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Epidemiological Status of Healthcare – Associated Infections and Related factors in a Hospital in Cali, Colombia

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Abstract

Purpose: The aim of this study is to describe the epidemiology of healthcare-associated infections (HAIs) in a teaching hospital of Cali.

Methods: This is a retrospective descriptive study that involved patients with HAIs who met the criteria for HAIs from January 2022 to December 2024. Data were obtained from reports confirmed by infectious disease specialists.

Results: In total, 471 reports were included, 103 patients (21.9%) had HAIs. The most common HAIs were: surgical site infections (34.2%), lower respiratory tract infection (25.1%), skin/soft tissue infections (16.6%), and sepsis (10.2%). On multivariable regression analysis, independent risk factors for HAIs included cardiovascular disease [odds ratio (OR) 2.41], anemia (OR=2.70), obstructive pulmonary disease (OR=7.69), presence of a central venous catheter (OR=7.51) or an urinary catheter (OR=5.98). *Klebsiella spp* (10.5%) and *Staphylococcus aureus* (8.7%) were the most common. Thirty-two isolates (9.6%) were drug-resistant, and most (27.9%) were Enterobacterales.

Conclusion: Surgical site and respiratory tract infections should be a priority in the control and reduction of HAIs in the country, especially in patients with comorbidities or invasive devices as the central venous catheters or urinary catheters.

KEY WORDS: Healthcare-associated infections; epidemiology, multidrug resistant pathogens, nosocomial infections.

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INTRODUCTION

Healthcare-associated infections (HAIs) are the most common adverse events reported in any healthcare system, regardless of available resources, contributing to increased healthcare costs worldwide[1,2].

In high-income countries, the prevalence of HAIs ranges between 3.5% and 12%[2,3]. In the United States, 3.2% of hospitalized patients presented HAIs[4], and in Europe, 12.7% of patients who remained hospitalized for more than two days developed some type of HAI[3].

In low- and middle-income countries, the problem is more acute due to the high morbidity and mortality caused by these infections[5]. In Colombia, the prevalence of HAIs ranges between 5% and 10% in hospitalized patients, with an attributable mortality rate that can reach 25%[6].

The HAIs include surgical site infections, bloodstream infections, urinary tract infections, and pneumonia, among others[2].

The most common risk factors include the use of invasive devices (such as catheters and mechanical ventilation), surgical procedures, prolonged stays in intensive care units (ICUs) and hospital wards, which increase the possibility of infections due to cross-contamination between patients and healthcare personnel. Comorbidities and immunosuppression, as well as the use of implants and prostheses, increase the susceptibility to developing HAIs[2,3,5].

HAIs caused by antimicrobial-resistant organisms exacerbate the situation due to the decline in the development of new lines of antimicrobials, which has caused a global crisis.

Among the pathogens commonly reported as causing HAIs are methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus* (VRE), extended-spectrum β-lactamase (ESBL)-producing Enterobacteriaceae, carbapenemase-producing non-fermenting bacilli, and multidrug-resistant (MDR) organisms[3,7]. A study conducted in low- and middle-income countries reported a mortality rate of 27.3 per-10,000 inhabitants due to infections caused by antibiotic-resistant bacteria, which represents a major challenge for health institutions and healthcare personnel[8]. The objective of this study was to describe the epidemiology of HAIs and factors associated with HAIs in a teaching hospital of Cali during the period 2022-2024.

MATERIALS AND METHODS

This is a descriptive retrospective study conducted at the San Juan de Dios teaching Hospital from January 2022 to December 2024. The hospital is located in the city center and has 180 beds to serve especially vulnerable and low-income population

The study included records from the database of patients admitted to the hospital wards.

Epidemiological information was collected from each medical record, including demographic data (age, sex, and social status), diagnosis, and clinical data: type of infection, comorbidities (diabetes mellitus [DM], arterial hypertension [HTN], cardiovascular disease [CVD], chronic kidney disease [CKD], obstructive pulmonary disease [COPD], hypothyroidism, liver disease, neurological disease, immunosuppression, malignancy, malnutrition, anemia, chronic bacterial infection [tuberculosis or syphilis] and HIV infection), and isolated pathogen. Other variables included in the study included smoking status, antibiotic therapy, device-associated HAIs, and patient survival.

The definition of HAIs was based on Centers for Disease Control/National Healthcare Safety Network (CDC/NHSN) criteria and was defined as signs and symptoms of infection presenting more than 48 hours after hospital admission or within 30 days after surgery, or up to 90 days if a surgical implant was involved, and not secondary to the patient's own condition (9). Surgical site infections, bloodstream infections, urinary tract infections, skin/soft tissue infections and lower respiratory tract infection were included.

Statistical analysis

Quantitative variables (age and length of hospital stay) were analyzed using measures of central tendency and dispersion, such as mean and standard deviation (SD). Qualitative variables were analyzed using frequency distributions and percentages. To identify independent factors associated with HAIs events and death from HAI, patients with and without HAIs were first compared using logistic regression analysis. Factors significantly associated with HAI in the univariate analysis or with clinical plausibility were entered into a multiple logistic regression model. Statistical significance was defined as a P value of ≤0.05. These analyses were performed using the SPSS Vs 26.00 statistical package (Inc, Chicago).

Ethical considerations

The study was authorized and endorsed by the hospital's ethics committee and was conducted in accordance with the international ethical principles contained in the Declaration of Helsinki.

RESULTS

A total of 471 medical records were included in this study. The median age of the patients was 54.5 (IQR,37.0–71.0) years, with 223 (47.3%) females and 248 (52.7%) males. Although our study showed that men are more affected than women, a slight predominance of women who developed HAIs was found. Patients who were in a special social condition (homeless or in a geriatric center) represented 8.4%.

The average hospital stay was 9,9 days (SD±53,393), and a total of 54 (11.5%) patients died during the study period.

Prevalence and distribution of HAIS

The most infections were surgical site infection (37.5%) followed by lower respiratory tract infection (25.1%), skin/soft tissue infections (16.6%), and sepsis (10.2%). The most frequent surgical interventions among patients who developed infection at the surgical site were: herniorrhaphy (38/161, 23,6%), sequestrectomy (20/161, 12.4%), and cholecystectomy (19/161, 11.8%).

Infections developed in patients with medical devices accounted for 18.9%. Device-associated pneumonia constituted 6.8%. Patients requiring the use of a urinary catheter and a central venous catheter (CVC) represented 4.2% and 3%, respectively. (Fig. 1).

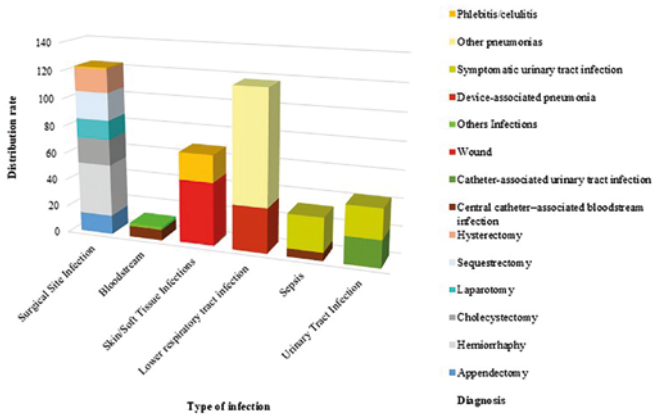

Figure 1. The distribution of reason of admission among healthcare-associated infection types. STS: skin and soft tissue infections; SSI: Surgical site infection

Factors associated with HAIS

In the unadjusted analysis, older patients, those with hypertension, CVD, anemia, DM, malnutrition, COPD, a CVC or urinary catheter had a higher risk of HAIs. Multivariable regression analysis showed that patients with CVD (OR=2.41; p=0.011), anemia (OR=2.70; p=0.003), COPD (OR=7.69; p<0.001), a CVC (OR=7.51; p=0.001) or urinary catheter (OR=5.98; p<0.001) had a higher risk of HAIs (Table 1).

The frequency of deceased patients (20.4%) was significant among those who developed HAIs, even after adjustment (OR=2.61; p=0.004).

Causative organisms and antimicrobial resistance

There were 333 identified pathogens in 218 of the 471 (46.3%) infections (Table 2). The most common pathogens were *Klebsiella spp.* (10.5%) and *S. aureus* (8.7%). However, 98 (29.4%) and 86 (25.8%) cases were reported with active infection by the human immunodeficiency virus (HIV) and *Mycobacterium tuberculosis*, respectively. Preexisting infection with *M. tuberculosis* (3.128, 1.697-5.767, P<0.001) or HIV (5.248, 2.904-9.984, P<0.001) was a risk factor for death.

Overall, thirty-two (9.6%) HAI isolates were drug-resistant and 75% (24/32) of them were ESBL- and carbapenems producing Enterobacteriaceae, especially *Klebsiella spp*, *Escherichia coli and Enterobacter spp.* MRSA was 20.7% of all *S. aureus* infection cases reported during the study period.

DISCUSION

This study found that HAIs affected 21.9% of hospitalized patients. It was influenced by comorbidities and the presence of invasive medical devices. Our result is within the range reported by the EPIC-I study (European Prevalence of Infections in Intensive Care) with HAI prevalences between 45% and 21% in ICUs in Western European countries[2,5]. However, it turns out to be much higher when we compare the point prevalence reported in the United States (3.2%)[4], Libya (13.7%)[10] and Ethiopia (14.9%)[11].

Although the literature indicates that men are more affected by HAIs (12-15), In our study, a slight predominance was observed among female patients, which coincides with other studies that report a higher incidence of HAIs in women[10,11,16].

When comparing the risk of acquiring a HAI based on patient comorbidities, we found that patients with COPD have the highest risk of HAI. We also observed

Table 1. Baseline Characteristics and Risk Factors for Healthcare-Acquired Infections

Characteristics	Patients Without HAI (n=368) n (%)	Patients With HAI (n=103) n (%)	Unadjusted OR (95% CI)	p-value	Adjusted OR[a] (95% CI)	p-value
Patient demographics						
Male sex	205 (50.5)	43 (41.7)	1.50 (0.96- 2.35)	0.073		
Age, median (IQR)	53,7 (37-68)	58,8 (41,8-76)	2,24 (1,43 3,50)	0.019*	0.997 (0.983-1.012)	0.680
Special social condition	33 (9)	11 (10.7)	1.21 (0.59- 2.49)	0.598		
Comorbidities						
Smoking	16 (4.3)	7 (6.8)	Ref	Ref		
Hypothyroidism	11 (3)	5 (4.9)	1.65 (0.562-4.878)	0.356		
Malignancy	43 (11.7)	11 (10.7)	0.90 (0.44-1.82)	0.777		
Liver disease	65 (17.7)	16 (15.5)	0.85 (0.47-1.55)	0.613		
Neurological disease	15 (0.1)	12 (11.7)	3.10 (1.40-6.86)	0.003*	2.10 (0.189-1.19)	0.114
Immunosuppression	6 (1.6)	4 (3.9)	2.43 (0.675-8.807)	0.161		
Chronic bacterial infection	100 (27.2)	31 (30.1)	1.15 (0.714-1.864)	0.558		
HIV infection	74 (20.1)	25 (24.3)	1.27 (0.75-2.13)	0.35		
CKD	26 (7.1)	7 (6.8)	0.95 (0.40-2.27)	0.92		
HTN	49 (13.3)	29 (28.2)	2.55 (1.51-4.31)	<0.001*	1.34 (0.361-1.542)	0.429
DM	32 (8.7)	18 (17.5)	2.22 (1.19-4.15)	0.011*	1.08 (0.403-2,121)	0.854
CVD	37 (10.1)	28 (27.2)	3.34 (1.92-5.79)	<0.001*	2.41 (1.21-4.78)	0.011*
COPD	11 (3)	6 (5.8)	7.21 (2.59-20.01)	<0.001*	7.69 (2.56-22.72)	<0.001*
Malnutrition	12 (3.3)	9 (8.7)	2.84 (1.16-6.94)	0.017*	1.01 (0.29-3.25)	0.975
Anemia	32 (8.7)	23 (22.3)	3.01 (1.67-5.43)	<0.001*	2.70(1.39-5.23)	0.003*
Device-associated HAIs						
Presence of CVC	8 (2.2)	6 (5.8)	5.13 (1.73-15.15)	0.001*	7.51 (3.37-23.80)	0.001*
Presence of urinary catheter	11 (3)	9 (8.7)	4.82 (1.93-11.98)	<0.001*	5.98 (2.25-15.87)	<0.001*
Ventilatory support	21 (5.7)	11 (10.7)	1.99 (0.92-4.29)	0.07		
Patient survival						
No survival	33 (9)	21 (20.4)	2.60 (1.43-4.78)	0.001*	2.61 (1.27-5.05)	0.004*

CVC, central venous catheter; CI, confidence interval; CKD, Chronic Kidney Disease; COPD, Chronic Obstructive Pulmonary Disease; CVD, cardiovascular disease; HAI, healthcare-associated infection; HTN, arterial hypertension; IQR, interquartile range; OR, odds ratio; *p<0.05

that anemia and CVD increase the risk of HAIs. The debilitating disorders suffered by patients, whether due to the use of immunosuppressive therapy[17,18] or the state of immunosuppression caused by iron deficiency in anemic patients[19] or by poor perfusion in patients with heart failure[20,21], are among the important predictive factors that increase vulnerability to developing HAIs and the severity of the disease. Additionally, although in our study tuberculosis or being infected with HIV did not represent a risk of developing HAIs, it is possible that these conditions may increase the risk of prolonged hospitalization and, therefore, the likelihood of developing an HAI. The meta-analysis by Liu et al. revealed that invasive procedures, hospital stays longer than 15 days, and secondary tuberculosis were among the main risk factors that negatively influenced HAIs in hospitalized tuberculosis patients in Chinese hospitals[22]. Similarly, a study conducted in an infectious

disease ICU in Romania showed that the mortality rate in patients with HAIs was influenced by HIV infection (OR: 11.82; 95% CI: 1.69-83.62; p ≤ 0.05)[23].

On the other hand, the most common type of HAI in our study was surgical site infection (34.2%), followed by lower respiratory tract infection (25.1%) and skin/soft tissue infections (16.6%). Those ratios are higher than those reported in United States[4], Singapur[24] and United Kingdom[25], but lower than that of the studies carried out in Libya[10] and Ethiopia[11].

The high rate of surgical site infections found in our study could be due to factors such as ineffective sterilization, inadequate dressings, and incorrect surgical procedures.

In this study, we found that the use of CVC and urinary catheters was independently associated with the risk of developing HAIs, consistent with the results of studies that found that these types of invasive interventions increase the risk of HAIs[18-25]. A systematic review of studies conducted in Australian hospitals concluded that the use of nasogastric tubes, urinary catheters, central venous catheters, orotracheal intubation, parenteral nutrition, and anesthesia significantly increase the risk of HAIs[26].

Microorganisms were identified in 46.3% of cases. We have presented in Table 2 the different pathogens isolated of samples from infected sites. Gram-negative bacteria were observed to be the most isolated pathogens (33.3%), while gram-positive bacteria and fungi accounted for 10.8% and 0.6%, respectively.

Klebsiella spp. was the most implicated microorganism in HAIs (10.5%), followed by *S. aureus* (8.5%), *E. coli* (7.5%), and *Pseudomonas aeruginosa* (6.3%).

When the prevalence of each pathogen was analyzed according to the type of HAI, it was found that in surgical site infection, the most common germs were *S. aureus* (22.4%) and *Klebsiella spp*. (17.9%).

The predominance of *Klebsiella spp.* and *S. aureus* among the most prevalent HAIs is perhaps due to their frequent persistence in the hospital environment and possible deficiencies in infection control practices[23,27,28]. The study carried out in hospitals in Asian countries showed that the *K. pneumoniae* ST15 clone was detected in the same ward of a hospital in India on multiple occasions, suggesting clonal persistence in the same environment, and was found to be identical to strains isolated that caused neonatal sepsis in Pakistan during similar periods, so the authors suggest the persistence of dominant clones over time[29].

Furthermore, patient-related factors such as immunosuppressant, comorbidities and the use of invasive devices that facilitate the invasion of microorganisms increase the risk of infections caused by these bacteria[19-21].

On the other hand, this study found that 9.6% of the isolates were resistant to antibiotics, the majority being ESBL and carbapenemase-producing Enterobacteriaceae, probably favored by the use of β-lactam antibiotics, which were the most frequent treatment used in the hospital as shown in figure 2. It is

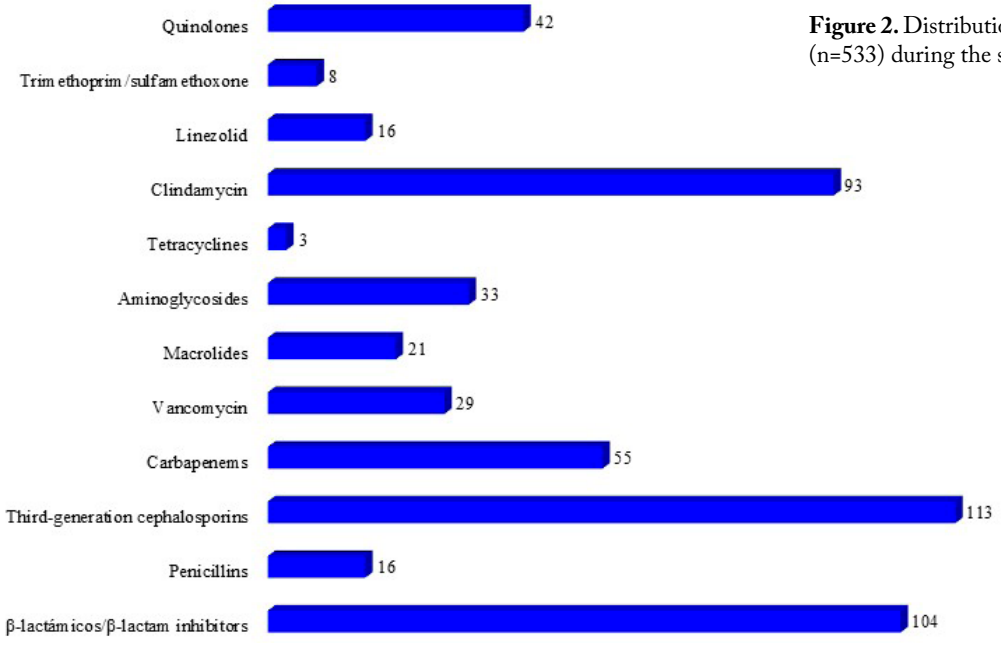

Figure 2. Distribution of antibiotics prescribed (n=533) during the study period 2022-2024.

Table 2. Distribution of reported causative microorganisms in each infection type

	Surgical Site Infection	Bloodstream	Skin/Soft Tissue Infections	Lower respiratory tract infection	Urinary Tract Infection	Sepsis
No. of infectios	161	17	78	118	42	48
Distribution of each infection type, % (95% CI)	3.07 (1.81-5.23)	0.81 (0.29-2.93)	11.90 (2.37-18.51)	6.32 (3.19-2.51)	1.85 (0.95-3.58)	2.917 (1.33-6.38)
No. of pathogens	67	10	39	160	26	31
Gram-negative bacteria						
P. aeruginosa	7 (10.4)	-	4 (10.3)	3 (1.9)	3 (11.5)	4 (12.9)
A. baumannii	2 (3.0)	-	-	-	-	2 (6.5)
E. coli	10 (14.9)	1 (10)	4 (10.3)	-	4 (15.4)	6 (19.4)
Klebsiella spp	12 (17.9)	5 (50)	7 (17.9)	2 (1.3)	3 (11.5)	6 (19.4)
P. mirabilis	3 (4.5)	-	3 (7.7)	2 (1.3)	2 (7.7)	-
S. marcences	-	-			2 (7.7)	-
Enterobacter sp.	5 (7.5)	1 (10)	2 (5.1)	1 (0.6)	1 (3.8)	1 (3.2)
Providencia spp	-	-	-	1 (0.6)	-	
C. fruendii	-	-	1 (2.6)	-	-	-
Pantoea agglomeraens	-	-	1 (2.6)	-	-	-
Gram-positive bacteria						
S. aureus	15 (22.4)	1 (10)	4 (10.3)	4 (2.5)	2 (7.7)	3 (19.7)
E. feacalis	3 (4.5)	-	1 (2.6)	-	1 (3.8)	-
C. dificille	2 (3.0)	-	-	-	-	-
Other pathogens						
M. tuberculosis	-	-	3 (7.7)	77 (48.1)	-	6 (19.4)
Candida spp	1 (1.5)	1 (10)				
HIV	7 (10.4)	1 (10)	9 (23.1)	70 (43.8)	8 (30.8)	3 (19.7)

The antibiotics with the highest prescription rates during the study were: third-generation cephalosporins (21.2%), β-lactam antibiotics/β-lactamase inhibitors (19.5%), and clindamycin (17.4%).

suggested that hospital surfaces are significant reservoirs of Gram-negative bacteria carrying extended-spectrum β-lactamases (*bla*CTX-M-15) and carbapenemases (*bla*NDM, *bla*OXA-48, and *bla*KPC) (GNB), primarily in hospitals in low- and middle-income countries, contributing to increased HAIs and patient mortality[29,30].

An important aspect of ensuring better quality healthcare is the education of healthcare personnel, as demonstrated by the study carried out by. Mehta et al., who, through the application of a training program on infection prevention and control measures, showed that it was an important strategic tool for reducing HAIs[31].

The main limitation of our study is related to its retrospective nature, which does not allow us to establish causality.

Another limitation included limitation of this study was that it only considered one hospital, and it is likely that the results cannot be generalized to other healthcare centers; therefore, multicenter studies are needed to corroborate these results.

It was not possible to extract information on the overlap of multiple HAIs in patients and other important variables because not all patient medical records had complete and adequate information.

CONCLUSION

Despite the limitations mentioned above, our study provided valuable data on the epidemiology of HAIs. Surgical site infections and lower respiratory tract infections were the most common infections. We found that comorbidities such as COPD, anemia, and cardiovascular disease, as well as the use of invasive devices such as central venous catheters or urinary catheters, increased

the risk of HAIs. The most common pathogens were *Klebsiella spp*. and *S. aureus*, while Enterobacteriaceae showed a greater number of antibiotic-resistant strains.

Surgical site and respiratory tract infections should be a priority in the control and reduction of HAIs in the country, especially in patients with comorbidities (including tuberculosis and HIV infection) or with invasive devices.

Although further research is needed to understand the epidemiology and costs of HAIs in Colombia, the results of our study contribute to the knowledge aimed at reducing HAIs and antimicrobial resistance.

Ethics Statement and Conflict of Interest Disclosures

Financial support and sponsorship: All authors have declared that no financial support was received from any organization for the submitted work.

Ethics Consideration: The authors declare that all the procedures and experiments of this study respect the ethical standards in the Helsinki Declaration of 1975, as revised in 2008(5), as well as the national laws. Written informed consent was provided by the patient participant in this study. This study was approved by the Institutional Research Board and Ethics Committee.

Conflict of interest: No known conflict of interest correlated with this publication.

Availability of data and materials: The data used and/ or analyzed throughout this study are available from the corresponding authors upon reasonable request.

Competing interests: The authors declared that they have no competing interests.

The use of generative AI and AI-assisted technologies: The authors did not use in this article generative AI and AI-assisted technologies.

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