Healthcare-associated infections in a rehabilitation hospital in Türkiye: A six-year retrospective analysis of incidence, pathogens and risk factors

Türkiye'de bir rehabilitasyon hastanesinde sağlık hizmeti ilişkili enfeksiyonlar: İnsidans, patojenler ve risk faktörlerinin altı yıllık retrospektif analizi

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ABSTRACT

Objective: This study aimed to evaluate the incidence, risk factors, causative microorganisms, and antibiotic resistance patterns of healthcare-associated infections (HAIs) over a six-year period in a tertiary physical medicine and rehabilitation hospital.

Methods: In this retrospective study, the medical records of 9,139 patients hospitalized between January 1, 2017, and December 31, 2022, in a 210-bed tertiary physical medicine and rehabilitation hospital were reviewed. HAIs were defined according to the National Healthcare-Associated Infections Surveillance Diagnostic Guideline of the Directorate General of Public Health, Ministry of Health of the Republic of Türkiye.

Results: During the study period, 179 patients developed HAIs. The incidence of HAIs was 1.95, and the incidence density was 0.56. The majority of patients were male (82.7%), with a median age of 40 years. The

ÖZET

Amaç: Bu çalışmada, üçüncü basamak bir fizik tedavi ve rehabilitasyon hastanesinde altı yıllık dönemde gelişen sağlık hizmeti ile ilişkili enfeksiyonların (SHİE) insidansı, risk faktörleri, etken mikroorganizmaları ve antibiyotik direnç paternlerinin değerlendirilmesi amaçlandı.

Yöntem: Bu retrospektif çalışmada, 1 Ocak 2017 – 31 Aralık 2022 tarihleri arasında, 210 yataklı üçüncü basamak bir fizik tedavi ve rehabilitasyon hastanesinde yatan 9.139 hastanın tıbbi kayıtları incelendi. SHİE'ler, Türkiye Cumhuriyeti Sağlık Bakanlığı Halk Sağlığı Genel Müdürlüğü Ulusal Sağlık Hizmeti ile İlişkili Enfeksiyonlar Sürveyans Tanı Rehberine göre tanımlandı.

Bulgular: Çalışma döneminde 179 hastada SHİE gelişti. SHİE insidansı 1,95 ve insidans dansitesi 0,56 saptandı. Hastaların çoğunluğu erkekti (%82,7) ve medyan yaş 40 idi. Hastaların en sık tanıları spinal

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most common diagnoses were spinal cord injury (62%) and stroke/traumatic brain injury (15.2%). Of the HAIs, 92.2% were urinary tract infections (UTIs) and 7.8% were skin and soft tissue infections. The most frequently isolated microorganism was *Escherichia coli* (*E. coli*) (52.5%). Multidrug-resistant organisms accounted for 27.9% of isolates. Over the six-year period, a decreasing trend in HAI incidence density was observed; the incidence density of catheter-associated UTIs decreased by 67%, while the standardized infection ratio (SIR) declined from 1.6 in 2017 to 0.6 in 2022. This reduction was associated with infection control measures such as regular staff training, improved compliance with hand hygiene, implementation of national infection prevention bundles, antimicrobial stewardship, daily catheter assessments, and timely removal of unnecessary catheters.

Conclusion: HAIs are common in physical medicine and rehabilitation centers, and this is particularly pronounced among patients with neurological disorders. The most frequent type of infection is UTI, with urinary catheter use being the main modifiable risk factor. *E. coli* was the most frequently isolated pathogen, and multidrug resistance remains a major concern. The decline in infection rates underscores the importance of infection control measures that are implemented effectively and continuously in rehabilitation hospitals.

Key Words: Healthcare-associated infections, rehabilitation hospital, spinal cord injury, urinary tract infection, multidrug resistance, infection control

kord yaralanması (%62) ve inme/travmatik beyin hasarı (%15,2) idi. SHİE'lerin %92,2'si üriner sistem enfeksiyonu (ÜSE), %7,8'i ise deri ve yumuşak doku enfeksiyonlarıydı. En sık izole edilen mikroorganizma *Escherichia coli* (*E. coli*) (%52,5) idi. Çok ilaca dirençli organizmalar izolatların %27,9'unu oluşturdu. Altı yıllık dönemde SHİE insidans dansitesinde azalma eğilimi izlendi; kateter ilişkili-ÜSE insidans dansitesi %67 oranında düşerken, standardize enfeksiyon oranı (SIR) 2017'de 1,6'dan 2022'de 0,6'ya geriledi. Bu düşüş; düzenli personel eğitimi, el hijyenine uyumun artırılması, ulusal enfeksiyon önleme paketlerinin uygulanması, antimikrobiyal yönetim, kateterlerin günlük değerlendirilmesi ve gereksiz kateterlerin zamanında çıkarılması gibi enfeksiyon kontrol önlemleri ile ilişkiliydi.

Sonuç: Fizik tedavi ve rehabilitasyon merkezlerinde SHİE'ler yaygın olup, bu durum özellikle nörolojik hastalığı olan hastalarda daha belirgindir. En yaygın enfeksiyon tipi ÜSE olup, üriner kateter kullanımı başlıca değiştirilebilir risk faktörüdür. *E. coli* en sık izole edilen patojen olup çoklu ilaç direnci önemli bir sorun olmaya devam etmektedir. Enfeksiyon oranlarındaki azalma, fizik tedavi ve rehabilitasyon hastanelerinde etkin ve sürekli şekilde uygulanan enfeksiyon kontrol önlemlerinin önemini vurgulamaktadır.

Anahtar Kelimeler: Sağlık hizmeti ile ilişkili enfeksiyonlar, rehabilitasyon hastanesi, spinal kord yaralanması, üriner sistem enfeksiyonu, çoklu ilaç direnci, enfeksiyon kontrolü

INTRODUCTION

Healthcare-associated infections (HAIs), previously termed "nosocomial infections," have been defined under this name by the Centers for Disease Control and Prevention since 2008. The National Healthcare Safety Network describes HAI as a localized or systemic clinical condition caused by infectious agents or toxins that were neither present nor incubating at the time of hospital admission (1). In Türkiye, the Ministry of Health's National Healthcare-Associated Infections Surveillance Guideline also defines HAIs within this framework and provides standardized criteria for their monitoring and reporting (2). Bacteria originating from the hospital environment and the human microbiota are the most common pathogens, although fungi and viruses may also be responsible. The most frequently encountered types of HAIs include bloodstream infections, urinary tract infections (UTI), pneumonia, and surgical site infections (3).

HAIs represent one of the most significant complications of modern medical care. Major risk factors include advanced age, comorbidities, increasing use of invasive devices, and inappropriate use of antibiotics. These infections increase morbidity and mortality in hospitalized patients while also prolonging the length of hospital stay and escalating healthcare costs (4). Studies from developed countries have reported that 5% to 15% of patients, particularly those in intensive care, transplantation, and surgical units, develop HAIs (5,6). However, HAIs are not limited to high-risk units and are also observed in wards where surgical procedures are not performed (7). The risk of developing HAIs increases with prolonged hospital stays, which are most commonly required in rehabilitation units. Rehabilitation services typically care for patients who have stabilized after acute medical processes such as intensive care treatment or surgical procedures, many of whom present with multiple comorbidities and require long-term follow-up (8). Surveillance data from Europe indicate that HAIs cause more deaths than any other infectious disease under monitoring and occur with similar frequency in long-term care facilities as in acute care hospitals (7). The incidence of HAIs in long-term care facilities, including rehabilitation hospitals, has been reported to range from 1.8 to 13.5 infections per 1,000 patient-days (9).

In the rehabilitation setting, HAIs further prolong hospitalization, delay recovery, worsen prognosis, increase disability, and deepen dependency in activities of daily living (10). Despite these critical outcomes, the number of studies focusing specifically on HAIs in rehabilitation hospitals remains limited. Existing research has largely concentrated on specific patient populations or has evaluated rehabilitation hospitals together with other long-term care institutions, such as nursing homes (7,11). Therefore, in line with both international definitions and the Ministry of Health's National Healthcare-Associated Infections Surveillance Guideline, we aimed to provide up-to-date and comprehensive data on HAIs among adult patients in a rehabilitation hospital.

MATERIAL and METHOD

This retrospective study evaluated the records of 9,139 patients hospitalized between January 1, 2017, and December 31, 2022, in a 210-bed tertiary rehabilitation hospital.

An HAI was defined as an infection occurring on or after the third day of hospital admission. The earliest date on which site-specific diagnostic criteria were fulfilled was considered the 'date of infection'. Diagnostic criteria were determined according to the National Healthcare-Associated Infections Surveillance Guideline of the General Directorate of Public Health, Ministry of Health of the Republic of Türkiye (2).

Our hospital operates a prospective, hospital-wide, laboratory-based surveillance system for the detection and monitoring of HAIs. All culture results obtained throughout the hospital were reviewed daily by the infection control team. Potential cases were systematically evaluated and discussed within the hospital infection control committee. Cases identified as HAIs were recorded and reported on a quarterly basis.

For each patient, the following variables were collected: age, sex, primary diagnosis, admitting department, risk factors, type of HAI, isolated microorganisms with resistance profiles, antibiotics administered, and length of hospital stay. Physical examination findings, laboratory results, and treatment protocols were obtained from hospital surveillance forms and the electronic medical records database.

The control group included 185 patients without HAIs, hospitalized in the same clinics during the study period, selected through simple random sampling. There was no significant difference between the study and control groups in terms of age and sex.

Microorganisms isolated from patients were identified by the hospital microbiology laboratory. Standard laboratory methods were used for quantitative urine and tissue cultures. Antimicrobial susceptibility testing was performed using the disk diffusion method on Mueller-Hinton agar in accordance with the guidelines and breakpoint values of the European Committee on Antimicrobial Susceptibility Testing (EUCAST). Plates were incubated at 36 °C for 16–20 hours; for tissue cultures, incubation was extended up to 48 hours when required. Inhibition zones were measured and classified as susceptible, intermediate, or resistant according to EUCAST criteria, and antimicrobial susceptibilities of bacteria were determined accordingly (12). MDR microorganisms were defined as non-susceptible to at least one agent in three or more antimicrobial categories (13).

All analyses were performed using the Statistical Package for the Social Sciences (SPSS) for Windows, version 20 (IBM SPSS Inc., Chicago, IL). Normality of data distribution was assessed with the Kolmogorov-Smirnov test. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages.

Comparisons between two groups were performed using the Student's t-test for normally distributed variables and the Mann-Whitney U test for non-normally distributed variables. Comparisons among three or more groups were conducted using ANOVA for normally distributed variables and the Kruskal-Wallis test for non-normally distributed variables. Pairwise comparisons were adjusted using the Bonferroni correction.

Categorical variables were compared with the Chi-square test. Longitudinal changes were assessed using mixed-effects models. A two-sided p-value <0.05 was considered statistically significant.

The study was approved by the Ankara Bilkent City Hospital Clinic Researchers Ethics Committee (Date: 01.03.2023 and Number: E2-23-3470).

RESULTS

Between 2017 and 2022, a total of 9,139 patients were hospitalized in our rehabilitation hospital, corresponding to 316,685 patient-days. HAIs developed in 179 patients, yielding an overall incidence of 1.95 and an incidence density of 0.56. Among patients with HAI, 148 (82.7%) were male and 31 (17.3%) were female, with a median age of 40 years (range: 18–93).

Regarding primary diagnoses, most patients with HAIs had spinal cord injury (SCI, n=111, 62.0%), followed by stroke or traumatic brain injury (TBI, n=27, 15.2%). Other diagnoses included malignancy, fracture, or amputation (n=21, 11.7%), neurological disorders such as Guillain–Barré syndrome, transverse myelitis, multiple sclerosis, or encephalitis (n=11, 6.1%), and degenerative joint or intervertebral disc disease (n=9, 5.0%). HAIs were particularly common in the SCI rehabilitation department, where they accounted for 50.3% of all cases.

The majority of infections were UTIs (n=165, 92.2%), followed by skin and soft tissue infections (SSTIs) (n=14, 7.8%). The overall incidence of UTI was 1.8. Of these, 133 (74.3%) were non-catheter-associated urinary tract infections (non-CAUTI, symptomatic UTI), while 32 (17.9%) were catheter-associated urinary tract infections (CAUTI, symptomatic UTI). All SSTIs (n=14, 7.8%) were identified as infected pressure ulcers. No cases of asymptomatic bacteremic UTI or pneumonia were detected during the study period.

HAIs were evaluated according to the method of bladder drainage. Clean intermittent catheterization (CIC) was used in 92 patients (51.7%), indwelling catheterization (IC) in 31 patients (17.4%), while 56 patients (30.9%) had voluntary bladder control.

Escherichia coli (*E. coli*) was the most frequently isolated pathogen in healthcare-associated urinary tract infections (HA-UTIs) (n=94, 52.5%). Pathogens identified in SSTIs included *Klebsiella* spp. (n=5), *Acinetobacter* spp. (n=4), *Pseudomonas* spp. (n=3), methicillin-resistant *Staphylococcus aureus* (MRSA) (n=1), and *Enterobacter* spp. (n=1).

Among the 179 HAIs, 50 (27.9%) were caused by multidrug-resistant (MDR) microorganisms. Evaluation of resistance profiles revealed that 23.4% of isolates were extended-spectrum β-lactamase-producing (ESBL+) and 4.5% demonstrated carbapenem resistance. MRSA was identified in one patient, whereas no vancomycin-resistant enterococcus was detected.

The most frequently used antibiotics were fluoroquinolones (29%), nitrofurantoin (20.1%), dual antibiotic therapy (16.8%), β-lactam/β-lactamase inhibitor combinations (10.6%), carbapenems (8.9%), cephalosporins (5.0%), and fosfomycin (4.0%). Other antibiotics, including tetracyclines, sulfonamides, and oxazolidinones, were prescribed in 5.6% of cases. The clinical and demographic characteristics of the patients are presented in Table 1.

Table 1. Demographic and clinical characteristics of the patients

Variable	n (%)
Age (median, range)	40 (18-93)
Gender	
Male	148 (82.7)
Female	31 (17.3)
Clinic/Ward	
SCI Rehabilitation	90 (50.2)
Acute Rehabilitation	48 (26.8)
Brain Injury Rehabilitation	17 (9.5)
Rheumatologic Rehabilitation	15 (8.4)
Orthopedic Rehabilitation	9 (5.1)
Type of HAI	
Non-CAUTI	133 (74.3)
CAUTI	32 (17.9)
SSTIs	14 (7.8)
Bladder drainage method	
CIC	92 (51.7)
IC	31 (17.4)
Voluntary bladder control	56 (30.9)

Table 1 (cont.). Demographic and clinical characteristics of the patients

Variable	n (%)
Isolated microorganisms	
E. coli	94 (52.5)
Klebsiella spp.	42 (23.5)
Pseudomonas spp.	13 (7.2)
Enterobacter spp.	10 (5.6)
Two types of microorganisms	7 (3.9)
Acinetobacter spp.	4 (2.2)
Proteus spp.	3 (1.7)
Enterococcus spp.	3 (1.7)
S. aureus / Coagulase-negative staphylococci	3 (1.7)
Antibiotic treatment	
Fluoroquinolones	52 (29.0)
Nitrofurantoin	35 (20.1)
Dual antibiotic therapy	30 (16.8)
β-lactam/β-lactamase inhibitor combinations	20 (10.6)
Carbapenems	16 (8.9)
Cephalosporins	9 (5.0)
Fosfomycin	7 (4.0)
Other (tetracycline, sulfonamide, oxazolidinone)	10 (5.6)

Note: n = number of patients, % = percentage. SCI: Spinal cord injury; HAI: Healthcare associated infections; non-CAUTI: non-catheter-associated urinary tract infections; CAUTI: catheter-associated urinary tract infections; SSTI: Skin and soft tissue infection; CIC: Clean intermittent catheterization; IC: Indwelling catheterization.

HAIs occurred significantly more often in patients with SCI and in those with stroke or TBI ($p<0.001$). The distribution of HAI types by primary diagnosis is presented in Table 2.

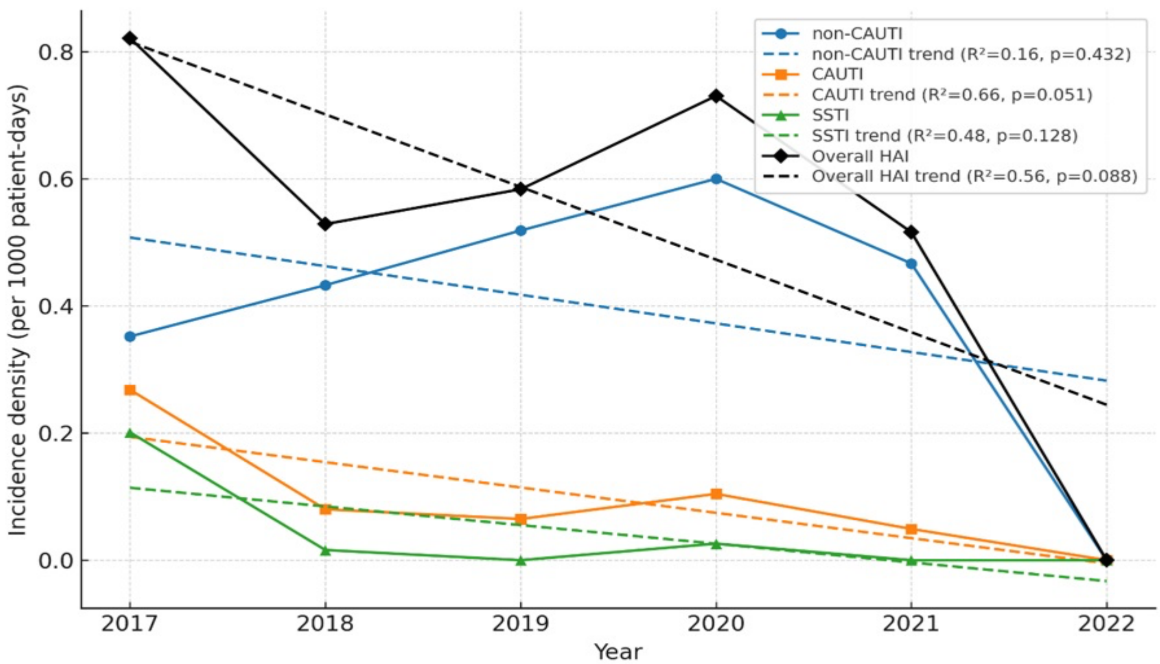
Over the six-year period, incidence density showed a declining trend across most infection types. A reduction was observed for CAUTI (R^2=0.66, p=0.051), SSTI (R^2=0.48, p=0.128), and overall HAI incidence density (R^2=0.50, p=0.091). In contrast, non-CAUTI showed a slight downward trend that did not reach statistical significance (R^2=0.16, p=0.432). Annual incidence densities and regression trend lines are displayed in Figure 1. Additionally, CAUTI rates and standardized infection ratios (SIRs) were analyzed separately due to their clinical importance as a quality indicator (Figure 2).

When the distribution of the most frequently isolated pathogens was compared by bladder drainage method, significant differences were observed among the groups ($p<0.001$). *E. coli* predominated in the CIC group (79.7%) and in patients with voluntary bladder control (60.5%), whereas the IC group showed a more heterogeneous profile with *Klebsiella* spp. (38.1%), *E. coli* (33.3%), and *Pseudomonas* spp. (28.6%) (Table 3). In patients who developed HAIs, both urinary catheter utilization rates and length of hospital stay were significantly higher compared with the control group without HAIs ($p<0.001$).

Table 2. Distribution of HAI types by clinical diagnosis

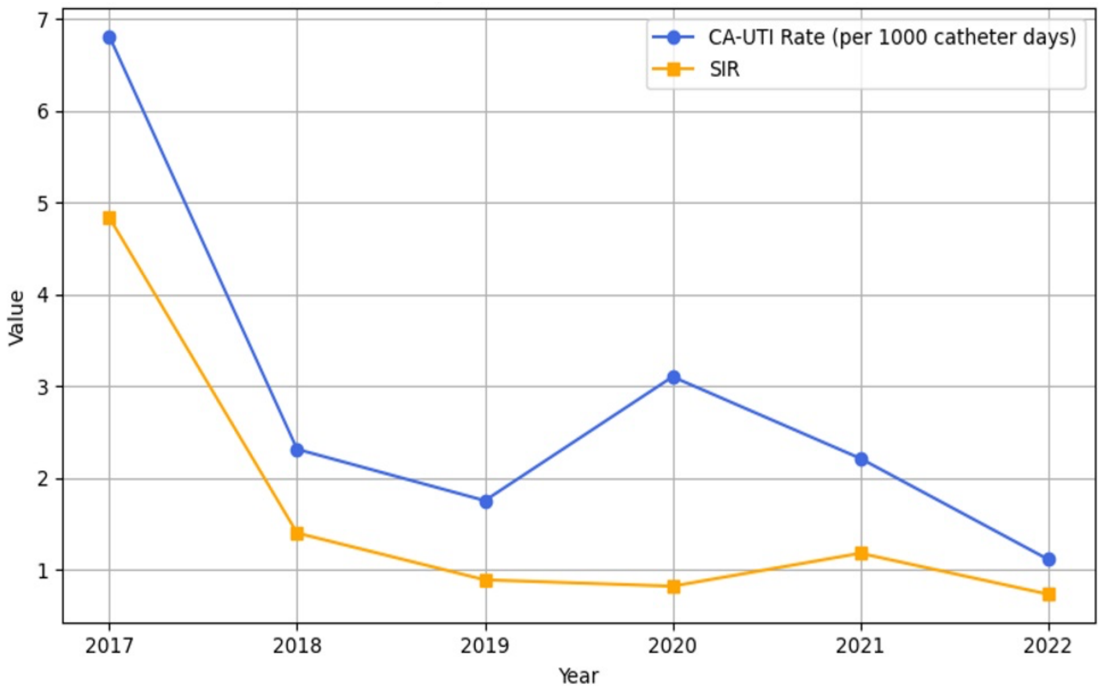
HAI type n(%)	SCI (n=111)	Stroke or traumatic brain injury (n=27)	Other neurological diseases* (n=11)	Degenerative joint and intervertebral disc anomalies (n=9)	Other diseases** (n=21)	p
Non-CAUTI	88 (79.3%)	22 (81.4%)	8 (72.7%)	8 (88.9%)	7 (33.3%)	
CAUTI	19 (17.1%)	4 (14.8%)	3 (27.3%)	1 (11.1%)	5 (23.8%)	<0.001 [a]
SSTIs	4 (3.6%)	1 (3.7%)	--	--	9 (42.9%)	

SCI: Spinal cord injury; non-CAUTI: non-catheter-associated urinary tract infection; CAUTI: catheter-associated urinary tract infection; SSTI: skin and soft tissue infection.
*Other neurological diseases: Guillain-Barré syndrome, transverse myelitis, multiple sclerosis, encephalitis.
**Other diseases: malignancy, fracture, amputation, etc.
a: Chi Square Test, (n / %)



HAI: healthcare-associated infection; CAUTI: catheter-associated urinary tract infection; non-CAUTI: non–catheter-associated urinary tract infection; SSTI: skin and soft tissue infection.

Figure 1. Annual incidence density trends of HAIs between 2017 and 2022



CAUTI: catheter-associated urinary tract infection; SIR: standardized infection ratio.

Figure 2. Annual CAUTI rates and SIR values, 2017–2022

DISCUSSION

Previous studies conducted in rehabilitation and long-term care settings have reported similar incidence rates of HAIs. For instance, a point prevalence study from Germany found an incidence of 1.7%, while an orthopedics and rehabilitation clinic reported 1.98% (14,15). Likewise, a multicenter study in Italy involving brain-injured patients reported an incidence of 1.93% (16). Similar to the literature, the incidence of HAI was found to be 1.95 in our study.

Over the six-year study period, a gradual decline was observed in the incidence density of HAIs, including CAUTIs, SSTIs, and overall infection rates. Specifically, CAUTI incidence density decreased from 0.27 in 2017 to 0.09 in 2022, corresponding to an approximate 67% reduction, while the SIR declined from 1.6 to 0.6, reflecting a 62% decrease. We believe that these improvements were closely linked to the strengthening of infection control practices following the appointment of a full-time infectious diseases specialist in 2018. During this period, regular staff training was intensified, national infection prevention bundles were implemented, antimicrobial stewardship with feedback mechanisms was reinforced, daily catheter indications were evaluated with prompt removal of unnecessary catheters, and hand hygiene practices were closely monitored. In a study conducted in India, a 60% reduction in CAUTI SIR was reported through similar infection control measures (17). Overall, our findings are consistent with international evidence and highlight the critical role of comprehensive and sustained infection control strategies in reducing infection rates in rehabilitation hospitals.

The etiopathogenesis of infectious diseases in physical therapy and rehabilitation hospitals varies according to the primary diagnosis of patients. SCI predisposes individuals to multiple complications in organs below the neurological lesion level. Owing to respiratory dysfunction—such as atelectasis and impaired secretion clearance—the risk of pneumonia is increased in these patients (18). Neurogenic bladder dysfunction leads to elevated intravesical pressure and bladder overdistension, which can cause ischemia and mucosal damage, thereby predisposing to urinary tract infections (19). In immobilized patients, sustained pressure over bony prominences compromises local blood flow and facilitates the development of pressure ulcers, which in turn increase the risk of secondary SSTIs, often aggravated by urinary or fecal incontinence (20). Additionally, patients with neurological disorders may be at increased risk of developing HAIs because of altered mental status and a higher tendency for aspiration. Immune suppression and a greater likelihood of concomitant trauma also contribute to this increased vulnerability (21). Several studies have shown that post-stroke immunosuppression contributes significantly to the increased risk of infections in this patient population (22,23). In a study conducted in the physical therapy and rehabilitation service, Demirdal et al. reported that 58.3% of HAIs occurred in patients with SCI, whereas 33% were observed in patients with stroke (24). Consistent with these findings, our study also demonstrated that HAIs were predominantly observed in patients with SCI or other neurological disorders, while they were significantly less frequent among patients with non-neurological conditions such as degenerative joint disease and intervertebral disc anomalies ($p<0.05$).

In a study from Germany, UTIs were the most common HAIs, accounting for approximately 50% of cases, followed by respiratory, SSTIs (15). Similarly, a ten-year study from the Netherlands identified UTIs as the most frequent HAIs in long-term care centers, with a prevalence of 1.7% (95% CI: 1.6–1.8) (25). In contrast, a multinational prevalence study from Europe found that respiratory tract infections were the most common HAIs in long-term care centers (21.4% pneumonia and 4.3% other lower respiratory tract infections), followed by UTIs (18.9%) and surgical site infections (18.4%) (7). In our study, the most common HAIs were UTIs (92.2%), followed by SSTIs (7.8%). In the study where respiratory tract infections were the most common HAIs, the lower frequency of UTIs was attributed to the fact that most of the evaluated patients were over the age of eighty-five (7). In contrast, the absence of healthcare-associated respiratory tract infections in our study may be explained by the younger age of our patient population, the high prevalence of neurogenic bladder dysfunction, and the widespread use of CIC or IC.

In our study, urinary catheter use was statistically significantly higher in patients with HAI compared to those without HAI. This association has also been emphasized in previous research: a study from Italy reported that 59.5% of patients with HAI in post-acute clinics and all patients with HAI in long-term rehabilitation centers had a urinary catheter (16), while another Italian study showed that one-third of catheterized rehabilitation patients developed HAIs (25). Another study from the Netherlands reported that 20% of HA-UTIs were catheter-related (26). In our study, this rate was 17.9%. Collectively, both our findings and previous reports highlight urinary catheterization as a major, yet preventable, risk factor for HAIs in rehabilitation settings.

Patients who undergo CIC are typically those with SCI and neurogenic bladder dysfunction. Compared to IC or suprapubic catheterization, CIC has been reported to be safer and associated with lower rates of complications and UTIs (27,28). In our study, 18.2% of patients were managed with an IC, 54.5% with CIC, and 27% had voluntary bladder control.

The higher frequency of HA-UTIs among patients undergoing CIC may be related to infection control policies: CIC was preferred over IC when clinically appropriate, and IC users were transitioned to CIC whenever feasible. Furthermore, the Spinal Cord Medical Consortium guidelines state that evidence on infection risk is mixed and does not clearly favor one bladder management method over another. Similarly, a recent systematic review emphasized that the hypothesis suggesting ICs cause more UTIs than CICs is not supported by current scientific evidence (29,30).

In our study, *E. coli* was the most frequently isolated microorganism across all diagnostic groups. Consistently, studies in similar patient populations have also reported *E. coli* as the leading pathogen in urinary tract infections (7,11,26). Our analysis showed that patients managed with CIC or voluntary voiding predominantly harbored common pathogens, whereas IC users exhibited a higher proportion of more resistant organisms such as Klebsiella and Pseudomonas. The literature also suggests that long-term catheterization may provide a favorable environment for colonization by more heterogeneous and resistant microorganisms, and that polymicrobial infections can be more frequent in this patient group (31,32). These findings support the importance of considering bladder management methods when selecting empirical antibiotic therapy.

In a multicenter study of patients with severe acquired brain injury, the prevalence of MDR microorganisms was reported as 30.3% (16). Likewise, a European point-prevalence study reported MDR in 28% of isolates and carbapenem resistance in 4.2% of isolates from long-term care centers (7). In our study, MDR microorganisms accounted for 27.9% of isolates, and carbapenem resistance was 4.5%. MRSA prevalence is generally low in rehabilitation hospitals, and in our study only one case was detected. Although the overall prevalence of resistant pathogens was comparable to reports from European rehabilitation and long-term care facilities, even a single MRSA case remains clinically significant, as it may trigger outbreaks with serious consequences in vulnerable patients with prolonged hospital stays (33).

When the antibiotics used in patients who developed HAI were examined in our study, it was noteworthy that, fluoroquinolones were the most frequently prescribed, accounting for 29%. Similarly, in Germany, fluoroquinolones were reported as the most commonly used agents in 31.3% of patients with HA-UTI (14). In our cohort, 16.8% of patients required dual antibiotic therapy, particularly in cases of polymicrobial growth or suspected highly resistant organisms. Recent evidence also shows that for carbapenem-resistant Gram-negative infections, combination therapy can reduce mortality and improve outcomes compared with monotherapy (34). Nevertheless, such regimens should be carefully balanced with antimicrobial stewardship principles, favoring targeted therapy guided by susceptibility testing (35).

Although research on HAIs and MDR HAIs in rehabilitation and neurorehabilitation settings remains limited, recent studies have consistently shown that these infections negatively affect rehabilitation outcomes and significantly prolong hospital stay, particularly in patients with severe brain injury (36). For example, a multicenter study in Italian neurorehabilitation centers reported a mean length of hospital stay of 88.3 ± 55 days in patients with HAI, compared with 56 ± 50.7 days in those without infection ($p < 0.05$) (37). Similar findings have been reported in other studies (11,16,36). In our study, the mean length of hospital stay was significantly longer in patients with HAI (56.6 ± 31.9 days) compared to those without HAI (30.8 ± 18.6 days) ($p < 0.001$).

Pressure ulcers are also frequent complications in individuals with SCI, occurring from the acute hospitalization phase through to community reintegration. They are associated with poorer quality of life, longer hospital stays, and increased morbidity and mortality (38). Reported prevalence rates during hospitalization vary, with some studies citing values between 12% and 16.1% (39,40). In our study, 7.8% of patients developed healthcare-associated SSTIs, all of which presented as infected pressure ulcers.

This study has several limitations. First, it was conducted retrospectively in a single tertiary rehabilitation hospital, which may restrict the generalizability of the findings. Second, due to the retrospective design, certain clinical details—such as symptom severity and functional outcomes—could not be systematically evaluated. Third, detailed molecular typing of resistant organisms was not performed; therefore, the epidemiological characterization of MDR pathogens remains incomplete.

In conclusion; in this six-year study, HAIs were shown to be a frequent complication in rehabilitation hospitals, particularly among patients with neurological disorders. HA-UTIs were the predominant infection type, with urinary catheterization identified as the main modifiable risk factor. Strengthened infection control practices were associated with a decline in overall HAI incidence and CAUTI SIR, emphasizing the need for comprehensive and sustained prevention strategies in rehabilitation settings.

ETHICS COMMITTEE APPROVAL

* The study was approved by the Ankara Bilkent City Hospital Clinic Researchers Ethics Committee (Date: 01.03.2023 and Number: E2-23-3470).

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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