

# Increased Prevalence of Invasive Pneumococcal Isolates and Reduced Penicillin Susceptibility of Non-Invasive Pneumococcal Isolates in Patients from Primorje-Gorski Kotar County (Croatia)

Kristina Franjić<sup>1,2</sup>, Maja Abram<sup>1,2</sup>, Đurđica Grbeša Cekinović<sup>3,4</sup>, Bojana Mohar Vitezić<sup>1,2</sup>, Tanja Grubić Kezele<sup>1,5</sup>, Marina Bubonja Šonje<sup>1,2</sup>

**1** Department of Clinical Microbiology, Clinical Hospital Center Rijeka, Croatia

**2** Department of Microbiology and Parasitology, Faculty of Medicine, University of Rijeka, Croatia

**3** Clinic for Infectious Diseases, Clinical Hospital Center Rijeka, Croatia

**4** Department of Infectious Diseases, Faculty of Medicine, University of Rijeka, Croatia

**5** Department of Physiology, Immunology and Pathophysiology, Faculty of Medicine, University of Rijeka, Croatia

## INTRODUCTION & AIM

*Streptococcus pneumoniae* causes both localized infections and invasive pneumococcal disease (IPD). Penicillin non-susceptible pneumococci are considered one of the major antimicrobial resistance threats among bacterial pathogens. Penicillin susceptibility varies by geographic location and site of infection.

This study aims to assess whether there has been a change in the prevalence of IPD, as well as in penicillin susceptibility rates among invasive and non-invasive (carriage) clinical isolates, over the past five years in patients from Primorje-Gorski Kotar County, Croatia.

## METHOD

- Between 2020 and 2024, a total of 927 non-copy *S. pneumoniae* isolates were collected from the Clinical Hospital Center Rijeka, Croatia.
- IPD isolates were defined as those originated from blood, pleural fluid, cerebrospinal fluid and intraoperative samples, while carriage isolates included those recovered from non-sterile sites, such as the respiratory tract.
- Penicillin susceptibility was assessed using EUCAST 2025 recommendations and interpretative criteria.
- Penicillin resistance levels were analyzed using Fisher's exact tests; p-values <0.05 were considered statistically significant.

## RESULTS & DISCUSSION

Clinical source (n)	2020	2021	2022	2023	2024
BC (126)	13	11	23	40	39
CSF (15)	2	4	2	4	3
Pleural fluid, punctate (18)	3	1	5	1	8
IPD isolates (159)	18	16	30	45	50
All isolates (927)	174	178	146	225	204
IPD percentage (17%)	10 %	9 %	21 %	20 %	25 %

**Table 1. Distribution of IPD isolates by clinical source.** The percentage of invasive isolates doubled in 2022-2024 compared to 2020 and 2021. Abbreviations: BC, blood culture; CSF, cerebrospinal fluid; IPD, invasive pneumococcal disease

Age group (years)	Number of patients (%)					
	2020	2021	2022	2023	2024	Total
0-2	0 (0%)	1 (6%)	2 (7%)	3 (7%)	2 (4%)	8 (5%)
3-20	1 (6%)	0	1 (3%)	2 (4%)	4 (8%)	8 (5%)
21-65	8 (44%)	5 (31%)	5 (17%)	16 (36%)	14 (28%)	48 (30%)
≥65	9 (50%)	10 (63%)	22 (73%)	24 (53%)	30 (60%)	95 (60%)

**Table 2. Distribution of IPD by patient age.** The majority of cases occur in patients aged ≥65 years. The low rate of IPD in children can be attributed to the introduction of mandatory childhood immunisation in Croatia in 2019.

	Population	Isolates n	PRSP + PRP n (%)	Comparison of penicillin susceptibility
2020	IPD	18	3 (17%)	p=0.043*
	Carriage	156	65 (42%)	
2021	IPD	16	6 (38%)	p=0.445
	Carriage	162	78 (48%)	
2022	IPD	30	8 (26%)	p=0.391
	Carriage	116	42 (36%)	
2023	IPD	45	12 (26%)	p=0.011*
	Carriage	180	88 (49%)	
2024	IPD	50	17 (34%)	p=0.132
	Carriage	154	77 (50%)	
Total	IPD	159	46 (28%)	P<0.001*
	Carriage	768	350 (46%)	

**Table 3. Reduced penicillin susceptibility of *S. pneumoniae* isolates.** Carriage isolates exhibited significantly higher levels of penicillin non-susceptibility (PRSP+PRP) compared to invasive isolates (\*p<0.05). Abbreviations: PRSP, pneumococci with reduced susceptibility to penicillin; PRP, penicillin-resistant pneumococci

## CONCLUSION

- Differences in penicillin susceptibility between carriage and IPD isolates were observed.
- The high prevalence of carriage strains with decreased susceptibility to penicillin is of great concern, as these strains are an important source of IPD and a reservoir of resistance.
- Rising penicillin resistance rates are affecting the treatment of IPD, especially pneumococcal meningitis. Nevertheless, parenteral penicillin remains the drug of choice for treating pneumococcal pneumonia in Croatia.
- Continued monitoring of antimicrobial susceptibility in both invasive and non-invasive isolates is essential for guiding treatment strategies and informing vaccination policies.

## REFERENCES

1. EUCAST, 2025. Available online: [https://www.eucast.org/clinical\\_breakpoints](https://www.eucast.org/clinical_breakpoints)