JOUR UMRANIYE PEDIATR
2024;4(3):102–107 doi: 10.14744/upd.2025.29290

ORIGINAL RESEARCH
Pediatric Allergy and Immunology

Clinical evaluation and determinants of hospital stay in children with parapneumonic effusion

Cansu Yılmaz Yeğit,[1] Esin Yıldız Aldemir,[2] Özge Kaba,[3] Mehmet Yazıcı,[4] Mustafa Eres,[1] Mehmet Arda Kılınç,[5] Melis Deniz,[3] Ahmet Baş,[4] Füsun Ünal,[1] Fatma Saraç,[4] Nurhayat Yakut,[3] Canan Caymaz[3]

[1]Department of Pediatric Pulmonology, Başakşehir Çam ve Sakura City Hospital, İstanbul, Türkiye
[2]Department of Pediatrics, Başakşehir Çam ve Sakura City Hospital, İstanbul, Türkiye
[3]Department of Pediatric Infectious Diseases, Başakşehir Çam ve Sakura City Hospital, İstanbul, Türkiye
[4]Department of Pediatric Surgery, Başakşehir Çam ve Sakura City Hospital, İstanbul, Türkiye
[5]Department of Pediatric Intensive Care, Başakşehir Çam ve Sakura City Hospital, İstanbul, Türkiye

ABSTRACT

Objective: Parapneumonic effusion is one of the most common complications of pneumonia in children. In this study, we aimed to address uncertainties by retrospectively analyzing our cohort of pediatric patients with parapneumonic effusion.

Material and Methods: The study included 61 patients hospitalized due to parapneumonic pleural effusion. Demographic and clinical characteristics, treatment modalities, short-term clinical outcomes, and factors affecting the length of hospitalization were also evaluated.

Results: The median age of the patients was 8 years (25–75th percentile: 5–14 years), and 54.1% (n=33) were male. Thoracentesis was performed in 55.7% (n=34) of the patients, while tube thoracostomy was performed in 45.9% (n=28). Ten patients (16.4%) underwent video-assisted thoracoscopic surgery (VATS). Age, sex, and culture results were not associated with the length of hospital stay, whereas the presence of septa, empyema, and the need for VATS were found to be associated with prolonged hospitalization.

Conclusion: Early recognition and management of septated effusions and empyema are essential to prevent long-term sequelae. Delayed treatment may lead to prolonged hospitalization and higher rates of invasive interventions.

Keywords: Empyema; parapneumonic effusion; thoracoscopy.

Cite this article as: Yılmaz Yeğit C, Aldemir EY, Kaba Ö, Yazıcı M, Eres M, Kılınç MA, et al. Clinical evaluation and determinants of hospital stay in children with parapneumonic effusion. Jour Umraniye Pediatr 2024;4(3):102–107.

Received (Başvuru): 19.02.2025 **Revised (Revizyon):** 02.03.2025 **Accepted (Kabul):** 02.03.2025 **Online (Online yayınlanma):** 04.03.2025

Correspondence (İletişim): Dr. Cansu Yılmaz Yeğit. Başakşehir Çam ve Sakura Şehir Hastanesi, Pediatrik Göğüs Hastalıkları Kliniği, İstanbul, Türkiye.
Phone (Tel): +90 212 909 60 60 **e-mail (e-posta):** cansuuuuyilmaz@gmail.com

Parapnömonik efüzyonu olan çocuklarda klinik değerlendirme ve hastane yatış süresine etki eden faktörlerin değerlendirilmesi

ÖZET

Amaç: Parapnömonik efüzyon, çocuklarda pnömoninin en sık görülen komplikasyonlarından biridir. Bu çalışmada, parapnömonik efüzyonu olan pediatrik hasta kohortumuzu retrospektif olarak analiz ederek mevcut belirsizlikleri ele almayı amaçladık.

Gereç ve Yöntemler: Çalışmaya, parapnömonik plevral efüzyon nedeniyle hastaneye yatırılan 61 hasta dâhil edildi. Hastaların demografik ve klinik özellikleri, tedavi yaklaşımları, kısa dönem klinik sonuçları ve hastanede kalış süresini etkileyen faktörler değerlendirildi.

Bulgular: Hastaların medyan yaşı 8 yıl (25–75. persentil: 5–14 yıl) olup %54,1'i (n=33) erkekti. Hastaların %55,7'sine (n=34) torasentez, %45,9'una (n=28) tüp torakostomi uygulandı. On hastaya (%16,4) video aracılı torakoskopik cerrahi (VATS) yapıldı. Yaş, cinsiyet ve kültür sonuçları hastanede kalış süresiyle ilişkili bulunmazken; septalı efüzyon varlığı, ampiyem ve VATS gereksinimi uzun süreli hastanede yatış ile ilişkiliydi.

Tartışma: Septalı efüzyonların ve ampiyem ile uyumlu efüzyonların erken tanı ve tedavisi, uzun dönem sekellerin önlenmesi açısından önemlidir. Gecikmiş tedavi, hastanede kalış süresinin uzamasına ve daha fazla invaziv girişim ihtiyacına yol açabilir.

Anahtar Kelimeler: Ampiyem; parapnömonik efüzyon; torakoskopi.

ORCID ID

CYY: 0000-0001-8239-4776; EYA: 0000-0001-6141-7940; ÖK: 0000-0002-8381-3255; MY: 0000-0003-4621-9836; ME: 0000-0001-8850-7153; MAK: 0000-0001-9121-2188; MD: 0000-0002-9740-4196; AB: 0000-0003-2612-9198; FÜ: 0000-0002-2796-2694; FS: 0000-0003-0894-7787; NY: 0000-0002-6383-0568; CC: 0000-0003-0990-7904

[1]Başakşehir Çam ve Sakura Şehir Hastanesi, Pediatrik Göğüs Hastalıkları Kliniği, İstanbul, Türkiye
[2]Başakşehir Çam ve Sakura Şehir Hastanesi, Çocuk Sağlığı ve Hastalıkları Kliniği, İstanbul, Türkiye
[3]Başakşehir Çam ve Sakura Şehir Hastanesi, Çocuk Enfeksiyon Hastalıkları Kliniği, İstanbul, Türkiye
[4]Başakşehir Çam ve Sakura Şehir Hastanesi, Çocuk Cerrahisi Kliniği, İstanbul, Türkiye
[5]Başakşehir Çam ve Sakura Şehir Hastanesi, Çocuk Yoğun Bakım Kliniği, İstanbul, Türkiye

INTRODUCTION

Parapneumonic effusion is a common complication of pneumonia in children, occurring in 2%–12% of cases and up to 28% in hospitalized patients. It results from increased pleural permeability due to inflammation, and bacterial invasion can lead to empyema with pus formation (1, 2). While symptoms resemble pneumonia, pleuritic pain, abdominal pain, dyspnea, and cough are more prominent (1). Identifying the causative pathogen is often challenging due to previous oral antibiotic treatment, which can impact culture positivity (2). In advanced stages, pleural thickening, loculations, and complications such as bronchopleural fistula or abscess formation may develop (2).

The primary goals of treatment are to eliminate the microbial agent, sterilize the pleural fluid, and facilitate lung re-expansion to restore normal lung capacity. Hospitalization is recommended for children with parapneumonic effusion (3). Key treatment options include antibiotic therapy, drainage via tube thoracostomy, fibrinolytic therapy for septation clearance, debridement through video-assisted thoracoscopic surgery (VATS), and, rarely, thoracotomy with decortication (3). Numerous studies have investigated the optimal treatment regimen, therapeutic algorithm, and duration. The current literature presents varying data regarding the appropriate stage for effusion drainage, the comparative efficacy of surgical versus non-surgical management, and their impact on clinical outcomes (4, 5).

This study aims to address factors associated with longer hospital stay and clinical outcomes of treatment modalities by retrospectively analyzing our cohort of pediatric patients with parapneumonic effusion and empyema. By exploring the clinical and demographic characteristics of this patient group, as well as their treatment responses, we hope to provide deeper insights into the management strategies and outcomes associated with this challenging condition. Additionally, we aim to identify factors influencing the length of hospital stay, such as patient characteristics, comorbidities, pleural fluid results, and treatment modalities, which may help predict high-risk patients and allow for earlier interventions and better monitoring to potentially shorten hospitalization and improve outcomes.

MATERIALS AND METHODS

This study was conducted as a retrospective cohort study, including patients who were hospitalized due to parapneumonic effusions between July 2022 and December 2024. Patients with effusions caused by other factors, such as malignancy, rheumatological diseases, chylothorax, or heart failure, were excluded. Patients with hospital-acquired pneumonia were excluded to minimize heterogeneity and potential confounders,

as they often have distinct pathogens, antibiotic resistance patterns, and comorbidities, allowing for a more homogeneous cohort. Clinical and demographic characteristics, treatment modalities, treatment responses, length of hospitalization, and complications were retrospectively recorded from the patients' medical records.

The treatment approach was primarily determined based on the patient's clinical findings and response to therapy. Patients were managed with antibiotics if the effusion was <2 cm, there was no accompanying respiratory distress, and fever resolved within 48 hours. Diagnostic thoracentesis was performed in cases with accompanying mediastinal lymphadenopathy, hepatosplenomegaly, tuberculosis exposure, or clinical suspicion of a disease other than pneumonia. Tube thoracostomy was performed if fever persisted despite antibiotic therapy, if there was respiratory distress, or if the effusion was >2 cm. In cases with no clinical improvement (persistent fever or lack of lung expansion on imaging), intrapleural fibrinolytic therapy or VATS was performed at the clinician's discretion. During or after VATS, if deemed necessary by the surgeon in complicated or severe cases, conversion to thoracotomy was performed.

Ethical approval was obtained with the approval number 2024–149. The study was conducted in accordance with the principles of the Declaration of Helsinki. Informed consents were obtained from the parents of the patients.

Statistical Analysis

Statistical analysis was performed with The Statistical Package for the Social Sciences (SPSS) version 20.0 for Windows (IBM Corp., Armonk, NY, USA). Normality was assessed using normality plots and the Kolmogorov-Smirnov test. Continuous variables with normal distribution were presented as mean±standard deviation, and data with non-normal distribution were presented as median and 25–75th percentiles. The association between categorical variables was investigated using the chi-square test. Continuous variables for two independent groups with non-normal distribution were assessed through the Mann-Whitney U test. Spearman's ρ was used for correlation analysis. Data were presented with 95% confidence intervals, and the significance level was set at a p-value<0.05.

RESULTS

The study included 61 patients who were hospitalized due to parapneumonic effusions between July 2022 and December 2024. The median age of the patients was 8 years (25–75th percentile: 5–14 years), while 54.1% (n=33) of the patients were male. A total of 73.8% (n=45) of the patients were older than 5 years, while only 11.5% (n=7) were younger than 2 years. Additionally, 24.6% of the patients (n=15) had underlying comorbidities. Fever was present in 85.2% (n=52), while cough was the most common symptom (93.4%, n=57). Hypoxia was present in 27.9% (n=17) of the patients at the time of hospital admission. Table 1 shows the demographic and clinical characteristics of the patients.

Table 1. Demographic and clinical characteristics of the patients (n=61)

	n	%
Age, years, Median (20–25th percentile)	8 (5–12)	
Sex		
Female	28	45.9
Male	33	54.1
Underlying comorbidities		
Neurological disease	6	9.8
Asthma	5	8.2
Genetic diseases (Down, Prader Willi)	2	3.3
Malignancy	1	1.6
Diabetes mellitus	1	1.6
Symptoms		
Cough	57	93.4
Fever	52	85.2
Chest pain	20	32.8
Stomach ache	12	19.7
Tacypnea	19	31.1

A total of 65.6% (n=40) of the patients had received oral antibiotherapy prior to hospitalization. All patients underwent chest X-ray, while ultrasonography and computed tomography were performed in 96.7% (n=59) and 72.1% (n=44) of the cases, respectively. Effusion was predominantly located on the right side in 52.5% (n=32) of the patients, while bilateral effusion was observed in 9.8% (n=6). The median size of the pleural effusion on the right side was 15 mm (IQR: 7.75–36 mm), and similarly, the median size of the pleural effusion on the left side was also 15 mm (IQR: 4–22 mm). Septation within the pleural effusion was present in 23% (n=14) of the patients.

Respiratory panels for respiratory pathogens (Polymerase Chain Reaction, PCR) were performed using nasal swabs in 37 patients. The PCR results were positive for *Streptococcus pneumoniae* in 13 patients, *Haemophilus influenzae* in 5 patients, *Mycoplasma pneumoniae* in 2 patients, and *S. pyogenes* in 1 patient with a history of chickenpox infection. The respiratory panel was positive for viral infections in 12 patients, with rhinovirus being the most common (n=4). In 32.8% (n=20) of the patients, the pleural fluid was consistent with empyema. The pleural fluid culture was sterile in 32 patients, while *H. influenzae* was isolated from the pleural fluid of one unvaccinated patient, and *S. pyogenes* was identified in another patient. No growth was detected in the blood cultures.

Anti-tuberculosis therapy was initiated in one patient due to suspected necrotizing granulomatous infection based on lung biopsy findings. Tuberculosis was diagnosed in three patients with positive interferon-gamma release assay test results, pleural fluid showing lymphocytic predominance and

Table 2. Factors influencing the lenght of hospital stay

	Hospitalisation Median (25–75th per)	p
Previous oral antibiotherapy		0.010
Yes, (n=40)	24.50 (14–41)	
No (n=21)	13 (7–27)	
Septa		0.001
Yes (n=14)	34 (27–43)	
No (n=46)	15 (10–26)	
Thoracentesis		<0.001
Yes (n=27)	34 (24–50)	
No n=34	12 (9–14)	
Empyema (n=20)		<0.001
Parapneumonic effusion (n=41)	14 (10–24)	
VATS		<0.001
Yes (n=10)	53.5 (35–50)	
No (n=51)	16 (11.5–20)	
Thoracotomy		<0.001
Yes (n=8)	53.50 (35–60)	
No (n=53)	16 (12–28)	

elevated pleural fluid adenosine deaminase (ADA) levels, and in one patient with a positive tuberculosis PCR in gastric aspirate. In total, tuberculosis was diagnosed in five patients (8.2% of all patients), and anti-tuberculosis treatment was started in all of them.

Thoracentesis was performed in 55.7% (n=34) of the patients, while tube thoracostomy was performed in 45.9% (n=28). Fibrinolytic therapy via tube thoracostomy was administered to 4 patients (6.6%). Ten patients (16.4%) underwent video-assisted thoracoscopic surgery (VATS). The median time from hospital admission to tube thoracostomy was 1 day (IQR: 1–2). Fibrinolytic therapy was initiated at a median of 4 days (IQR: 3.5–5.5), while VATS was performed at a median of 18 days (IQR: 9–20). Thoracotomy was required in 8 patients (13.1%), with a median timing of 20.5 days (IQR: 15–29). The median length of hospital stay was 22 days (IQR: 13–38).

There was no significant difference in the median length of hospitalization according to age, sex, comorbidity, side of effusion, or pleural fluid culture results. A moderate positive correlation was found between the size of the effusion and length of hospitalization (Spearman's rho=0.493, p=0.011). Longer hospital stays were significantly associated with previous oral antibiotic treatment, the presence of septa, thoracentesis, empyema, and the need for surgical interventions (VATS or thoracotomy) (p≤0.05 for all). Table 2 shows the factors that significantly affected hospital stay.

Complications were observed in 11 patients (18%), including bronchopleural fistula in 5 patients, necrotizing pneumonia-associated pneumatoceles in 2 patients, sequelae of atelectasis in 3 patients, and abscess formation in 1 patient. No mortality was observed in this cohort.

DISCUSSION

Parapneumonic effusions are common complications of respiratory infections in children and may cause increased morbidity and potential mortality (6). In this study, we retrospectively evaluated the demographic and clinical characteristics of parapneumonic effusion in children and analyzed factors influencing the duration of hospital stay. Empyema and septated effusions were found to be associated with prolonged hospitalization, requiring close follow-up, appropriate antibiotherapy, and timely management of invasive procedures, if needed.

In our study, there was a slight male predominance (53.4%), while a higher proportion of the patients were older than 5 years (73.8%). Only 11.5% were younger than 2 years. Similarly, previous studies have reported a male predominance of up to 60%–68% (7, 8). Alanazi et al.(7) from Saudi Arabia included 150 patients with pleural effusions and reported that 70% of patients were younger than 5 years and showed a male predominance. However, they also noted a low routine childhood vaccination rate (35.4%) and a high comorbidity rate (81.5%) in their study, which included both hospital-acquired and community-acquired pneumonia. In contrast, our study excluded hospital-acquired pneumonia, and only one patient lacked routine vaccinations, while the comorbidity rate was 24.6%. A higher vaccination rate in our study may contribute to a shift in disease burden toward older age groups by reducing the incidence and severity of infections in younger children.

Even though some studies reported a higher incidence of pleural effusion after PCV-7 vaccination, possibly due to nonvaccine serotypes, the introduction of PCV-13 vaccination led to a decrease in incidence (9, 10). However, other factors, such as differences in demographics, comorbidities, and healthcare access, might also play a role.

Previous antibiotic use can significantly influence the clinical course of pleural effusion in children. Some studies suggest that prior administration of oral antibiotics in children with parapneumonic pleural effusion is associated with a shorter hospital stay and fewer complications, though it reduces pathogen detection in culture samples. Despite this limitation, it is suggested that previous antibiotic use does not significantly impact pleural fluid biochemical parameters or overall disease duration, which is primarily driven by infection-induced inflammation (11, 12). In our study, 65.6% of patients had received antibiotic therapy before hospital admission. Pleural fluid cultures were positive in only two patients—*H. influenzae* in one unvaccinated patient and *S. pyogenes* in another—while nasal swab respiratory panel (PCR) testing identified bacterial pathogens in 21 patients (56.7%). Surprisingly, we found that

patients who had received previous oral antibiotic treatment (n=40) had a significantly longer hospital stay (median: 24.5 days, range: 14–41) compared to those who had not received antibiotics before hospitalization (n=21, median: 13 days, range: 7–27) (p=0.010). This discrepancy may be explained by a delay in hospital admission due to an initial partial clinical response to oral antibiotics, leading to a more advanced disease stage at presentation and potential antibiotic resistance. Further research is needed in this area.

Several factors may contribute to prolonged hospital stay in children with parapneumonic effusions. Previous studies have linked underlying comorbidities, hospital-acquired pneumonia, empyemic pleural effusions, and the need for pleural drainage or decortication to longer hospitalization (7, 13). Similarly, we found that patients with empyema, septated effusions, and those requiring pleural drainage or decortication had a longer median hospital stay. While we observed no significant difference related to underlying diseases, our sample size was small. Additionally, pleural fluid biochemical parameters, including pH, glucose, neutrophil ratio, LDH, and albumin, were not associated with hospital stay. Similarly, Soriano et al. (13) also reported no significant correlation between hospitalization duration and pleural fluid biochemistry, except for LDH and polymorphonuclear elastase (13, 14).

Septated effusions were associated with longer hospitalization in our study. Similarly, Ramnath et al. (14) found that early sonographic findings, such as fibrinous organizations, correlated with longer hospital stays, particularly when not managed surgically. Several studies have found no significant differences in outcomes between fibrinolytics and VATS regarding length of stay and success rates (15, 16). Some studies reported that chest tube with fibrinolytics is more cost-effective than VATS (16, 17), while others reported higher rates of additional procedures with fibrinolytics compared to VATS (15–17). Overall, both VATS and fibrinolytics demonstrate high success rates with low complication rates and no reported mortality (18). The choice of treatment depends on patient-related factors and clinician experience. At our hospital, VATS is mostly preferred over fibrinolytics due to clinical expertise, and no operation-related mortality was observed. In our study, the median time to VATS was 18 days, which might be a relatively late period. The lack of a standardized algorithm for pediatric empyema, patient-related factors including clinical instability and disease severity, and initial treatment failure may explain these results.

There are some limitations to this study. First, it was designed as a retrospective, single-center study. Second, the sample size was relatively small. Additionally, we included only patients with community-acquired pneumonia and excluded those with hospital-acquired pneumonia. Despite these limitations, this study contributes to the existing knowledge on parapneumonic effusion in children, emphasizing the importance of early diagnosis, appropriate antibiotic therapy, and timely intervention to reduce hospital stay and improve outcomes.

Our findings underscore the need for early intervention and close monitoring in cases with septations and effusions consistent with empyema. Delayed management may lead to prolonged hospitalization, increased need for invasive procedures, and higher complication rates. Larger, multicenter studies and long-term research are needed to compare the outcomes of different therapeutic approaches, including fibrinolytics and VATS. Additionally, prospective studies evaluating biomarkers such as proinflammatory cytokines (TNF-α, IL-1β, IL-6) and fibrinolytic system enzymes (tPA, PAI-1), as well as imaging techniques that predict disease progression, could further guide clinical decision-making and improve patient outcomes.

Ethics Committee Approval: The Başakşehir Çam and Sakura City Hospital Scientific Research Ethics Committee granted approval for this study (date: 14.08.2024, number: 2024-149).

Authorship Contributions: Concept – CYY, EYA, ÖK, NY, CC; Design – MY, ME, MAK; Supervision – MD, NY, FÜ; Fundings – CYY, MY, ME; Materials – AB, MD, NY; Data Collection and/or Processing – FÜ, CYY, ME; Analysis and/or Interpretation – FS, NY, CC; Literature Search – ÖK, EYA, MY; Writing – CYY, ME, CC; Critical Review – MY, AB, FÜ, FS, NY, CC.

Conflict of Interest: No conflict of interest was declared by the authors.

Use of AI for Writing Assistance: Not declared.

Informed Consent: Written informed consent was obtained from the families of the patients who participated in this study.

Financial Disclosure: The authors declared that this study has received no financial support.

Etik Kurul Onayı: Başakşehir Çam ve Sakura Şehir Hastanesi Bilimsel Araştırmalar Etik Kurulu'ndan bu çalışma için onay alınmıştır (tarih: 14.08.2024, sayı: 2024-149)

Yazarlık Katkıları: Fikir – CYY, EYA, ÖK, CC; Tasarım – MY, ME, MAK; Denetleme – MD, NY, FÜ; Kaynaklar – CYY, MY, ME; Materials – AB, MD, NY; Veri Toplanması ve/veya İşlemesi – FÜ, CYY, ME; Analiz ve/veya Yorum – FS, NY, CC; Literatür Taraması – ÖK, EYA, MY; Yazıyı Yazan – CYY, ME, CC; Eleştirel İnceleme – MY, AB, FÜ, FS, NY, CC.

Çıkar Çatışması: Yazarlar çıkar çatışması bildirmemişlerdir.

Yazma Yardımı için Yapay Zeka Kullanımı: Beyan edilmedi.

Hasta Onamı: Yazılı hasta onamı bu çalışmaya katılan hastaların ailelerinden alınmıştır.

Mali Destek: Yazarlar bu çalışma için mali destek almadıklarını beyan etmişlerdir.

REFERENCES

1. Thomas MF, Spencer DA. Management and complications of pneumonia. Paediatr Child Health 2011;21:207–12.
2. Mani CS. Acute pneumonia and its complications. In: Long SS, Prober CG, Fischer M, editors. Principles and practice of pediatric infectious diseases. Philadelphia: Elsevier; 2018. p.238–49.
3. Prentice B, Jaffé A. Air and fluid in the pleural space. In: Wilmott RW, Deterding RR, Li A, Ratjen F, Bush A, editors. Kendig's disorders of the respiratory tract in children. 9th ed. Philadelphia: Elsevier; 2019. p.1007–26.e3.
4. Redden MD, Chin TY, van Driel ML. Surgical versus non-surgical management for pleural empyema. Cochrane Database Syst Rev 2017;3:CD010651.

5. Bueno Fischer G, Teresinha Mocelin H, Feijó Andrade C, Sarria EE. When should parapneumonic pleural effusions be drained in children? Paediatr Respir Rev 2018;26:27–30.
6. Çifci A, Hızlı Ş, Yöney A. Çocuklarda parapnömonik efüzyonlar: Beş yıllık deneyim. Çağdaş Tıp Derg [Article in Turkish] 2017;7:340–7.
7. Alanazi Y, Alkhurayji A, Alawni O, Alkhalaf H. Prevalence of parapneumonic effusion and the associated factors among children: A 3-year experience in a single tertiary hospital. Int J Child Health Nutr 2024;13:88–99.
8. Kwarteng Owusu S, Owusu SA, Ofori Nyarko O, Owusu RK, Mahama H, Adjetey ND, et al. Retrospective review of empyema and parapneumonic effusions in hospitalized children in Ghana. J Pan Afr Thorac Soc 2023;4:131–6.
9. Bernaola E, Gil F, Herranz M, Gil-Setas A, Guevara M, Castilla J. Pneumococcal vaccination and pneumonia associated with pleural effusion in a pediatric population. Pediatr Infect Dis J 2018;37:e87–92.
10. Masson A, Ménetrey C, Garnier F, Bahans C, Fargeot A, Layadi M, et al. Parapneumonic pleural effusion incidence in a French region before and during the antipneumococcal vaccine era. Arch Pediatr [Article in French] 2011;18:846–9.
11. Forster J, Piazza G, Goettler D, Kemmling D, Schoen C, Rose M, et al. Effect of prehospital antibiotic therapy on clinical outcome and pathogen detection in children with parapneumonic pleural effusion/pleural empyema. Pediatr Infect Dis J 2021;40:544–9.
12. Becker A, Amantéa SL, Fraga JC, Zanella MI. Impact of antibiotic therapy on laboratory analysis of parapneumonic pleural fluid in children. J Pediatr Surg 2011;46:452–7.
13. Soriano T, Alegre J, Alemán C, Ruiz E, Vázquez A, Carrasco JL, et al. Factors influencing length of hospital stay in patients with bacterial pleural effusion. Respiration 2005;72:587–93.
14. Ramnath RR, Heller RM, Ben-Ami T, Miller MA, Campbell P, Neblett WW 3rd, et al. Implications of early sonographic evaluation of parapneumonic effusions in children with pneumonia. Pediatrics 1998;101:68–71.
15. Livingston MH, Colozza S, Vogt KN, Merritt N, Bütter A. Making the transition from video-assisted thoracoscopic surgery to chest tube with fibrinolytics for empyema in children: Any change in outcomes? Can J Surg 2016;59:167–71.
16. St Peter SD, Tsao K, Spilde TL, Keckler SJ, Harrison C, Jackson MA, et al. Thoracoscopic decortication vs tube thoracostomy with fibrinolysis for empyema in children: A prospective, randomized trial. J Pediatr Surg 2009;44:106–11. Erratum in: J Pediatr Surg 2009;44:1865.
17. Shah SS, Hall M, Newland JG, Brogan TV, Farris RW, Williams DJ, et al. Comparative effectiveness of pleural drainage procedures for the treatment of complicated pneumonia in childhood. J Hosp Med 2011;6:256–63.
18. Fernandez Elviro C, Longcroft-Harris B, Allin E, Leache L, Woo K, Bone JN, et al. Conservative and surgical modalities in the management of pediatric parapneumonic effusion and empyema: A living systematic review and network meta-analysis. Chest 2023;164:1125–38.