbidities or not. Patients without comorbidities showed significant differences in age, body temperature, and leukocyte count compared to patients with comorbidities. We also noted significant correlations between age, weight, hemoglobin level, hematocrit, erythrocyte count, pCO_2, pH, and HCO_3 which led to a conclusion that it is likely that in young children with bronchiolitis, the issue is not in the elimination of CO_2 through lungs. Rather, it is the transport of CO_2 to the lungs due to reduced erythrocyte count and so we believe, that if proven feasible, bronchiolitis could be treated with pure erythrocyte transfusions.

Keywords: bronchiolitis, respiratory acidosis, newborn, virus respiratory tract infection.

Резюме

Бронхиолитът е сравнително често срещано респираторно заболяване, което обикновено се проявява през първите две години от живота. То е последвано от звукови феномени, дължащи се на възпалителна обструкция на дихателните пътища. Честите симптоми са секреция от носа, кашлица, тахипнея, треска и цианоза. Причинителят е вирусен, най-често респираторен синцитиален вирус. Бронхитът води до респираторна ацидоза и натрупване на въглероден диоксид. Анализирахме 83 пациенти с диагноза бронхиолит при изписването от Педиатричната клиника на Клиничния център на Университета в Сараево. Наблюдавахме връзките между параметрите на киселинно-алкалния статус, параметрите на кръвната картина, възрастта и теглото и ги поставихме в групи въз основа на това дали са имали съпътстващи заболявания или не. Пациентите без съпътстващи заболявания показват значителни разлики във възрастта, телесната температура и броя на левкоцитите в сравнение с пациентите със съпътстващи заболявания. Също така отбелязахме значителни корелации между възрастта, теглото, нивото на хемоглобина, хематокрита, броя на еритроцитите, pCO_2, pH и HCO_3, което доведе до заключението, че е вероятно при малки деца с бронхиолит проблемът да не е в елиминирането на CO_2 през бели дробове. По-скоро това е транспортирането на CO_2 до белите дробове поради намаления брой на еритроцитите. Затова ние считаме, че ако това предположение се докаже, бронхиолитът може да се лекува с трансфузии на чисти еритроцити.

* Corresponding author: mufida.aljicevic@mf.unsa.ba
Acta Microbiol. Bulg. 2023;39(04). https://doi.org/10.59393/amb23390405

Introduction

Bronchiolitis is a relatively common respiratory condition affecting 2-3% of infants, younger than 1 year (Smyth and Openshaw, 2006). It usually presents in the first two years of life (Paranhos-Baccalà *et al.*, 2008; Kirolos *et al.*, 2021), the peak incidence being between two and six months (NICE Guidelines, 2015; Paranhos-Baccalà *et al.*, 2008). It begins as an upper respiratory tract infection, then spreads into the lower respiratory tract, followed by audible phenomena such as wheezing as crepitations, due to inflammatory airway obstruction (Smyth and Openshaw, 2006; Meissner, 2016; Jerath, 2021). The most common symptoms are stuffy and runny nose, persistent cough, tachypnoea, chest recession, fever, and poor feeding (NICE Guidelines, 2015; Gill *et al.*, 2020). In patients younger than 6 weeks, the only symptoms may be apnea and cyanosis. (NICE Guidelines, 2015; Gill *et al.*, 2022). The cause is viral, with most infections (50-80%) being attributed to respiratory syncytial virus (Friedman *et al.*, 2014; Meissner, 2016). Bronchitis leads to respiratory acidosis and leads to accumulation of carbon dioxide (CO_2). Elevation of CO_2 level decreases levels of bicarbonate (HCO_3), which neutralizes pH. Moreover, kidneys also excrete more acid and reabsorb more bases (Patel and Sharma, 2022). Treatment for bronchiolitis remains supportive with oxygen and respiratory support (Schroeder *et al.,* 2020; Kirolos *et al.*, 2021). Several attempts at treating bronchiolitis have been made, using bronchodilators, inhaled epinephrine, nebulized saline, antibiotics, and steroids. However, all of these proved ineffective in reducing complications and changing the outcome (Gill *et al.*, 2022).

Material and Methods

We analyzed patients with a diagnosis of bronchiolitis at discharge from the Pediatric clinic of the Clinical Center of the University of Sarajevo. We observed the relationships between acid-base status parameters, blood work parameters, age, and weight. Distribution of data was performed using the Kolmogorow-Smirnof test. We compared continuous variables with Spearman correlations and categoric variables with the Whitney U test. Statistical analysis was performed using SPSS statistical software v. 26.0.

Results

We analyzed the patient data of 83 patients with bronchiolitis, 51 (61,45%) male and 32 female (38.55%) (Fig. 1), placing them in groups based on whether they had any comorbidities or not. Of all the patients 61 (73.5%) had no comorbidities, while 22 (26.5%) had any comorbidities. The most common comorbidities were gastroenterocolitis, otitis media, and bacteriemia. The median age of all patients was 2.5 months (IQR 1.5-4.5). The median weight of all patients was 5.47 kg (IQR 4.3-6.8 kg). The median CRP of all patients was 3.2 (IQR 1.8-9.8). The median leukocyte count was 11.7 (IQR 9.4-15.9). Median O_2 saturation was 86 (IQR 75.25-92.75). When comparing the groups, patients without comorbidities showed significant age differences (2 months IQR 1.5-4 vs 4.75 months IQR 1.67-6.5), body temperature (36.5°C IQR 36.4-36.7°C vs 36.5°C IQR 36.5-37.65°C), and leukocyte count (11.4 IQR 8.9-14.2 vs 14.2 IQR 10.67-19.97) (every $p<0.05$) compared to patients with comorbidities, however, no difference was found between CRP and acid-base status. We found that age and weight positively correlate with increased erythrocyte count and pO_2, while negatively correlating with pCO_2, and positively with pH. Significant correlations are shown in Table 1. The data show that age and weight positively correlate with increased erythrocyte count and pO_2, while negatively cor-

Table 1. Significant correlations between patients' parameters

Parameters	Age		Weight	
	r	p	r	p
CRP	0.217	<0.05	0.218	<0.05
Erythrocytes (n)	0.563	<0.001	0.516	<0.001
Neutrophiles (%)	0.596	<0.001	0.487	0.002
pH	0.316	0.008	0.342	0.004
pO_2	0.317	0.002	0.388	0.001
pCO_2	-0.435	<0.001	-0.509	<0.001

CRP – C reactive protein; pH – blood acidity level; pO_2 – partial oxygen pressure in the blood; pCO_2 – partial carbon dioxide pressure in the blood; r- Spearman's coefficient of correlation; p – level of statistical significance.

relating with pCO_2, and positively with pH.

Figure 1. shows that the majority of patients in our study (61.45%) were male, and the length of hospital stay was slightly longer than 5 days or more.

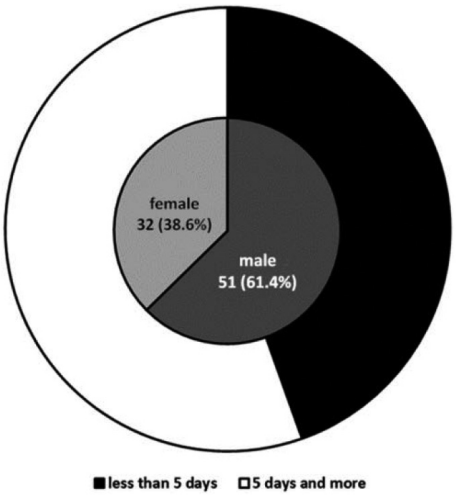

Fig. 1. Patient gender ratio (inner circle) and hospitalization time (outer circle)

Other significant correlations are between hemoglobin level and erythrocyte count (r=.399; p<0.001) and hemoglobin level and HCO_3 (r=.340; p=0.004). However, there was no significant correlation between HCO_3 and pH.

Median patients' hospitalization time was 5 IQR (4-7) and has shown no significant difference concerning age and comorbidities and has not significantly correlated to any examined parameter. However, there was a significant difference between the groups of hospitalization time under five days and five days and more in monocyte count (p<0.05).

Discussion

Treatment of bronchiolitis remains supportive and predictors of disease course remain inconclusive (Masarweh *et al.*, 2020). The average patient age in our study was 2.5 months, which is a bit younger than other authors report (Voets *et al.*, 2006; Masarweh *et al.*, 2020). The majority of patients in our study (61.45%) were male, which is similar to the findings of Masawreh et al. (Masarweh *et al.*, 2020). They found that 80.3% of all patients had no comorbidities and our result was somewhat similar (73.5%). However, their study found that the length of stay was dependent on O_2 saturation, fever intensity, gestational age, and birth weight, while our study had no such findings. We believe this is because of the bacterial nature of comorbidities which were successfully treated with antibiotics. Moreover, our median O_2 saturation was 86, compared to 90 in this study. They also found higher fever among the patients with comorbidities which agrees with our data as well. However, the data for acid-base status was not analyzed in this study (Masarweh *et al.*, 2020). Voets et al. found that oxygen saturation of less than 95% increased the length of hospital stay, however, our study did not reach the same conclusion. Possibly since the majority of such patients in that study were already in intensive care (Voets *et al.*, 2006). Mai et al. found that parameters of physical examination of patients' respiration correlated with length of stay (Mai *et al.*, 1995), however, our study found no such conclusions. In our study, patients who had more body weight showed higher pH levels, and patients who were older with more body weight (p<0.05) had lower levels of pCO_2 (p<0.001), while patients' HCO_3 significantly correlated only with hemoglobin concentration (p<0.05) and hematocrit (p<0.05). This is possibly due to the constant balancing of pH levels by the interaction of bicarbonate buffer, in which carbonic anhydrase converts CO_2 to carbonic acid in the tissues and then back to CO_2 in the lungs. Moreover, there is some evidence that carbonic anhydrase binds to hemoglobin. (Backman, 1981). Hemoglobin and hematocrit of our patients correlated with erythrocyte count (both p<0.001). We conclude, that since CO_2 has much better alveolar permeation than oxygen (Wagner, 2015), it is likely that in young children with bronchiolitis, the issue is not in the elimination of CO_2 through the lungs, but rather the transport of CO_2 to the lungs.

Conclusion

In our study, children who were younger and with less body weight had a lower number of erythrocytes and therefore were less able to eliminate CO_2 through the lungs. Based on the results of our study, we believe that more research should be done on this topic and that if proven feasible, bronchiolitis could be treated with pure erythrocyte transfusions.

References:

Backman, L. (1981). Binding of human carbonic anhydrase to human hemoglobin. *Eur. J. Biochem*. **120**: 257–261.

Friedman, J. N., M. J. Rieder, J. M. Walton (2014). Bronchiolitis: recommendations for diagnosis, monitoring and management of children one to 24 months of age. *Paediatr. Child Health* **19**: 485–498.

Gill, P. J., M. R. Anwar, E. Kornelsen, P. Parkin, Q. Mahood, S. Mahant (2021). Parenteral versus enteral fluid therapy for children hospitalized with bronchiolitis. *Cochrane Database Syst. Rev.***12**: CD013552.

Gill, P. J., N. Chanchlani, S. Mahant (2022). Bronchiolitis. *Can. Med. Assoc. J*. **194**: E216.

Jerath, N. (2021). Viral bronchiolitis in children: Less is more. *Indian J. Crit. Care Med.* **25**: 1219–1220.

Kirolos, A., S. Manti, R. Blacow, G. Tse, T. Wilson, M. Lister, S. Cunningham, A. Campbell, H. Nair, R. M. Reeves, R. M. Fernandes, H. Campbell, RESECEU Investigators (2020). A systematic review of clinical practice guidelines for the diagnosis and management of bronchiolitis. *J. Infect. Dis*. **222**: 672–679.

Mai, T. V., A. M. Selby, J. M. Simpson, D. Isaacs (1995). Use of simple clinical parameters to assess severity of bronchiolitis. *J. Paediatr. Child Health* **31**: 465-468.

Masarweh, K., M. Gur, R. Leiba, R. Bar-Yoseph, Y. Toukan, V. Nir, G. Gut, Y. Ben-David, F. Hakim, L. Bentur (2020). Factors predicting length of stay in bronchiolitis. *Respir. Med*. **161**: 105824.

Meissner, H. C. (2016). Viral Bronchiolitis in Children. *New. Engl. J. Med*. **374**: 62-72.

National Institute for Health and Care Excellence (NICE guideline). Bronchiolitis in children: diagnosis and management (2015). Available from: https://www.nice.org.uk/guidance/ng9.

Paranhos-Baccala, G., F. Komurian-Pradel, N. Richard, G. Vernet, B. Lina, D. Floret (2008). Mixed Respiratory Virus Infections. *J. Clin. Virol*. **43**: 407–410.

Patel, S., S. Sharma (2022). Respiratory Acidosis. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; (2023) Jan. PMID: 29494037.

Schroeder, A. R., L. A. Destino, W. Ip, E. Vukin, R. Brooks, G. Stoddard, E. R. Coon (2020). Day of illness and outcomes in bronchiolitis hospitalizations. *Pediatrics* **146**: e20201537.

Smyth, R. L., P. J. M. Openshaw (2006). Bronchiolitis. *Lancet* **368**: 312-322.

Voets, S., G. Van Berlaer, S. Hachimi-Idrissi (2006). Clinical predictors of the severity of bronchiolitis. *Eur. J. Emerg. Med*. **13**: 134–138.

Wagner, P. D. (2015). The physiological basis for pulmonary gas exchange: implications for clinical interpretation of arterial blood gasses. *Eur. Respir. J.* **45**: 227-243.