Comparison of the Distribution of Healthcare-Associated Infections and Causative Agents Between Intensive Care Units and Other Clinics

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ABSTRACT

Objective: To compare the trends in the distribution of healthcare associated infectious (HAIs) and causative agents in intensive care units (ICUs) and other clinics.

Study Design: Descriptive study.

Place and Duration of the Study: Department of Infectious Diseases and Clinical Microbiology, Health Sciences University, Diskapi Yildirim Beyazit Training and Research Hospital, Ankara, Turkiye, from 2015 to 2022.

Methodology: The study included patients who were diagnosed with HAIs and admitted to both the ICUs and the clinics. The data of HAIs identified between 2015-2022 were accessed and analysed retrospectively from the surveillance records of the IPC committee between 28.05.2023-07.08.2023.

Results: There was a decreasing trend observed in both ICU and clinics regarding the ratio of patients developing HAIs and the overall HAI rate (all p-values <0.001). These two measures were found to be significantly lower in the years 2019-2022 compared to the years 2015-2018. Over the years, particularly after 2020, a significant increasing trend in carbapenem resistance was observed in *E. coli*, *K. pneumoniae*, and *P. aeruginosa* (p=0.009, p<0.001, and p<0.001, respectively). The ratio of patients developing HAIs in the ICUs was higher than in the clinics (p<0.001). There was an increasing trend in the ratio of pneumonia and bloodstream infection (BSI) in ICUs.

Conclusion: The increasing ratio of BSI and pneumonia in ICUs highlighted the need to review infection control bundles. Carbapenem resistance has been increasing over the years, suggesting that antimicrobial description and consumption practices should be re-evaluated, especially in the context of the COVID-19 pandemic.

Key Words: *Intensive Care Unit, Healthcare-Associated Infections, Surveillance, Infection prevention and control, Antibiotic resistance*.

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INTRODUCTION

Healthcare-associated infections (HAIs) are a significant health problem in intensive care units (ICU) with increased mortality, negative impact on quality of life, rise in treatment costs, development of antibiotic resistance, and the additional burden they impose on healthcare services.[1,2]

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ICUs are multidisciplinary units prepared for patients requiring special care and continuous monitoring in cases requiring advanced support.[2] Many factors such as the high frequency of invasive procedures in ICUs, the severity of comorbidities, suppression of the immune system, and prolonged hospitalisation affect the rate of HAIs.[3] Infection prevention and control (IPC) efforts are conducted by national authorities, such as international health organisations and ministries of health, through the implementation of guidelines that adhere to national/international standards and evidence-based practices.[1,2,4-7]

HAI surveillance including following the responsible pathogens and antimicrobial resistance (AMR) is one of the core components of IPC programs in hospitals.[8,9] Despite advancements in healthcare services and infection control measures, HAIs continue to be a significant concern in hospital settings.[3] Determining the distribution of HAIs and their causative agents in

clinics and ICUs is crucial in planning IPC strategies and reviewing antimicrobial consumption practices.[10]

The study aimed to compare the trends in the distribution of HAIs and causative agents in ICUs and clinics by assessing HAI surveillance data over eight years.

METHODOLOGY

The study enrolled adult patients aged 18 years and above who were diagnosed with HAIs during their hospitalisation at the Department of Infectious Diseases and Clinical Microbiology, Health Sciences University, Diskapi Yildirim Beyazit Training and Research Hospital, Ankara, Turkiye, from 2015 to 2022. The study included patients admitted to both the ICUs and the clinics. Patients under the age of 18 years, patients with infections except for HAI, and patients hospitalised in departments that did not conduct the surveillance were excluded from the study. There were seven ICUs (Anaesthesiology and Reanimation, Internal Medicine, Neurology, Cardiovascular Surgery, Neurosurgery, General Surgery, Coronary Intensive Care Unit) with a total of 64 beds and 16 clinics (Internal Medicine, Hematology, Oncology, Neurology, Nephrology, Infectious Diseases, Cardiology, Chest Diseases, Dermatology, Gastroenterology, Physical Medicine and Rehabilitation, Neurosurgery, General Surgery, Urology, Cardiovascular Surgery, Orthopaedics) in the hospital.

In line with the inpatient Treatment Institutions Infection Control Regulation in 2005 in Turkiye, the hospital had an IPC Committee and HAI surveillance dedicated IPC team consisting of five IPC nurses and four IPC physicians. IPC nurses conducted active, prospective, patient-based, and targeted surveillance in the ICUs following the national standards published by the *Ministry of Health* (MoH).[3,11] In clinics, laboratory-based surveillance was conducted. IPC nurses diagnosed HAIs using criteria adapted from the National Healthcare Safety Network (NHSN) surveillance definitions by the Centers for Disease Control and Prevention (CDC), as specified in the National HAI Surveillance Guide.[11] HAIs were recorded and tracked online in the National HAI Surveillance System (called USHİESA). The IPC team reviewed surveillance data on a weekly basis and presented it at IPC Committee (IPCC) meetings, which were convened at least once every three months. Ethical approval for this study was granted by the Ankara Etlik City Hospital Ethics Committee on 03.05.2023 (approval no: AEŞH-EK1-2023-135). Data on HAIs identified between 2015 and 2022 were retrospectively extracted from the IPC committee's surveillance records. Data analysis commenced on 28 May 2023 and concluded in August 2023. The antibiotic susceptibilities of isolated bacteria were evaluated and reported based on the standards of the European Committee on Antimicrobial Susceptibility Testing (EUCAST).[12] Categorical variables were summarised using counts (n), percentages (%), and 95% confidence intervals. The Chi-square test or Fisher's exact test where appropriate was used for comparisons. The chi-square test for linear trend was applied to detect trends over the years. Continuous variables were summarised using the mean and standard deviation. Independent samples t-test was employed for comparisons between independent groups.

Confidence intervals were calculated using the Score (Wilson) method for percentage estimation, while ratios that could be greater than 1.0 were calculated using the Mid-P exact test. A significance level of 0.05 was considered statistically significant. No sample size calculation was performed since all available data recorded and tracked in USHİESA were included in the study. Microsoft Excel program (2009) and the open-access OpenEpi calculator (Version 3) (http://www.openepi.com/-Menu/OE_Menu.htm) were used for data analysis. Graphs were created using the Microsoft Excel program (2009).

RESULTS

Between 2015 and 2022, a total of 4,430 HAIs were identified among 3,031 patients out of 297,470 hospital admissions across seven ICUs and 15 clinics that were part of the surveillance. The overall number of identified pathogens is 45,142. The mean age of the patients in the ICU was 66 ± 17.6 years, while the mean age of the patients in the clinics was 59.4 ± 17.4 years. The mean age of the patients was significantly higher in the ICUs ($p<0.001$). The mean length of stay in the ICU was 38.7 ± 39.5 days, compared to 35.4 ± 31.2 days in the clinics. The mean length of stay was significantly higher in the ICUs ($p=0.010$). Gender distribution remained similar over the years and between clinics and ICUs (ps>0.005). The ratio of patients developing at least one HAI among hospitalised patients was 1.02%. The overall HAI rate stood at 1.46%. Among patients who developed HAIs, the mean number of HAIs per person was 1.43. In the ICU, the ratio of patients developing at least one HAI, the overall HAI rate, and the mean number of HAIs per person were 3.10 %, 4.95 %, and 1.60, respectively. In the clinics, the corresponding percentages were 0.52 %, 0.62 % and 1.19. Significantly higher rates of patients developing at least one HAI, the overall HAI rate, and the mean number of HAIs per patient were observed in the ICUs compared to clinics ($p<0.001$ for all). Over the years, there was a decreasing trend in both ICUs and clinics regarding the ratio of patients developing at least one HAI and the overall HAI rate (all p-values <0.001). Particularly, both of these two measures were found to be significantly lower in the years 2019-2022 compared to the years 2015-2018 ($p<0.001$).

Between 2015 and 2022, the most common type of HAIs across all units under surveillance was bloodstream infection (BSI) with a ratio of 36.0%, followed by pneumonia with a ratio of 20.5% in the second place and urinary tract infection (UTI) ranked third with a ratio of 18.8%. In 2015, pneumonia held the top spot for HAI, but in subsequent years, BSI took the lead. The trend was consistent in the ICUs, but in clinics, surgical site infection (SSI) ranked second with a ratio of 26.1%, following BSI (Table I). It is noteworthy that lower respiratory tract infections were more prevalent in the ICUs, while central nervous system infections (CNSI) were more commonly observed in clinics among all HAIs.

Table I: The distribution of identified HAI types by years and units, 2015-2022.

Units	HAIs Types	2015 n (%)	2016 n (%)	2017 n (%)	2018 n (%)	2019 n (%)	2020 n (%)	2021 n (%)	2022 n (%)	2015-2022 n (%)
All Units	LRTI	32(6.7)	53(8.3)	56(8.9)	91(13.8)	39(7.9)	20(4.6)	34(7.5)	27(5.0)	352(8.1)
	SSI	82(17.2)	111(17.4)	89(14.2)	30(4.6)	36(7.3)	15(3.4)	19(4.2)	42(7.7)	424(9.8)
	GTI	5(1.1)	7(1.1)	1(0.2)	2(0.3)	5(1.0)	0(0.0)	1(0.2)	0(0.0)	21(0.5)
	UTI	116(24.4)	94(14.7)	132(21.1)	137(20.8)	92(18.6)	98(22.5)	66(14.5)	81(14.9)	816(18.8)
	BSI	95(20.0)	171(26.8)	171(27.3)	253(38.4)	206(41.7)	207(47.5)	214(46.9)	241(44.4)	1558(36.0)
	CVSS	0(0.0)	4(0.6)	4(0.6)	3(0.5)	5(1.0)	3(0.7)	1(0.2)	4(0.7)	24(0.6)
	PNEU	126(26.5)	165(25.8)	140(22.3)	100(15.2)	82(16.6)	77(17.7)	94(20.6)	105(19.3)	889(20.5)
	CNSI	1(0.2)	1(0.2)	3(0.5)	24(3.6)	18(3.6)	12(2.8)	21(4.6)	28(5.2)	108(2.5)
	STI	19(4.0)	33(5.2)	31(4.9)	19(2.9)	11(2.2)	4(0.9)	6(1.3)	15(2.8)	138(3.2)
	All HAIs	476(100.0)	639(100.0)	627(100.0)	659(100.0)	494(100.0)	436(100.0)	456(100.0)	543(100)	4330(100.0)
ICUs	LRTI	27(9.2)	46(11.3)	46(12.8)	90(19.4)	37(12)	17(5.6)	33(9.7)	27(7.3)	323(11.3)
	SSI	6(2.1)	19(4.7)	4(1.1)	4(0.9)	0(0.0)	0(0.0)	3(0.9)	2(0.5)	38(1.3)
	GTI	1(0.3)	1(0.2)	1(0.3)	1(0.2)	1(0.3)	0(0.0)	1(0.3)	0(0.0)	6(0.2)
	UTI	62(21.2)	40(9.8)	56(15.6)	89(19.1)	60(19.4)	61(19.9)	46(13.6)	53(14.2)	467(16.4)
	BSI	68(23.3)	129(31.7)	118(32.9)	183(39.4)	145(46.9)	161(52.6)	159(46.9)	181(48.7)	963(33.8)
	CVSS	0(0.0)	1(0.2)	1(0.3)	3(0.6)	0(0.0)	0(0.0)	1(0.3)	0(0.0)	187(6.6)
	PNEU	110(37.7)	145(35.6)	114(31.8)	75(16.1)	54(17.5)	58(19)	88(26)	87(23.4)	731(25.7)
	CNSI	1(0.3)	1(0.2)	2(0.6)	3(0.6)	1(0.3)	5(1.6)	2(0.6)	7(1.9)	22(0.8)
	STI	17(5.8)	25(6.1)	17(4.7)	17(3.7)	11(3.6)	4(1.3)	6(1.8)	15(4.0)	112(3.9)
	All HAIs	292(100.0)	407(100.0)	359(100.0)	465(100)	309(100.0)	306(100.0)	339(100.0)	372(100)	2849(100.0)
Clinics	LRTI	5(2.7)	7(3.0)	10(3.7)	1(0.5)	2(1.1)	3(2.3)	1(0.9)	0(0.0)	29(2.0)
	SSI	76(41.3)	92(39.7)	85(31.7)	26(13.4)	36(19.5)	15(11.5)	16(13.7)	40(23.4)	386(26.1)
	GTI	4(2.2)	6(2.6)	0(0.0)	1(0.5)	4(2.2)	0(0)	0(0.0)	0(0.0)	15(1.0)
	UTI	54(29.3)	54(23.3)	76(28.4)	48(24.7)	32(17.3)	37(28.5)	20(17.1)	28(16.4)	349(23.6)
	BSI	27(14.7)	42(18.1)	53(19.8)	70(36.1)	61(33)	46(35.4)	55(47)	60(35.1)	414(28.0)
	CVSS	0(0.0)	3(1.3)	3(1.1)	0(0.0)	5(2.7)	3(2.3)	0(0.0)	4(2.3)	18(1.2)
	PNEU	16(8.7)	20(8.6)	26(9.7)	25(12.9)	28(15.1)	19(14.6)	6(5.1)	18(10.5)	158(10.7)
	CNSI	0(0.0)	0(0.0)	1(0.4)	21(10.8)	17(9.2)	7(5.4)	19(16.2)	21(12.3)	86(5.8)
	STI	2(1.1)	8(3.4)	14(5.2)	2(1.0)	0(0.0)	0(0.0)	0(0.0)	0(0)	26(1.8)
	All HAIs	184(100.0)	232(100.0)	268(100.0)	194(100.0)	185(100.0)	130(100.0)	117(100.0)	171(100.0)	1481(100.0)

LRTI: Lower respiratory tract infections (excluding pneumonia), SSI: Surgical site infections, GTI: Gastrointestinal tract infections, UTI: Urinary tract infections, BSI: Bloodstream infections, CVSS: Cardiovascular system infections, PNEU: Pneumonia, CNSI: Central nervous system infection, STI: Soft tissue infections, HAI: Healthcare-Associated Infection, ICU: Intensive Care Unit.

Table II: The distribution of identified pathogens by years and units, 2015-2022.

Unit	HAI Pathogens	2015 n (%)	2016 n (%)	2017 n (%)	2018 n (%)	2019 n (%)	2020 n (%)	2021 n (%)	2022 n (%)	2015-2022 n (%)
All Units	Gram-positive bacteria	85(17.4)	120(3.6)	174(26.8)	153(22.2)	130(24.6)	112(24.7)	103(21.5)	145(25.9)	1022(22.6)
	Enterobacterales	158(32.4)	245(14.2)	229(35.2)	277(40.3)	200(37.8)	175(38.5)	153(32)	199(35.5)	1636(36.2)
	Escherichia coli	55(11.3)	95(12.7)	86(13.2)	92(13.4)	80(15.1)	61(13.4)	46(9.6)	65(11.6)	580(12.8)
	Klebsiella spp	66(13.5)	85(9.7)	87(13.4)	130(18.9)	74(14)	85(18.7)	59(12.3)	94(16.8)	680(15.1)
	Non-fermenting Gram-negative bacteria	205(42,0)	275(28.2)	214(32.9)	242(35.2)	166(31.4)	136(30.0)	195(40.8)	165(29.5)	1598(35.4)
	Acinetobacter spp	148(30.3)	188(8.1)	144(22.2)	173(25.1)	103(19.5)	99(21.8)	154(32.2)	114(20.4)	1123(24.9)
	Pseudomonas spp	54(11.1)	54(4.9)	62(9.5)	51(7.4)	43(8.1)	28(6.2)	32(6.7)	45(8)	369(8.2)
	Anaerobes	0(0.0)	3(3.6)	1(0.2)	1(0.1)	3(0.6)	1(0.2)	1(0.2)	0(0.0)	10(0.2)
	Candida spp	40(8.2)	24(100)	32(4.9)	15(2.2)	30(5.7)	30(6.6)	26(5.4)	51(9.1)	248(5.5)
	Total	488(100.0)	667(100.0)	650(100.0)	688(100.0)	529(100.0)	454(100.0)	478(100.0)	560(100.0)	4514(100.0)
ICUs	Gram-positive bacteria	41(13.6)	66(2.6)	81(21.7)	94(19.4)	70(21.1)	67(21)	70(19.8)	91(23.5)	580(19.5)
	Enterobacterales	79(26.2)	130(9.6)	115(30.8)	176(36.4)	104(31.3)	126(39.5)	102(28.8)	123(31.8)	955(32.0)
	Escherichia coli	21(7.0)	41(12.4)	30(8.0)	40(8.3)	27(8.1)	36(11.3)	22(6.2)	37(9.6)	254(8.5)
	Klebsiella spp	44(14.6)	53(8.4)	54(14.5)	96(19.8)	50(15.1)	68(21.3)	43(12.1)	61(15.8)	469(15.7)
	Non-fermenting Gram-negative bacteria	154(51.0)	213(34.5)	153(41.0)	201(41.5)	138(41.6)	108(33.9)	162(45.8)	136(35.1)	1265(42.4)
	Acinetobacter spp	119(39.4)	148(9.3)	111(29.8)	150(31)	88(26.5)	80(25.1)	130(36.7)	96(24.8)	922(30.9)
	Pseudomonas spp	34(11.3)	40(5.8)	39(10.5)	39(8.1)	36(10.8)	20(6.3)	26(7.3)	35(9)	269(9)
	Anaerobes	0(0.0)	0(4.7)	1(0.3)	0(0.0)	0(0.0)	1(0.3)	1(0.3)	0(0.0)	3(0.1)
	Candida spp	28(9.3)	20(100)	23(6.2)	13(2.7)	20(6)	17(5.3)	19(5.4)	37(9.6)	177(5.9)
	Total	302(100.0)	429(0.0)	373(100.0)	484(100.0)	332(100.0)	319(100.0)	354(100.0)	387(100.0)	2980(99.9)
Clinics	Gram-positive bacteria	44(23.7)	54(5.5)	93(33.6)	59(28.9)	60(30.5)	45(33.3)	33(26.6)	54(31.2)	442(28.8)
	Enterobacterales	79(42.5)	115(22.7)	114(41.2)	101(49.5)	96(48.7)	49(36.3)	51(41.1)	76(43.9)	681(44.4)
	Escherichia coli	34(18.3)	54(13.4)	56(20.2)	52(25.5)	53(26.9)	25(18.5)	24(19.4)	28(16.2)	326(21.3)
	Klebsiella spp	22(11.8)	32(12.2)	33(11.9)	34(16.7)	24(12.2)	17(12.6)	16(12.9)	33(19.1)	211(13.8)
	Non-fermenting Gram-negative bacteria	51(27.4)	62(16.8)	61(22.0)	41(20.1)	28(14.2)	28(20.7)	33(26.6)	29(16.8)	333(21.7)
	Acinetobacter spp	29(15.6)	40(5.9)	33(11.9)	23(11.3)	15(7.6)	19(14.1)	24(19.4)	18(10.4)	201(13.1)
	Pseudomonas spp	20(10.8)	14(3.4)	23(8.3)	12(5.9)	7(3.6)	8(5.9)	6(4.8)	10(5.8)	100(6.5)
	Anaerobes	0(0.0)	3(1.7)	0(0.0)	1(0.5)	3(1.5)	0(0.0)	0(0.0)	0(0.0)	7(0.5)
	Candida spp	12(6.5)	4(100.0)	9(3.2)	2(1.0)	10(5.1)	13(9.6)	7(5.6)	14(8.1)	71(4.6)
	Total	186(100.0)	238(100.0)	277(100)	204(100.0)	197(100.0)	135(100.0)	124(100.0)	173(100.0)	1534(100.0)

Gram-positive bacteria: CNS: Coagulase-negative staphylococci, Enterococcus spp, Streptococcus spp.
Klebsiella spp: Klebsiella spp, Klebsiella pneumoniae, Klebsiella oxytoca.
Acinetobacter spp: Acinetobacter baumannii, Acinetobacter lwoffii, Acinetobacter spp.
Pseudomonas spp: Pseudomonas aeruginosa, Pseudomonas spp.
Anaerobes: Bacteroides spp, Clostridium difficile, Bacteroides fragilis.
Candida spp: Candida albicans, Candida dubliniensis, Candida glabrata, Candida kefyr, Candida krusei, Candida parapsilosis, Candida spp, Candida tropicalis.

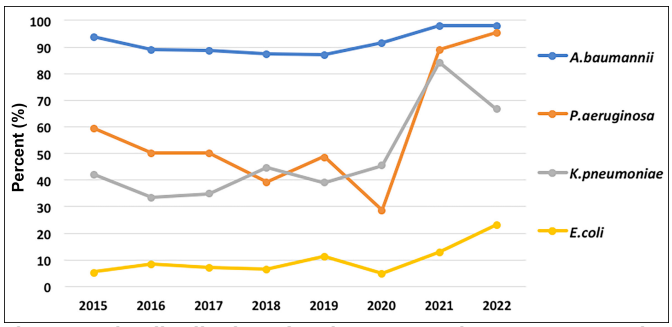

Figure 1: The distribution of carbapenem-resistant gram-negative HAI pathogens by Years, 2015-2022.

Over the years, there has been an increasing ratio of pneumonia and BSIs in the ICUs. A similar trend was also evident in the clinics, with an increase in BSIs, particularly from 2017 onwards, along with a rise in central nervous system infections. Additionally, SSIs in the clinics showed a decrease from 2018 compared to previous years. The most commonly identified causative agents were *Enterobacterales* (36.2%) and non-fermentative gram-negative bacilli (35.4%). These two groups collectively constituted 74.4% of all HAIs in the ICUs, whereas in the clinics, they accounted for 66.1% of cases. Despite showing slight fluctuations trend over the years, non-fermentative gram-negative bacilli remained to be the predominant group of causative agents in the ICUs, while *Enterobacterales* dominated the clinics. Among non-fermentative gram-negative bacilli, *Acinetobacter* species held the majority, while among *Enterobacterales*, *Klebsiella* species were the most frequently identified in the ICUs, and (*E.coli)* was commonly found in the clinics (Table II).

When examining changes in antimicrobial resistance patterns over the years for epidemiologically significant pathogens and resistance patterns, a notable increasing trend in carbapenem resistance was observed only in *E. coli, K. pneumoniae*, and *P. aeruginosa* ($p=0.009$, $p<0.001$, and $p<0.001$, respectively, Figure 1). It was evident that carbapenem resistance in *K. pneumoniae* and *P. aeruginosa* was significantly higher in the ICUs ($p<0.001$ and $p=0.007$). Moreover, an acceleration in the rising trend of carbapenem resistance ratios in these Gram-negative pathogens was particularly pronounced after 2020. Conversely, no statistically significant increasing trend was observed over the years for methicillin resistance in *S. aureus* and *Coagulase-negative staphylococci* (CNS), as well as vancomycin resistance in *Enterococcus faecalis* and vancomycin resistance in *Enterococcus faecium* ($p=0.599$, $p=0.221$, $p=0.089$, and $p=0.363$, respectively). Similar resistance ratios were observed between the ICUs and the clinics ($p=0.404$, $p=0.866$, $p=0.949$, and $p=0.893$, respectively).

DISCUSSION

This study revealed a decreasing trend in the incidence of patients developing at least one HAI and the overall HAI rate over the years, both in the ICUs and the clinics. Notably, these two measures, especially in the years 2019-2022, were lower than the years 2015-2018. However, in contrast, a significant increase in carbapenem resistance was observed over the years, particularly after 2020, in *E. coli*, *K. pneumoniae*, and *P. aeruginosa*. The ratio of patients developing at least one HAI in the ICUs, the overall HAI incidence, and the mean number of HAIs per patient were higher than in the clinics. Additionally, over the years, there has been an increasing trend in the ratio of pneumonia and BSI in the ICUs.

The hospital initiated HAI surveillance in 2005, aligning with current scientific data and keeping pace with evolving national and international guidelines. Over the years, surveillance has been improved by increasing data completeness, accessing microbiological data, and operating room records. Regular IPC training has been provided to physicians, nurses, and other healthcare workers. The decreasing trend in the ratio of patients developing HAIs and the overall HAI rate in the ICU and the clinics over the years serves as a testament to the overall success of the hospital's IPC program. In Turkiye, a national remote infection control training program for physicians and nurses has been initiated since 2017.[3] In 2017, an automated system that can monitor the use of antibiotics in hospital pharmacies was implemented at the national level.[13] Furthermore, bundle practices for invasive device-associated infections have been initiated in the hospital from 2021 onwards.[3,14,15] These initiatives have likely played a significant role in reducing HAI rates between the years 2019 and 2022. The increased demand for healthcare services and improved accessibility has led to longer patient stays in ICUs.[16] It is well-established that HAIs are frequently observed in ICUs due to various factors, including the decrease in immune system functions, comorbidities, interventional applications, the use of broad-spectrum antibiotics, and colonisation by resistant organisms.[17,18] Extended hospital stays and advanced age have been identified as risk factors for HAIs.[17-19] In this study, the mean age of patients in the ICUs was higher than in the clinics. Furthermore, the most common type of HAI was BSI, followed by pneumonia, and UTI, which is consistent with the 2021 USHIESA summary report.[2] However, there was an upward trend observed in the incidence ratios of BSI and pneumonia in the ICUs over the years. BSI can increase due to patient-related risk factors such as skin integrity disruption, comorbidities, and the presence of infection in another region, as well as due to catheter and hospital-related risk factors.[1,3,16,20] The increase in pneumonia can also result from patient-related risk factors and risks such as aspiration, intubation, sedation, and mechanical ventilation.[3,4,21,22] It has been considered necessary to identify the underlying risks contributing to the rise in BSI and pneumonia, and to enhance adherence to infection control measures. On the other hand, the SSI ratio in the clinics has demonstrated a consistent decline since 2018. According to

the national surveillance data of Turkiye in 2021, the compliance ratio for surgical antibiotic prophylaxis has increased over the years. This positive development, which has also been evident within the hospital, may have played a significant role in reducing the incidence of SSI.[2]

The common and uncontrolled use of carbapenems contributes to the increase in resistance and causes restrictions in empirical treatment options when HAI develops.[23] The ratio of carbapenem-resistant Gram-negative bacteria was increasing in many countries in Europe according to The European Centre for Disease Prevention and Control (ECDC) 2022 report.[24] In this study, the most commonly identified pathogens were *Entero-bacterales* and non-fermentative Gram-negative bacilli. There has been a significant increasing trend in carbapenem resistance in *E.coli*, *K.pneumoniae*, and *P.aeruginosa* over the years, and the acceleration of this trend after 2020 is concerning. The observed results could be attributed to both the increase in carbapenem resistance in the hospital and possible shortcomings in IPC measures. It is important to thoroughly assess and address these factors to effectively combat the rise of carbapenem resistance and ensure effective IPC practices.

The results of this study are essential for guiding IPC measures, as it includes prospective, active surveillance data spanning a length period and encompassing most healthcare settings within the hospital. However, it is worth noting that changes in surveillance sensitivity, shifts in patient demographics, alterations in healthcare delivery, variations in healthcare worker composition, and the quality of microbiological tests over the years might have influenced findings. Furthermore, limitations of this study include the lack of evaluation regarding patients' admission reasons, risk factors, nurse-to-patient ratios, and specimen collection practices. Nonetheless, the study's strengths lie in its use of active, prospective, and patient-based surveillance, adherence to diagnostic criteria and surveillance management in line with national standards, data collection conducted by trained nurses with extensive surveillance experience, and data evaluation by IPC professionals holding national education certificates.

CONCLUSION

The ratio of patients developing the overall HAI rate in the ICUs was significantly higher in ICUs than in clinics. The upward trends in BSI and pneumonia within the ICUs highlight the need to review infection control bundles and compliance ratios. Furthermore, the increasing prevalence of carbapenem-resistant *E. coli, K. pneumoniae, and P. aeruginosa* over the years, especially after 2020, suggests the need to re-evaluate antimicrobial consumption practices, particularly in the context of the COVID-19 pandemic.

ETHICAL APPROVAL:
Ethical approval for this study has been obtained from the Ankara Etlik City Hospital Ethics Committee (approval no: AEŞH-EK1-2023-135, approval date: 03.05.2023).

PATIENTS' CONSENT:
Written informed consent was obtained from all hospitalised patients, declaring the infection status that requires isolation during hospitalisation and informing them of the essential conditions for isolation.

COMPETING INTEREST:
The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTION:
TUU: Literature review, designing, and drafting the manuscript.
CHH: Analysing and revising the manuscript.
HNKP: Drafting and revising the manuscript.
NA: Conceptualisation, data curation.
GCS, IS: Revising the manuscript.
All authors approved the final version of the manuscript for publication.

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