Revista Prevenção de Infecção e Saúde
The Official Journal of the Human Exposome and Infectious Diseases Network

ORIGINAL ARTICLE
DOI: 10.26694/repis.v11i1.6928

Healthcare-associated infections and antimicrobial resistance as mortality predictors: a retrospective analysis of a university hospital

Infecções relacionadas à assistência em saúde e a resistência antimicrobiana como preditores de mortalidade: uma análise retrospectiva de um hospital universitário

Infecciones asociadas a la atención sanitaria y resistencia a los antimicrobianos como predictores de mortalidad: un análisis retrospectivo de un hospital universitario

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How to cite this article:
Santos JGR, Galiza FT, Batista OMA, Avelino FVSD. Healthcare-associated infections and antimicrobial resistance as mortality predictors: a retrospective analysis of a university hospital. Rev Pre Infec e Saúde [Internet]. 2025; 11: 01: 6928. Available from: http://periodicos.ufpi.br/index.php/repis/article/view/6928. DOI: https://doi.org/10.26694/repis.v11i1.6928.

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ABSTRACT

Objective: The objective was to analyze healthcare-associated infections (HAIs) that occurred in a university hospital in Northeast Brazil. Method: This was a retrospective observational study conducted in a university hospital in Piauí. The sample comprised two groups: the occurrences of HAIs that happened in 2022 throughout the hospital, and the total number of affected individuals. Results: The final sample consisted of 290 cases of HAIs in 228 patients. The most prevalent were COVID-19, catheter-associated urinary tract infection (CA-UTI), ventilator-associated pneumonia (VAP), and primary bloodstream infection. There was a significant difference in the frequency of UTIs ($p = 2.2 \times 10{-}16$) and pneumonia ($p = 3.6 \times 10{-}15$) associated with and not associated with invasive devices. The main etiological agents were SARS-CoV-2, Pseudomonas aeruginosa, Klebsiella pneumoniae, Escherichia coli, and Acinetobacter baumannii. Sensitivity profiles were higher than resistance profiles for all antibiotics except vancomycin. Carbapenem resistance was statistically associated with death ($p = 0.04$). Implications: Most of those affected were male, aged 70-79 years, with a progression to hospital discharge. Age ≥ 60 years was associated with death ($p = 0.05$).

DESCRIPTORS
Cross Infection. Patient Safety. Drug Resistance, Microbial. Infection Control.

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Submitted: 26/07/2025
Accepted: 24/09/2025
Published: 30/10/2025

INTRODUCTION

In 2013, the National Patient Safety Program (PNSP, as per its Portuguese acronym) was established by Ordinance MS/GM nº 529/2013. As established in this Ordinance, Patient Safety refers to reducing the risk of unnecessary harm associated with healthcare to an acceptable minimum[1].

In this context, the first Global Challenge launched by the World Health Organization (WHO), covering the years 2005 to 2006, focused precisely on the prevention of healthcare-associated infections (HAIs), where simple and clear standards for hand hygiene were established[2].

The clinical manifestations of infection in a hospital setting are classified as HAIs when they arise from the 3rd day of hospitalization in healthcare services, provided the patient has undergone some healthcare procedure that could be associated with the infection[3].

Furthermore, the occurrence of the infection when associated with healthcare must also meet the following criteria: the incubation period of the causative microorganism is unknown, and there is an absence of clinical and/or laboratory evidence of active infection upon admission. It is also emphasized that HAIs can manifest even after discharge[3].

Similarly, if the incubation period of the microorganism causing the infection is unknown, and there is no clinical or laboratory data confirming the presence of infection at the time of any healthcare procedure, it is conventionally considered a HAI any clinical manifestation of infection that arises following the procedure, even if the patient is not hospitalized[3].

Brazilian studies point to them as a very present portion among adverse events (AEs) that occur in healthcare services[4,5]. An AE is understood as any incident (event or circumstance that could have resulted or resulted in harm to the patient) that evolves with harm[1].

Infection prevention and control, according to the National Health Surveillance Agency (ANVISA, as per its Portuguese acronym), consists of a practical approach based on scientific evidence to prevent clients and healthcare professionals from suffering harm from avoidable and preventable infections. No place in the world, regardless of its level of development, is exempt from HAIs, and their prevention has never been so imperative[6].

An important example of HAIs is that related to the use of invasive devices. In Brazil, the three HAIs associated with devices that require mandatory reporting to the National System are: primary bloodstream infection (PBSI), primary catheter-associated bloodstream infection (CA-PBSI), ventilator-associated pneumonia (VAP), and catheter-associated urinary tract infection (CA-UTI)[7].

According to ANVISA, for HAIs to be considered associated with an invasive device, the client must have used the device for more than two consecutive days, considering day 1 as the day the device was installed, in addition to the fact that, on the date of the infection, the patient was using the device or had it removed the day before[7].

Data from a prospective cohort conducted with patients admitted to approximately 198 Intensive Care Units (ICUs) in 46 cities across 12 Latin American countries (Argentina, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Mexico, Panama, Peru, Venezuela, and Brazil) over 24 years (1998-2022) indicated Brazil as 4th in mortality rate for VAP, CA-PBSI, and CA-UTI[8].

One of the factors closely related to the perpetuation of the persistence of these adverse events worldwide is the high prevalence of pathogens resistant to antimicrobial drugs[9], a factor that unfortunately continues to be a significant public health problem[10].

Considering the impact of this type of condition, especially on the mortality of those affected, and given that these events are often preventable, it is important to understand the epidemiological behavior of their occurrences and their impact on in-hospital mortality.

METHODS

This is an observational study with a retrospective longitudinal design and a quantitative approach, conducted using data collected from the Health Surveillance Unit (UVS, as per its Portuguese acronym) database of a university hospital in Teresina, Piauí, Northeast Brazil, regarding cases of HAIs that occurred in the institution throughout the year 2022.

The hospital has approximately 195 beds, of which 20 are in the ICU setting, 53 consulting rooms, an outpatient clinic, 10 operating room rooms, an advanced diagnostic and therapeutic center with magnetic resonance imaging, tomography, X-ray, ultrasound, hemodynamics, video endoscopy, electrocardiographs, electroencephalogram, and ergometry. The hospital only cares for people aged 18 and older.

The sample comprised two groups: 1 - the total occurrences of HAIs and their features; and 2 - the total number of individuals affected by these HAIs and their characteristics. The decision to analyze them separately was due to the fact that the same patient could develop more than one different type of infection at different times, and the authors intended to evaluate all occurrences of HAIs individually, as well as their antimicrobial resistance profiles.

All notifications classified as HAIs by infectious disease professionals working in the sector, registered in the UVS database, which occurred from January to December 2022 throughout the hospital were included, excluding only duplicate records and those without a detected microorganism (whose diagnosis was only clinical/without positive culture). The data collection period took place during January 2024.

It was decided to analyze only cases of infections caused by known agents to accurately evaluate the sensitivity to the tested antibiotics. The sample was, therefore, a census sample.

For this article excerpt, different variables related to the occurrences of the infection were selected (type of HAIs, etiological agent, antimicrobial susceptibility profile, and outcome of hospitalization/admission to the healthcare service where the occurrence took place), as well as the total number of affected individuals (biological sex, age group, and clinical outcome of the patients).

COVID-19 was classified among the type group of HAIs, complying with the criteria established by ANVISA, for patients with SARS-CoV-2 infection confirmed by real-time RT-PCR from naso-oropharyngeal swab samples collected from the 14th day of hospital admission.

The sensitivity profile was obtained from the antibiogram using the agar diffusion or Kirby-Bauer method, according to the criteria adopted by the institution, mainly observing the sensitivity/resistance to carbapenems (namely the drugs called imipenem and meropenem) for gram-negative bacteria. For gram-positive bacteria, the sensitivity/resistance to the antibiotics called oxacillin or vancomycin was primarily observed.

With regard to fungal infections, although resistance to antifungal drugs has been tested, it is not part of the routine adopted by the sector to account for sensitivity specifically to these drugs due to the lack of epidemiological relevance of pathogens of this type for the hospital. Therefore, for this study, they were only considered as “Other Fungi or viral infections.”

The collected data were tabulated in Microsoft Excel software. After the necessary corrections were made, they were exported to R software, version 4.3.2, where the statistical processing of the information took place.

Descriptive statistics of the findings were carried out. As for the analysis of associations between categorical variables, the Chi-square and Fisher’s exact tests were used, considering p-values significant at a 5% significance level (≤ 0.05).

In 2022, 375 cases of HAIs were recorded at the university hospital in question, of which 84 were excluded from the analyses due to being clinical diagnoses/not having a positive culture, leaving, consequently, a total of evaluated 290 records.

This study is part of the research project “Profile of healthcare-associated infections in a university hospital in Northeast Brazil,” and was approved by the Research Ethics Committee of the Federal University of Piauí (CEP-UFPI, as per its Portuguese acronym), CAAE nº 74628223.9.0000.5214 and opinion nº 6.494.718, dated November 8, 2023.

RESULTS

The most common types of infection were COVID-19 (N = 68; 23.4%), followed by catheter-associated urinary tract infection (CA-UTI) (N = 58; 20.0%), laboratory-confirmed ventilator-associated pneumonia (VAP) (N = 42; 14.5%), laboratory-confirmed primary bloodstream infection (LC-PBSI) (N = 39; 13.5%), surgical site infection (SSI) (N = 26; 9.0%), non-catheter-associated urinary tract infection (NCA-UTI) (N = 22; 7.6%), and Non-ventilator healthcare-associated pneumonia (NV-VAP) (N = 17; 5.9%) (see Table 1).

Table 1. Profile of healthcare-associated infections occurred in 2022 with a known etiological agent. N = 290 occurrences of infection. Teresina - PI, Brazil, 2024.

Profile of Healthcare-Associated Infections	**N**	**%**
Type of infection		
COVID-19	68	23.4
Catheter-associated urinary tract infection	58	20.0
Laboratory-confirmed ventilator-associated pneumonia	42	14.5
Laboratory-confirmed primary bloodstream infection	39	13.5
Surgical site infection	26	9.0
Non-catheter-associated urinary tract infection	22	7.6
Non-ventilator healthcare-associated pneumonia	17	5.9
Others	18	6.2
Outcome of hospitalization/admission to the healthcare service where the event occurred		
Type of outcome		
Discharge	148	51
Death	117	40.3
Remained hospitalized	24	8.3
Unknown	1	0.4

Source: Prepared by the authors.

When comparing the proportion of device-related and non-device-related infections—specifically catheter-associated urinary tract infections (CA-UTI) and non-catheter-associated urinary tract infection (NCA-UTI), as well as ventilator-associated and non-ventilator-associated pneumonia—the variables showed statistically different proportions from each other, with p-values ≤ 0.05 (Fisher's exact test) in both cases, suggesting that the mentioned invasions significantly increased HAIs in the evaluated sample.

Table 2. Impact of the presence of invasive devices on the occurrence of infection. Teresina - PI, Brazil, 2024

Differences between the urinary tract infection and pneumonia rates associated with and not associated with invasive devices			
Type of infection	**Associated with device**	**Not associated with device**	***p***
Urinary tract infection	58	22	<0.001
Laboratory-confirmed pneumonia	42	17	<0.001

Source: Prepared by the authors.

The most identified etiological agents were SARS-CoV-2 (N = 68; 23.5%), Pseudomonas aeruginosa (N = 60; 20.7%), and Klebsiella pneumoniae (N = 58; 20.0%), followed by Escherichia coli and Acinetobacter baumannii, both with 21 occurrences (7.2%). To a lesser extent, Candida albicans and Stenotrophomonas maltophilia emerged with seven records each (2.4%) (see Table 3).

Table 3. Etiological agents identified in cases of healthcare-associated infections in the year 2022. N = 290 occurrences of infection. Teresina - PI, Brazil, 2024.

Identified microorganism	**N**	**%**
SARS-Cov-2	68	23.5
Pseudomonas aeruginosa	60	20.7
Klebsiella pneumoniae	58	20.0
Escherichia coli	21	7.2
Acinetobacter baumannii	21	7.2
Candida albicans	7	2.4
Stenotrophomonas maltophilia	7	2.4
Others	48	16.6

Source: Prepared by the authors.

The antibiotic susceptibility profiles were more evident than the resistance profiles for the carbapenem class, oxacillin, and the Sulfamethoxazole-Trimethoprim complex, with a higher occurrence of resistance patterns than susceptibility only observed for vancomycin. Only the resistance profile to the carbapenem class showed a statistically significant difference (p = 0.04) regarding the occurrence of death during the follow-up of infection events (see Table 4).

Table 4. Sensitivity profile to the tested antimicrobials and verification tests of the association between antimicrobial resistance and death. N = 290 occurrences of infection. Teresina - PI, Brazil, 2024.

Descriptive analysis of the observed sensitivity patterns	**N**	**%**
Tested antimicrobial susceptibility profile		
Sensitive to carbapenems	100	34.5
Resistant to carbapenems	86	29.7
Sensitive to oxacillin	5	1.7
Resistant to oxacillin	4	1.4
Sensitive to vancomycin	1	0.3
Resistant to vancomycin	3	1.0
Sensitive to sulfamethoxazole-trimethoprim	4	1.4
Resistant to sulfamethoxazole-trimethoprim	2	0.7
No antibiogram released	7	2.4
Fungal and viral infections	81	27.9
Verification of association with death outcome	**Statistics**	***p*-value**
Resistência a carbapenêmicos[a]	4.182	0.04
Resistente a oxacilina[b]	-	0.15
Resistente a sulfametoxazol-trimetoprim[b]	-	1
Resistente à vancomicina[b]	-	0.06

Legend: [a]Chi-square test; [b]Fisher's exact test.
Source: Prepared by the authors.

Based on the number of infectious episodes, duplicate medical records were excluded and the characteristics of individuals affected by healthcare-associated infections were analyzed separately. This second group comprised a sample size of 228 patients (Table 5).

The client profile most frequently affected by HAIs was male, elderly, with the most common outcome being discharge. The age of the population ranged from 20 to 98 years, with an average of approximately 58 years, and the most affected age group being 70-79 years. Those whose outcome was "Remained hospitalized until the follow-up period" refer to individuals who continued to be hospitalized (and therefore without a known outcome) until the end of 2022.

Table 5. Characterization of patients affected by healthcare-associated infections. N = 228 patients. Teresina - PI, Brazil, 2024.

Characteristics	**N**	**%**
Sex		
Male	121	53.1
Female	107	46.9
Age group		
20-29	19	8.3
30-39	17	7.5
40-49	37	16.2
50-59	35	15.4
60-69	51	22.4
70-79	55	24.1
80 or older	14	6.1
Clinical outcome		
Discharge	123	54.0
Death	88	38.6
Remained hospitalized until the follow-up period	16	7.0
Unknown	1	0.4

Source: Prepared by the authors.

Based on the cross-analysis of patient-related variables with the death outcome, using the Chi-square Test, only the characteristic "Age ≥ 60 years" showed a statistically significant association (p = 0.05) (Table 6).

Table 6. Association tests of the characteristics of patients affected with the death outcome. N = 228 patients. Teresina - PI, Brazil, 2024.

Variable	Statistics	*P*
Gender	0.047	0.82
Age ≥ 60 years	3.831	0.05

Source: Prepared by the authors.

DISCUSSION

The most prevalent HAIs in 2022 at the surveyed institution were COVID-19, CA-UTI, VAP, and PBSI, while the microorganisms most frequently causing infection were SARS-CoV-2, Pseudomonas aeruginosa, Klebsiella pneumoniae, Escherichia coli, and Acinetobacter baumannii. Death in the sample was associated with the presence of carbapenem resistance and age ≥ 60 years. Furthermore, the presence of IUC and MV significantly increased the occurrence of UTI and pneumonia, respectively.

Although these findings are situated in a post-peak period of the SARS-CoV-2 pandemic, their presence was still highly noticeable. These can be classified as HAIS, provided they meet the criteria established by ANVISA. Regarding such findings, the authors suggest that, in that same year, the third major wave of cases of this infection was still occurring in the country and that, despite the progressive increase in the number of vaccinated individuals up to 2022, this occurred quite unevenly in Brazil[11].

Despite the simultaneous start across the country, the North and Northeast regions reached higher vaccination rates more slowly than the other regions, especially the Southeast. This inequality reflects the lack of effective participation and coordination between municipal, state, and federal management, as well as the uneven leadership of municipal and state administrations in terms of tackling the pandemic[11].

Conversely, in countries where there was greater investment by managers in network governance, financing management, and organization (such as Australia, South Korea, Turkey, and Portugal), better outcomes were achieved. These data highlight the importance of developing skilled health management and the significance of public investment in the continuous and systematic planning of actions that truly prioritize the health of communities[12].

Added to the political-administrative factor, the resistance of Brazilians themselves to immunization, with widespread vaccine denialism, also hindered the speed of vaccination coverage. What followed was a deterioration of the healthcare context, with increased ICU bed occupancy rates, the use of MV, and the prevalence of HAIs (when comparing the year 2020 with 2021) [13].

The influence of this pathogen on patient safety is remarkable not only as an etiological agent but also as a trigger for the emergence of other HAIs. For example, in an ICU in Teresina-PI, a significant increase in nosocomial infections caused by multidrug-resistant strains was observed during the pandemic and post-pandemic periods, and infection due to COVID-19 was associated with bacterial multidrug resistance[14].

These data highlight the need for constant epidemiological surveillance to evaluate the impact of new diseases on fluctuations in healthcare-associated infection rates. Improving management, however, is not a simple task, since health governance is complex, given its intersection with political and historical aspects and the various conflicts of interest present[12].

The second most frequent type of HAIs in the current study was CA-UTI. If all cases of UTI (both associated with and not associated with IUC) are considered, it emerges as more recurrent even than COVID-19, and the number of occurrences of UTI associated with the device was statistically higher than those not associated with the device.

The duration of urinary catheterization, good practices for insertion and maintenance of IUC, as well as the clinical characteristics of the individual using the device, are among the factors associated with their occurrence. Their prevalence ranges from 10-25% in healthcare institutions, reaching rates of up to 28% in ICUs, mainly in countries with less investment in healthcare, or when there is inadequate adherence to infection prevention and control protocols[15].

According to ANVISA, two very important issues to be highlighted for deteriorating this context are the fact that 16-25% of all hospital clients will eventually be subjected to IUC or relief, recurrently with clinical indication that, when not mistaken, does not exist, or occurs without medical knowledge, and even for an unnecessarily long time[16].

That said, the following are understood as ways to reduce the incidence of this infection: an integrated multidisciplinary approach guided by well-defined institutional protocols that encourage the removal of the IUC as soon as possible, adherence to strict aseptic protocols, and the adoption of new technologies such as the use of antimicrobial catheters to prevent the formation of bacterial biofilms[15].

Furthermore, VAP was a device-associated infection of significant prevalence, showing a statistically higher frequency than non-ventilator-associated pneumonia. In view of this, it is noted that the acquisition of VAP, as well as a higher rate in terms of using MV, has already been observed as an independent factor for increased mortality in ICUs8 and prolonged length of stay in another study[17].

In addition to the increase in morbidity and mortality rates among those affected, it is known that its presence has an impact on the economic factor, as it generates additional expenses for healthcare systems, due to the prolonged length of stay in intensive care centers and the use of supplementary medications in their clinical management[18].

The development of this infection is multifactorial and involves both internal and external aspects of the patient. By preventing the closure of the glottis, the endotracheal tube, facilitates direct communication between the upper airways and the lungs (thus allowing microaspiration of nasopharyngeal secretions), especially when there is insufficient inflation of the cuff, which contributes to the leakage of accumulated secretions[19].

A possible explanation for their perpetuation in healthcare systems is the lack of knowledge among professionals regarding their prevention. In their study, Galdino Júnior et al. (2024)[20] detail the insufficient knowledge of the nursing team concerning the components of a prevention bundle for VAP, one of the strategies to prevent the infection.

According to the definition of the Institute for Healthcare Improvement, these care bundles, consist of a small group of evidence-based interventions (targeted at a specific patient population and care setting), which, when implemented together, result in better outcomes than if each intervention were implemented individually[21], with a beneficial impact on morbidity and mortality and cost reduction, especially in the ICU setting[22].

No episodes of non-catheter-associated PBSI were found in the analyzed database, given that all documented cases were laboratory-confirmed. As for this question, it is suggested that this occurred due to the greater availability of resources at the surveyed institution to evaluate the presence of microorganisms in this type of infection.

These are conditions with significant repercussions both for the clinical care of individuals and for the economy of healthcare organizations, since the use of venous catheters spans different types of care at the hospital level. Facilitating factors include the use of total parenteral nutrition (TPN), multilumen catheters, chemotherapy, immune compromise, and longer duration of invasive device use[23].

Regarding associated mortality, it is known to be related to similar factors, such as greater individual clinical severity, advanced age, prior use of antibiotics, multidrug resistance of the causative agents, fungal infections or those caused by gram-negative bacteria, and the use of multiple forms of therapeutic invasion in the same patient[24].

Studies focusing on the prevention of CA-PBSI mention technologies such as chlorhexidine-impregnated dressings, whose proper use has the potential to reduce adverse events, as well as additional costs (related to the treatment of HAIs) for the institution[25]. Evenly, the use of bundles also has documented benefits but faces similar barriers to those encountered with the prevention bundle for VAP (lower knowledge and adherence by professionals)[22].

The data introduced here align with the findings of other observational studies, thus indicating a higher prevalence of gram-negative bacteria compared to gram-positive ones[26-29] among the etiological agents of HAIs. Among them, Pseudomonas aeruginosa emerges as the most prevalent. It is known that its global distribution is highly heterogeneous, with a progressive increase in multidrug-resistant strains in several countries, including Brazil[30].

In turn, Klebsiella pneumoniae was present in this study in proportions almost equal to the aforementioned Pseudomonas aeruginosa. Internationally, the prevalence of multidrug-resistant hospital strains was estimated at 38.2% (based on a meta-analysis that analyzed data from 28 countries), with their resistance profiles being more pronounced for beta-lactam antibiotics, as well as for the classes of quinolones and aminoglycosides(31).

The analysis of 37,915 individuals with bacteremia due to Klebsiella pneumoniae generated mortality estimates of 17% up to 7 days, 24% up to 14 days, and 29% up to 30 days, being even higher for cases of bacteria proven to produce extended-spectrum beta-lactamase (ESBL), acquired in a hospital setting, or resistant to carbapenem-class antibiotics(32).

Similar observations occur with Escherichia coli and Acinetobacter baumannii, which also emerged in higher proportions in the current study. Extensive investigations, based on records of affected individuals around the world, document a significant prevalence of isolates of these bacteria that possess recognized mechanisms of antibiotic resistance (such as biofilms and ESBL)(33-35).

It is perceived that, over the years, microorganisms have rapidly and continuously developed strategies to resist treatment drugs(36). In the examined sample, the pharmacological class with the highest observed resistance percentage was the carbapenem antibiotics, which, similarly, was statistically associated with a fatal outcome during the follow-up of hospitalizations/contacts with the healthcare service where the HAIs took place.

This issue is global and relates to a range of aspects concerning both the individual and healthcare services. Insufficient allocation of supplies, lack of and/or poor quality personal protective equipment (PPE), lower knowledge and/or adherence by healthcare workers to infection prevention and control measures, communication failures, individual risk perception, among others, are some of the factors highlighted in the national literature(37,38).

In turn, international authors add contributing elements in the spread and morbidity and mortality associated with HAIs, such as, for example, the misuse of antibiotics(39), as well as highlighting perceived barriers to addressing resistant microorganisms, including limited administrative attention capacity, insufficient reinforcement of relevant guidelines, excessive accountability pressure on medical professionals, and a shortage of specialized human resources(40).

In turn, the act of caring for patients colonized by resistant organisms is more difficult for healthcare professionals. The literature shows situations in which providing care to this patient profile caused an overload on those attending to them, due to the time spent putting on and removing PPE for specific precautions, for example, creating job dissatisfaction among workers who felt unable to provide care with the quality they would like(41).

Among so many complex variables, more easily manageable modifiable factors in this context require a managerial-level rearrangement on the part of healthcare institutions, and the establishment of integrated and interconnected interventions, encompassing everything from the reevaluation of empirical prescription practices to the adoption of technologies such as artificial intelligence predictive algorithms for diagnostic support, and the establishment of digital microbiological databases(35,42).

Nevertheless, many of the necessary changes require discussion and strengthening of joint actions by the actors involved at the municipal, state, and federal levels in the formulation and reinforcement of public policies and guidelines supporting clinical decision-making, with an increase and optimization in the use of resources(38). Interprofessional and interdisciplinary collaboration between research institutions and healthcare and educational institutions, as well as with regulatory bodies at all three levels, is equally essential(42).

Truly, most of the risk factors for the issue under analysis could be minimized through the implementation of infection prevention and control programs in healthcare institutions. It is also imperative that robust programs for the judicious use of antimicrobial drugs be implemented, and that constant monitoring actions be encouraged, in accordance with the most recent guidelines for this factor(43).

Despite the challenges, it is perceived that adequate public investment in combating HAIs and microbial resistance would result in a lower burden than treating these conditions. Data from Brazilian studies show how bacterial resistance has substantially increased the cost of therapies for patients with HAIs(44,45). This increase seems to be caused particularly by the prolonged length of hospital stays, which, in addition to the direct financial impact, undermines the optimization of hospital and ICU bed occupancy(46).

In this context, a low-cost but highly effective practice for the prevention and control of infections is proper hand hygiene, the 5th global patient safety goal. The results of a study conducted in a Chinese university hospital can be mentioned, where the consumption of hand sanitizer gel showed a negative correlation with morbidity from multidrug-resistant Pseudomonas aeruginosa[39].

Scientific texts like the aforementioned highlight the existing weaknesses in patient care systems. Furthermore, it is important to emphasize the understanding that factors that may amplify the barriers between error and patient harm require increasingly more research, given the global problem posed by HAIs and antimicrobial resistance evidenced both in this article and in the pertinent literature.

The findings introduced here elucidated the epidemiological profile of HAIs in a university hospital in Northeast Brazil, their antimicrobial susceptibility profile, as well as the characteristics of the commonly affected patients, highlighting their influence on death outcomes. Evenly, it exposed the role that the use of invasive devices, specifically IUC and MV, plays in the development of UTI and healthcare-associated pneumonia, respectively.

It is noteworthy that the authors were unable to evaluate the relationship between the occurrence of infections and other variables of interest for public health, such as the increased length of hospital stay, as well as the lack of multivariate analyses that would take into account more clinical aspects of the participants, in addition to the analyzed period being limited to the year 2022, without encompassing the subsequent years for a better analysis of the context of HAIs after the pandemic peak.

CONCLUSION

The analysis of the profile of HAIs occurred in the university hospital in question in 2022 revealed that they were mainly of the types classified as COVID-19, CA-UTI, VAP, and LC-PBSI, with the most frequent etiological agents including SARS-CoV-2, Pseudomonas aeruginosa, Klebsiella pneumoniae, Escherichia coli, and Acinetobacter baumannii, and the most common sensitivity profile being sensitivity to carbapenem-class antibiotics.

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AUTHOR CONTRIBUTIONS

Study conception or design: Santos JGR, Avelino FVSD. Data collection: Santos JGR. Data analysis and interpretation: Santos JGR, Avelino FVSD. Article writing or critical review: Santos JGR, Avelino FVSD, Galiza FT, Batista OMA. Final approval of the version to be published: Santos JGR, Avelino FVSD, Galiza FT, Batista OMA.

ETHICS APPROVAL

The study was approved by the Research Ethics Committee of the Federal University of Piauí (CEP/UFPI), according to opinion 6.494.718 and Certificate of Submission for Ethical Review 74628223.9.0000.5214.

CONFLICT OF INTEREST

The authors declare no conflict of interest.