European Journal of Pediatrics (2025) 184:3
https://doi.org/10.1007/s00431-024-05859-y

RESEARCH

Practice in bronchiolitis management in Polish hospitals—a multicenter retrospective cohort study

Sara Szupieńko[1] · Karolina Bojarska-Cikoto[2] · Ewa Woźny-Sędek[3] · Filip Kazubski[4,5] · Karolina Kazubska[4] · Joanna Stryczyńska-Kazubska[4] · Damian Struck[2] · Piotr Stecko[2] · Aleksandra Buczek[1] · Henryk Szymański[1]

Received: 9 July 2024 / Revised: 8 October 2024 / Accepted: 14 October 2024

Abstract

Bronchiolitis is one of the main reasons for the hospitalization of young children. Based on updated recommendations, only supportive therapy is recommended for treatment. In Poland, many children that are hospitalized with bronchiolitis undergo a treatment that is not supported by current research. The study aimed to assess clinicians' adherence to the guidelines. This was a multicenter retrospective study of hospitalized infants with bronchiolitis; a cohort study design was utilized. Data were collected in four Pediatric Departments in Poland. All infants aged less than 24 months that had been hospitalized for their first and subsequent episodes of acute bronchiolitis from January 1, 2021, to December 31, 2022, were included. The exclusion criterion was an age over 24 months. A total of 629 infants with a median age of 8.5 months were included in this study. The medical interventions and treatments varied between the four hospitals. Laboratory blood tests were run for almost all children (99.5%), and the percentage of children for which a chest X-ray was performed ranged from 1.3% to 44%. The other measures were the use of intravenous hydration (51.3%-93.3%), use of hypertonic saline nebulization (1.3%-43.6%), use of normal saline nebulization (10%-95.1%), use of oxygen (7.3%-42%), use of beta-mimetics (19.1%-89.4%), use of nebulized steroids (8%-76.9%), use of systemic steroids (0.9%-42%), use of nebulized adrenaline (0%-8.1%), and use of antibiotics (12%-21.8%).

Conclusions: In total, 70% of infants who were hospitalized in four hospitals in Poland underwent examinations and treatment methods that are not supported by current guidelines and evidence-based research. This study shows that non-recommended medications are overused in bronchiolitis treatment, and there is a need to take action to implement the guidelines into healthcare providers' work.

What is Known:

- *Bronchiolitis is a lower respiratory tract viral infection and is one of the main reasons for hospitalization among young children.*
- *Only supportive therapy is recommended in the guidelines.*
- *Bronchodilators, nebulized adrenaline, nebulized or systemic steroids, and antibiotics are not recommended.*

What is New:

- *Non-recommended medications are overused in bronchiolitis treatment in Poland.*
- *Up to 70% of hospitalized children in the studied centers underwent treatment that is not supported by guidelines.*

Communicated by Vincent Peters

✉ Henryk Szymański
henryk.t.szymanski@gmail.com

[1] Department of Paediatrics, St Hedwig of Silesia Hospital, Prusicka 53/55, 55-100, Trzebnica, Poland

[2] Department of Paediatrics, Sokołowski Hospital in Wałbrzych, Wałbrzych, Poland

[3] Department of Paediatrics, Municipal Hospital in Żory, Żory, Poland

[4] Greater Poland Centre of Children's Health, Healthcare Facilities for Mother and Child in Poznań, Poznań, Poland

[5] Karol Jonscher's Clinical Hospital of Poznań University of Medical Sciences, Poznań, Poland

Published online: 11 November 2024

Table 1 National bronchiolitis clinical practice guidelines [1, 6–8]

Treatment	AAP 2014	Polish guidelines 2016	NICE 2021	Italian guidelines 2022
Age (months)	< 24	< 24	< 24	< 12
Pulsoxymetry	+ if oxygen supplementation needed	+	+ before hospital admission	+ if oxygen supplementation needed
Blood analysis	-	-	-	-
Chest x-ray	-	-	- consider if intensive care is being proposed	-
Oxygen	+	+	+	+
Nasal suctioning	deep suctioning not recommended	not mentioned	not routinely	+
Feeding and hydration	+	+	+	+
Bronchodilators	-	± individual cases	-	-
Nebulized epinephrine	-	± individual cases	-	-
Inhaled steroids	-	-	-	-
Systemic steroids	-	-	-	-
Hypertonic saline	-	+ in patients administrated to the hospital	-	- not enough evidence

Keywords Bronchiolitis · Bronchiolitis guidelines · Bronchiolitis treatment · Hospitalized infants · Infants

Introduction

Bronchiolitis is a lower respiratory tract viral infection; it is most commonly caused by respiratory syncytial virus (RSV), but other viruses such as Rhinovirus (RV), Influenza virus, Parainfluenza virus, Metapneumovirus (MPV), and Adenovirus can also cause this disease [1]. The diagnosis of bronchiolitis is based on clinical symptoms, and due to the lack of one definition, there are differences in its diagnosis between countries and even hospitals. This diversity primarily concerns those that are under the age of 12 or 24 months, the presence of auscultation findings (rales—crackles with or without wheezing), and the first or subsequent episode of the disease [2].

Bronchiolitis is one of the main reasons for the hospitalization of young children; it affects 13–17% of all hospitalized children that are younger than 2 years old. [3, 4]. Based on updated recommendations, only supportive therapy is recommended as a means to treat bronchiolitis; this includes suctioning nasal secretions, water–electrolyte balance maintenance, and oxygen supplementation when needed. The evidence-based guidelines do not recommend inhaled bronchodilators, nebulized adrenaline, and nebulized or systemic steroids [1, 5–8]. Although normal saline (NS)—0,9% NaCl—is not recommended, it is commonly used to treat children with bronchiolitis, and it has the status of supportive treatment in Poland. Table 1 shows the recommendations from selected guidelines.

Clinical practice guidelines can help guide clinicians and benefit patients by promoting evidence-based practices [9]. However, according to research, many children with bronchiolitis undergo a treatment that is not supported by current research [10]; data from many countries has confirmed this observation [10–14]. In addition, a recently published Polish multicenter study was limited to RSV infections only [15].

Study objectives

The aim of our study was to evaluate the hospital management of children in Polish hospitals that were hospitalized due to bronchiolitis, and doctors' adherence to guidelines.

Methods and analysis

Study design

This was a multicenter retrospective study of hospitalized infants with bronchiolitis that used a cohort study design. The reporting of this study conforms to the STROBE statement.

Setting and participants

Data were collected in four cooperating Pediatric Departments from different regions of Poland: St Hedwig of Silesia Hospital in Trzebnica; Sokołowski Hospital in Wałbrzych; Municipal Hospital in Żory; and the Greater Poland Centre of Children's Health—Healthcare Facilities For Mother And Child—in Poznań.

All infants aged less than 24 months that were hospitalized for their first or subsequent episodes of acute bronchiolitis from January 1, 2021 to December 31, 2022 were included. The exclusion criteria were those aged over 24 months.

Patients were identified based on the ICD10 code diagnosis of bronchiolitis (J21.0, J21.1, J21.8, and J21.9). The diagnosis was based on clinical symptoms in accordance with current guidelines.

Physicians from four centers reviewed the medical records to collect the data. The information comprised age; presence of risk factors for severe acute bronchiolitis such as prematurity, bronchopulmonary dysplasia, congenital heart disease, immune disease, neuromuscular disease, and genetic disease; and previous medical history including earlier episodes of shortness of breath and previous hospitalization due to acute bronchiolitis. The clinical data that were collected from the time of the bronchiolitis episode included the date and length of hospitalization; viral epidemiology; chest X-ray examination; and applied treatment including oxygenation, nutritional support, hypertonic or normal saline inhaled, bronchodilators inhaled, adrenalin inhaled, steroids inhaled, and systemic and antibiotics, along with the duration they were taken for and the presence of any bacterial complications.

Statistical analysis

The analysis was conducted using the statistical software R (R-4.1.2). The categorical variables were described using n and the % of the respective group. The numerical variables were described using median and interquartile range. The distribution normality was checked using the Shapiro–Wilk test and was verified using skewness and kurtosis, while variance homogeneity was assessed using the Levene test. Comparisons were made with Pearson's chi-square test, Fisher's exact test, or the Kruskal–Wallis test, as appropriate. The Dunn test with Bonferroni adjustment was used for pairwise comparisons. A two-step linear regression analysis was utilized to understand the factors impacting the length of hospitalization. The cutoff p value for the variables' selection into multivariate models was $p = 0.157$ [16]. A stepwise selection method was used for the final variables' selection. Multivariate models were assessed using R^2 and adjusted R^2. A VIF analysis was run to understand potential multicollinearity. All statistical tests assumed $\alpha = 0.05$.

Patient and public involvement: Patients or the public were not involved in the design, conduct, reporting, or dissemination plans of our research.

Results

Participant Characteristics

A total of 629 infants were included in this study; Sites A, B, C, and D enrolled 200, 225, 123, and 78 patients, respectively. The characteristics of the infants are shown in Table 2. Many differences were observed between the center. For example, the age of patients and the duration of their hospitalization varied significantly; the median age was the highest in Site B (8.5 months) and the lowest in Site D (3.5 months). The median duration of hospitalization was 74.3 h, with the longest record being in Site A (120.0 h) and the shortest in Site B (49.9 h). The time from the first observed symptoms to hospital admission was 3.5 days on average. Moreover, more than one in four patients had a risk factor for a severe course of illness (26.4%), primarily in patients below 3 months in age (78.2%). The presence of risk factors prolonged hospitalization by almost 1.5 days ($\beta = 35.7$ CI 95% [23.2;48.3], $p < 0.001$). Additionally, the proportion of children with a history of at least one episode of dyspnea was 11.3%; the highest proportion was observed in Site B (18.2%). Nearly one in ten children had a history of hospitalization due to bronchiolitis (9.1%), with the highest value being in Site B (14.2%). Taken together, older children with a more frequent history of dyspnea and previous hospitalization due to bronchiolitis were admitted to Site B; this was also the center where the hospitalization time was the shortest.

Viral epidemiology

Almost all children were tested to determine the type of virus infection (96.5%). In the total group and each of the centers, more than half of the tested children were RSV-positive (70.0% in the total group, 90.9% in Site D, 75.8% in Site A, 73.0% in Site C, and 56.3% in Site B). The RSV distribution by months and years for each center is presented in Fig. 1.

Medical interventions by site

Laboratory blood tests were run for almost all children (99.5%); no significant difference was found between centers

Table 2 Characteristics of total study group and centers

Variable	Total group *n*(%)	Site A *n*(%)	Site B *n*(%)	Site C *n*(%)	Site D *n*(%)	*p*
Number of patients	626	200	225	123	78	-
Median age, in months	5.8(3.1;13.2)	4.7(2.0;10.2)[ab]	8.5(4.2;17.4)[ac]	6.1(4.7;11.6)[bd]	3.5 (1.6;6.6)[cd]	**< 0.001**
Risk factor of severe disease	165 (26.4)	77 (38.5)	44 (19.6)	9 (7.3)	35 (44.9)	**< 0.001**[1]
Age below 3 months*	129 (78.2)	66 (85.7)	34 (77.3)	1 (11.1)	28 (80.0)	**< 0.001**[1]
Heart disorders (hemodynamically significant)*	14 (8.5)	5 (6.5)	4 (9.1)	1 (11.1)	4 (11.4)	0.7[2]
Prematurely born (< 32 Hbd)*	12 (7.3)	4 (5.2)	4 (9.1)	2 (22.2)	2 (5.7)	0.2[2]
Chronic lung illness*	10 (6.1)	6 (7.8)	1 (2.3)	3 (33.3)	0 (0.0)	**0.007**[2]
Immunity disorders*	3 (1.8)	0 (0.0)	1 (2.3)	1 (11.1)	1 (2.9)	0.07[2]
Neuromuscular disorders*	4 (2.4)	1 (1.3)	1 (2.3)	2 (22.2)	0 (0.0)	**0.02**[2]
Two or more episodes of dyspnea	71 (11.3)	12 (6.0)	41 (18.2)	11 (8.9)	7 (9.0)	**0.001**[1]
Previous hospitalization due to bronchiolitis	57 (9.1)	10 (5.0)	32 (14.2)	11 (8.9)	4 (5.1)	**0.005**[1]
Duration of hospitalization in hours	74.31 (48.0;123.3)	120.00 (96.0;174.0)[efh]	49.95 (40.9;71.6)[egi]	79.52 (49.0;120.8)[fg]	93.71 (56.3;142.7)[hi]	**< 0.001**
Time from first symptoms to hospital admission (days)	3.53 (2.4;4.8)	3.00 (2.0;5.0)	3.52 (2.5;4.7)	3.50 (2.4;4.7)	3.59 (2.6;4.5)	0.4

Data are presented as n (%) for categorical variables, or median (interquartile range) for numerical variables. A p value lower than 0.05 indicated significant difference between centers, as calculated using Kruskal–Wallis test, Pearson's chi-square test[1], or Fisher's exact test[2]. The letters a–i indicated the post hoc outcome produced using the Dunn test with Bonferroni adjustment (a: p adj < 0.001, b: p adj = 0.004, c: p adj < 0.001, d: p adj < 0.001, e: p adj < 0.001, f: p adj < 0.001, g: p adj < 0.001, h: p adj = 0.001, i: p adj < 0.001)

* % referred to total group with risk of severe disorders

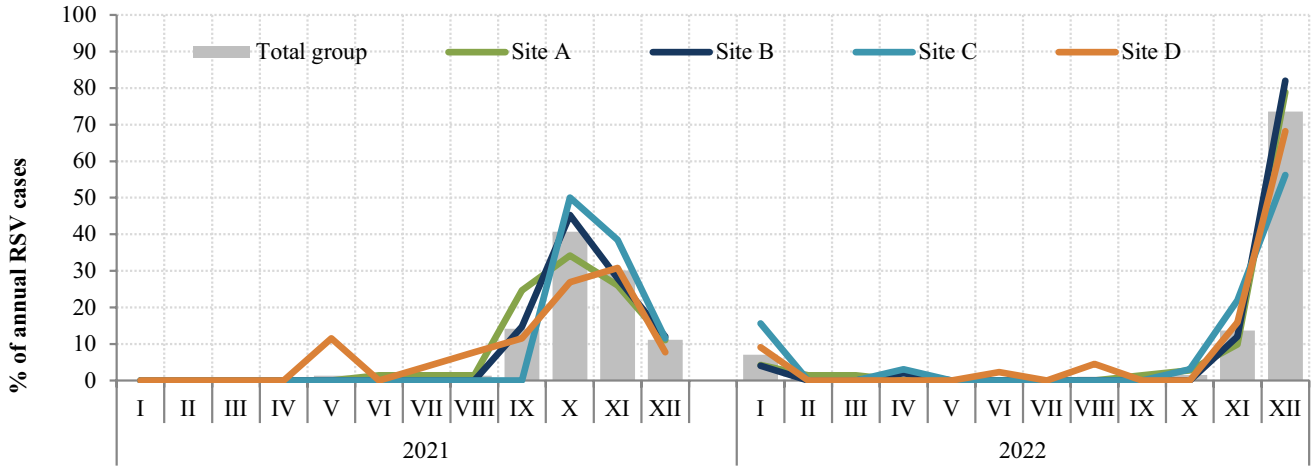

Fig. 1 Distribution of annual RSV cases by months, in the total group and in centers (100%—all RSV cases in a respective year)

($p = 0.9$). In the total group, 22.7% of children received chest X-rays; this number varied across centers ($p < 0.001$), ranging from 1.3% in Site D to 44.0% in Site A. Intravenous hydration was observed in the case of 74.1% of the total group, with numbers varying significantly across centers ($p < 0.001$). The lowest proportion was observed in Site D (51.3%) and the highest was observed in Site B (93.3%). Probe feeding took place in the case of five children, and the proportion of children who moved to OITD was 2.4% in the total group. In both, there were no significant differences across the centers.

Medical treatments by site

There were also marked differences in medical treatments between sites (Figs. 2 and 3). Nebulized hypertonic saline (HS)—3% NaCl—was used for 28.4% of children. More frequently, nebulized NS was used (totaling 56.9% of children),

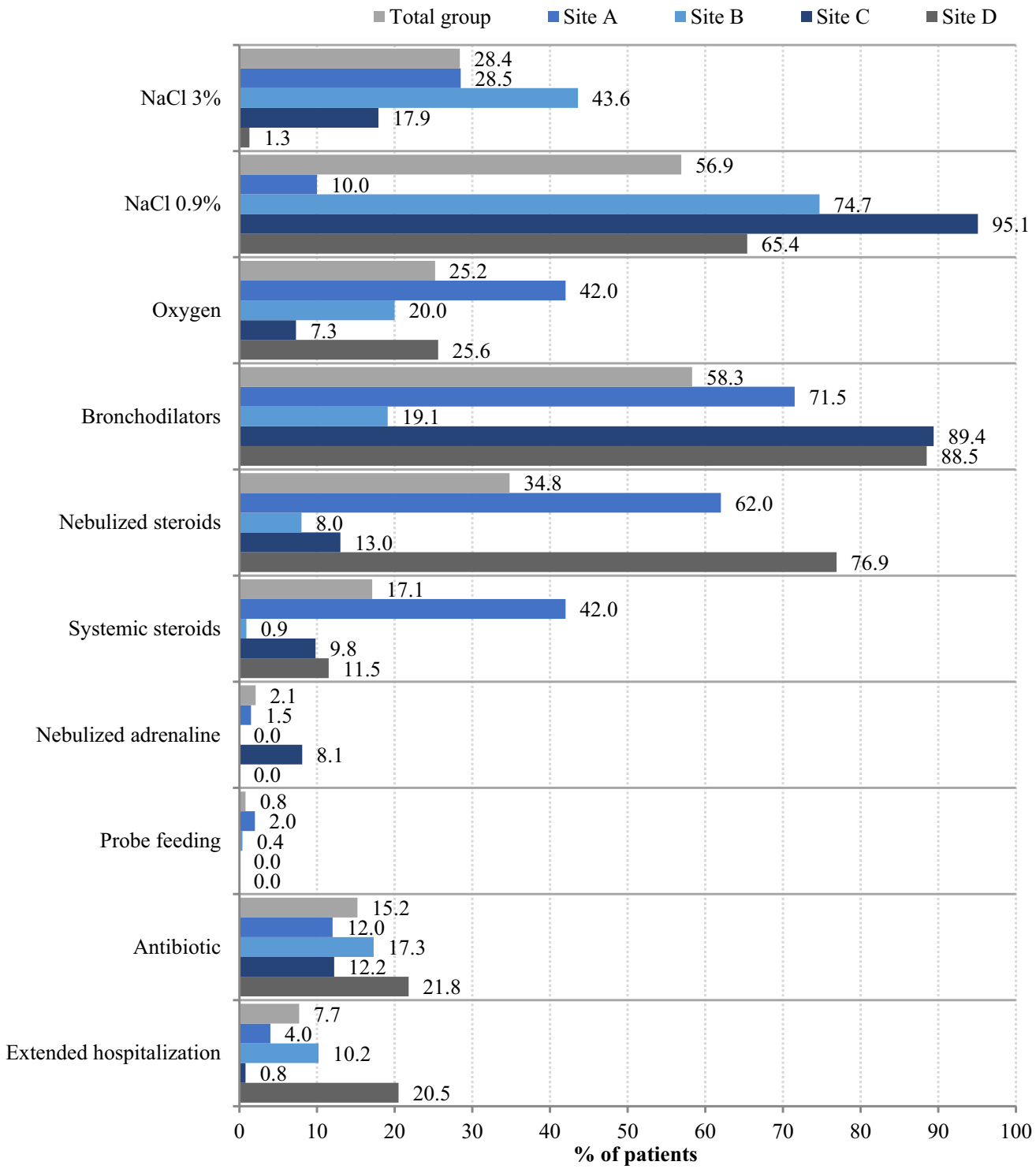

Fig. 2 Proportion of patients < 24 months with selected treatments for total group and centers during hospitalization

from 10% in Site A to 95.1% in Site C. In total, oxygen was used in the case of one in four children (25.2%); this percentage varied across the centers ($p < 0.001$). More frequent oxygen therapy lasted for over 48 h (49.7%). Bronchodilators were used during hospitalization in the case of 58.3% of children, while nebulized steroids were prescribed during hospitalization to 34.8% of children. In both the percentage varied significantly between centers ($p < 0.001$). Systemic steroids and nebulized adrenaline were used much less frequently (17.1% vs 2.1%). Antibiotics were given to 15.2%

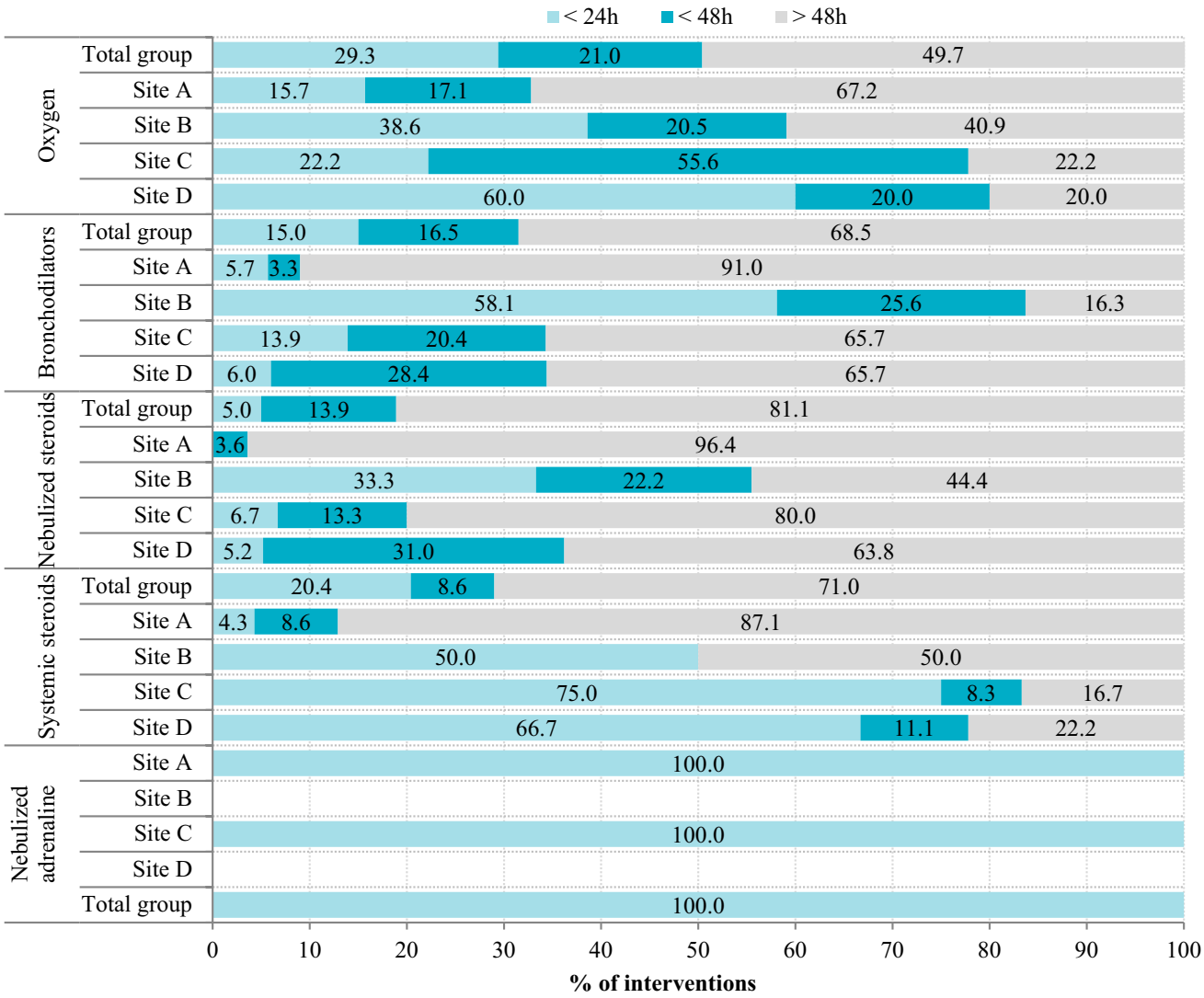

Fig. 3 Duration of selected interventions for total group and centers

of patients; no significant differences were observed across centers ($p=0.1$). Additional illnesses were diagnosed during hospitalization in the case of 7.8% of patients; Sites B and C were the centers with the highest proportion (43.6%). In Site B, 69.4% of patients also received a diagnosis of otitis media; however, this extended the duration of hospitalization only in 10.2% of cases.

Considering the type of treatment used, the final number of patients treated according to the recommendations (without the administration of bronchodilators, steroids, adrenaline, or antibiotics) was the highest in Site B (64%). It should be noted that in this center, the main reason in which the recommendations were not followed was in relation to the prescription of antibiotics, which were administrated due to bacterial superinfections, mainly acute otitis media. A comparatively low compliance with the guidelines was observed in other centers, in the following amounts: Site A (13.5%), Site C (10.6%), and Site D (9%). In the entire group, treatment based on the guidelines was applied only in 30% of cases.

Due to different age criteria for bronchiolitis diagnosis in the guidelines we decided to analyze separately subgroup of children under 12 months. The examination performed and the treatment used did not differ significantly (Fig. 4). Also the percent of children treated according to the recommendation was low (totaling 27.2%, in Site A 14.5%, Site B 61.5%, Site C 11.8%, Site D 9.1%).

Discussion

In our study, we found that the management and treatment of bronchiolitis differs between the studied centers. When analyzing the management of inpatients with bronchiolitis,

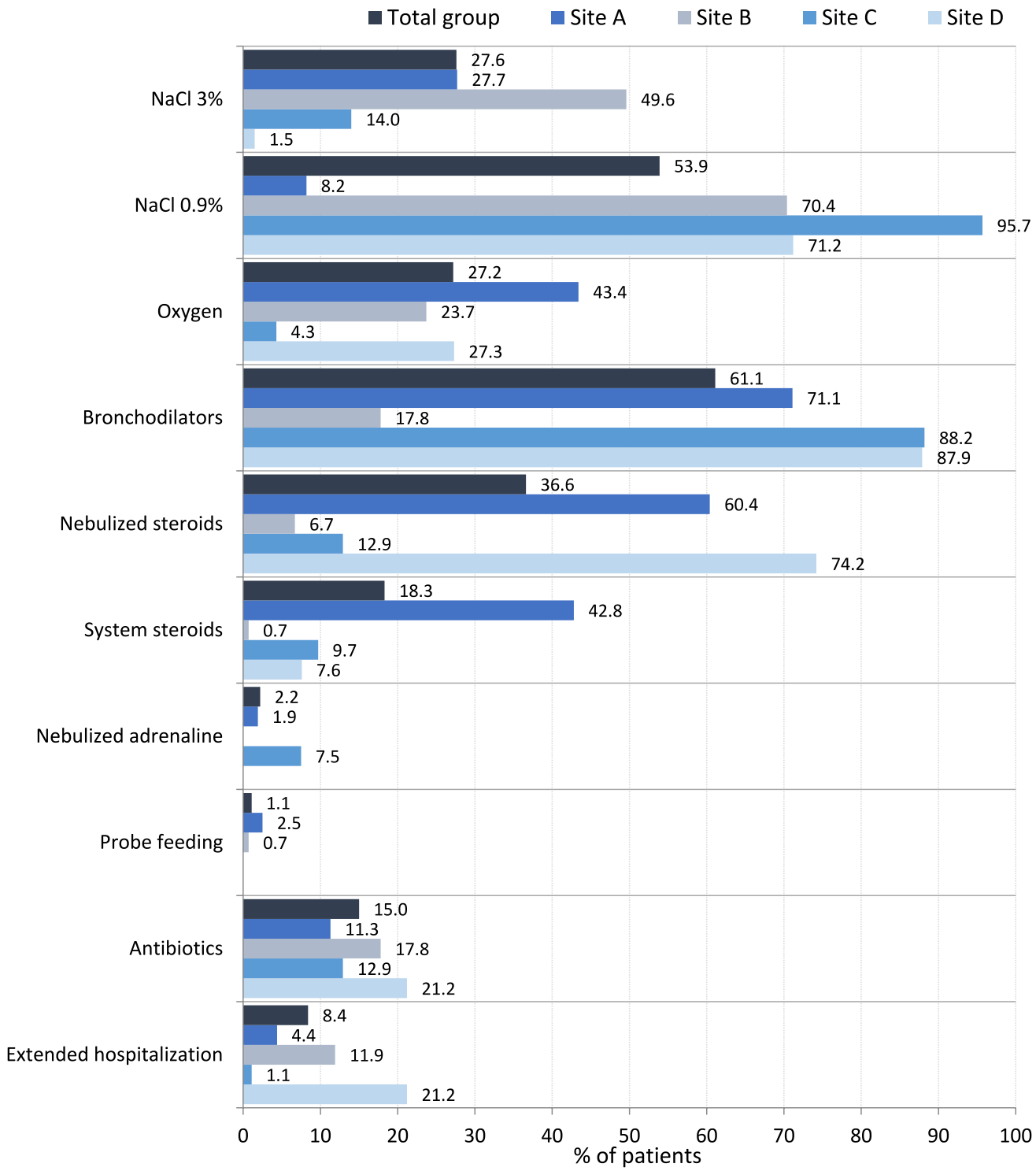

Fig. 4 Proportion of patients < 12 months with selected treatments for total group and centers during hospitalization

we relied on the current guidelines, which emphasize the lack of a need to perform tests when making a diagnosis, as well as supportive treatment with oxygenation and nutrition.

One of the problems while bronchiolitis analyzing is the lack of one, coherent, worldwide definition. The diversity among definitions concerns age (< 12 months or < 24), the presence of auscultation findings (rales—crackles with or without wheezing), and first or subsequent episodes. There are distinct phenotypes of bronchiolitis [17] and there is an ongoing discussion about the need to introduce a new

definition [2]. Due to the age difference in global recommendations, we decided to analyze the data both in the group of children up to 12 and 24 months of age.In the treatment of bronchiolitis, the guideline-based procedure was applied only in 30% of inpatients, with a significant difference being observed between sites. Not considering the site where the recommendations were followed in more than 60% of cases, in other hospitals, guideline-recommended treatments were implemented only in 10% of patients; most commonly, bronchodilators and nebulized steroids were overused.

Instances of not following guidelines have been described in the previous studies; however, there are differences between countries in the type of inappropriate treatment used. Based on research conducted in Canada and Finland, nebulized epinephrine is overused, while in the United States and Italy, it is bronchodilators that are overused [1–5]. Despite this, there is a decrease in the use of unnecessary diagnostic and therapeutic interventions, which is related to the updated guidelines [11]. The implementation of guidelines for bronchiolitis diagnosis and management helps change physicians' behavior toward evidence-based practices [18].

Our study indicates the need to find methods that can improve adherence to the guidelines. The review of published studies indicated the involvement of all staff treating bronchiolitis patients participated in the preparation and implementation of local guidelines gave the best results [19]. In Australia and New Zealand, tools such as: site-based clinical leads, stakeholder meetings, a train-the-trainer workshop, targeted educational delivery, other educational and promotional materials, and audit were used to indicate the guidelines. The achieved compliance was 85% [20]. Considering that the last Polish guidelines were published in 2016 and differ from the latest international recommendations, we believe that they require updating. In Poland there is no nationwide system for implementing recommendations. Cooperation of clinicians could have a positive impact on their implementation.

The strengths of our study are the fact that it is a multiseason and multicenter cohort of inpatient children with bronchiolitis.

During data collection, factors of the severe course of the infection that may influence the management were identified. Our study has several limitations. The major is the retrospective character of the review. This study does depend on data being collected from medical records. The collected data does not provide detailed information about each patient, which makes it impossible to relate the severity of the disease to the assessed treatment. This may also contribute to differences in diagnoses between centers, especially among children under 12 months of age. Retrospectively, we cannot check whether, in some centers, bronchiolitis was not ultimately diagnosed as viral pneumonia as a result of the changes described in the X-ray, which is overused. The relatively small number of children with bronchiolitis among the children in Site D and the lower number of X-rays performed in that site may indicate such a practice. Additionally, some of the information was unable to be recalled; for example, it was not possible to check if the administration of a bronchodilator was associated with a history of atopy in the child or asthma in the family. The difference between medical centers in relation to the percentage of children with previous episodes of dyspnea and bronchiolitis hospitalization can occur because of the lack of common bronchiolitis definition. Secondly our population included only patients treated in 4 hospitals, therefore our results cannot be generalized to the other care settings, thus further multicenter analyses are needed to confirm our results.

Based on the study we cannot explain why the recommendations are not followed. Our main conclusion is the necessity to develop a system for introducing recommendations to help healthcare providers follow the guidelines.

Conclusion

In total, 70% of infants that were hospitalized in four hospitals in Poland underwent examinations and treatments that are not supported by current guidelines and evidence-based research, and non-recommended medications are overused in the treatment of bronchiolitis. Differences between centers indicate that the treatment used is based on local customs and the individual preferences of physicians. This study shows the need to take action to implement the guidelines into clinicians' work.

Authors' contribution HS conceptualized the study. SS developed the first draft of the manuscript. HS, SS, and AB contributed to the development of the study protocol. HS, SS, AB, KBC, EWS, FK, KK, JSK, DS, and PS participated in the collection of the data, were involved in the analyses or interpretation of the data, and approved the final draft of the manuscript.

Funding This study was fully funded by the Department of Paediatrics, St Hedwig of Silesia Hospital, Trzebnica, Poland.

Data availability No datasets were generated or analysed during the current study.

Declarations The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Ethics The study was conducted in accordance with the Declaration of Helsinki, and approved by Bioethics Committee of the Lower Silesia Medical Chamber in Wroclaw approved the study protocol (4/PNDR/2023).

Competing interest The authors declare no competing interests.

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