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Evaluation of the microbiological profile of patients admitted to the intensive care unit of a reference hospital in southwest Bahia

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Abstract

Objective: This study primarily aimed to evaluate the microbiological profile of patients hospitalized in an Intensive Care Unit (ICU) who were receiving antimicrobial treatment. A secondary objective was to analyze adherence to hospital infection control guidelines, specifically regarding prescription justification and the involvement of infectious disease specialists. **Methods:** We conducted a descriptive, quantitative, and cross-sectional study with a retrospective approach. Data were collected from the ICU of a reference hospital in southwestern Bahia during 2023. The study population included patients admitted and discharged within the same year who were undergoing antimicrobial treatment. Microbiological cultures analyzed included tracheal secretions, urine, skin, and blood cultures. **Results:** A total of 88 microorganisms were isolated from various samples, with the most frequent being tracheal secretion (34), urine (18), skin (14), and blood (14). The most prevalent pathogens were *Acinetobacter baumannii* (15.9%), *Klebsiella pneumoniae* (15.8%), *Pseudomonas aeruginosa* (14.8%), *Escherichia coli* (11.1%), and *Proteus mirabilis* (7.9%). Regarding prescribed antimicrobials, the AWaRe categorization showed a predominance of the "watch" category, with ceftriaxone (26.8%), piperacillin-tazobactam (16.6%), and meropenem (11.6%) being the most prominent. Additionally, there was a low incidence of consultations with infectious disease specialists and inadequate completion of prescription justification forms. **Conclusion:** The high prevalence of multidrug-resistant pathogens and the predominant use of "watch" category antimicrobials suggest the absence of an effective control program and the indiscriminate use of these drugs. Deficiencies in the Hospital Infection Control Committee's (CCIH) responsibilities, such as limited involvement of infectious disease specialists and inadequate justification of prescriptions, contribute to this scenario. Implementing strict guidelines and promoting regular consultations with infectious disease specialists are crucial to mitigate antimicrobial resistance and control the spread of these microorganisms.

Keywords: Agent, Antimicrobial; Intensive Care Units; Drug Resistance, Microbial.

Avaliação do perfil microbiológico de pacientes internados em unidade de terapia intensiva de um hospital de referência do sudoeste da Bahia

Resumo

Objetivo: Este estudo teve como objetivo principal avaliar o perfil microbiológico de pacientes internados em uma Unidade de Terapia Intensiva (UTI) que estavam em uso de antimicrobianos. Um objetivo secundário foi analisar a adesão às diretrizes de controle de infecção hospitalar, especialmente no que se refere à justificativa de prescrições e ao envolvimento de especialistas em doenças infecciosas. **Métodos:** Conduzimos um estudo descritivo, quantitativo e transversal, com abordagem retrospectiva. Os dados foram coletados na UTI de um hospital de referência no sudoeste da Bahia, durante o ano de 2023. A população de estudo incluiu pacientes admitidos e com alta no mesmo ano que estavam em tratamento antimicrobiano. As culturas microbiológicas analisadas abrangeram secreção traqueal, urina, pele e hemoculturas. **Resultados:** Foram isolados um total de 88 microrganismos de diversas amostras. As mais frequentes foram secreção traqueal (34), urina (18), pele (14) e sangue (14). Os patógenos mais prevalentes foram *Acinetobacter baumannii* (15,9%), *Klebsiella pneumoniae* (15,8%), *Pseudomonas aeruginosa* (14,8%), *Escherichia coli* (11,1%) e *Proteus mirabilis* (7,9%). Quanto aos antimicrobianos prescritos, a categorização AWaRe revelou uma predominância da categoria "vigilância", com destaque para ceftriaxona (26,8%), piperacilina-tazobactam (16,6%) e meropenem (11,6%). Adicionalmente, observou-se uma baixa ocorrência de pareceres de infectologistas e um preenchimento inadequado das fichas de justificativa de prescrição. **Conclusão:** A alta prevalência de patógenos multirresistentes e o uso predominante de antimicrobianos da categoria "vigilância" sugerem a ausência de um programa de

controle eficaz e o uso indiscriminado desses fármacos. As deficiências no cumprimento das responsabilidades da Comissão de Controle de Infecção Hospitalar (CCIH), como a limitada participação de infectologistas e a falha na justificativa das prescrições, contribuem para esse cenário. A implementação de diretrizes rigorosas e a promoção de consultas regulares com especialistas em infectologia são cruciais para mitigar a resistência antimicrobiana e controlar a disseminação desses microrganismos.

Palavras-chave: Agentes Antimicrobianos; Unidades de Terapia Intensiva; Resistência a Medicamentos Antimicrobianos.

Introduction

The indiscriminate use of antimicrobials (ATM) in hospitals is a global problem, impacting public health. According to the World Health Organization (WHO), more than 50% of antibiotics are used inappropriately in several countries. To monitor their consumption and mitigate microbial resistance, the organization developed the AWaRe classification (Access, Watch, Reserve), a system that supports the monitoring of antibiotic consumption, the establishment of guidelines, and the analysis of the impact of strategies for the rational use of these drugs, contributing to the control of antimicrobial resistance. [1]

In healthcare services, infections predominate in intensive care units (ICUs), generally associated with invasive procedures, patient severity, prolonged hospitalization, the presence of multidrug-resistant microorganisms (MDR), and the inappropriate prescription of antimicrobials. According to the Brazilian Health Regulatory Agency (ANVISA), the increase in microbial resistance, marked by the emergence of superbugs, is directly associated with the misuse of these drugs, which, although seemingly harmless, cause serious public health problems. In this context, Pereira et al. emphasize that microbial resistance represents a serious threat to public health, mainly intensified by the excessive and inappropriate use of these drugs in humans, as well as by the ineffective implementation of preventive measures against infections.[2,3]

A study published in *The Lancet* (2022), analyzing data from 204 countries for the year 2019, estimated that antimicrobial resistance (AMR) contributed to 4.95 million deaths, with 1.27 million directly attributable to infections caused by resistant microorganisms. The study identified *Escherichia coli* as the leading pathogen associated with AMR-related deaths, followed by *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Streptococcus pneumoniae*, *Acinetobacter baumannii* complex, and *Pseudomonas aeruginosa*. These microorganisms accounted for 929,000 deaths directly related to AMR and 3.57 million deaths associated with antimicrobial resistance. [4]

In summary, ANVISA projects that by 2050, one person will die every three seconds as a result of conditions caused by antimicrobial resistance, leading to approximately 10 million deaths per year, surpassing the current cancer mortality rate (8.2 million annual deaths). Reducing the excessive use of antimicrobials is therefore crucial for the effective control of infectious diseases, ensuring their efficacy when truly necessary. [5]

In view of this, Pereira, Andrade, and Abreu stress that rigorous analysis of medical prescriptions is essential to prevent bacterial resistance, ensuring that the type, dose, and duration of antimicrobial treatment are appropriate to the patient's condition, thus avoiding inappropriate or unnecessary use. Therefore, they highlight the relevance of the hospital pharmacist within the multidisciplinary team, emphasizing their role in infection control and antimicrobial management.[6,7]

Given the above, this study aims to fill a gap in the literature by assessing the microbiological profile of patients undergoing antimicrobial therapy admitted to an intensive care unit, thereby enabling a comprehensive characterization of the hospital's microbial landscape. Furthermore, it intends to examine the prescribing patterns of these drugs, pointing to potential deficiencies in their appropriate administration, a crucial factor in the spread of antimicrobial resistance.

Methods

Study design and setting

A retrospective, descriptive, and quantitative cross-sectional study was conducted with patients admitted to an ICU of a public hospital in the interior of Bahia, Brazil, during the year 2023. The study site was a large, state-reference hospital with 336 active beds. It serves a population of over 600,000 inhabitants from 27 municipalities referred to this unit through the Municipal Regulation Center, the State Regulation Center, and spontaneous demand (without regulation). The hospital offers specialties in internal medicine, general surgery, orthopedics, neurosurgery, pediatrics, psychiatry, adult and pediatric emergency care, as well as adult and pediatric intensive care. The adult ICUs are subdivided into four units: two with 10 beds and two with 9 beds. For this study, a general-profile ICU with 9 beds was selected.

Sample, inclusion, and exclusion criteria

All medical records of patients admitted to the selected ICU in 2023, who received antimicrobial therapy and had a clinical outcome (discharge, death, or transfer) within the same year, were included. The year 2023 was chosen because an outbreak of multidrug-resistant microorganisms occurred during this period in the unit. Medical records of patients who received antimicrobials exclusively for surgical prophylaxis were excluded.

Data collection instrument

Data were collected between October 2023 and August 2024 by a previously trained team (composed of undergraduate research fellows and resident professionals) using an electronic instrument created in Google Forms, available only in the Google Drive of the principal investigators. The instrument was developed to meet the objectives of the present study. Data were retrospectively collected from patients' electronic medical records. Initially, the form underwent a pilot test in which the medical records of ten patients included in the study sample were analyzed, after which necessary adjustments were made.

Variables

Variables were divided into sociodemographic, clinical, microbiological, and pharmacological categories. Sociodemographic variables included sex (male or female), age group (adult: 18–59 years; elderly: 60–79 years; very elderly: ≥80 years), race/skin color (mixed-race or non-mixed-race), marital status (with or without a partner), and length of stay. According to the unit census, hospital stay was stratified into normal or prolonged using the 75th percentile as a cutoff. Patients hospitalized for <27 days were classified as normal stay, and those hospitalized for ≥27 days as prolonged stay. Other variables included justification form for antimicrobial prescription recorded in the medical record (yes or no), and outcome (death or survival, with survival defined as ICU discharge or hospital unit transfer).

Microbiological variables included infectious disease consultation (yes or no); presence of pressure injury (PI) (yes or no); use of indwelling urinary catheter (IUC) or intermittent urinary catheter (IUC-int) (yes or no); request for microbiological culture (yes or no); collection of microbiological culture (yes or no); whether antimicrobial cultures were collected before the initiation of antimicrobial therapy (yes or no); type of specimen requested; antimicrobial susceptibility test result (positive or negative); microorganisms isolated; and resistance mechanisms presented by pathogens.

Prescribed antimicrobials were classified according to their spectrum of activity and potential for developing microbial resistance, using the AWaRe tool. Thus, antimicrobials were categorized into three classes: Access (antimicrobials that may be used without restrictions, as they have lower resistance potential), Watch (antimicrobials that should be used with caution due to higher resistance potential), and Reserve (antimicrobials that should be used as last-resort options for treating confirmed or suspected infections caused by resistant microorganisms). The tool aims to promote rational use and combat microbial resistance, and its 2021 update includes a total of 258 antimicrobials.

Data analysis procedures

Only descriptive analysis of quantitative variables was performed, calculating absolute and relative frequencies, means, standard deviations (SD), and interquartile ranges. Data were tabulated in Microsoft Excel 2010 and analyzed using SPSS statistical software, version 21.0.

Results

Medical records of 259 patients admitted to the ICU who received at least one antimicrobial prescription were analyzed. The mean length of hospital stay was 21.17 days (SD ± 19.05), ranging from 1 to 105 days, considering all hospital sectors where the patient received care until the clinical outcome was defined. Among these patients, 247 (95.4%) were admitted through the emergency department, with an average stay of 3.73 days (SD ± 6.49); 130 (50.2%) were admitted to the inpatient ward, with an average of 5.56 days (SD ± 10.77); and all 259 (100%) remained in the ICU for a mean period of 12.31 days (SD ± 13.29).

Among the analyzed patients, 54.1% were male. The most common marital status was without a partner (65.3%). The majority self-identified as mixed-race (83.8%), and the predominant age group was 60–79 years, representing 44.0% of the sample. The most frequent outcome was death, recorded in 148 patients (57.1%). Only 29% of the medical records contained completed justification forms for antimicrobial prescriptions, as shown in Table 1.

During hospitalization, 15.4% of patients had an infectious disease consultation requested. Among the analyzed medical records, 29.3% (76) showed the presence of pressure injuries, and 78.4% (203) used an indwelling urinary catheter (IUC) and/or an intermittent urinary catheter (IUC-int).

Of the evaluated data, 60.6% of patients had requests for microbiological cultures, of which 97.5% were collected. Among these, 49.01% yielded positive results for microorganisms, and 34.6% were collected before the initiation of antimicrobial therapy, as described in Table 1.

The most frequently requested microbiological cultures were: first blood culture sample 26.4% (123), second blood culture sample 24.7% (115), urine culture 22.5% (105), orotracheal secretion 18.5% (86), and wound fragment 3.2% (15), as shown in Figure 1.

A total of 88 microorganisms were isolated from different types of clinical samples: 34 from tracheal secretions, 18 from urine cultures, 14 from skin samples, and 14 from blood cultures. Among the identified microorganisms, those that exhibited multidrug resistance (MDR), detected through laboratory analyses, were distributed as follows: *Acinetobacter* complex with ESBL production (10.2%), *Citrobacter freundii* with ESBL (1.1%), *Enterobacter aerogenes* with ESBL (1.1%), *Enterobacter cloacae* complex (2.4%), *Escherichia coli* with ESBL (3.4%), *Klebsiella pneumoniae* with ESBL (4.5%), *Klebsiella pneumoniae* KPC (4.5%), *Klebsiella pneumoniae* NDM (1.1%), *Proteus mirabilis* with ESBL (3.4%), *Proteus mirabilis* NDM (1.1%), *Pseudomonas aeruginosa* with KPC and NDM (1.1%), *Pseudomonas aeruginosa* with isolated NDM (2.4%), *Pseudomonas aeruginosa* with KPC (1.1%), *Serratia marcescens* with ESBL (1.1%), and *Staphylococcus aureus* with ESBL (1.1%).

According to Table 2, *Acinetobacter* showed 40% ESBL production and 60% overall resistance. *Escherichia coli* demonstrated 30% extended-spectrum β-lactamase (ESBL) production. For *Klebsiella pneumoniae*, 28.6% were identified with ESBL, 28.6% with KPC-type carbapenemase, and 7.14% with NDM. *Proteus mirabilis* exhibited 48.8% ESBL and 14.3% NDM. *Pseudomonas aeruginosa* showed 17.7% combined resistance to KPC and NDM, 15.4% exclusively NDM, and 7.7% exclusively KPC.

Ceftriaxone was the most prescribed antibiotic, used by 26.8% of patients, followed by the combination of piperacillin and tazobactam, accounting for 16.6% of prescriptions. Meropenem ranked third, corresponding to 11.6% of the total.

According to the AWaRe classification, antibiotics in the "Watch" group represented 72.2% of consumption, while those in the "Access" group accounted for 21.6%. "Reserve" drugs showed limited use, totaling only 1.9% throughout the year, as shown in Table 3.

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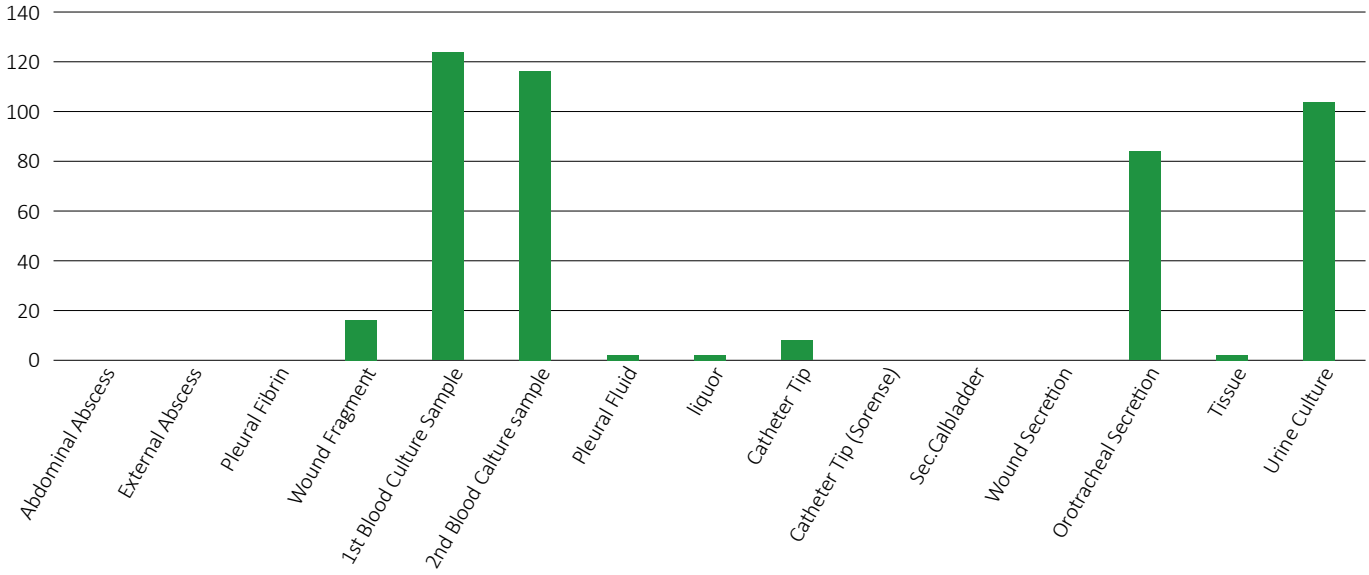
Table 1. Sociodemographic and microbiological characteristics of patients admitted to an intensive care unit in a referral hospital in southwestern Bahia, Brazil, in 2023 (N=259).

Sociodemographic[1]		Microbiological[2]	
Variable	N (%)	Variable	N (%)
Sex		Infectious disease consultation	
Female	119 (45.9)	Yes	40 (15.4)
Male	140 (54.1)	No	219 (84.6)
Race/Color		Pressure Injury (LPP)	
Brown	217 (83.9)	Yes	76 (29.3)
Non-Brown	41 (15.8)	No	183 (70.7)
No information	1 (0.4)	SVD / SVA	
Marital Status		Yes	203 (78.4)
Single	169 (65.3)	No	56 (21.6)
Married/Partnered	67 (25.9)	Microbiological culture request	
No information	23 (8.9)	Yes	157 (60.6)
Age Group		No	102 (39.4)
Adult	89 (34.4)	Microbiological culture collection	
Elderly	114 (44.0)	Yes	153 (97.5)
Long-lived	56 (21.6)	No	4 (2.5)
Length of Stay		Culture result	
< 27 days	192 (74.1)	Positive	67 (43.7)
≥ 27 days	67 (25.9)	Negative	86 (56.2)
Antimicrobial prescription justification form		Culture collected before antimicrobial prescription	
Yes	75 (29.0)	Yes	53 (34.6)
No	184 (71.0)	No	100 (65.4)
Outcome			
Death	148 (57.1)		
Survived	111 (42.9)		

[1]Source: Authors' elaboration, 2024; [2]Source: Authors' elaboration, 2024; LPP: Pressure Injury, SVD: Indwelling Urinary Catheter, SVA: Intermittent Urinary Catheter.

Figure 1. Records of microbiological culture collections from patients admitted to an intensive care unit in a referral hospital in southwestern Bahia, Brazil, in 2023.



Source: Authors' elaboration, 2024; Sec.: Secretion.

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Table 2. Characteristics of microorganisms isolated from microbiological cultures of patients admitted to an intensive care unit in a referral hospital in southwestern Bahia, Brazil, in 2023.

Laboratory Findings									
Microorganism Isolated	N	%	Blood	Ascitic Fluid	Skin	Catheter tip	Tracheal secretion	Ear secretion	Urine
Acinetobacter baumanni	5	5.7					5		
Acinetobacter baumanni complex ESBL	9	10.2	3			1	4		1
Burkholderia cepacia complex	2	2.4	1				1		
Candida albicans	2	2.4							2
Candida parapsilosis	1	1.1							1
Citrobacter freudii ESBL	1	1.1							1
Enterobacter aerogenes ESBL	1	1.1					1		
Enterobacter cloacae	1	1.1					1		
Enterobacter cloacae complex	2	2.4			1				1
Enterococcus faecalis	4	4.5							4
Enterococcus faecium	3	3.4	2						1
Escherichia coli	7	7.7			2		1		4
Escherichia coli ESBL	3	3.4				1	1		
Klebsiella pneumoniae	5	5.7			1		4		
Klebsiella pneumoniae ESBL	4	4.5	1		1	1			1
Klebsiella pneumoniae KPC	4	4.5					2		2
Klebsiella pneumoniae NDM	1	1.1	1						
Proteus mirabilis	3	3.4			1	1	1		
Proteus mirabilis ESBL	3	3.4			2	1			
Proteus mirabilis NDM	1	1.1			1				
Pseudomonas aeroginosas	9	10.2	1		1	1	5	1	
Pseudomonas aeroginosas KPC, NDM	1	1.1					1		
Pseudomonas aeroginosas NDM	2	2.4	1				1		
Pseudomonas aeroginosas KPC	1	1.1				1			
Serratia marcescens	2	2.4	1				1		
Serratia marcescens ESBL	1	1.1			1				
Staplylococcus aureas	6	6.9	2	2		2		2	
Staplylococcus áureas ESBL	1	1.1				1			
Stenotrophomonas maltophilia	2	2.4					2		
Streptococcus agalactiae	1	1.1	1						

Source: Authors' elaboration, 2024; X: Presence of microorganism in the microbiological culture; (n): Number of microorganisms isolated; ESBL: Extended-Spectrum Beta-Lactamase; KPC: Klebsiella pneumoniae carbapenemase; NDM: New Delhi Metallo-beta-lactamase; Blood (Hemo): Blood culture; Skin: Wound secretion and wound fragment; Asc. Fluid: Ascitic fluid.

Discussion

This study, conducted with patients admitted to an Intensive Care Unit (ICU), revealed the isolation of 88 microorganisms from different clinical samples. The most frequent microbiological cultures corresponded to 34 tracheal secretion samples, 18 urine cultures, 14 skin samples, and 14 blood cultures. Among the pathogens identified, the most prevalent were *Acinetobacter baumannii* (15.9%), *Klebsiella pneumoniae* (15.8%), *Pseudomonas aeruginosa* (14.8%), *Escherichia coli* (11.1%), and *Proteus mirabilis* (7.9%). Furthermore, most of the antibiotics prescribed in this study belonged to the "Watch" category of the AWaRe classification, accounting for 72.2% of prescriptions. The most frequently administered antibiotics were ceftriaxone (26.8%), piperacillin/tazobactam (16.6%), and meropenem (11.6%).

Table 3 . Number of prescriptions per patient and AWaRe classification of antibiotics prescribed to patients admitted to an intensive care unit in a referral hospital in southwestern Bahia, Brazil, in 2023.

Antimicrobial	N	%	AWaRe Classification
Ceftriaxone	220	26.8	Watch
Piperacillin + Tazobactam	136	16.6	Watch
Meropenem	95	11.6	Watch
Clindamycin	91	11.1	Access
Metronidazole	43	5.2	Access
Vancomycin	34	4.1	Watch
Teicoplanin	31	3.8	Watch
Azithromycin	28	3.4	Watch
Gentamicin	17	3.4	Access
Cefepime	15	1.8	Watch
Polymyxin B	15	1.8	Reserve
Levofloxacin	15	1.8	Watch
Ceftazidime	10	1.2	Watch
Ciprofloxacin	9	1.1	Watch
Amikacin	5	0.6	Access
Ampicillin	5	0.6	Access
Oxacillin	4	0.5	Access
Cefazolin	4	0.5	Access
Sulfamethoxazole + Trimethoprim	3	0.4	Access
Amoxicillin	2	0.2	Access
Amoxicillin + Clavulanate	2	0.2	Access
Ampicillin + Sulbactam	2	0.2	Access
Ceftazidime + Avibactam	1	0.1	Reserve

Source: Authors' elaboration, 2024. N: Number of prescriptions. AWaRe: WHO classification for monitoring antibiotic use.

One of the main findings was a mortality rate of 51.8% among patients. This result is consistent with the study by Menotti et al., which analyzed 144 patients admitted to three ICUs and found that 63.88% progressed to death during hospitalization. This outcome may be attributed to the clinical complexity of these patients, as well as the increased risk of infection by multidrug-resistant microorganisms, a factor that further worsens prognosis.[8]

A predominance of male patients (54.1%) and an age group of older adults between 60 and 79 years (44.0% of the sample) was observed. Similarly, a study conducted in Mozambique in 2023 analyzed 300 medical records and found a majority of male patients, totaling 59.3% (178 patients). The most prevalent age group was 35 years or older (40.3%; 121 patients); however, it should be noted that patients aged 60 years or older were also included in this proportion. In another study conducted at a University Hospital in Lagarto/SE, Souza et al. reported age variation among patients, although older adults accounted for the majority, representing 41.51% of the requests, reinforcing the results of this study.[9,10]

Supporting these findings, Garcia, Oliveira, and Nascimento pointed out that men often believe it makes no sense to seek care for potential health problems when they are asymptomatic, which contributes to their exposure to conditions that may worsen but could be detected earlier. Moreover, the persistence of a hegemonic model of masculinity contributes to men not seeking healthcare, as cultural norms hinder behaviors associated with self-care.[11,12]

On the other hand, Souza explained that the predominance of older adults in such studies may be related to physiological changes associated with aging, which affect the immune system and make individuals more susceptible to opportunistic infections, requiring the use of antibiotics. Additionally, hospitalization time and costs are higher among this age group compared to others.

From the analyzed data, 78.4% of patients used an indwelling urinary catheter (IUC) and/or a vascular access device (VAD) during hospitalization. In agreement with this study, Mota and de Oliveira reported that 25% of hospitalized patients use an IUC at some point, a percentage that reaches 70% in ICU admissions. Although a therapeutic resource, the IUC is the main risk factor for urinary tract infections (UTIs). UTIs are among the most frequent healthcare-associated infections (HAIs), arising from the colonization of microorganisms that affect the genitourinary tract, and account for approximately 30% of all adverse event reports.[14,15]

The prevalence of Pressure Injuries (PIs) was 29.3%, a relevant finding consistent with the results of a study conducted in a teaching hospital in Sergipe, which identified a 30.3% incidence of PIs among patients admitted to an Intensive Care Unit (ICU). The occurrence of these lesions is associated with longer hospital stays, an increased risk of severe infections such as sepsis, and higher mortality rates. These factors justify their direct relationship with the increased use of antimicrobials (ATM).[16,17]

The study revealed that 820 antimicrobials were prescribed to 259 ICU patients. However, only 75 (29%) of the medical records contained justification forms for antimicrobial prescriptions, required for evaluation by the Hospital Infection Control Committee (HICC). This gap is concerning, as the absence of such information prevents verification of the compatibility between the infection site and the antimicrobial selected for treatment, in addition to compromising the assessment of the real necessity of prescribing these drugs.

A study conducted in a university hospital in Piauí found that the release of antimicrobials for up to 7 days of treatment (D0–D6) may occur without HICC approval, provided that justification is documented in the medical prescription notes. For treatment extensions, however, approval by an infectious disease specialist is required. According to Menegueti et al., the main functions of the HICC include collecting and reporting infection types, standardizing antimicrobial use, and implementing justification forms for antimicrobial prescriptions. Nevertheless, the inadequate completion of these forms compromises compliance with these responsibilities.[18,19]

Furthermore, it was identified that most antibiotics prescribed in this study belonged to the "Watch" category of the AWaRe classification, accounting for 72.2%. The AWaRe classification is a key tool for monitoring antimicrobial resistance, aiming to ensure access to effective antibiotics. The WHO General Programme of Work for 2019–2023 set a national target for at least 60% of total antibiotic consumption to come from the "Access" group.

Bezerra et al. also reported that, in 2018, most antibiotics prescribed were in the "Watch" group, with 993 treatments, corresponding to 64% of the total. According to AWaRe, antibacterials prioritized for empirical therapy should be those in the "Access" category, as first- or second-choice agents, since they provide the best therapeutic value while minimizing resistance potential.[20,21]

Among the most frequently prescribed antimicrobials, ceftriaxone (26.8%), piperacillin+tazobactam (16.6%), and meropenem (11.6%) were highlighted. The high prescription rate of ceftriaxone, a third-generation cephalosporin, is explained by its global importance in antimicrobial therapy, being widely used due to its excellent bioavailability. Its extensive and empirical use is associated with high antibacterial efficacy, broad spectrum of action, and low toxicity. However, despite its relevance in infection management, there is a concerning incidence of inappropriate prescription and indiscriminate use, both in developed and developing countries, which contributes to the rise of antimicrobial resistance.

These findings highlight the importance of implementing an Antimicrobial Stewardship Program to reduce such rates and meet the targets established by WHO. As emphasized in this study, antibiotics from the "Watch" category are recommended as first- or second-choice therapy only for a limited and specific set of syndromes, as they are more prone to resistance development; thus, their use should be prioritized within antimicrobial control and stewardship programs.[22]

In a point-prevalence study conducted across 33 hospitals in five Latin American countries (Cuba, El Salvador, Mexico, Paraguay, and Peru), third-generation cephalosporins were the most prescribed class of antibiotics (26.8%), followed by carbapenems (10.3%) and fluoroquinolones (8%). Perez et al. demonstrated that the majority of antimicrobials used were bactericidal agents (90.4%), with cephalosporins (33.1%) and carbapenems (23.5%) being the most prominent, and the most frequently used drugs were ceftriaxone (26.5%) and meropenem (21.1%), corroborating the findings of this study.[23,24]

Rationalizing the use of antimicrobials is a key component of a multifactorial approach to preventing microbial resistance, aligning with the hypothesis that the healthcare environment plays a significant role in this process. In this context, Gyssens and Wertheim highlight a relationship between excessive antibiotic use and the emergence of microbial resistance. Therefore, reducing the consumption of these drugs may represent a beneficial strategy, particularly in healthcare institutions where antimicrobials are overprescribed.[25,26]

According to the collected data, 84.6% of patients did not have an infectious disease consultation recorded in their medical charts to validate antimicrobial prescriptions. A study by Souza et al. reported that 223 prescriptions (67.78%) were accepted without modifications by the infectious disease specialist, while 88 prescriptions (26.75%) were approved with modifications made by the specialists and pharmacy team. Only 18 prescriptions (5.47%) were not approved. Although the measurement of the latter indicator was not possible in this study, it reinforces the importance of evaluations by infectious disease specialists, which can significantly contribute to controlling inadequate or irrational prescriptions, thus reducing the emergence of multidrug-resistant (MDR) strains.[10] This study observed that only 60.6% (157) of patients had requests for microbiological cultures, and among these, only 34.6% were collected prior to the initiation of antimicrobial therapy.

Sick-Samuels et al. highlighted that the absence of microbiological testing is not necessarily associated with increased empirical antimicrobial use. However, the collection of samples after starting antimicrobials may have influenced culture results, as 56.2% (86) of samples returned negative for microorganisms.[27]

It is important to note that empirical antibiotic therapy is prescribed to treat known or suspected infections based on patient symptoms and the most likely pathogens before definitive test results, including antibiotic susceptibility tests, are available. Targeted antibiotic therapy, on the other hand, is initiated after microbial identification and susceptibility analysis, allowing the selection of the most effective antibiotic, preferably the least toxic, with a narrower spectrum, and the most cost-effective for treatment.[28]

Additionally, in the laboratory context, medications are often associated with clinical tests, potentially generating drug interactions that can impact results. While many of these effects are predictable, some interactions may lead to inaccurate data, compromising therapeutic efficacy. According to Masson et al., the use of antibiotics can interfere with cultures by inhibiting bacterial growth if the patient is under treatment. De Souza et al. recommended that, depending on the drug, therapy should be suspended for several days before laboratory tests, with a minimum pause of seven days for patients on antibiotics prior to culture testing.[21,29,30]

The most frequently detected microorganisms were *Acinetobacter baumannii* (15.9%), *Klebsiella pneumoniae* (15.8%), *Pseudomonas aeruginosa* (14.8%), *Escherichia coli* (11.1%), and *Proteus mirabilis* (7.9%). The microbiological cultures with the highest frequency of isolation included 34 tracheal secretion samples, 18 urine cultures, 14 skin samples, and 14 blood cultures. The most frequent pathogens included *Acinetobacter baumannii*, identified in 9 tracheal secretion samples with 44.4% resistance and in 3 blood cultures showing 100% resistance. *Pseudomonas aeruginosa* was isolated in 8 tracheal secretions with 37.5% resistance. *Klebsiella pneumoniae* was present in 6 tracheal samples with 33.3% resistance. Finally, *Escherichia coli* and *Enterococcus faecalis* were detected in 4 urine cultures each, with no resistance observed.

Data from ANVISA regarding healthcare-associated infections (HAIs) and microbial resistance in Brazilian healthcare facilities in 2023 indicate that the main microorganisms isolated in primary bloodstream infections were: coagulase-negative *Staphylococcus* (5,469 cases, 60% resistance), *K. pneumoniae* (4.063 cases, 48.13%), *S. aureus* (2.871 cases, 57.68%), *Acinetobacter* (2.428 cases, 52.41%), and *P. aeruginosa* (1.703 cases, 26.43%). In urinary tract infections, the most frequent pathogens were *K. pneumoniae* (3.522 cases, 48.49% resistance), *Escherichia coli* (3.037 cases, 20.24%), *P. aeruginosa* (2.106 cases, 30.33%), *Acinetobacter* (960 cases, 55.66%), and *Enterococcus faecalis* (855 cases, 12.81%). A study conducted by Meirelles, Milani, and Pilger (2023) in the ICU of a hospital in Rio Grande do Norte identified *K. pneumoniae* (13.98%), *S. aureus* (13.44%), and *A. baumannii* (11.83%) as the predominant microorganisms.

Corroborating these findings, De Freitas et al. highlighted that the most frequently isolated microorganisms were *Acinetobacter* spp., *Pseudomonas* spp., and *Klebsiella* spp., showing high resistance to carbapenems: 80% in *Acinetobacter* spp., nearly 70% in *Pseudomonas* spp., and approximately 32% in *Klebsiella* spp. This scenario represents a global concern, as the primary resistance is associated with *Acinetobacter* spp., *P. aeruginosa*, and Enterobacteriaceae strains producing extended-spectrum β-lactamases (ESBL), and *K. pneumoniae* with carbapenemases (KPC).[32]

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In the present study, resistance mechanisms were identified in isolated microorganisms as follows: *Acinetobacter* presented 40% ESBL production and 60% overall resistance; *Escherichia coli* showed 30% ESBL production; *Klebsiella pneumoniae* had 28.6% ESBL, 28.6% KPC-type carbapenemase, and 7.14% NDM; *Proteus mirabilis* exhibited 48.8% ESBL and 14.3% NDM; and *Pseudomonas aeruginosa* showed 17.7% KPC and NDM, 15.4% NDM, and 7.7% KPC. The presence of these bacteria in infectious processes is associated with high mortality rates, representing a serious problem in several countries, including Brazil.[33]

Given this context, the pharmacist is a professional directly linked to the policy of rational drug use, playing a key role in preventing indiscriminate antimicrobial use and, consequently, in controlling the emergence of multidrug-resistant microorganisms. Pharmacists are crucial in various settings, with responsibilities that include guiding the correct use of medicines, including antimicrobials. The relevance of pharmacists is highlighted in the study by Santos et al., which reported interventions such as reducing treatment duration (18%), discontinuing unnecessary antimicrobials (9%), and dose adjustments according to renal function (8%), totaling 35% of prescriptions.[34,35]

The main limitation of this study was the absence of a prior analysis of the microbiological profile, which prevented a more in-depth subsequent evaluation. Additionally, the lack of documentation of the diagnostic hypothesis at hospital and ICU admission hindered possible associations between HAIs and community-acquired infections. Finally, the absence of completed antimicrobial prescription justification forms precluded a deeper analysis of the necessity of prescriptions and the corresponding diagnosis. Therefore, prospective studies are recommended to assess interventions and adjustments in antimicrobial prescriptions, along with establishing an updated microbiological profile for the unit.

Another relevant point is the lack of previous studies conducted in this institution, which made it impossible to compare trends in antimicrobial prescriptions over time. In this context, the implementation of an Antimicrobial Stewardship Program (ASP) becomes essential, followed by investigations to analyze changes in prescribing practices after its adoption.

The importance of this study for the institution lies in understanding the hospital microbiological profile and antimicrobial prescribing patterns, thus providing evidence to support strategic decision-making and guiding the implementation of programs and new clinical protocols.

Conclusion

The microbiological analysis and antimicrobial prescription review in ICU patients at the reference hospital in Southwest Bahia revealed a critical scenario. The high prevalence of multidrug-resistant microorganisms and the predominant use of "Watch" category antimicrobials indicate ineffective management.

Deficiencies in the Infection Control Committee (CCIH), such as limited infectious disease consultations and inadequate completion of prescription justification forms, contribute to the spread of resistance.

To mitigate resistance, the implementation of an Antimicrobial Stewardship Program (ASP) is essential. This includes adopting strict protocols, encouraging consultations with infectious disease specialists, and active participation of pharmacists in the CCIH. Such measures are crucial to optimizing rational drug use and improving clinical outcomes.

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Contributors

LVPS: Study conception and design; data acquisition; data analysis and interpretation; manuscript drafting; critical review of intellectual content. JVTR: Data collection. IPA:Datacollection. MERS:Datacollection. IFF:Datacollection. GSL: Review of intellectual content; Coordinator of the research project titled *Pharmaceutical Care: Evaluation of Patients Using Medications in a Regional Hospital*. TDBS: Data interpretation; provision of critical resources; review of intellectual content.

Conflict of Interest Statement

The authors declare no conflicts of interest regarding this article.

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