Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Complicated Pneumonia in Fully PCV13-Vaccinated Children: Persistent Morbidity in the Post-Vaccine Era – A Cohort Study From Eastern Europe

Nicolas Kardos
Pavol Jozef Šafárik University
Michal Balogh
Pavol Jozef Šafárik University
Katarína Čurová
katarina.curova@upjs.sk

Pavol Jozef Šafárik University
Erika Liptáková
Technical University of Košice
Martin Červený
Pavol Jozef Šafárik University
Ján Železník
Pavol Jozef Šafárik University
Veronika Vargová
Pavol Jozef Šafárik University

Research Article

Keywords: community-acquired pneumonia, children, complications, management, PCV13, Streptococcus pneumoniae

Posted Date: March 10th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9023733/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Aim

To evaluate the clinical characteristics, microbiological aetiology, management strategies, and short-term outcomes of severe complicated community-acquired pneumonia (CAP) in fully PCV13-vaccinated children treated at a tertiary referral centre in Eastern Europe.

Methods

We conducted a retrospective cohort study of 25 previously healthy children hospitalised with severe complicated CAP between January 2023 and June 2024 in Eastern Slovakia. Demographic data, laboratory findings, microbiological results, therapeutic interventions, and outcomes were analysed. Management strategies (conservative treatment, intrapleural fibrinolysis, and surgery) were compared using non-parametric statistical methods.

Results

All children had completed PCV13 immunisation. A causative pathogen was identified in 92% of cases. *Streptococcus pneumoniae* remained the predominant pathogen (42%), followed by *Staphylococcus aureus* (24%) and *Streptococcus pyogenes* (12%). All patients developed pleural effusion requiring chest drainage; 56% received intrapleural fibrinolysis and 48% required surgical intervention. The median duration of chest drainage was 9 days, and the median length of hospitalisation was 24 days. No deaths occurred.

Conclusion

Severe complicated CAP persists despite complete PCV13 vaccination and remains associated with substantial morbidity and frequent invasive management. These findings highlight the need for strengthened microbiological surveillance, including pneumococcal serotyping, and optimisation of therapeutic strategies in the post-vaccine era.

Introduction

Community-acquired pneumonia (CAP) remains a major cause of paediatric hospitalisation worldwide despite widespread pneumococcal vaccination and advances in antimicrobial therapy [1–3]. While most cases are uncomplicated, a clinically significant proportion progresses to complicated pneumonia, characterised by parapneumonic effusion, empyema, pulmonary abscess or necrotising lung disease [4, 5]. These severe forms are associated with prolonged hospitalisation, invasive procedures and substantial healthcare burden. Following the introduction of pneumococcal conjugate vaccines, a shift in

pneumococcal serotype distribution has been observed in many European countries [6, 7]. Although overall invasive pneumococcal disease has declined, complicated CAP persists, with *Streptococcus pneumoniae* remaining the leading pathogen [4, 8]. Increasing reports of severe disease caused by non-vaccine serotypes, particularly serotype 3, as well as toxin-mediated infections due to *Staphylococcus aureus* and *Streptococcus pyogenes*, suggest evolving pathogen dynamics [9]. However, national data from Central and Eastern Europe remain limited, and pneumococcal serotyping is not routinely performed in Slovakia. Management of complicated CAP is heterogeneous. Current strategies range from conservative treatment with antibiotics and chest drainage to intrapleural fibrinolysis and surgical intervention, including video-assisted thoracoscopic surgery (VATS) or thoracotomy [10–12]. Although early VATS has been proposed to shorten recovery, evidence comparing outcomes between invasive and non-invasive approaches remains inconsistent, particularly in smaller healthcare systems. Therefore, this study aimed to describe the clinical characteristics, aetiology, management strategies and short-term outcomes of children with complicated CAP treated at a tertiary paediatric centre in Eastern Slovakia.

Methods

2.1 Study Design and Setting

This retrospective observational study included paediatric patients hospitalised with complicated CAP between January 2023 and June 2024 at the Department of Paediatrics and Adolescent Medicine, Children's University Hospital, Košice, Slovakia. The hospital serves as the main tertiary referral centre for Eastern Slovakia, providing specialized paediatric care for approximately 800,000 children and managing complex cases referred from regional hospitals [13]. The study was conducted and reported in accordance with the STROBE guidelines for observational studies [14].

2.2 Study Population

During the study period, more than 500 children were admitted with respiratory diseases, including 420 diagnosed with pneumonia. Of these, 25 patients met the inclusion criteria for severe, complicated CAP requiring invasive management and were identified retrospectively through the hospital's electronic medical records. Complicated pneumonia was defined as a lack of clinical improvement within 48–72 hours of appropriate empirical antibiotic therapy, or the development of local or systemic complications, including parapneumonic effusion, empyema, pulmonary abscess, fibrothorax, bronchopleural fistula, or necrosis of the lung parenchyma [4, 15]. Children with underlying chronic diseases, such as congenital heart defects, cystic fibrosis, immunodeficiency, or malignancy, were excluded.

2.3 Variables

For each patient, the following variables were collected: age, sex, etiological agent, laboratory values (white blood cell count, C-reactive protein, albumin), type and frequency of complications, need for chest drainage, administration of fibrinolytic therapy, type of surgical intervention (video-assisted thoracoscopic surgery [VATS] or open thoracotomy), duration of hospitalization, and pneumococcal

vaccination status. All data were anonymized prior to analysis. Ethical approval was obtained from the Ethics Committee of the Children's University Hospital in Košice (approval number 06/2025).

2.4 Treatment Strategy and Allocation

Initial management consisted of broad-spectrum intravenous antibiotic therapy and chest tube drainage in patients with significant pleural effusion. Treatment decisions were made by a multidisciplinary team comprising paediatric infectious disease specialists, paediatric surgeons and radiologists. Intrapleural fibrinolytic therapy was preferred in patients with loculated effusions without extensive pleural thickening or organised fibrothorax on imaging. Surgical intervention (VATS or thoracotomy) was considered in cases of clinical deterioration, persistent fever or elevated inflammatory markers despite appropriate antimicrobial therapy, failure of fibrinolysis, or radiological evidence of advanced pleural organisation, necrotising pneumonia, or fibrothorax. The choice between VATS and open thoracotomy was based on intraoperative findings, degree of pleural organisation and surgeon discretion. Treatment allocation reflected real-world clinical decision-making and was not randomized.

2.5 Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as median (interquartile range, Q1–Q3) and range (minimum–maximum); means ± standard error (SE) are provided where appropriate. Categorical variables are reported as absolute and relative frequencies (%). Due to the small sample size, non-parametric statistical methods were applied. Differences among management groups (thoracotomy, VATS, and non-surgical treatment) were evaluated using the Kruskal-Wallis test. A two-sided $p\text{-value} < 0.05$ was considered statistically significant. The study was exploratory in nature and not powered for formal comparison between management strategies.

Results

3.1 Patient characteristics

During the study period, 25 children (15 boys, 10 girls) with complicated community-acquired pneumonia were hospitalised. The median age was 4.9 years (IQR 2.1–8.2; range 5 months–13 years), with most cases occurring in preschool-aged children. All patients resided in Eastern Slovakia, and 40% originated from socially marginalised communities. All had received complete PCV13 vaccination according to the national immunisation schedule.

3.2 Clinical presentation and laboratory findings

Fever was present in 24 patients (96%), cough in 14 (56%) and tachypnoea in 10 (40%). Eight children (32%) required oxygen supplementation at admission. Inflammatory markers were elevated. The median white blood cell count was 17.0×10^9/L (IQR 13.6–21.4), and the median C-reactive protein concentration was 156 mg/L (IQR 122–198). Hypoalbuminemia was frequently observed. No statistically

significant differences were found between management groups in white blood cell count, C-reactive protein or albumin levels ($p > 0.05$; Table 1).

Table 1
Descriptive statistics of baseline characteristics of the three groups of patients who are divided into groups according to surgical intervention

Patients (N)	**Thoracotomy**	**VATS**	**None**	**p-value***
	6	**6**	**13**	
Men	5 (83%)	2 (33%)	8 (62%)	
Women	1 (17%)	4 (67%)	5 (38%)	
Age at time of hospitalization (years)				
Mean (± SE)	5.6 (± 2.0)	4.7 (± 1.3)	4.4 (± 0.7)	0.955
Median (Q1-Q3)	5 (1–10)	4 (2.4–8.3)	4 (3–5.5)	
Min	7 months	5 months	9 months	
Max	13	9	11	
Hospital stays (days)				
Mean (± SE)	26.2 (4.1)	27.3 (± 2.0)	20.3 (± 1.5)	0.064
Median (Q1-Q3)	26.5 (16.8–34.3)	25 (23.8–33.3)	19 (16–24)	
Min	13	23	13	
Max	41	34	32	
Chest drain (days)				
Mean (± SE)	13.2 (± 2.8)	7.8 (± 1.8)	9.2 (± 1.0)	0.222
Median (Q1-Q3)	14 (8.8–17)	7 (4.8–10)	8 (6.5–12)	
Min	2	4	5	
Max	23	16	16	
WBC				
Mean (± SE)	20.1 (± 3.7)	15.2 (± 2.2)	15.2 (± 2.1)	0.510
Median (Q1-Q3)	19.3 (5.3–32.2)	15.5 (8.2–23.0)	14.0 (5.6–27.6)	
Min	14.8	10.0	7.5	
Max	28.2	19.6	23.2	

*According to Kruskal-Wallis test. P-value < 0.05 is considered statistically significant. Abbreviations: WBC, white blood cell count; CRP, C-reactive protein.

Patients (N)	Thoracotomy	VATS	None	p-value*
	6	6	13	
CRP				
Mean (± SE)	108.9 (± 7.8)	174.6 (± 55.2)	161.6 (± 20.8)	0.337
Median (Q1-Q3)	110.3 (94.5–125.7)	141.0 (70.1–330.6)	162.9 (98.6–208.2)	
Min	77.3	4.0	56.2	
Max	131.4	342.8	334.9	
Albumin				
Mean (± SE)	28.7 (± 1.7)	35.0 (± 2.5)	32.8 (± 1.2)	0.062
Median (Q1-Q3)	29.4 (24.5–32.4)	35.1 (31.4–38.5)	32.2 (30.5–36.8)	
Min	22.3	25.5	25.5	
Max	33.6	44.3	38.9	
*According to Kruskal-Wallis test. P-value < 0.05 is considered statistically significant. Abbreviations: WBC, white blood cell count; CRP, C-reactive protein.				

Insert Table 1 here

3.3 Microbiological findings

A causative pathogen was identified in 23/25 patients (92%). *Streptococcus pneumoniae* was the most common organism (11/25, 42%), followed by *Staphylococcus aureus* (6/25, 24%), including three cases of methicillin-resistant *S. aureus* (MRSA), and *Streptococcus pyogenes* (3/25, 12%). Sporadic isolates included *Streptococcus constellatus*, *Haemophilus influenzae* and *Pseudomonas aeruginosa*. Two patients had no pathogen identified; one had *Mycobacterium spp*., and one presented with a mixed infection (*S. pneumoniae* and *S. aureus*).

Pneumococcal serotyping was not performed. The distribution of pathogens according to the management group is shown in Fig. 1.

Insert Fig. 1 here

3.4 Complications and clinical course

All patients developed pleural effusion requiring chest drainage. Additional complications included pulmonary abscess in 12 patients (48%), fibrothorax in nine (36%), bronchopleural fistula in five (20%) and necrotising pneumonia in four (16%). The median duration of chest drainage was 9 days (IQR 7–12), and the median length of hospitalisation was 24 days (IQR 18–31). Children requiring surgical

intervention had longer hospital stays; however, this difference did not reach statistical significance (p = 0.064). Detailed information about the clinical symptoms, treatment and complications of pneumonia is shown in the Table 2.

Table 2
Clinical symptoms, treatment and complications of pneumonia – absolute and relative frequencies of the three groups of patients according to management type

Complicated pneumonia (n = 25)		**Thoracotomy (n = 6)**		**VATS (n = 6)**		**None (n = 13)**	
Clinical symptoms on admission	Fever	5	*83%*	6	*100%*	13	*100%*
	Cough	3	*50%*	3	*50%*	8	*62%*
	Tachypnoea	2	*33%*	3	*50%*	5	*38%*
Radiological examination	X-ray	6	*100%*	6	*100%*	13	*100%*
	Computer tomography	6	*100%*	6	*100%*	13	*100%*
	Ultrasound	6	*100%*	6	*100%*	13	*100%*
Therapy	ATB (3rd gen. cephalosporin + VAN)	6	*100%*	6	*100%*	13	*100%*
	Alteplase	3	*50%*	1	*17%*	10	*77%*
	PICU	5	*83%*	5	*83%*	3	*23%*
Complication of pneumonia	Fluidothorax	3	*50%*	2	*33%*	11	*85%*
	Pyothorax	1	*17%*	1	*17%*	2	*15%*
	Fibrothorax	2	*33%*	4	*67%*	0	*0%*
	Pneumothorax	2	*33%*	0	*0%*	0	*0%*
	Bronchopleural fistula	3	*50%*	2	*33%*	0	*0%*
	Necrosis	2	*33%*	2	*33%*	0	*0%*
	Empyema	1	*17%*	1	*17%*	0	*0%*
	Abscess	4	*67%*	5	*83%*	3	*23%*

Abbreviations: VATS, video-assisted thoracoscopic surgery; ATB, antibiotics; VAN, Vancomycin; PICU, Paediatric Intensive Care Unit.

Insert Table 2 here

3.5 Management of treatment

All patients received intravenous combination antibiotic therapy with a third-generation cephalosporin and vancomycin. Metronidazole was added in cases of pulmonary abscess. Intrapleural fibrinolytic therapy with alteplase was administered to 14 patients (56%); four of these subsequently required surgery. Overall, 12 children (48%) underwent surgical intervention, equally divided between video-assisted thoracoscopic surgery (VATS) and thoracotomy. No deaths occurred.

Discussion

Complicated community-acquired pneumonia (CAP) remains a significant cause of paediatric morbidity in the post-PCV13 era. In this cohort of fully vaccinated children from a tertiary centre in Eastern Slovakia, severe pleuropulmonary complications persisted despite complete pneumococcal immunisation [4, 16]. These data provide contemporary regional insight from Central and Eastern Europe, where post-vaccine epidemiological evidence remains limited. *Streptococcus pneumoniae* remained the leading pathogen (42%), confirming that pneumococci continue to drive severe complicated CAP despite vaccination. Although serotyping was not performed, international data increasingly implicate non-vaccine serotypes - particularly serotype 3 - in pleural and necrotising disease. The absence of routine serotyping in Slovakia limits evaluation of vaccine effectiveness and highlights the need for strengthened microbiological surveillance [17–19]. These findings may reflect ongoing serotype replacement and potentially incomplete protection against certain serotypes, such as serotype 3, rather than true vaccine failure. Pathogen identification was achieved in 92% of cases, supporting the robustness of the microbiological findings. *Staphylococcus aureus* and *Streptococcus pyogenes* accounted for a substantial proportion of infections, consistent with recent European reports of increased invasive and toxin-mediated bacterial disease in children [20, 21]. The clinical burden was considerable: all children required chest drainage, nearly half developed pulmonary abscesses, and 48% underwent further surgical intervention. The median hospital stay of 24 days reflects substantial morbidity and healthcare utilisation, even in a vaccinated population. No deaths occurred, underscoring the effectiveness of timely multidisciplinary management [7, 22, 23]. No statistically significant differences were observed between conservative, fibrinolytic and surgical approaches; however, the study was not powered for comparative analysis. Intrapleural fibrinolysis prevented surgery in most treated children, supporting its role as a less invasive option in selected cases [12, 24]. Notably, 40% of patients originated from socially marginalised communities. This finding suggests that vaccination alone may not fully mitigate risk where adverse social determinants persist, including delayed access to care and overcrowded living conditions [25, 26].

5 Strengths and Limitations This study is limited by its retrospective, single-centre design, small sample size and lack of pneumococcal serotyping, which restricts assessment of vaccine effectiveness and serotype distribution. Referral bias may have enriched the cohort with more severe cases. However, as the principal tertiary paediatric centre in Eastern Slovakia, our hospital captures most cases of severe complicated CAP requiring advanced intervention, providing relevant insight into the regional burden of disease. Because treatment allocation was based on clinical judgment rather than randomisation, comparisons between conservative, VATS, and thoracotomy groups are susceptible to confounding.

Severe complicated CAP therefore remains clinically significant despite widespread PCV13 immunisation. Strengthening microbiological surveillance, including routine serotyping, and prospective multicentre studies are essential to clarify evolving pathogen dynamics and optimise management strategies in the vaccine era.

Conclusion

Complicated community-acquired pneumonia remains associated with substantial morbidity and prolonged hospitalisation in children despite widespread pneumococcal vaccination. *Streptococcus pneumoniae* was the predominant pathogen, followed by *Staphylococcus aureus* and *Streptococcus pyogenes*. Pleural effusion occurred in all patients, and nearly half developed additional complications such as pulmonary abscess or fibrothorax. Although surgically treated children had numerically longer hospital stays, no statistically significant differences were observed between management groups. Intrapleural fibrinolytic therapy was frequently used and may represent an effective, less invasive therapeutic option in carefully selected patients. The absence of pneumococcal serotyping limits assessment of vaccine impact and serotype distribution. Strengthening microbiological surveillance, including routine serotyping, is essential to monitor evolving pneumococcal epidemiology. Early recognition, appropriate antimicrobial therapy and multidisciplinary management remain central to optimising outcomes in paediatric complicated pneumonia.

Declarations

Author Contributions

Nicolas Kardos: Investigation, Conceptualization, and Writing – original draft. Michal Balogh: Investigation, Conceptualization, and Resources. Katarína Čurová: Funding acquisition, Data curation, and Writing – review and editing. Erika Liptáková: Formal Analysis, and Visualisation. Martin Červený: Investigation, Resources, and Methodology. Ján Železník: Methodology, and Supervision. Veronika Vargová: Supervision, and Writing – review and editing.

Acknowledgements

The authors thank the medical and nursing staff of the Department of Paediatrics and Adolescent Medicine, Children’s University Hospital in Košice, for their dedicated care.

Funding

This study was supported by the Ministry of Education, Research, Development and Youth of Slovak Republic under the grant number VEGA 1/0529/25.

Conflict of Interest

The authors declare no conflict of interest.

Informed Consent and Ethical Considerations

Given the retrospective design of the study, individual informed consent was waived by the Ethics Committee. All patient data were anonymized prior to analysis to ensure confidentiality. The study was conducted in accordance with the Declaration of Helsinki.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

References

1. World Health Organization. Pneumonia in children: fact sheet. Geneva: WHO; 2024. Available from: https://www.who.int/news-room/fact-sheets/detail/pneumonia..
2. Tukbekova B, Zhanpeissova A, Kysabekova A, Sarmankulova G, Turlybekova S. More complex investigations improved diagnoses of community-acquired pneumonia in children with different vaccination histories. Acta Paediatr. 2025;114:1414–1420. https://doi.org/10.1111/apa.17586
3. Goldberg O, Shmueli E, Levinsky Y, Vardi Y, Yaniv N, Bar-On O, et al. Fever duration enhanced biomarker sensitivity in diagnosing radiographically confirmed community-acquired pneumonia in children. Acta Paediatr. 2025;114:1015–1021. https://doi.org/10.1111/apa.17531
4. de Benedictis FM, Kerem E, Chang AB, et al. Complicated pneumonia in children. Lancet. 2020;396(10270):1577–1583.
5. Rafi IK, et al. A review on pneumonia in children: clear insights. Front Pediatr. 2024;12:10051935. https://doi.org/10.5281/zenodo.14279043
6. Silva-Costa C, Ribeiro-Gonçalves B, Saraiva C, et al. Continued vaccine breakthrough cases of serotype 3 pneumococci globally remain a concern. Microbiol Spectr. 2022;10(4):e01077-22. doi: 10.1128/spectrum.01077-22.
7. Menéndez R, et al. Pneumococcal serotypes associated with community-acquired pneumonia in hospitalized adults and children. Microorganisms. 2023;11(11):2781. https://doi.org/10.3390/microorganisms11112781
8. Gomes-Silva J, Pinho MD, Friães A, et al. Pneumococci remain the main cause of complicated pediatric pneumonia in the post-vaccine era. Pneumonia (Nathan). 2024;16:26. doi: 10.1186/s41479-025-00179-7.
9. Trifonova I, Korsun N, Levterova V, Pavlova D, Simeonovski I, Ivanova M, Velikov P, Voleva S, Ivanov I, Ivanov D, Dakov T, Tcherveniakova T, Angelova S, Christova I. Respiratory infections in the post-COVID-19 era: impact, prevalence, and clinical characteristics of bacterial and viral co-infections. Front Med (Lausanne). 2025;12:1597782. doi: 10.3389/fmed.2025.1597782.
10. Korppi M. Antibiotic therapy in children with community-acquired pneumonia. Acta Paediatr. 2021;110:3246–3250. https://doi.org/10.1111/apa.16030

11. British Thoracic Society. Guidelines for the management of pleural infection in children. Thorax. 2023;78(Suppl 1):i1–i24.
12. Miscia ME, et al. Video-assisted thoracoscopic surgery versus tube thoracostomy with fibrinolytics for empyema in children: a meta-analysis of randomized controlled studies. Children (Basel). 2025;12(9):1225. doi: 10.3390/children12091225.
13. National Health Information Centre (Slovakia). Hospital statistics 2023 – pediatric admissions. Bratislava; 2024.
14. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, et al. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. J Clin Epidemiol. 2008;61(4):344–349.
15. Bradley JS, Byington CL, Shah SS, et al. The management of community-acquired pneumonia in infants and children older than 3 months of age: clinical practice guidelines by the Pediatric Infectious Diseases Society and the Infectious Diseases Society of America. Clin Infect Dis. 2011;53(7):e25–e76. doi: 10.1093/cid/cir531.
16. Buonsenso D, et al. Parapneumonic empyema in children: a scoping review of the last decade. Pediatr Infect Dis J. 2024;43(5):e151–e158. doi: 10.1186/s13052-024-01701-1.
17. de Sevilla MF, et al. Pediatric invasive pneumococcal disease after PCV13 introduction: serotype distribution and outcomes. Pediatr Infect Dis J. 2021;9(7):1428. doi: 10.3390/microorganisms9071428.
18. Goettler D, et al. Increase in serotype 3 complicated parapneumonic effusion in children under 5 years. Pediatr Pulmonol. 2019;54(1):11–19. doi: 10.1016/j.vaccine.2019.10.056.
19. Izquierdo C, et al. Pneumococcal serotypes in children: clinical presentation and outcomes. PLoS One. 2020;15(7):e0235448. doi: 10.1017/S0950268820002708.
20. Ness-Cochinwala M, Goyal L, Goyal M. Pediatric necrotizing pneumonia: epidemiology and outcomes. Children (Basel). 2025;12(9):1248. https://doi.org/10.3390/children12091248
21. Wang J, Han Y, Wei X, et al. The impact of COVID-19 pandemic on the etiological spectrum of respiratory infections in children. Eur J Clin Microbiol Infect Dis. 2025;44(11):2655–2664. doi: 10.1007/s10096-025-05222-5.
22. European Centre for Disease Prevention and Control. Pneumococcal serotype surveillance report 2024. Stockholm: ECDC; 2024.
23. Abdelhady S, et al. Childhood necrotising pneumonia, empyema and complicated parapneumonic effusion. Respir Res. 2025;26(1):235. doi: 10.1186/s12931-025-03291-w.
24. St Peter SD, Tsao K, Spilde TL, et al. Thoracoscopic decortication vs tube thoracostomy with fibrinolytics for empyema: a prospective randomized trial. J Pediatr Surg. 2009;44(1):106–111. doi: 10.1016/j.jpedsurg.2008.10.018.
25. UNICEF Regional Office for CEE/CIS. Child health equity report 2024. Geneva: UNICEF; 2024.

26. European Centre for Disease Prevention and Control. Social determinants and child respiratory disease – report 2023. Stockholm: ECDC; 2023.

Figures

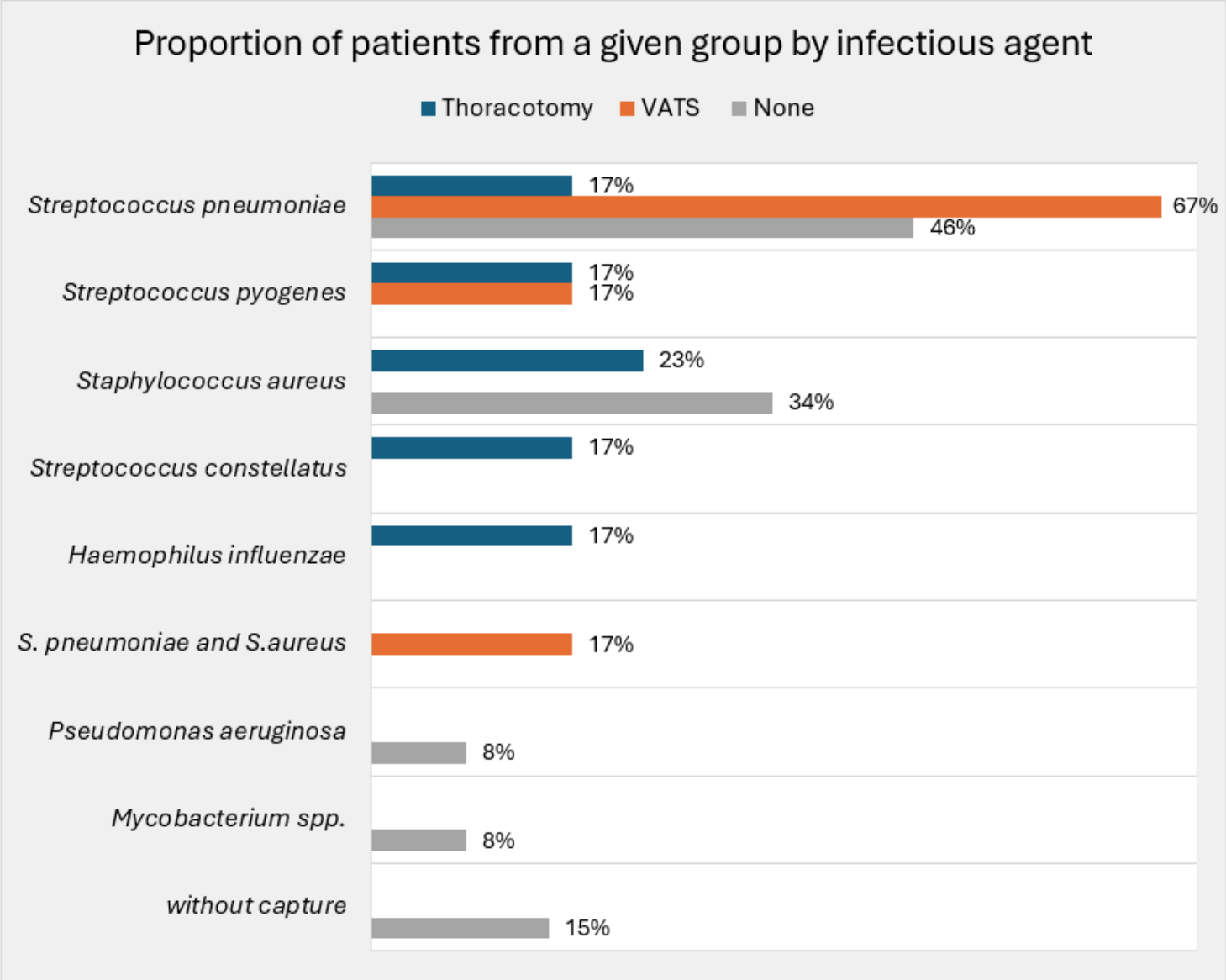


Figure 1

Relative frequency of patients according to infectious agent and their affiliation to the relevant group

Abbreviations: VATS, video-assisted thoracoscopic surgery.