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Paper Accepted*

ISSN Online 2406-0895

Original Article / Оригинални рад

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The effects of complications and comorbidities on physical therapy duration in children with pneumonia

Утицај компликација и коморбидитета на трајање физикалне терапије код деце са пнеумонијом

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Received: June 27, 2023
Revised: October 15, 2023
Accepted: October 16, 2023
Online First: November 8, 2023
DOI: https://doi.org/10.2298/SARH230627097M

*__Accepted papers__ are articles in press that have gone through due peer review process and have been accepted for publication by the Editorial Board of the *Serbian Archives of Medicine*. They have not yet been copy-edited and/or formatted in the publication house style, and the text may be changed before the final publication.
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SUMMARY

Introduction/Objective Physical therapy aims to improve airway clearance, breathing and enhance gas exchange. It is widely used as an additional therapy in children with pneumonia. The aim of this study was to assess the effects of complications and comorbidities on physical therapy duration in children with pneumonia.

Methods We conducted a retrospective descriptive study including 40 children with pneumonia admitted to a tertiary children hospital. Study participants were divided into two groups, group with and without complications and group with and without comorbidities. All children received physical therapy one time daily five days a week plus standard treatment for pneumonia. Physical therapy procedures that were applied were chest physical therapy and kinesiotherapy.

Results Chest physical therapy ($p < 0.001$) and kinesiotherapy ($p = 0.024$) were applied significantly longer in group with complications versus those without complications. Chest physical therapy was applied significantly longer in group with comorbidities versus group without comorbidities ($p < 0.001$), while there was no difference regarding duration of kinesiotherapy in group with and without comorbidities ($p = 0.239$).

Conclusion Our results show that the presence of complications and/or comorbidities significantly prolongs the duration of chest physical therapy in children with pneumonia.

Keywords: children; pneumonia; physical therapy

САЖЕТАК

Увод/Циљ Физикална терапија има за циљ да побољша муко-цилијарни клиренс дисајних путева, дисање и размену гасова. Често се користи као додатна терапија у лечењу деце са пнеумонијом. Циљ овог истраживања био је да се процени утицај компликација и коморбидитета на трајање физикалне терапије код деце са пнеумонијом.

Методе Ова ретроспективна дескриптивна студија је обухватила 40 деце са пнеумонијом која су лечена у терцијарној болници. Испитаници су били подељени у две групе, у групу са и без компликација и у групу са и без коморбидитета. Код све деце физикална терапија је примењивана једном дневно, пет дана у недељи уз стандардну терапију за лечење пнеумоније. Програм физикалне терапије је подразумевао респираторну рехабилитацију и кинезитерапију.

Резултати У групи испитаника са компликацијама у односу на испитанике без компликација значајно дуже су примењиване респираторна рехабилитација ($p < 0,001$) и кинезитерапија ($p = 0,024$). Такође, респираторна рехабилитација примењивана је значајно дуже у групи испитаника са коморбидитетима у односу на испитанике без коморбидитета ($p < 0,001$). Разлика у дужини кинезитерапије између ове две групе испитаника није утврђена ($p = 0,239$).

Закључак Наши резултати показују да присуство компликација и/или коморбидитета значајно повећавају трајање респираторне рехабилитације код деце са пнеумонијом.

Кључне речи: деца; пнеумонија; физикална терапија

INTRODUCTION

Community-acquired pneumonia is an acute disease caused by an infection of the lung parenchyma acquired outside of a hospital setting [1]. Childhood pneumonia is still a significant clinical and public health problem and one of the leading causes of morbidity in children [2, 3]. Physical therapy is widely used as additional therapy in children with pneumonia. Currently in clinical practice different physical therapy techniques are available that aim to improve evacuation of inflammatory exudates and tracheobronchial secretions, remove airway obstruction, decrease airway resistance, improve gas exchange and reverse pathological progression [4, 5]. However, strong scientific evidence is missing to support those

beneficial effects in children with pneumonia and lack of data showing that physical therapy may contribute to patients' recovery. Authors of systematic review have concluded that there was insufficient evidence to make a clear recommendation for clinical practice and consequently reject or accept chest physical therapy as a standard treatment option in children with pneumonia [6]. However, to our knowledge, there are no studies investigating the effects of complications and comorbidities on physical therapy duration in this population. Therefore, the primary aim of this study was to assess the effects of complications and comorbidities on physical therapy duration in children with pneumonia. Additionally, we wanted to evaluate treatment outcome in study group regarding presence of complications and comorbidities.

METHODS

The study was based on a sample of 40 children (22 male and 18 female, mean age 34.5 ± 18.5 months, range 1 month to 10 years) hospitalized due pneumonia. Pneumonia was defined as the presence of fever, acute respiratory symptoms (cough, tachypnoea, difficult breathing) or both, plus presence of new infiltrate on chest radiography or consolidation not attributable to some other etiology [7]. Exclusion criteria were severe concomitant disease (chronic pulmonary disease, cerebral palsy, immune deficiency), hemodynamic instability, chest drain, bone fragility or rib fractures [4]. The study was approved by Ethics Committee of University Children's Hospital in Belgrade (number 017 16/53).

Out of 40 children with pneumonia, 17 had complications. The most common complications were pleural effusion in 12 children, empyema in 3 children and necrotizing pneumonia in 2 children. Among 40 children with pneumonia, comorbidities were present in 10 children. Five children had congenital heart defects, 2 had repaired esophageal atresia with tracheoesophageal fistula and 1 child had epilepsy, celiac disease and Hirschsprung disease.

All children received physical therapy one time daily with standard treatment for pneumonia (antibiotic therapy, fluid therapy and oxygen, if needed, administered by the attending pediatrician) until discharge. Regarding physical therapy procedures, two modes were evaluated: chest physical therapy and kinesiotherapy. Each session of physical therapy was about 30 minutes and consisted of postural drainage, thoracic squeezing, chest percussion, vibration, cough stimulation, aspiration of secretions (if needed) and kinesiotherapy [4, 8]. The positions for postural drainage were directed by the chest radiograph to provide more effective drainage of secretions and exudates from the most affected areas [4, 8]. The decision to

discharge from hospital was made by the attending pediatrician. Regarding treatment outcome two categories were assessed: discharge and prolonged hospitalization. Prolonged hospitalizations in this study were defined as those lasting 14 days or longer.

Statistical analysis

Results were presented as whole numbers (N) and percentages (%), while continuous values were presented as mean values (MV) with standard deviation (SD). Student's t-test and Mann-Whitney U test were used to compare continuous variables depending on the normality of distribution, and Chi-square test or Fishers exact test were used for categorical variables. Spearman rank correlation was used to measure the degree of association between the presence and number of complications or comorbidities and the duration of physical therapy. A value of $p < 0.05$ was considered as statistically significant.

RESULTS

In group of children with complications, chest physical therapy ($p < 0.001$) and kinesiotherapy ($p = 0.024$) were applied significantly longer compared to children without complications (Table 1). Moreover, it was shown that chest physical therapy was applied significantly longer in the group of children with pleural effusion compared to children without pleural effusion ($p < 0.001$), whereas there was no difference regarding duration of kinesiotherapy in children with and without pleural effusion ($p = 0.428$) (Table 1).

In group of children with comorbidities chest physical therapy was applied significantly longer compared to children without comorbidities ($p < 0.001$) while there was no difference regarding duration of kinesiotherapy in children with and without comorbidities ($p = 0.239$) (Table 2).

In addition, when we analyzed patients who had comorbidities and complications, we noticed that in those children both chest physical therapy ($p < 0.001$) and kinesiotherapy ($p = 0.038$) were applied significantly longer compared to children without comorbidities and complications (Table 3).

There was statistically significant correlation between the presence and number of complications and the duration of chest physical therapy ($p < 0.001$) as well as with duration of kinesiotherapy ($p < 0.001$) (Table 4). Furthermore, there was statistically significant

correlation between the presence and number of comorbidities and the duration of chest physical therapy ($p < 0.001$), while no statistically significant correlation between the presence and number of comorbidities and the duration of kinesiotherapy ($p = 0.229$) was found (Table 4). Moreover, there was statistically significant correlation between the presence of comorbidities and complications and the duration of chest physical therapy ($p < 0.001$) as well as with the duration of kinesiotherapy ($p = 0.008$) (Table 4).

More than half of tested patients with complications had prolonged hospitalization (58.8%), while none of those without complications had prolonged hospitalization (0%). Regarding comorbidities, also more than have of children with comorbidities (60%), had prolonged hospitalization while only 13.3% of those without comorbidities had prolonged hospitalization. Patients with complications and comorbidities had highest proportion of prolonged hospitalization (75%), while none of those without complications and comorbidities had prolonged hospitalization (0%) (Table 5).

DISCUSSION

In this study we assessed the application of physiotherapy in children with pneumonia. There are very few studies of physical therapy in children with pneumonia and the results of those studies are controversial. The randomized trial from Brazil found that chest physical therapy as supplementary to standard treatment did not hasten the clinical resolution of children hospitalized with acute pneumonia and that physical therapy may prolong duration of coughing and rhonchi [9]. Another randomized study from Brazil demonstrated that the chest physical therapy had no beneficial effects in children hospitalized with community-acquired pneumonia [10]. On the contrary, the authors in a more recent study from Egypt concluded that chest physical therapy showed significant improvements in children hospitalized with pneumonia. They reported that children treated with standard treatment for pneumonia and chest physical therapy had shorter time to clinical resolution and greater improvement in respiratory rate and arterial oxygen saturation compared to children treated with standard treatment for pneumonia alone without chest physical therapy [11]. Moreover, the authors from Portugal studying adult outpatients with lower respiratory tract infections, recently found that adding respiratory physical therapy to the pharmacological treatment results in greater recovery of symptoms and function parameters [12]. Given the observations of above-mentioned studies it should be pointed out that physical therapy particularly chest physical therapy in patients with pneumonia

could lead to elimination and reduction of mucus in lung airways [13] thus affecting recovery and prevention onset and further deterioration of present complications.

Bearing in mind that pediatric population consists of very young infant up to the patients 18 years of age, modifications to physical therapy procedures are applied [13]. Susan and al. pointed out that chest physical therapy used in infants was associated with improved oxygenation and secretion clearance and improvement in respiration and chest sound [14]. Furthermore, Leelarungrayub et al. reported that chest physical therapy possibly reduces oxidative stress and enhance oxygenation status in infants with pneumonia [15]. These findings clearly demonstrate the importance of chest physical therapy in children particularly infants with pneumonia.

According to the literature, there is still a lack of scientific evidence to make a clear, justified recommendation for the clinical practice, supporting or refusing physical therapy in children or adults with pneumonia. Authors of recent systematic review on chest physical therapy in children with pneumonia emphasized that no reliable conclusions can be drawn concerning the use of chest physical therapy for children with pneumonia due to the small number of included trials with differing study characteristics and statistical presentation of data [16]. Moreover, recently concluded systematic review stressed that current evidence was very uncertain about the beneficial effect of chest physical therapy in adults with pneumonia [17].

To our knowledge, this is the first study to present effects of complications and comorbidities on physical therapy duration in children with pneumonia. Our results showed that among children with pneumonia those with additional complications had significantly longer chest physical therapy and kinesiotherapy than those without complications. Another important finding in our study is that we observed statistically significant correlation between the presence and number of complications and the duration of chest physical therapy and duration of kinesiotherapy procedures. This is expected since the one with complications should be treated longer to gain improvement and complications resolution. Additionally, we found that children with complicated pneumonia more often had prolonged hospitalization, which is in agreement with data in literature [18, 19].

Furthermore, children with comorbidities, had significantly longer chest physical therapy versus those without comorbidities, while there was no difference regarding duration of kinesiotherapy. Moreover, there was statistically significant correlation only between the presence and number of comorbidities and duration of chest physical therapy. These findings demonstrate that the role of chest physical therapy is important in children with pneumonia and

additional comorbidities, and this is further supported by the findings that comorbidities alone or with complications are significantly more frequent in the one with prolonged hospitalizations. On the contrary authors from Brazil did not find longer hospital stays in children with community-acquired pneumonia and comorbidities [20].

However, it should be considered that the results in our study might be influenced by the fact that evaluated group of patients were presenting to a tertiary medical facility – university children's hospital, therefore patients with more severe infections may have been overrepresented, of which some could affect the production and elimination of secretions.

The present study has some limitations that should be considered in the analysis and interpretation of the results. First, the study-design included retrospective collection of information. We did not have a control group due to ethical reasons, considering that respiratory physical therapy is often prescribed in children with pneumonia in our institution. Besides, the prolonged hospitalization was used as an endpoint in this study, although it is known that the decision about the duration of hospitalization varies among doctors and hospitals (10). However, our study was conducted at a single institution therefore that the doctor/facility profiles were unlikely to have biased length of hospitalization.

CONCLUSION

Our results suggest that the presence of complications and/or comorbidities significantly prolongs the duration of chest physical therapy and prolongs hospitalization in children with pneumonia.

ACKNOWLEDGEMENT

The results in this study are part of the subspecialty thesis in Pulmonology by Dr. Olivera Ćalović, which was completed in 2022 at the Faculty of Medicine in Belgrade.

Calovic O. Effects of acute rehabilitation on treatment outcome in children with pneumonia. [Subspecialty thesis]. Belgrade: Faculty of Medicine; 2022.

Conflict of interest: None declared.

REFERENCES

1. Aliberti S, Dela Cruz CS, Amati F, Sotgiu G, Restrepo MI. Community-acquired pneumonia. Lancet 2021; 398(10303):906-19. [DOI: 10.1016/S0140-6736(21)00630-9] [PMID: 34481570]
2. Yadav KK, Awasthi C. Childhood Pneumonia: What's Unchanged, and What's New? Indian J Pediatr 2023; 90(7):693–9. [DOI: 10.1007/s12098-023-04628-3] [PMID: 37204597]
3. Meganathan P, Awasthi S. Predicting Complicated Parapneumonic Effusion in Community Acquired Pneumonia: Hospital Based Case-Control Study. Indian J Pediatr 2019;86(2):140–7. [DOI: 10.1007/s12098-018-2769-y] [PMID: 30182278**]**
4. Balachandran A, Shivbalan S, Thangavelu S. Chest physiotherapy in pediatric practice. Indian Pediatr. 2005;42(6):559–68. [PMID: 15995272]
5. Sharma N, Chahal A, Sharma A. Chest Physiotherapy Interventions for Children During SARS-COV-2 Pandemic. Clin Pediatr 2023;26:99228231169892. [DOI: 10.1177/00099228231169892] [PMID: 37098728]
6. Chaves G, Fregonezi G A, Dias F A, Ribeiro C, Guerra R , Freitas D et al et al. Chest physiotherapy for pneumonia in children. Cochrane Database Syst Rev. 2013;20(9):CD010277. [DOI: 10.1002/14651858.CD010277.pub2] [PMID: 24057988]
7. McIntosh K: Community-acquired pneumonia in children. N Engl J Med 2002;346(6):429-37. [DOI: 10.1056/NEJMra011994] [PMID: 11832532]
8. Levine A. Chest physical therapy for children with pneumonia. J Am Osteopath Assoc. 1978;78(2):122–5. [PMID: 361656]
9. Paludo C, Zhang L, Lincho CS, et al. Lemos DV, Real GG, Bergamin JA. Chest physical therapy for children hospitalized with acute pneumonia: a randomized controlled trial. Thorax. 2008;63(9):791-4. [DOI: 10.1136/thx.2007.088195] [PMID: 18276723]
10. Lukrafka LL, Sandra C F, Fischer GB, Flores AJ, Fachel JM, Castro-Rodriguez JA. Chest physiotherapy in pediatric patients hospitalized with community-acquired pneumonia: a randomized clinical trial. Arch Dis Child. 2012;97(11):967-71. [DOI: 10.1136/archdischild-2012-302279] [PMID: 23000693].
11. Abdelbasset W K M, Elnegamy T E H. Effect of Chest Physical Therapy on Pediatrics Hospitalized With Pneumonia. IJHRS. 2015;4(4):219-26. [DOI: 10.5455/ijhrs.000000095].
12. Marquesa A, Pinhoa C, De Francesco S, Martins P, Neves J, Oliveira A. A randomized controlled trial of respiratory physiotherapy in lower respiratory tract infections. Respir Med. 2020;162:105861. [DOI: 10.1016/j.rmed.2019.105861] [PMID: 31916533]
13. Wright S, Wakeman R, Collins N, Chatwin M. Physical therapies in pediatric respiratory disease. In: Wilmott RW, Deterding R, Li A, Ratjen F, Sly P, Zar HJ, Bush A, editors. Kendig's Disorders of the Respiratory Tract in Children, 9th edition. Amsterdam: Elsevier; 2019. pp. 273-288.e3.
14. Susan R, Hintz MD. Therapeutic techniques chest physiotherapy in the neonates Neoreviews. 2004;5(12):534- 5. [10.1542/neo.5-12-e534]
15. Leelarungrayub J, Borisuthibandit T, Yankai A, Boontha K. Changes in oxidative stress from tracheal aspirates sampled during chest physical therapy in hospitalized intubated infant patients with pneumonia and secretion retention. Ther Clin Risk Manag. 2016;12:1377–86. [DOI: 10.2147/TCRM.S112972] [PMID: 27660455]
16. Chaves GS, Freitas DA, Santino TA, Nogueira PA, Af Fregonezi G, Mendonça K. Chest physiotherapy for pneumonia in children. Cochrane Database Syst Rev. 2019;1(1):CD010277. [DOI: 10.1002/14651858.CD010277.pub3] [PMID: 30601584]
17. Chen X, Jiang J, Wang R, Fu H, Lu J, Yang M. Chest physiotherapy for pneumonia in adults. Cochrane Database Syst Rev. 2022;9(9):CD006338. [DOI: 10.1002/14651858.CD006338.pub4] [PMID: 36066373]
18. Masarweh K, Gur M, Toukan Y, Bar-Yoseph R, Kassis I, Gut G et al. Factors associated with complicated pneumonia in children. Pediatr Pulmonol 2021;56(8):2700-6. [DOI: 10.1002/ppul.25468] [PMID: 33991059]
19. Caroline J G, Porter J J, Lipsett S C, Monuteaux M C, Hirsch A W, Neuman I M. Variation in Management and Outcomes of Children With Complicated Pneumonia. Hosp Pediatr 2021;11(3):207-14. [DOI: 10.1542/hpeds.2020-001800] [PMID: 33579749]
20. Aurilioa R B, Sant'Annaa C C, Bazhuni Pombo March M F. Clinical profile of children with and without comorbidities hospitalized with community-acquired pneumonia. Rev Paul Pediatr 2020;38:e2018333. [DOI: 10.1590/1984-0462/2020/38/2018333] [PMID: 32401948]

Table 1. Duration of physical therapy procedures with regards to the presence of complications and pleural effusion

Tested parameters		**Group with complications/ pleural effusion**	**Group without complications/ pleural effusion**	**p**
Complications	Chest physical therapy (MV ± SD), days	11.82 ± 5.71	4.39 ± 1.64	< 0.001*
	Kinesiotherapy (MV ± SD), days	10.13 ± 6.26	4 ± 2.55	0.024*
Pleural effusion	Chest physical therapy (MV ± SD), days	10.83 ± 5.71	6.14 ± 5.6	< 0.001**
	Kinesiotherapy (MV ± SD), days	8.91 ± 5.49	8.4 ± 7.11	0.428*

MV – mean value; SD – standard deviation;

*Student's t-test;

**Mann–Whitney U test

Table 2. Duration of physical therapy procedures with regard to the presence of comorbidities

Tested parameters		Group with comorbidities	Group without comorbidities	p
Comorbidities	Chest physical therapy (MV ± SD), days	11.4 ± 6.1	6.27 ± 4.51	< 0.001*
	Kinesiotherapy (MV ± SD), days	9.7 ± 6.18	7.73 ± 6.26	0.239**

MV – mean value; SD – standard deviation;

*Mann–Whitney U test;

**Students t-test

Table 3. Duration of physical therapy procedures with regard to the presence of complications and comorbidities

Tested parameters		Group with complications and comorbidities	Group without complications and comorbidities	p
Complications and comorbidities	Chest physical therapy (MV ± SD), days	12.63 ± 6.21	4.19 ± 1.50	< 0.001*
	Kinesiotherapy (MV ± SD), days	10.75 ± 6.41	3 ± 1.73	0.038*

Table 4. Correlations between duration of physical therapy modes and presence and number of complications and comorbidities

Tested parameters		Duration of physical therapy	
		r	p
Presence and number of complications	Chest physical therapy	0.827	< 0.001
	Kinesiotherapy	0.673	< 0.001
Presence and number of comorbidities	Chest physical therapy	0.522	< 0.001
	Kinesiotherapy	0.274	0.229
Presence and number of complications and comorbidities	Chest physical therapy	0.781	< 0.001
	Kinesiotherapy	0.746	0.008

r – correlation coefficient

Table 5. Treatment outcome in tested patients regarding presence of complications and comorbidities

Presence of complications and/or comorbidities	Treatment outcome	Patients		p
		N	(%)	
Complications				
Yes	Discharge	7	41.2	< 0.001*
	Prolonged hospitalization	10	58.8	
No	Discharge	23	100	
	Prolonged hospitalization	0	0	
Comorbidities				
Yes	Discharge	4	40	0.007**
	Prolonged hospitalization	6	60	
No	Discharge	26	86.7	
	Prolonged hospitalization	4	13.3	
Complications and comorbidities				
Yes	Discharge	2	25	< 0.001**
	Prolonged hospitalization	6	75	
No	Discharge	21	100	
	Prolonged hospitalization	0	0	

*χ^2 test;

**Fisher's exact test

