

Multidrug-resistant microorganisms in military intensive care: analysis of positive microbiological surveillance records

Microorganismos multirresistentes em cuidados intensivos militares: análise de registros positivos de vigilância microbiológica

Microrganismos multirresistentes em terapia intensiva militar: análise de registros positivos de vigilância microbiológica

Raquel Lúcio Walverde¹

ORCID: 0000-0001-5470-2946

**Priscila Brigolini Porfírio
Ferreira¹**

ORCID: 0000-0001-7225-2782

Patricia da Silva Olario¹

ORCID: 0000-0002-5598-4049

**Aline Miranda da Fonseca
Marins¹**

ORCID: 0000-0002-3398-9922

Iuri Bastos Pereira¹

ORCID: 0000-0002-6323-2883

**Soraia do Socorro Furtado
Bastos¹**

ORCID: 0000-0002-1124-9456

Francimar Tinoco de Oliveira^{1*}

ORCID: 0000-0001-7477-6723

¹Universidade Federal do Rio de Janeiro. Rio de Janeiro, Brazil.

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*Corresponding author:

fran.toliveira@gmail.com

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Abstract

This study aimed to analyze the profile of positive microbiological surveillance records for multidrug-resistant microorganisms in the Intensive Care Units of a military hospital in Rio de Janeiro, considering recommendations from the World Health Organization and the National Health Surveillance Agency regarding the prevention and control of their spread. It was an observational, descriptive, and retrospective study with a quantitative approach, based on institutional microbiological surveillance records and conducted in the ICUs of a military hospital in Rio de Janeiro between January 2020 and December 2023. Descriptive statistical analysis was performed. A total of 1,699 positive records were identified, with a predominance of male patients. Carbapenem-resistant Enterobacteriaceae were the most frequent, followed by *Acinetobacter baumannii*. The inability to identify unique patients and verify the completeness of the records limits the interpretation of frequencies and associated outcomes. The described profile provides a basis for defining local surveillance priorities and planning prevention and control measures. Key factors highlighted include the quality of record-keeping and the coordination among nursing staff, the multidisciplinary team, and management to guide continuing education and monitoring of practices.

Descriptors: Infections; Drug Resistance, Microbial; Intensive Care Units; Military Hospitals; Epidemiological Monitoring.

Resumen

Este estudio tuvo como objetivo analizar el perfil de los registros positivos de vigilancia microbiológica de microorganismos multirresistentes en las unidades de cuidados intensivos de un hospital militar del municipio de Río de Janeiro, a la luz de las recomendaciones de la Organización Mundial de la Salud y de la Agencia Nacional de Vigilancia Sanitaria para la prevención y el control de su diseminación. Se trata de un estudio observacional, descriptivo y retrospectivo, con un enfoque cuantitativo, basado en registros institucionales de vigilancia microbiológica, realizado en las unidades de cuidados intensivos de un hospital militar del municipio de Río de Janeiro entre enero de 2020 y diciembre de 2023. Se llevó a cabo un análisis estadístico descriptivo. Se identificaron 1.699 registros positivos, con un predominio del sexo masculino. Se observó una mayor frecuencia de enterobacterias resistentes a los carbapenémicos, seguidas por *Acinetobacter baumannii*. La imposibilidad de identificar a pacientes únicos y de verificar la integridad de los registros limita la interpretación de las frecuencias y de los desenlaces asociados. El perfil descrito proporciona elementos para definir prioridades de vigilancia local y planificar acciones de prevención y control. Cabe destacar la importancia de la calidad de los registros y la articulación entre el personal de enfermería, el equipo multiprofesional y la gestión, con el fin de orientar la educación permanente y el seguimiento de las prácticas.

Descriptores: Infecciones; Farmacorresistencia Microbiana; Unidades de Cuidados Intensivos; Hospitales Militares; Vigilancia Epidemiológica.

Resumo

Este estudo buscou analisar o perfil dos registros positivos de vigilância microbiológica para microrganismos multirresistentes nas unidades de terapia intensiva de um hospital militar do município do Rio de Janeiro, à luz das recomendações da Organização Mundial da Saúde e da Agência Nacional de Vigilância Sanitária para a prevenção e o controle de sua disseminação. Trata-se de estudo observacional, descritivo, retrospectivo, de abordagem quantitativa, baseado em registros institucionais de vigilância microbiológica, conduzido nas Unidades de Terapia Intensiva de um hospital militar do município do Rio de Janeiro, entre janeiro de 2020 e dezembro de 2023. Realizou-se análise estatística descritiva. Identificaram-se 1.699 registros positivos, com predominio do sexo masculino. Houve maior frequência de Enterobactérias resistentes a carbapenêmicos, seguidas por *Acinetobacter baumannii*. A impossibilidade de identificar pacientes únicos e verificar a completude dos registros limita a interpretação das frequências e dos desfechos associados. O perfil descrito oferece subsídios para definir prioridades de vigilância local e planejar ações de prevenção e controle. Destacam-se a qualificação dos registros e a articulação entre enfermagem, equipe multiprofissional e gestão para orientar a educação permanente e o monitoramento das práticas.

Descritores: Infecções; Resistência Microbiana a Medicamentos; Unidade de Terapia Intensiva; Hospitais Militares; Monitoramento Epidemiológico.



Introduction

In 2017, the World Health Organization (WHO) published the Priority Pathogens List, a document identifying microorganisms with a high potential to affect human health worldwide. Among the pathogens described, those of relevance in hospital settings stand out, especially because they are associated with healthcare-associated infections (HAIs) that are difficult to treat and frequently linked to antimicrobial resistance. These include carbapenem-resistant Enterobacterales (CRE), methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus* (VRE), *Pseudomonas aeruginosa*, and *Acinetobacter baumannii*¹.

In 2022, the WHO published its global report on infection prevention and control, reaffirming that infection prevention and control, together with antimicrobial resistance (AMR), continue to represent major global health challenges. These issues have been addressed for years and are considered priorities by WHO Member States and partners. Unfortunately, the report's comparison of surveys conducted in 2017–2018 and 2021–2022 revealed that infection prevention and control programs had been implemented to a limited and inconsistent extent worldwide².

In 2024, a new publication based on the 2017 edition¹, updated the list of antibiotic-resistant bacterial pathogens, classifying them into critical, high, and medium priority groups. Its purpose was to guide research and development, public health interventions, and investments in AMR prevention through regionally adapted strategies³.

According to the Brazilian Health Regulatory Agency (Agência Nacional de Vigilância Sanitária - ANVISA), the most widely used definition of a multidrug-resistant (MDR) microorganism is resistance to three or more classes of antimicrobial agents. However, the identification of resistance does not distinguish colonization from infection. Colonization is characterized by the presence of microorganisms without impairment of the normal functions of the organ or tissue or an inflammatory response attributable to them, whereas infection involves microbial multiplication accompanied by organic changes. This distinction requires the joint interpretation of the isolation site and the patient's clinical condition⁴.

Intensive care units (ICUs) are settings conducive to the development of hospital-acquired infections caused by MDR microorganisms, particularly because patients are highly exposed to invasive procedures. These infections increase patient morbidity and mortality and directly affect treatment costs, the availability of therapeutic alternatives, length of hospital stay, and the risk of death⁵.

MDR microorganisms can spread within ICUs through contact with healthcare professionals and contaminated surfaces, requiring targeted measures to control infection and colonization⁵. In this regard, epidemiological surveillance plays an essential role in the early identification of carriers. It is an effective strategy for preventing HAIs through surveillance cultures, which are essential for detecting and monitoring microorganisms that

pose potential risks to human health and thereby contribute to their prevention and control⁴.

These strategies are coordinated by the Healthcare-Associated Infection Control Service, which comprises professionals with appropriate qualifications who are designated to perform this function. Nurses are responsible for activities ranging from training in standard operating procedures (SOPs), the correct use of personal protective equipment (PPE), hand hygiene, and equipment and isolation management to continuing education to ensure compliance with established measures and the monitoring of epidemiological surveillance data⁶. Strengthening protection within the hospital environment also involves providing guidance to caregivers and visitors, ensuring the proper disposal of bodily fluids, and maintaining environmental cleanliness. These actions complement surveillance strategies⁴.

The increasing prevalence of MDR microorganisms in ICUs is one of the main challenges to patient safety and healthcare systems worldwide. The COVID-19 pandemic, a period marked by an increase in infections caused by critical Gram-negative bacteria and by rising levels of antimicrobial resistance, exacerbated this situation^{7–10}. Among the pathogens of greatest epidemiological relevance are *Acinetobacter baumannii* and *Klebsiella pneumoniae*, which are frequently associated with carbapenem resistance, environmental persistence, and high morbidity and mortality rates^{11–16}. Studies conducted in Brazil, Mexico, Iran, and Jordan have reported extremely high rates of CRAB/XDR strains, frequently exceeding 90%, with case-fatality rates approaching 80%^{11–14}.

Gram-negative bacteria, particularly *Acinetobacter* spp., *Klebsiella* spp., and *Pseudomonas aeruginosa*, are among the main causes of HAIs in ICUs^{17–26}. Ventilator-associated pneumonia, bloodstream infections, and urinary tract infections are among the most frequent infection sites and are often associated with unfavorable outcomes^{19–23}. The high prevalence of extended-spectrum beta-lactamase (ESBL)-producing strains, carbapenem resistance, and the emergence of colistin resistance demonstrate the increasingly limited range of available therapeutic options^{18,19,21–25}.

In this context, understanding the local profile of MDR microorganism colonization among critically ill patients is essential to support the development of institutional antibiograms, strengthen antimicrobial stewardship programs, and implement targeted infection surveillance, prevention, and control measures. These efforts may help reduce transmission and improve patient outcomes. This study is justified by the epidemiological, clinical, and institutional importance of monitoring MDR colonization, thereby contributing to resistance mitigation strategies and improved clinical outcomes. The study was guided by the following questions: "Which MDR microorganisms most commonly colonize patients in the ICUs of a military hospital in the municipality of Rio de Janeiro, and what actions can be adopted to prevent this colonization?" The objective was to analyze the profile of positive microbiological surveillance records for MDR microorganisms in the ICUs of a military



hospital in the municipality of Rio de Janeiro, considering WHO and ANVISA recommendations for preventing and controlling their spread.

Methodology

This was an observational, descriptive, retrospective study with a quantitative approach, based on institutional microbiological surveillance records. It was conducted in the ICUs of a military hospital located in the municipality of Rio de Janeiro, Brazil, with 30 adult ICU beds.

The data source consisted of surveillance spreadsheets maintained by the Hospital Infection Control Service (Serviço de Controle de Infecção Hospitalar - SCIH), which contained exclusively positive results submitted to the service. All available records from January 2020 to December 2023 originating from the institution's ICUs were included, provided they were associated with individuals aged 18 years or older and were positive for one of the five microbiological categories investigated: CRE, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, VRE, and MRSA.

The unit of analysis was each positive record available in the spreadsheets. Records originating from other hospital departments and those concerning individuals younger than 18 years were excluded. The database did not allow unique patients to be identified or each record to be linked to a distinct sample or microbiological isolate. It was also not possible to determine whether repeated positive results or multiple isolates from the same individual had occurred or had been addressed. Counts were therefore expressed as frequencies of positive records.

The institutional microbiological surveillance protocol included screening upon admission and during hospitalization. For hospital stays exceeding seven days with initially negative cultures, weekly screening was planned. Samples were collected by the healthcare team using bilateral nasal swabs for MRSA, rectal or perianal swabs for VRE and CRE, and oropharyngeal or rectal swabs for *P. aeruginosa* and *A. baumannii*, according to the reported institutional protocol.

Microbiological identification and classification were used as recorded by the SCIH. The identification methods, antimicrobial susceptibility tests, and laboratory criteria required to retrospectively verify the multidrug-resistance classification were not available. The researchers did not conduct independent laboratory validation.

The variables analyzed were microbiological category, year of record, sex as reported in the spreadsheet, and associated outcome. Outcomes were limited to discharge and death, as provided in the available consolidated dataset. The source also included length of hospital stay, but it was not possible to reconstruct how these records had been handled in the consolidation analyzed. The available information did not specify whether discharge referred to discharge from the ICU or from the hospital, the department in which death occurred, its cause, or the interval between sample collection and outcome.

Data selection and organization were guided by a checklist that included verification of eligibility criteria and distribution of records by year, microbiological category, sex, and outcome. The data were organized and analyzed using Microsoft Excel, part of Microsoft 365®, through descriptive statistics, with calculation of absolute and relative frequencies. Percentages for microbiological categories and sex were calculated using the 1,699 included records as the denominator. For the distribution of discharge and death, the denominator was the total number of records with those outcomes in each microbiological category. The analysis characterized the distribution of records available in the institutional source without estimating measures based on unique patients or attributing deaths to the identified microorganisms.

The study was conducted in accordance with Brazilian National Health Council Resolution No. 466/2012. The project was approved by the Research Ethics Committee of the Anna Nery School of Nursing at the Federal University of Rio de Janeiro under Certificate of Presentation for Ethical Consideration (CAAE) No. 76517123.6.0000.5238 and Opinion No. 6,635,151.

During manuscript preparation, the authors used the free versions of ChatGPT, Consensus, NotebookLM, and Claude to assist with language and methodological review, grammatical correction, and text organization. Content produced with this assistance was reviewed and edited by the authors, who assume full responsibility for the final version of the manuscript.

Results and Discussion

A total of 1,699 positive microbiological surveillance records were identified between January 2020 and December 2023. Of these, 1,011 (59.51%) were associated with male patients and 688 (40.49%) with female patients.

Table 1. Distribution of positive microbiological surveillance records by category and associated outcome. Rio de Janeiro, RJ, Brazil, 2020–2023

Microorganism	Positive swabs, n (%) ¹	Associated discharge, n (%) ²	Associated death, n (%) ²
MRSA	55 (3.24%)	35 (63.64%)	20 (36.36%)
<i>Acinetobacter baumannii</i>	540 (31.78%)	329 (60.93%)	211 (39.07%)
<i>Pseudomonas aeruginosa</i>	267 (15.72%)	173 (64.79%)	94 (35.21%)
CRE	759 (44.67%)	463 (61.00%)	296 (39.00%)
VRE	78 (4.59%)	46 (58.97%)	32 (41.03%)
Total	1,699 (100.00%)	1,046 (61.57%)	653 (38.43%)

Note: ¹Denominator: total number of positive records included (n = 1,699). ²Denominator: total number of records in the respective category; for the "Total" row, n = 1,699.

CRE was the most frequent category, accounting for 759 records (44.67%), followed by *Acinetobacter baumannii*,

with 540 (31.78%); *Pseudomonas aeruginosa*, with 267 (15.72%); VRE, with 78 (4.59%); and MRSA, with 55 (3.24%).



The distribution of microbiological categories and associated outcomes is presented in Table 1. The percentages for each microorganism were calculated using the 1,699 records as the denominator, whereas the percentages for discharge and death were calculated using the total number of records in the respective category.

Because it was not possible to identify unique patients or verify repeated samples, these frequencies describe the available records and do not constitute patient-level mortality estimates; therefore, they should not be interpreted as mortality rates.

The annual distribution of CRE records comprised 229 in 2020, 402 in 2021, 87 in 2022, and 41 in 2023. The highest number was observed in 2021, followed by a reduction in records over the subsequent two years. This variation describes the absolute frequency in the source consulted but does not establish whether colonization decreased, since the annual totals of screened patients and tests performed were unavailable, and the completeness of the records could not be verified.

Overall, 1,046 records (61.57%) were associated with discharge and 653 (38.43%) with death. In all categories, the proportion of records associated with discharge was higher than that associated with death. The percentages of records associated with death ranged from 35.21% for *P. aeruginosa* to 41.03% for VRE. Although VRE had the highest descriptive percentage, CRE accounted for the largest absolute number of records associated with death ($n = 296$). These measures do not represent patient-level mortality and do not allow the outcome to be attributed to the identified microorganism.

The main finding was the concentration of records in the CRE and *A. baumannii* categories, which together accounted for 1,299 records (76.46%). When *P. aeruginosa* was included, the three Gram-negative bacterial categories represented 92.17% of the analyzed dataset. This distribution characterizes the profile of positive results recorded by institutional surveillance and provides a reference for organizing monitoring activities. However, it does not demonstrate a higher prevalence of colonization among patients or establish transmission within the ICUs.

Regarding the predominance of records associated with male patients, although the care profile of a military hospital may contribute to this distribution, the numbers of hospitalized or screened men and women were unavailable, as were individual data on disease severity, length of stay, and exposure to devices. Therefore, the results do not support the conclusion that men are more susceptible to colonization or to the acquisition of multidrug-resistant microorganisms.

The peak in CRE records in 2021 occurred during the COVID-19 pandemic, a period associated with an increased prevalence of multidrug-resistant microorganisms in ICUs⁷⁻¹⁰. However, this temporal coincidence may inform discussion of changes in healthcare delivery and surveillance during that period. Because COVID-19 diagnoses, bed occupancy, antimicrobial consumption, device use, and changes in screening frequency were not analyzed, these factors remain explanatory hypotheses to be investigated

rather than mechanisms demonstrated by the results. Similarly, the reduction in CRE records in 2022 and 2023 cannot be attributed to the effectiveness of preventive measures or to the recovery of healthcare services following the pandemic.

Regarding outcomes associated with the records, the percentages for discharge and death describe information linked to positive results without identifying unique patients, causes of death, or the interval between sample collection and outcome. Therefore, the higher percentage of records associated with death for VRE does not demonstrate greater lethality, and the higher absolute number observed for CRE does not establish a greater causal impact on mortality.

Positive surveillance cultures must also be distinguished from the diagnosis of infection. According to ANVISA, the distinction between colonization and infection depends on the isolation site and the patient's clinical condition, rather than on microbiological identification alone. Consequently, the records analyzed do not establish the presence of active infection caused by the detected microorganism⁴.

Maintaining and strengthening infection prevention and control (IPC) programs requires multiple strategies and the engagement of the multidisciplinary team. Within this group, nurses play a fundamental role in preventing colonization and infection by MDR microorganisms, conducting clinical surveillance, supervising care practices, and coordinating preventive measures, integrating technical, managerial, and educational activities^{3,4,6}.

Training and continuing education activities conducted by nurses improve healthcare professionals' understanding and help foster changes in institutional culture and behavior. Key elements include monitoring, auditing, feedback on results, the adoption of a nonpunitive culture, and training and education for all staff members^{2,4,6}. Engaging patients, service users, caregivers, administrative support teams, ancillary departments, outsourced cleaning and sanitation services, and the wider community may further improve IPC outcomes^{2,4,6}.

Beyond individual precautionary measures, effective control of MDR microorganism dissemination in ICUs requires the coordinated implementation of complementary structural and organizational strategies. These include placing colonized or infected patients in single rooms or cohorting them to interrupt cross-transmission, particularly when bed capacity is under pressure; rigorous and systematic environmental cleaning and disinfection; surveillance cultures using screening swabs; decolonization strategies in outbreak settings or where prevalence is high; and specific precautions during the transfer and transport of colonized or infected patients. These precautions include notifying the receiving unit in advance, using PPE throughout transport, and disinfecting equipment after use. Implementing or strengthening antimicrobial stewardship programs is an integral component of these efforts, since the selective pressure exerted by inappropriate antimicrobial use is one of the main mechanisms driving the amplification of resistance in hospital settings^{4,6}.



Effective communication among team members, particularly during shift handovers, is an additional measure with a direct impact on patient safety. It reduces the likelihood of interruptions in precautionary measures and cross-contamination involving multidrug-resistant microorganisms^{4,6}. All implementation efforts require management support, adequate resources, and shared responsibilities, thereby avoiding the concentration of prevention efforts exclusively on individual behavior.

In addition to the strategies described, genomic surveillance has been identified as a resource for determining the genetic relatedness of isolates and characterizing the mechanisms underlying their increased antimicrobial resistance, particularly resistance to last-line antibiotics. Its implementation requires specialized technology and therefore greater financial investment, leading low- and middle-income countries to identify limited resources as a barrier to its full implementation. Beyond serving as a scientific method for characterization, genomic surveillance is an effective clinical decision-making and public health tool for guiding the rational use of antibiotics and strengthening infection control measures by accurately identifying “who” is spreading pathogens and “how” they are spreading within the hospital environment^{14,16,19}.

Finally, it is recommended that the institution establish a system for protected individual identification and record collection dates, outcomes, sample sites, microbiological methods, susceptibility profiles, and explicit rules for handling repeated records. Integrating these data with the total numbers of patients screened, tests performed, and negative results would make it possible to distinguish record frequencies from test positivity and patient-based measures.

Despite the limitations described, this study contributes to the systematization of microbiological surveillance records from a specific institutional setting, making available the profile of multidrug-resistant microorganism categories identified in the source consulted. This information provides a basis for discussing surveillance and prevention priorities within the institution and

highlights opportunities to improve data quality. The study's contribution lies in the contextualized description of the records and the identification of questions for future investigations. These analyses could be expanded by incorporating screening denominators, unique patient identification, and the integration of clinical and laboratory information.

Conclusion

This study described the distribution of 1,699 positive microbiological surveillance records from the ICUs of a military hospital in the municipality of Rio de Janeiro between 2020 and 2023. CRE was the most frequently recorded category, followed by *Acinetobacter baumannii* and *Pseudomonas aeruginosa*. The discharge and death outcomes associated with these records should be interpreted descriptively, because the inability to identify unique patients, verify repeated records, and ensure the completeness of the source precludes estimating the risk of colonization or death and establishing a causal relationship between the microorganisms and the outcomes.

The identified profile provides a basis for planning institutional infection prevention and control activities in accordance with WHO and ANVISA recommendations, including hand hygiene, contact precautions, environmental cleaning and disinfection, microbiological surveillance, and antimicrobial stewardship. Improvements in recordkeeping are also needed, including unique patient identification and documentation of tests performed and outcomes, to improve surveillance quality and enable future evaluations of preventive strategies.

Strengthening nurses' leadership in hospital infection control committees and coordination services, as well as in management, direct patient care, practice supervision, and continuing education, contributes to consolidating an institutional culture focused on patient safety. This reinforces the principle that prevention remains the most effective, safe, and cost-effective measure for addressing the challenges posed by antimicrobial resistance.

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