SELCUK UNIVERSITY PRESS

GENEL TIP DERGİSİ
The Journal of General Medicine

Received: 16 Oct 2025 | **Accepted:** 01 Dec 2025 **Genel Tıp Derg. Volume** 36 (2026), 1-6

DOI: 10.54005/geneltip.1805063

ORIGINAL ARTICLE

Clinical Characteristics and Antimicrobial Resistance Profile of Myroides spp. Infections in a Tertiary Hospital: A Retrospective Analysis of 106 Cases

Üçüncü Basamak Bir Üniversite Hastanesinde Saptanan Myroides spp. İzolatlarının Klinik, Epidemiyolojik ve Antimikrobiyal Direnç Özellikleri: 106 Vakanın Retrospektif Analizi

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How to cite ?

Gülbay SR, Ağralı MŞ, Doğan M. Clinical Characteristics and Antimicrobial Resistance Profile of Myroides spp. Infections in a Tertiary Hospital: A Retrospective Analysis of 106 Cases. Genel Tıp Derg. 36 (2026), 1-6

ABSTRACT

Aim: Myroides spp. is a rare opportunistic pathogen causing infections that are difficult to treat due to its intrinsic and broad-spectrum antibiotic resistance. This study aimed to retrospectively investigate the clinical and epidemiological characteristics and antimicrobial resistance profiles of multidrug-resistant Myroides spp. strains isolated in our hospital.
Methods: A total of 106 Myroides spp. isolates, obtained from various clinical specimens at the Necmettin Erbakan University Medical Microbiology Laboratory of Faculty of Medicine Hospital between June 2021 and June 2025, were retrospectively analyzed. Bacterial identification was performed using MALDI-TOF MS, and antibiotic susceptibility testing (AST) was conducted with an automated system (BD Phoenix™). The results were interpreted according to EUCAST criteria.
Results: The mean age of the 106 patients was 67.9 years, and 72.6% were male. The vast majority of isolates were obtained from intensive care units (78.3%) and urine samples (94.3%). All isolates demonstrated 100% resistance to amikacin, ciprofloxacin, imipenem, levofloxacin, piperacillin/tazobactam, and ceftazidime. The resistance rate for tigecycline was found to be 89.3%.
Conclusion: Myroides spp. is a significant nosocomial pathogen in our institution, predominantly isolated from urinary tract samples in intensive care patients and exhibiting a profile nearing pan-resistance against the tested antimicrobial agents. The severely limited therapeutic options underscore the critical importance of diagnosis, surveillance, and the rigorous implementation of infection control measures for this rare pathogen.

Keywords: Intensive care unit, multidrug resistance, myroides spp., nosocomial infection, urinary tract infection, .

ÖZ

Amaç: Myroides spp., doğal ve geniş spektrumlu antibiyotik direnci nedeniyle tedavisi zor fırsatçı enfeksiyonlara neden olan nadir bir patojendir. Bu çalışmada, hastanemizde izole edilen çoklu ilaç dirençli Myroides spp. suşlarının klinik ve epidemiyolojik özellikleri ile antimikrobiyal direnç profillerinin geriye dönük olarak incelenmesi amaçlanmıştır.
Gereç ve Yöntemler: Haziran 2021 ile Haziran 2025 tarihleri arasında Necmettin Erbakan Üniversitesi Hastanesi Tıbbi Mikrobiyoloji Laboratuvarı'nda çeşitli klinik örneklerden izole edilen 106 Myroides spp. izolatı retrospektif olarak incelenmiştir. Bakteri identifikasyonu MALDI-TOF MS, antibiyotik duyarlılık testleri (ADT) ise otomatize sistem (BD Phoenix™) kullanılarak yapılmış ve EUCAST kriterlerine göre yorumlanmıştır.
Bulgular: Toplam 106 hastanın yaş ortalaması 67,9 olup, %72,6'sının erkek olduğu görülmüştür. İzolatların büyük çoğunluğu (%78.3) yoğun bakım ünitelerinden ve idrar örneklerinden (%94,3) elde edilmiştir. Tüm izolatlar amikasin, siprofloksasin, imipenem, levofloksasin, piperasilin/tazobaktam ve seftazidime karşı %100 direnç göstermiştir. Tigesiklin için direnç oranı ise %89,3 olarak saptanmıştır.
Sonuç: Myroides spp. kurumumuzda özellikle yoğun bakım hastalarında idrar örneklerinden izole edilen, test edilen antimikrobiyallere karşı pan-rezistansa yakın bir profil sergileyen önemli bir nozokomiyal patojendir. Tedavi seçeneklerinin ileri derecede kısıtlı olması, bu nadir patojenin tanısı, sürveyansı ve enfeksiyon kontrol önlemlerinin titizlikle uygulanmasının kritik önem taşıdığını göstermektedir.

Anahtar Kelimeler: Çoklu ilaç direnci, myroides spp., nozokomiyal enfeksiyon, üriner sistem enfeksiyonu, yoğun bakım ünitesi.

Peer-Review: Double anonymized - Two External
Plagiarism Checks: Yes - intihal.net
Complaints: geneltip@selcuk.edu.tr
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Introduction

Healthcare-associated multidrug-resistant (MDR) microorganisms continue to be a global health concern due to increased morbidity, mortality, and treatment costs [1]. Among these pathogens, non-fermentative Gram-negative bacilli are of particular importance, as they severely limit therapeutic options through their intrinsic resistance mechanisms. Within this group, the genus Myroides, although rare, is an opportunistic pathogen capable of causing clinically challenging infections [2].

The genus Myroides comprises aerobic, non-motile, Gram-negative bacilli commonly found in natural environments such as soil, freshwater, and saltwater. Formerly classified within the genus Flavobacterium, this bacterium is generally considered to have low virulence. However, it can cause serious infections, particularly in patients who are immunocompromised, have underlying malignancies, require prolonged hospitalization, or are monitored in intensive care units [3].

The most striking and clinically significant feature of Myroides species is their intrinsic and broad-spectrum resistance to numerous antibiotic classes. This resistance is associated with the presence of chromosomally encoded metallo-beta-lactamase (MBL) enzymes (e.g., TUS-1, MUS-1) that can hydrolyze broad-spectrum beta-lactam antibiotics, including carbapenems [4, 5]. Consequently, Myroides spp. isolates are intrinsically resistant to essential antibiotic groups frequently used in clinical practice, such as penicillins, cephalosporins, carbapenems, and aminoglycosides. This characteristic renders empirical therapy ineffective and poses significant challenges for clinicians in providing targeted therapy [6].

Clinical presentations caused by Myroides spp. reported in the literature include urinary tract infections, bacteremia, cellulitis, wound infections, and pneumonia. The rarity of these infections means that data on the epidemiological characteristics and regional antibiotic resistance patterns of this bacterium are often limited to case reports or small case series [6–12].

This study aimed to retrospectively analyze the clinical and epidemiological characteristics, specimen and departmental distributions, and antimicrobial resistance profiles of Myroides spp. strains isolated over a three-year period at a tertiary university hospital.

Materials and Methods

This retrospective, descriptive study was conducted at the Medical Microbiology Laboratory of Necmettin Erbakan University Medical Faculty Hospital. A total of 106 Myroides spp. strains, isolated from various clinical specimens sent to the laboratory between June 11, 2021, and June 9, 2025, were included in the study. Data pertaining to the strains, along with patient demographic information (age, sex), specimen type, and the respective clinical department, were retrospectively retrieved from the laboratory information management system (LIMS).

Clinical specimens (urine, blood, catheter) received by the laboratory were cultured on 5% sheep blood agar and Eosin Methylene Blue (EMB) agar using standard methods. The plates were incubated at 37°C for 24-48 hours. Following evaluation, colonies from urine samples that grew in pure culture at a count of $\geq 10^5$ cfu/mL were considered significant and included in the study. For blood and catheter samples, pure growths were included regardless of the colony count.

Suspected colonies were first evaluated using conventional methods such as Gram staining, oxidase, and catalase tests. Following this preliminary assessment, definitive species-level identification of the isolates was performed using the MALDI-TOF VITEK MS (bioMérieux, France) mass spectrometry system.

Antimicrobial susceptibility testing (AST) of the isolates was performed using the fully automated BD Phoenix™ system (Becton Dickinson, USA). The test results were interpreted according to the current criteria of the European Committee on Antimicrobial Susceptibility Testing (EUCAST) valid at the time of the study.

As information to distinguish between infection and colonization could not be obtained for the isolates, all reported isolates were included in the study.

Descriptive statistical methods were used for data analysis. Numerical data were presented as mean, median, and range, while categorical data were presented as numbers (n) and percentages (%).

Results

In our study, a total of 106 Myroides spp. isolates, obtained from various clinical specimens between June 11, 2021, and June 9, 2025, were analyzed.

Demographic and Epidemiological Characteristics

Of the 106 patients included in the study, 77 (72.6%) were male and 29 (27.4%) were female. The mean age of the patient population was 67.9 years, with a median age of 71 (age range: 18 –92).

Analysis of the hospital units of origin revealed that the vast majority of cases (78.3%, n= 83) came from intensive care units (ICUs). The proportion of isolates from general wards was 18.9% (n= 20), while the proportion from outpatient clinics was 2.8% (n= 3). Among the ICUs, the Chest Diseases ICU (n= 26) was the unit from which the highest number of isolates was obtained. The distribution of isolates by department is summarized in Figure 1.

An analysis of the clinical specimens from which Myroides spp. isolates were obtained revealed that urine was the most common sample type (n= 100, 94.3%). This was followed by blood culture (n= 5, 4.7%) and catheter culture (n= 1, 0.9%). The demographic and epidemiological data are summarized in Table 1.

Antimicrobial Susceptibility Profile

The antimicrobial susceptibility profiles of the isolates revealed widespread and high-level resistance to the tested agents. The isolates demonstrated 100% resistance to amikacin (AN), ciprofloxacin (CIP),

imipenem (IPM), levofloxacin (LVX), piperacillin/tazobactam (TZP), and ceftazidime (CAZ). In contrast, the resistance rate for tigecycline (TGC) was determined to be 89.3%.

DISCUSSION

This study provides a critical snapshot of the role of Myroides spp., a rare but clinically formidable pathogen, within our hospital. Our findings indicate that this microorganism is more than a simple environmental contaminant; it is a formidable nosocomial pathogen equipped with intrinsic resistance mechanisms that primarily targets critically ill patient populations.

When our findings are compared with a previous study conducted by Ezer et al. covering the 2015-2021 period at the same center, they reveal alarming trends in the epidemiology and resistance profile of Myroides spp. [13]. In both study periods, the vast majority of isolates were obtained from hospitalized patients (81.25% vs. 97.2% in our study) and predominantly from urine samples (87.5% vs. 94.3%), confirming the established nosocomial and urinary-associated character of the pathogen in our institution. However, the most striking difference was observed in the antimicrobial resistance profile. While some isolates were reported to be susceptible to meropenem and levofloxacin in the previous period, our period saw resistance to these antibiotics reach 100%. More critically, resistance to tigecycline, often considered a last-resort antibiotic, increased from 71.4% to 89.3%. This increasing trend in resistance might be attributed to the selective pressure created by the extensive use of broad-spectrum antibiotics in our intensive care units, or potentially the dissemination of specific resistant clones within the hospital environment. These data clearly demonstrate that this pathogen has become more resistant to treatment over just a few years, that therapeutic options are progressively diminishing, and that it poses a growing threat in our institution.

The patient demographics clearly reflect the opportunistic nature of the genus Myroides. The concentration of cases in elderly (mean age 67.9) and predominantly male patients is consistent with general trends in the literature. The fact that an overwhelming majority of isolates (78.3%) originated from intensive care units (ICUs) reinforces the reality that this bacterium is a typical opportunistic and healthcare-associated pathogen. Indeed, outbreaks reported in Turkey in recent years, where all cases involved ICU patients with urinary catheters, support this assertion [4, 14]. Furthermore, previous studies show that Myroides cases are not an anomaly specific to certain centers; they have been reported across a wide geography, including North America (USA), Europe (Italy, Romania, Belgium, Germany, Greece, UK), Asia (Turkey, China, India, South Korea, Taiwan), Africa (Tunisia), and Latin America (Peru, Argentina). The 97 cases in the review by Khan et al. [3, 6, 15], along with widespread urinary-source outbreaks from our country (Kutlu et al.), a hospital-acquired UTI outbreak from Tunisia [16], catheter-related nosocomial cases from China [17], and a series of UTIs in immunosuppressed patients from Romania [18], reveal that Myroides infection is not just a general hospital problem but also a clustered threat in critical care areas where invasive procedures, immunosuppressive conditions, and intense antibiotic pressure are at their peak. The concentration we observed in the Chest Diseases ICU, in particular, suggests a threat where underlying chronic lung diseases and factors like long-term mechanical ventilation may leave patients more vulnerable to colonization and subsequent infection by this environmental microorganism.

One of the key findings of our study is that the clinical presentation of Myroides spp. in our hospital is predominantly characterized by isolations from the urinary tract (94.3%). Indeed, all cases in the outbreak reported by Kutlu et al. presented as urinary tract infections [14]. Although various types of infections have been described in the literature, such a pronounced tendency for urinary isolation suggests that this bacterium plays a significant role, especially when the integrity of the urinary system is compromised [6, 7]. The near-universal practice of urinary catheterization in the ICU setting supports this finding. As emphasized by Karvar et al., this, combined with the bacterium's known strong biofilm-forming capacity [4], creates an ideal setting for persistent colonization on catheter surfaces and recurrent infections. This indicates that Myroides spp. is a pathogen that should not be overlooked in the etiology of Catheter-Associated Urinary Tract Infections (CAUTIs).

The antimicrobial resistance profile of the isolates constitutes the most clinically critical and alarming aspect of the study. The observed 100% resistance to antibiotic classes that form the cornerstone of empirical therapy, such as beta-lactams (penicillins, cephalosporins), carbapenems, aminoglycosides, and quinolones, stems from the bacterium's genetic makeup. Myroides species are known to carry a resistance island containing genes such as chromosomally encoded metallo-beta-lactamases (MBLs) (e.g., TUS-1, MUS-1), tetX (tetracycline resistance), cat (chloramphenicol resistance), and bla-OXA-347/bla-OXA-209 (β-lactam resistance) [5]. This profile shows a strong resemblance to the "pan-drug resistant" (PDR) phenotype described by Karvar et al. in their outbreak, which exhibited resistance to all tested agents, including colistin [4]. Furthermore, the fact that all isolates in the outbreak reported by Kutlu et al. were also found to be resistant to all tested antibiotics is an indicator of how consistent and widespread this resistance profile is [14]. This implies that the resistance is not an adaptation that develops during treatment but rather an inherent, insurmountable characteristic of the bacterium. This carries a strong clinical message that any empirical therapy initiated with these antibiotic groups for a suspected Myroides spp. infection is destined to fail [4, 5].

The high resistance rate of 89.3% we detected against tigecycline, which is often considered a beacon of hope for treating Gram-negative pathogens, shows that even this last-resort antibiotic is not a reliable

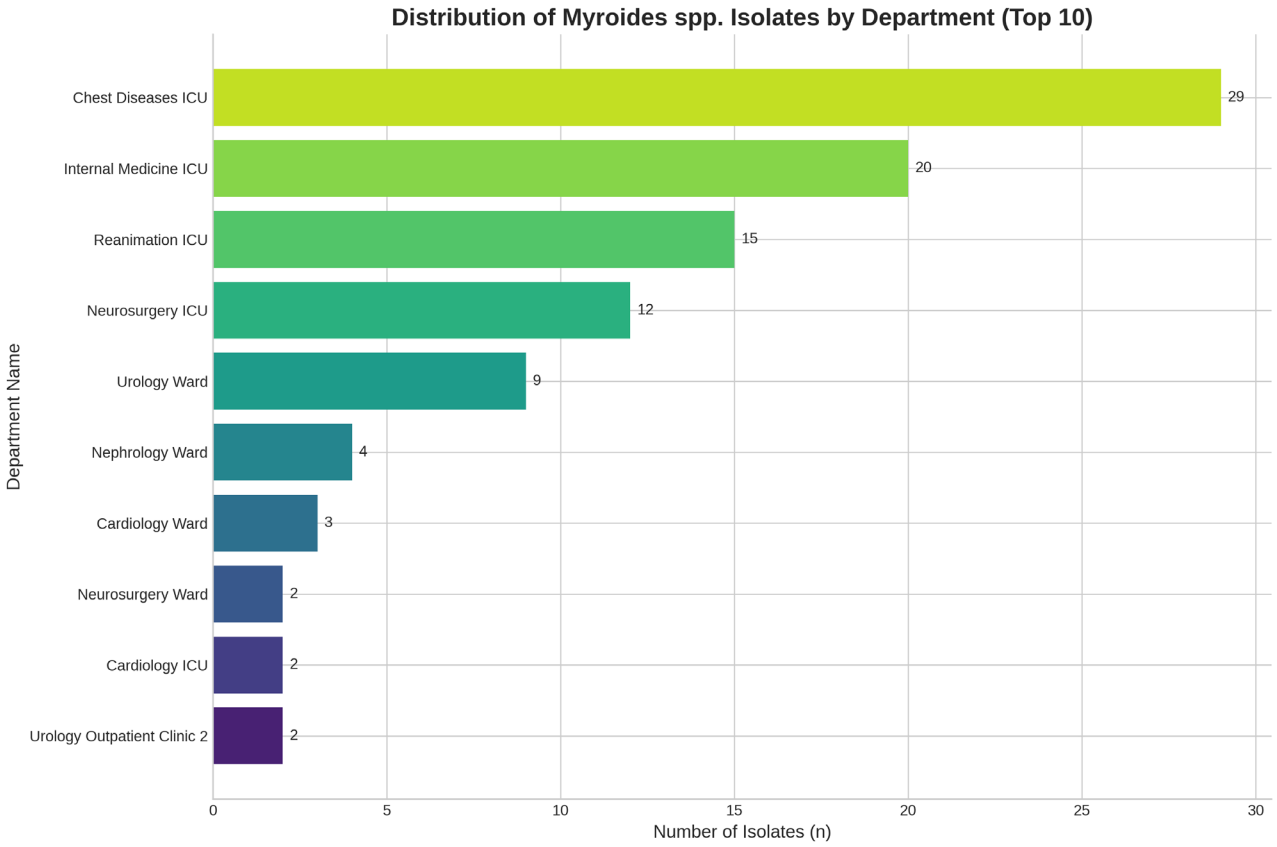

Figure 1. Distribution of Myroides spp. isolates by department (Top 10).

Table 1. Demographic and epidemiological data of the patients (n=106).

	Subgroup	Value
Gender	Male	77 (72.6%)
	Female	29 (27.4%)
Age (Year)	Mean	67.9
	Median	71
	Minimum	18
	Maximum	92
Sample Type	Urine	100 (94.3%)
	Blood	5 (4.7%)
	Catheter	1 (0.9%)
Department Type	ICU	83 (78.3%)
	Ward	20 (18.9%)
	Outpatient Clinic	3 (2.8%)

option against our local strains. Although this rate is lower than in another study where tet(X2) genes were detected and the tigecycline resistance rate was 100% [19], it proves the importance of regional resistance patterns and the necessity of basing treatment on in-vitrosusceptibility test results. This high resistance rate clinically aligns with the report by Kutlu et al. of treatment failure in a patient treated with tigecycline, demonstrating how severe the clinical repercussions of in-vitro resistance can be [14]. Although mortality data were not collected in our study, the severity of these infections cannot be ignored. The high mortality rate of 70.3% observed by Karvar et al. in a similar patient group during a PDR M. odoratimimus outbreak highlights the potential adverse impact of these infections on patient prognosis. The fact that this reported mortality rate was higher than the expected mortality based on patients' APACHE II scores and the overall ward mortality further underscores the seriousness of the situation [4]. Therefore, it is evident that we are facing a therapeutic crisis in the treatment of

Myroides spp. infections and that new treatment strategies are needed in case more virulent variants emerge.

The findings of this study hold significant implications for clinicians, microbiologists, and infection control committees. First, the rapid and accurate identification of Myroides spp. (using methods like MALDI-TOF MS as in our study) is crucial, as it allows for the early discontinuation of ineffective empirical therapies, potentially shortening hospital stays and helping prevent outbreaks. Second, the presence of such a highly resistant organism once again underscores the importance of antimicrobial stewardship programs and the rational use of antibiotics. The potential for carbapenemase-producing microorganisms to spread clonally by transferring resistance genes explains why these isolates spread more easily in the hospital environment and why they require more intensive infection control measures [20]. Third, and most importantly, the presence of Myroides spp. in ICUs highlights how meticulously basic infection control measures—such as catheter care protocols, hand hygiene, and environmental decontamination—must be implemented.

Our study has several limitations, such as its retrospective and single-center design, which limits the generalizability of our findings. Additionally, the lack of clinical outcome data (e.g., mortality, treatment response) prevents us from determining the true virulence of the isolated strains and the net impact of the infection on patient prognosis. Another limitation is that molecular typing methods, such as PFGE, were not used to investigate the clonal relationship among the isolates. Such methods could provide valuable data in investigating a genetic link between isolates, thereby elucidating a potential outbreak and cross-contamination pathways [14]. To distinguish between Myroides spp. colonization and infection, the patients' clinical signs and laboratory data must be evaluated alongside the culture result. The presence of clinical and laboratory findings is essential for diagnosing an infection; otherwise, the isolate should be considered a colonizer [16]. A further limitation of our study is the insufficient information to clearly differentiate between infection and colonization for our isolates. Future studies that can make this distinction will further deepen the body of literature on this rare pathogen.

In conclusion, this study has comprehensively demonstrated that Myroides spp. is a significant pathogen in our institution, with the potential to cause highly treatment-resistant nosocomial infections, primarily associated with the urinary tract in critically ill patients. These data provide a critical foundation to guide clinicians' diagnostic and therapeutic approaches, reinforce the role of laboratories in identifying this rare yet important pathogen, and strengthen the surveillance and prevention strategies of infection control committees. Continuous surveillance is of critical importance to monitor for potential changes in the epidemiology of this challenging pathogen.

Highlights

•Myroides spp. is a significant nosocomial pathogen predominantly isolated from elderly patients (mean age 67.9 years) hospitalized in intensive care units (78.3%).

•The bacterium exhibits a distinct affinity for the urinary tract, as the vast majority of isolates (94.3%) were obtained from urine samples.

•A profile nearing pan-resistance was observed, with all isolates demonstrating 100% resistance to all key antibiotics tested for empirical therapy, including piperacillin/tazobactam, ceftazidime, imipenem, amikacin, and ciprofloxacin.

•Therapeutic options are critically limited, as resistance to the last-resort antibiotic tigecycline was alarmingly high at 89.3%, underscoring the urgent need for strict surveillance and infection control protocols.

Conflict of Interest

The authors declare that they have no conflict of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgements

None.

Table 2. Antimicrobial resistance profile of Myroides spp. isolates (n=106).

Antibiotic	Resistance Rate (%)
Amikacin (AN)	100
Ciprofloxacin (CIP)	100
Imipenem (IPM)	100
Levofloxacin (LVX)	100
Piperacillin/Tazobactam (TZP)	100
Ceftazidime (CAZ)	100
Tigecycline (TGC)	89.3

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