



## MICROBIOLOGICAL ANALYSIS OF PERIPHERALLY INSERTED CENTRAL CATHETERS AND SHORT PERIPHERAL INTRAVENOUS CATHETERS: A CROSS-SECTIONAL STUDY\*

### ANÁLISE MICROBIOLÓGICA DE CATETERES CENTRAIS DE INSERÇÃO PERIFÉRICA E CATETERES INTRAVENOSOS PERIFÉRICOS CURTOS: UM ESTUDO TRANSVERSAL

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#### RESUMO

**Objetivo:** Analisar o perfil microbiológico de cateteres centrais de inserção periférica (*peripherally inserted central catheter*, PICC) e de cateteres intravenosos periféricos (CIVP) curtos. **Método:** Estudo transversal, quantitativo, realizado entre abril de 2023 e outubro de 2024. A retirada dos CIVP curtos foi indicada por sinais sugestivos de infecção, flebite ou outras alterações clínicas. A remoção dos PICC ocorreu por prescrição médica ou término da terapêutica. Dados sociodemográficos e clínicos foram coletados no momento da retirada de ambos os dispositivos. **Resultados:** Foram analisados 30 CIVP curtos, dos quais 12 (40%) apresentaram crescimento microbiano. Os microrganismos mais prevalentes foram *Staphylococcus epidermidis* e *Staphylococcus haemolyticus*, ambos resistentes a oxacilina, gentamicina, levofloxacina, clindamicina, eritromicina e rifampicina. Entre 18 pontas de PICC analisadas, 5,55% apresentaram crescimento de *Staphylococcus capitis*. Hemocultura positiva por *Pseudomonas putida* foi observada em 5,55% dos casos, sem crescimento correspondente na ponta do cateter. **Conclusão:** Houve predominância de bactérias Gram-positivas, com maior ocorrência nos CIVP curtos. Os achados indicam que o diagnóstico do paciente influencia o perfil microbiológico identificado.

**Descritores:** Cateterismo Periférico; Infecção Relacionada a Cateter; Cuidados de Enfermagem; Análise Microbiológica; Enfermagem.

#### ABSTRACT

**Objective:** To analyze the microbiological profile of peripherally inserted central catheters (PICC) and short peripheral intravenous catheters (PIVC). **Method:** A cross-sectional, quantitative study was conducted from April 2023 to October 2024. Removal of PIVC was indicated by signs suggestive of infection, phlebitis, or other clinical changes. Removal of PICC occurred per medical order or upon completion of therapy. Sociodemographic and clinical data were collected at the time of device removal. **Results:** A total of 30 PIVCs were analyzed, 12 of which (40%) showed microbial growth. The most prevalent organisms were *Staphylococcus epidermidis* and *Staphylococcus haemolyticus*. Both were resistant to oxacillin, gentamicin, levofloxacin, clindamycin, erythromycin, and rifampin. Of the 18 PICC tips, 5.55% yielded *Staphylococcus capitis*. A positive blood culture for *Pseudomonas putida* occurred in 5.55% of cases without corresponding growth on the catheter tip. **Conclusion:** Gram-positive bacteria predominated, with a higher occurrence in PIVC. Findings suggest that the patient's diagnosis influences the identified microbiological profile.

**Descriptors:** Peripheral Catheterization; Catheter-Related Infection; Nursing Care; Microbiological Analysis; Nursing.

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#### What is already known:

- Venous catheters can act as portals of entry for microorganisms and may be colonized by different agents.
- Even when colonization is present, a concurrent positive blood culture is not always observed.
- Some microorganisms are classically linked to bloodstream infection, although a direct causal link to the catheter is not always established.

#### What this study adds:

- PIVC showed higher colonization than PICC.
- Detection of microorganisms on the catheter was not associated with a high prevalence of positive blood cultures.
- The patient's underlying diagnosis influenced both the presence and characteristics of the microorganisms identified.

## INTRODUCTION

Intravenous therapy is among the most frequently used procedures in hospital care and relies on technologies such as short peripheral intravenous catheters (PIVC) and central venous catheters. Main indications include administration of medications, fluids, blood products, and parental nutrition<sup>(1-3)</sup>.

Data from Brazil's National Health Surveillance Agency (Anvisa) on patient-safety incidents reported in 2021 indicate approximately 40,000 failures involving venous catheters<sup>(4)</sup>. These figures underscore the need for continuous nursing care from catheter insertion through removal.

Catheter-related bloodstream infection (CRBSI) is a major complication associated with high mortality. International estimates range from 10% to 25%, and Brazilian studies in hospitalized patients report mortality as high as 40%<sup>(3,5)</sup>.

Short PIVC are widely used in intravenous therapy. Manufactured from polyurethane, they measure less than 60 mm and range from 14 to 26 gauge (G). Despite their routine use, they may lead to infiltration, extravasation, occlusion, and phlebitis, the latter defined as inflammation of the venous intima<sup>(2,6-7)</sup>.

Beyond clinical consequences, adverse events from intravenous devices prolong hospital stay and increase care costs<sup>(8)</sup>.

This study also addresses the peripherally inserted central catheter (PICC), which is a long-term, semi-implantable central device. It is inserted through peripheral veins, and the tip is positioned at the cavoatrial junction<sup>(2,9-11)</sup>. Although usually placed electively at the bedside, the PICC is invasive and requires specific nursing management, with an emphasis on best practices for insertion, maintenance, and removal to prevent complications and adverse events<sup>(2,3,12)</sup>.

Inadequate catheter care promotes microbial colonization and health care-associated infections (HCAIs). Multiple agents are implicated and frequently isolated from catheter tips, including *Staphylococcus aureus*, coagulase-negative staphylococci, *Pseudomonas aeruginosa*, *Enterobacter* spp., *Escherichia coli*, *Klebsiella* spp., *Candida albicans*, and other Gram-negative bacilli. Additional HCAIs involve *Enterococcus* and Gram-negative bacteria, often linked to urinary and respiratory tract infections<sup>(3,10,13)</sup>.

In the pathophysiology of CRBSI, colonization may occur via extraluminal and intraluminal routes, through infusion of contaminated solutions, or by hematogenous spread. In the latter, tip colonization may result from pre-existing infections at other sites<sup>(3)</sup>.

Thus, identifying microorganisms on catheter tips that may increase morbidity and mortality is essential. Microbiological analysis helps define the etiologic agents and guides prevention and control strategies. The findings are also expected to support health team training and routine im-

plementation of the institutional bundle.

This study addressed the following research questions: which microorganisms are present on PICC and short PIVC, and what are their antimicrobial susceptibility profiles? The objective was to analyze the microbiological profile of PICC and short PIVC.

## METHOD

This cross-sectional, quantitative study is reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline.

Data collection was conducted through a partnership between two public universities in the state of Rio de Janeiro. The setting comprised medical and specialty wards (rheumatology, neurology, and hematology) of a university hospital, from April 2023 to October 2024. Microbiological analyses were performed in the hospital's Microbiology Laboratory.

For short PIVC, sequential sampling was used because it was not possible to estimate a sample size owing to the lack of systematic records of devices inserted and removed during the study period. For PICC, the sample size was determined from the number of implants in the previous year (2023), applying the formula  $n = Z^2 \times p \times (1 - p) \div E^2$ , with  $Z = 1,96$  for a 95% confidence level, expected proportion  $p$ , and margin of error  $E = 0,02$ . Substituting  $p = 0,9231$  yielded  $n = 15$ . A total of 18 PICC tips were collected.

Inclusion criteria were patients of both sexes, adolescents (12-18 years), adults (> 18 years), and older adults ( $\geq 60$  years) using short PIVC or PICC inserted at the study hospital, with device dwell time > 48 h. Exclusion criteria were pregnancy (suspected or confirmed) and cognitive impairment.

The study complied with Brazilian National Health Council Resolution 466/12. All eligible participants were informed about the study objectives, risks, and benefits; those who consented signed written informed consent. Patients with cognitive impairment were not included because they could not provide informed consent; pregnant individuals were excluded given increased susceptibility to infections during gestation.

Clinical and sociodemographic data were extracted from the electronic medical record using standardized institutional instruments. Data collection was performed by two researchers and trained nurses.

Catheter removal followed a standardized aseptic technique to avoid sample contamination. For both devices, the procedure occurred in three steps: i) disinfection of the insertion site and adjacent skin with 70% alcohol; ii) after removal, for PICC, a 5-cm segment of the distal tip was cut with a sterile blade; for short PIVC of different types and sizes, the deepest intradermal segment was measured and collected without prior flushing; and iii) the fragment was

placed in a sterile container without transport medium and sent to the laboratory within 1 hour to prevent excessive drying<sup>(3,14)</sup>.

For short PIVC, removal was prompted by signs suggestive of infection, phlebitis, or other changes that resulted in loss of peripheral access. The Infusion Nurses Society Visual Phlebitis Scale was used<sup>(2)</sup>. Insertion-site infection was diagnosed by the presence of at least two of the following: edema, pain, paresthesia, warmth, and erythema, with or without purulent exudate, extending up to 2 cm around the insertion site, plus fever and/or chills; systemic infection could be present or absent.

For PICC, removal followed the institutional protocol, either by medical order or completion of therapy. For tip culture, counts > 15 colony-forming units (CFU) were considered indicative of infection/colonization<sup>(3)</sup>.

In the laboratory, catheter tips were inoculated onto blood agar and processed using the semiquantitative Maki roll-plate technique, gently rolling the fragment with sterile forceps over the agar surface, followed by incubation for 24-48 h to detect extraluminal biofilm<sup>(15)</sup>. After incubation, CFU were quantified, and samples were analyzed on the VITEK<sup>®</sup> 2 System<sup>®</sup> (bioMérieux) using Gram-positive and Gram-negative identification cards, following the manufacturer's instructions. Identification accuracy  $\geq 90\%$  at genus and species levels was considered acceptable. Antimicrobial susceptibility testing (AST) was performed on the VITEK<sup>®</sup> 2 using the AST cards 637 (Gram-positive) and 409 (Gram-negative), with interpretation according to the Brazilian Committee on Antimicrobial Susceptibility Testing (BrCAST).

The outcome variable was presence/absence of microorganisms. Explanatory variables included sociodemographic data (age, sex) and clinical-therapeutic data (medical diagnosis and device indication). For PICC, the following were additionally recorded: catheter impregnation, number of lumens, French size (F), zone insertion method (ZIM) area, use of maximal barrier precautions at insertion, antiseptic, number of attempts, performance of dermatotomy, first dressing and fixation method, scheduled maintenance, reason for removal, signs of infection at removal, prior blood culture collection, isolated microorganism, and dwell time. For short PIVC, G and dressing type were recorded.

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Descriptive statistics included simple frequencies and percentages, mean, and standard deviation. Data were tabulated in Microsoft Excel and initially analyzed using descriptive statistics. Inferential analyses were conducted in IBM SPSS Statistics for Windows, version 20 (IBM Corp., Armonk, NY, USA), adopting  $p < 0,05$ . Normality was assessed with the Kolmogorov-Smirnov test. The chi-square test was used for sociodemographic variables and Fisher's exact test for clinical variables. Based on these results, logistic regression was fitted considering  $n = 18$  for PICC, and the odds ratio (OR) was calculated to estimate the odds of infection, as bacterial growth was observed in only one of the tips analyzed.

## RESULTS

The sample included 45 participants of both sexes; 17 (37.77%) had PICC and 28 (62.23%) had short PIVC. In total, 18 PICC and 30 short PIVC were collected, since the same patient could use more than one device.

Among PICC users, most were male (58.82%). Age ranged from 17 to 73 years, with a median of 52 years. Hematologic diseases were the most frequent diagnoses (eight; 47.07%), followed by cardiovascular conditions (three; 17.65%). The main indications for PICC insertion were chemotherapy (nine; 50%) and antibiotic therapy (eight; 44.44%). In one case (5.56%), the indication was intravenous therapy lasting more than 21 days.

Regarding PICC characteristics, 13 devices (72.23%) had double lumens. The 5F diameter predominated (9; 66.67% of recorded cases). All catheters had a pressure-activated safety valve. Transparent sterile film was the most common dressing type, and in five insertions (27.78%) the dressing was impregnated with chlorhexidine. Stabilizing devices were used in all cases. Maximal barrier precautions and 0.5% chlorhexidine skin antisepsis were adopted in 100% of insertions. Puncture occurred in the green zone in 17 cases (94.44%). Device placement was successful on the first attempt, including dermatotomy when indicated.

PICC dwell time ranged from 6 to 256 days. The most frequent reason for removal was completion of intravenous therapy (seven; 38.88%). Maintenance followed the institutional protocol in 94.44% of insertions. Only one blood culture (5.55%) tested positive, with growth of *Pseudomonas putida*, although no microorganism was isolated from the corresponding catheter tip. Bacterial growth on the PICC tip was detected in one case (5.55%), identifying *Staphylococcus capitis*.

Among short PIVC users, ages clustered predominantly between 61 and 70 years. The mean was 54 years, with a standard deviation of 18, and there was a higher frequency of males. Ten catheters were 20G (33.33%) and 20 were 22G (66.67%). Neoplasms were identified in 13 patients (60%), neurological and rheumatologic diseases in seven (23.34%), and five individuals (12%) were undergoing diagnostic investigation, with infusion indications including hydration and antibiotic therapy. Dressings and fixation methods varied, including transparent films, adhesive tape, and microporous tape, revealing heterogeneous practices potentially associated with contamination risk.

Statistical analysis revealed significant associations for a set of variables. Age, sex, catheter gauge, and number of lumens were associated with the probability of infection (Table 1).

Age  $\geq 70$  years and male sex were significant risk factors for infection. Odds ratio (OR) analysis showed that males had approximately 2 times the odds of catheter-related bloodstream infection, and individuals aged  $\geq 70$  years had about 4 times the risk.

In microbiological analyses of catheter tips, colonization occurred in 12 short PIVC (40%) and in 1 PICC (5.55%). Both Gram-positive and Gram-negative microorganisms were identified, with a predominance of *Staphylococcus* spp., isolated in 11 samples (36.66%). The distribution of isolated microorganisms is presented in Table 2.

**Table 1** – Analysis of variables associated with infection risk by catheter type. Rio de Janeiro, RJ, Brazil, 2024 (n = 48)

Variable	PICC (n = 18)		Short PIVC (n = 30)		p-value*
	F	%	F	%	
Male sex	10	58.82%	17	60.71%	*0.53
Female sex	07	41.18%	11	39.28%	
20G	-	-	10	33.33%	*0.023
22G	-	-	20	66.66%	
Single lumen	05	27.77%	-	-	*0.014
Double lumen	13	72.23%	-	-	

\*Fisher’s exact test and chi-square test, comparing distributions between the PICC and short PIVC groups. PICC = peripherally inserted central catheter; PIVC = peripheral intravenous catheter; G = gauge.

Source: prepared by the authors, 2024.

**Table 2** – Microbiological analysis of collected catheter tips. Rio de Janeiro, RJ, Brazil, 2024 (n = 13 isolates)

Microbiological finding	Short PIVC – 20G	Short PIVC – 22G	PICC 4F	PICC 5F	PICC 6F
<b>Microorganisms</b>					
<i>Staphylococcus epidermidis</i>	0	3	0	0	0
<i>Staphylococcus haemolyticus</i>	1	2	0	0	0
<i>Klebsiella pneumoniae</i>	0	1	0	0	0
<i>Staphylococcus aureus</i>	0	0	0	0	0
<i>Staphylococcus capitis</i>	0	1	0	1	0
<i>Staphylococcus hominis</i>	1	2	0	0	0
<i>Staphylococcus warneri</i>	0	1	0	0	0

Note: PIVC = peripheral intravenous catheter; PICC = peripherally inserted central catheter; G = gauge; F = French.  
 Source: prepared by the authors, 2024.

The 22G catheters yielded a greater number of positive cultures, consistent with their higher frequency in the sample. Among the short PIVC collected, 30 (66%) were 22G and 10 (34%) were 20G. Microbiological analysis showed growth of more than one bacterial species in two tips, corresponding to patients 7 and 13. Patient 7 had a neoplasm and was under contact precautions; patient 13 had no diagnosis of immunosuppression and was not colonized.

Regarding resistance profiles, Table 3 summarizes the main microorganisms and their respective antibiograms among catheters that were positive with 100,000 CFU/mL of bacterial growth. The highest relative frequencies of resistance were observed for oxacillin (16.4%), clindamycin and levofloxacin (both 14.7%), and gentamicin (13.1%). Patients 7 and 13 showed no resistance. Patient 26 exhibited the broadest resistance profile and was already receiving vancomycin.

## DISCUSSION

Placing PICC requires adherence to best practices and depends on the training and expertise of professionals responsible for insertion, handling, and removal. Among the 18 PICC tips analyzed, only one showed microbial growth, identified as *Staphylococcus capitis*. This sample corresponded to a catheter from a patient who did not undergo the recommended periodic maintenance, reinforcing the importance of appropriate follow-up.

As recommended by Anvisa, central catheter insertion must strictly follow an insertion checklist, along with systematic monitoring of patients using the device in both inpatient and outpatient settings<sup>(3)</sup>. Within this scope, PICC implantation requires a rigorous aseptic technique with maximal barrier precautions, appropriate antiseptic, and a trained team. First-attempt success, facilitated by ultrasound-guided micropuncture, is desirable because multiple attempts increase pain and the risk of CRBSI<sup>(10)</sup>. These management elements may help explain the low colonization rate observed in PICC tips.

Most insertions occurred in the green zone according to the zone insertion method, which aims to reduce infection, thrombosis, and/or occlusion. The red zone is associated with a higher risk of occlusion and thrombosis due to limb flexion, whereas the yellow zone lies near the axilla, a moist region more prone to infection. In this method, puncture in the green zone is considered ideal<sup>(16)</sup>. Consistent adoption of this protocol likely contributed to the lower colonization, with identification only of *S. capitis*.

Literature supports that primary bloodstream infection rates are closely related to the implantation technique and to the rigor of prevention measures, directly influencing outcomes<sup>(3,17)</sup>. In line with current recommendations for CRBSI prevention, all PICC were secured with sutureless adhesive devices. In an Italian study of neonates, the use of cyanoacrylate glue in combination with transparent dressings was an alternative for stabilization, reducing accidental dislodgement of 35%-20% and helping control bleeding/exudate at the insertion site<sup>(7)</sup>.

Among the 18 PICC analyzed, blood culture was performed in one case and was positive for *Pseudomonas putida*; however, there was no bacterial growth from the corresponding catheter tip, suggesting no direct relationship between the device and the bacteremia in that episode.

In this case, the patient had non-Hodgkin lymphoma. Blood culture is the gold standard for identifying microorganisms associated with the catheter, and onco-hematologic patients are more prone to primary bloodstream infection due to characteristic neutropenia, with particular concern for a higher prevalence of multidrug-resistant Gram-negative bacteria<sup>(17)</sup>.

**Table 3 – Main microorganisms and resistance profiles in catheters with positive cultures. Rio de Janeiro, RJ, Brazil, 2024**

Patient ID	Microorganism	OXI	GEN	LEV	CLI	ERI	RIF	SUL	AMI	TEI	PEP	AMO	CIP	CEF
5	<i>Staphylococcus capitis</i>	X	X	X	X		X							
7	<i>Staphylococcus hominis</i>	X	X	X	X	X								
8	<i>Staphylococcus hominis</i>	X	X	X	X	X								
10	<i>Staphylococcus haemolyticus</i>	X	X	X	X	X	X	X						
13	<i>S. epidermidis/S. haemolyticus</i>	X	X											
14	<i>Staphylococcus epidermidis</i>	X	X	X	X	X				X				
18	<i>Staphylococcus epidermidis</i>	X			X									
26	<i>Klebsiella pneumoniae</i>	X	X	X	X	X	X	X	X	X	X	X	X	X
33	<i>Klebsiella pneumoniae</i>			X	X									

Note: OXI, oxacillin; GEN, gentamicin; LEV, levofloxacin; CLI, clindamycin; ERI, erythromycin; RIF, rifampin; SUL, sulfamethoxazole/trimethoprim; AMI, amikacin; TEI, teicoplanin; PEP, piperacillin/tazobactam; AMO, amoxicillin; CIP, ciprofloxacin; CEF, cefuroxime/cefuroxime axetil.

Source: prepared by the authors, 2024.

The insertion of short PIVC is an invasive procedure that disrupts the skin’s epithelial barrier and, if performed without rigorous aseptic technique, facilitates pathogen entry into the bloodstream. Nursing teams must therefore maintain strict care throughout insertion, maintenance, and removal to ensure patient safety and prevent complications<sup>(18)</sup>. Although short PIVC insertion is the most common vascular access procedure performed by nurses and technicians, technical errors occur frequently, increasing the risk of device loss due to phlebitis, infection, occlusion, and tip colonization by multiple microorganisms<sup>(19)</sup>.

Key infection risk factors include insertion site, catheter material, presence of multiple lumens, repeated punctures, dressing type, the microbiological profile involved, and the patient’s immune status. In this study, catheter gauge and number of lumens were associated with increased infection risk in the hospital setting. Inadequate measures at insertion may result in infiltration, occlusion, malfunction, and phlebitis, with consequences for morbidity and mortality, length of stay, and care costs<sup>(20)</sup>.

Catheter loss may also be related to colonization by the patient’s own microbiota, especially in the presence of immunosuppression due to rheumatologic, neurologic, or oncologic conditions. In this context, health professionals must ensure appropriate selection, insertion, and maintenance of intravenous devices, with continuous clinical surveillance and systematic assessment of patient responses to prevent failures, report events, and promote safety, particu-

larly in immunosuppressed individuals and/or those receiving antibiotics<sup>(2-3,21)</sup>.

Use of personal protective equipment for patients under contact precautions and proper hand hygiene remains essential to contain the spread of epidemiologically important microorganisms, including multidrug-resistant organisms<sup>(22)</sup>.

In the microbiological analysis, the genus *Staphylococcus* had the highest incidence on catheter tips. The literature identifies *Staphylococcus aureus* as a major Gram-positive agent in CRBSI, often originating from the patient’s skin at insertion or disseminated via health professionals<sup>(20)</sup>. Gram-positive bacteria such as *S. aureus* are most frequently involved in vascular access infections, particularly in immunocompromised patients and in prolonged catheterization<sup>(23)</sup>. In this study, approximately 67% of participants had neoplasms, a condition that, due to chemotherapy, reduces immune response effectiveness and increases susceptibility to CRBSI.

Gram-negative bacilli such as *Acinetobacter* spp., *Serratia* spp., *Enterobacter* spp., *Klebsiella pneumoniae*, *Pseudomonas* spp., and *Stenotrophomonas maltophilia* are frequently associated with HCAI, often originating in the hospital environment and favored by broad-spectrum antimicrobial use and cross-infection<sup>(23)</sup>. Herein, *K. pneumoniae* was identified in two catheter-tip samples from Patient 26, who was under contact precautions and had a history of autoimmune rheumatologic disease. Although Gram-positive organisms are common in bacterial infections, other infec-

tious sites may involve Gram-negative bacilli or polymicrobial infections, particularly when deep tissues are invaded<sup>(24)</sup>. Evidence also points to the growing importance of Gram-negative pathogens in infections among patients with solid tumors, with increasing multidrug resistance<sup>(24)</sup>.

With respect to antimicrobial resistance, a broad spectrum of resistance was observed among the microorganisms analyzed. Over recent decades, resistance across multiple antibiotic classes has progressed steadily. The 2019 report from the U.S. Centers for Disease Control and Prevention identified antimicrobial resistance as a major public-health threat<sup>(14)</sup>. This scenario limits therapeutic options for HCAI and, in U.S. hospitals, an estimated 70% of isolated microorganisms are resistant to at least one antibiotic, with half of infections related to invasive devices<sup>(25)</sup>. A plausible explanation for the expansion of resistance is indiscriminate antimicrobial use, which favors selection of resistant strains by eliminating more susceptible ones and enabling dissemination of resistance determinants<sup>(25)</sup>.

Negative catheter-tip cultures may be related to device material, such as polyurethane or silicone, which tends to be associated with fewer infectious complications and hinders microbial adhesion and infection, thereby improving safety<sup>(23)</sup>. This variable was not assessed in the present analysis. Conversely, the use of sterile, transparent dressings to occlude short PIVC, combined with appropriate skin antiseptics, reduces the occurrence of CRBSI and, consequently, tip colonization<sup>(3)</sup>, which is consistent with our findings.

Data suggest that infection diagnosis was not necessarily associated with catheter type but rather with adherence to best practices by the nursing team during device selection, insertion, maintenance, and removal. Consistent implementation of aseptic measures was decisive for risk reduction, underscoring the central role of nursing in preventing infections and promoting a culture of patient safety.

Laboratory logistics prevented sample submissions on weekends and holidays. For short PIVC, nonprobability sampling may have introduced selection bias. Additional losses occurred due to short PIVC samples not meeting predefined size criteria and difficulties standardizing the length of submitted fragments. It is also important to note that the evaluated devices differ in nature, with PICC being a long-term catheter. Moreover, the use of nonsterile dressings on short PIVC and occasional insertions without strict aseptic technique may have influenced the results, and translocation of skin microbiota into the vessel during insertion cannot be excluded.

Further investigations focusing on short PIVC are

warranted, given their widespread use in medical wards, along with deeper analysis of potential failures associated with these devices, considering the impact on adverse events and patient safety risks.

## CONCLUSION

The microbiological analysis of PICC and short PIVC revealed a predominance of Gram-positive bacteria, with a higher incidence in short PIVC. *Staphylococcus* spp. — particularly *S. epidermidis*, *S. haemolyticus*, and *S. hominis* — were the most frequently identified microorganisms, along with detection of *Klebsiella pneumoniae*. Among PICC samples, *Staphylococcus capitis* was identified in one case. Multidrug resistance was observed, most frequently to oxacillin, gentamicin, levofloxacin, and clindamycin.

Findings suggest that the patient's clinical condition influences the microbiological profile, reinforcing the need for continuous surveillance and strict adherence to best practices for insertion, maintenance, and removal of intravenous devices. Systematic incorporation of microbiological analysis into PICC and short PIVC management may support therapeutic decision-making, enhance nursing practice, and improve patient safety, particularly among immunocompromised individuals or those under contact precautions.

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## CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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All authors are responsible for the textual writing and critical review of the intellectual content, the final published version, and all ethical, legal, and scientific aspects related to the accuracy and integrity of the study.



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