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Investigation of hospital-acquired infections in units other than the intensive care unit

Şebnem Çalık[1*], Alpay Arı[1], Bengisu Ay[1], Özlem Yüksel Ergin[2], Selma Tosun[1]

1 Department of Infectious Diseases and Clinical Microbiology, University of Health Sciences, Izmir Bozyaka Training and Educational Hospital, Izmir, Turkey. 2 Department of Microbiology and Clinical Microbiology, University of Health Sciences, Izmir Bozyaka Training and Educational Hospital, Izmir, Turkey.

Abstract

Backround: Hospital-acquired infections (HAIs) are issues for not only patients who get treatment in the intensive care unit but also for patients who are being treated in internal medicine and surgical departments. HAIs cause functional disorders, less life quality or even death. The aim of this study was to investigate the prevalence of HAIs, distribution of the infections, and isolated microorganisms in units other than the intensive care units (ICU).

Materials and Methods: Data of the patients who developed hospital infections between January 2014 and December 2017 were evaluated retrospectively. The McCabe score was used for categorical evaluation.

Results: The overall HAI rate was 0.17%. Of these, 619 (53.1%) occurred in departments other than the intensive care units. The most common HAI was surgical site infection (n: 223, 36%) followed by urinary tract infection (n: 176, 28.4%) and pneumonia (n: 125, 20.2%). According to patients' comorbid disease status, 48% (n: 297) was McCabe class 1, 30% (n: 186) was McCabe class 2, and 22% (n:136) was McCabe is class 3. In 85 (13.7%) of 619 HIA cases, the agent could not be isolated, and the diagnosis of HIA was based on clinical findings. Four-hundred-ninety-two bacteria were isolated and 409 (83.1%) were gram-negative whereas 83 (16.9%) were gram-positive.

Conclusions: HAIs are important health problems not only for patients in intensive care units, but also for patients who are treated in services. It was thought that the characteristics of the concomitant diseases need to be taken into consideration in preventing hospital infections.

Key words: *Hospital-acquired infections, prevalence, McCabe score, mortality*

***Corresponding Author:** Şebnem Çalık, Department of Infectious Diseases and Clinical Microbiology, University of Health Sciences, Izmir Bozyaka Training and Educational Hospital, Izmir, Turkey. Adress: Saim Çıkırıkçı Caddesi No:59 Karabağlar, İzmir,Turkey. **Phone:** +90 232 250 5050, **E-mail:** sebnemozkoren@yahoo.com **Received:** Jul, 2019. **Accepted:** Sept, 2019.

Introduction

Hospital-acquired infections (HAIs) are still a major cause of mortality and morbidity in the world. It is also an important factor that increases the length of hospital stay and associated costs (1). HAIs affect 5–15% of hospitalized patients in wards and more than 50% of intensive care unit (ICU) patients (2). Hospital-acquired infection is a problem not only in patients in intensive care units but also in patients who are followed in various clinics such as internal medicine or surgery. It may cause functional impairment, decreased quality of life and death. In addition, it increases the economic burden due to the prolongation of hospital stay, the emergence of job loss, the increase in drug use, the need for isolation and the use of extra laboratory or other diagnostic methods (3-5).

HAI surveillance is a field of study which involves continuously, systematic and active data collection in a particular group, and is a study area covering detailed review and feedback. Infected patients should be detected by surveillance of hospital-acquired infections, through which infection frequency, factors and risk factors are determined. By regular surveillance monitoring, clinical follow-up and empirical antimicrobial treatment modalities have improved and actions necessary to assess the effectiveness of the infection control systems in centers providing health care have been taken (3,4). Patient infections which are related to invasive and surgical interference are being routinely scrutinized in our country. Whereat, there are limited information about hospital infections, which are developed out of intensive care unit, on National Hospital Infections surveillance network data and literature (6). The aim of this study was to investigate the prevalence of HAIs, distribution of the infections, patient characteristics, comorbidities and isolated microorganisms in units other than the intensive care unit of hospital (ICU).

Materials and methods

Our hospital is a tertiary health care institution with 572 bed capacity. Data of the patients who were followed-up in units other than the intensive care unit and developed HIA between January 2014 and December 2017 were evaluated retrospectively. In our hospital, active surveillance of hospital-acquired infections is routinely performed by a team of two infectious diseases specialists, four infection control nurses by reviewing daily patient visits and electronic patient files and interviewing with treating physicians in other than ICUs. The obtained data are regularly entered in patient follow-up forms. Patient follow-up forms include data on age, sex, concomitant disease status of the patients, monitoring unit, hospitalization time and history of developing hospital-acquired infections, isolated microorganisms, and susceptibility to various antimicrobials and previous surgeries and antibiotic treatments undertaken.

In evaluating the data, the departments where the patients are monitored were classified as internal services, surgical services, hematology service and palliative care unit. The reason for classifying patients being monitored in hematology and palliative care units separately from the internal diseases unit is that the risk of developing hospital-acquired infections is higher because of the perception of a better general condition of the patients monitored in these clinics and the expectation of long term hospitalization. Our hospital does not accommodate obstetrics and gynecology, pediatrics or cardiology units.

The McCabe score is referred as a useful predictor of risk for hospital acquired infection in selected settings. McCabe score was calculated for patients with hospital-acquired infections according to comorbid diseases (7). According to this score;

Class 1: Patients without comorbid disease and those with diabetes mellitus, genitourinary system, gastrointestinal system diseases. This group is classified as non-lethal and life expectancy is over 5 years.

Class 2: Diseases like aplastic anemia, non-metastatic carcinomas, chronic leukemias, lymphomas other than stage 4, portal hypertension, non-severe heart failure, organ transplant patients, chronic hemodialysis patients, chronic respiratory failure requiring oxygen, early stage HIV infection. This group, which is classified as lethal, has a life expectancy of 1-5 years.

Class 3: Acute leukemias, blastic phase of chronic leukemias, malignant lymphomas and Hodgkin stage 4, metastatic carcinomas, severe heart failure, hepatic failure with encephalopathy, rapid progressive respiratory failure, disease such as advanced stage HIV infection. In this group classified as rapidly fatal, patients with a life expectancy<1 year are included.

Hospital-acquired infections (HAIs) were diagnosed according to the Centers for Disease Control and Prevention (CDC) criteria. HAIs are classified as urinary system, pneumonia, primary bloodstream, catheter-associated bloodstream, skin-soft tissue, thrombophlebitis, and eye, mouth-throat infection (8).

Microbiology

We have been working with BD Phoenix automated system (Phoenix 100, Becton Dickinson, BD Diagnostic Systems, Franklin Lakes, New Jersey, USA) since 2012. CLSI criteria were used to determine antibiotic susceptibility until 2016, but it has been replaced with EUCAST criteria as January 2016 (9).

2.1 Data analysis

All data were recorded in SPSS version 21 program, and mean values, standard deviation and percentages were analyzed.

Ethics committee approval was received for the study.

Results

During the study period, 658402 patient days were examined and a total of 1165 HAI developed. The overall HAI rate was 0.17% in hospital. Of these, 619 (53.1%) occurred in departments other than the intensive care units. The rate of nosocomial infection was 0.10% in units other than the intensive care units. The age range of 599 patients who developed hospital-acquired infection was 18-96 years and their mean age was 63 years (±16.5). Of the patients, 341 (56.9%) were male and 258 (43.1%) were female. The most common comorbidities were solid organ malignancy (%21.4), hematological malignancy (17.5%) and diabetes mellitus (17%). Of them, 51.8% had a history of surgery during their current hospitalization. Of the patients, 4.7% were hospitalized due to trauma. Demographic data of the patients are shown in Table 1.

The most common HAI was surgical site infection (n:223, 36%) followed by urinary tract infection (n:176, 28.4%) and pneumonia (n:125, 20.2%). Urinary tract infection was more common in internal diseases (40.3%) and surgical services (39.8%). Forty-six-point-four

percent of the pneumonia cases and 76% of primary bloodstream infections occurred in the hematology service. Distribution of HAIs was shown in Table 2.

When hospital-acquired infections (n:619) were evaluated in terms of survival expectancy according to patients' comorbid disease status, 48% (n:297) was McCabe class 1, 30% (n:186) McCabe class 2, and 22% (n:136) McCabe is class 3. The most common infection in patients with McCabe class 1 was surgical site infection (124/297; 41.8%) followed by urinary tract infection (99/297; 33.3%). The most common infection in patients with McCabe class 2 was surgical site infection (95/186; 51.1%) followed by urinary tract infection (52/186; 28%). The most common infection in the group with McCabe class 3 was pneumonia (57/136, 41.9%), followed by catheter-associated bloodstream infection and primary bloodstream infection and thrombophlebitis. (43/136, 31.6%). The overall mortality rate was 23.1% and was higher in McCabe class 3 patients. HAIs, patient survival rates by infection and McCabe score are shown in Table 3.

In 85 (13.7%) of 619 hospital-acquired infection cases, the agent could not be isolated, and the diagnosis of HAI was based on clinical findings. In the eight surgical site infections, dual agents were isolated. Four-hundred-ninety-two bacteria were isolated and 409 (83.1%) were gram-negative whereas 83 (16.9%) were gram-positive. The most common microorganism was *E. coli* (147/619, 23.7%), followed by *Klebsiella spp.* (96/619, 15.5%) and *Pseudomonas aeruginosa* (76/619, 12.3%). While 92 (95.8%) of the *Klebsiella species* were *K.pneumoniae*, 4 (4.2%) were *K. oxytoca*. *E. coli*, *Klebsiellaspp* and *P.aeruginosa* were found to be more frequent agents in surgery site and urinary tract infections. Enterococci, the most common Gram-positive bacteria, were followed by *S.aureus*. While Enterococci were the causative agent of urinary tract and surgical site infection, *S. aureus* has been isolated as a surgery site and catheter-associated bloodstream infection and primary bloodstream infection and thrombophlebitis infection. In 14 patients, possible fungal infection (clinical, serological and radiological diagnosis) was diagnosed, and in one case, the diagnosis of CMV disease (clinical and molecular diagnosis) was made among the patients with diagnosed hematological malignancy receiving chemotherapy. Twenty-seven (4.4%) *Candida spp.* were isolated as agents and 12 (44.4%) were *C.albicans* and 9 (33.3%) were *C.tropicalis*. Candida *spp.*was more common in the urinary system infection, catheter-associated bloodstream infection, primary bloodstream infection and thrombophlebitis infection. The distribution of microorganisms as the cause of HAI is shown in Table 4.

The susceptibility of gram-negative bacteria to various antibiotics is shown in Table 5. The susceptibility rate of *E. coli* strains to ceftriaxone, meropenem and colistin were 28.1%, 98.6%, 100% respectively. The susceptibility rate of *Klebsiella spp.* strains to cetfriaxone, meropenem and colistin were 22.9%, 58.3% and 87.5% respectively. The susceptibility of *P. aeruginosa* strains to meropenem and colistin were 85.5% and 97.3%, versus 11.1% and 92.1%, respectively, for *Acinetobacter baumanni* strains. The susceptibility of Gram-positive bacteria to various antibiotics is shown in Table 6. Vancomycin susceptibility rates for *E. faecium* and *E. faecalis* strains were 79.3% and 95.2%, respectively. Methicillin susceptibility was 55.6% in *S.aureus* strains and 18.2% in coagulase-negative staphylococci (CoNS). Vancomycin sensitivity was 100% for both *S.aureus* and CoNS strains.

Table 1. Demografic and clinical features of patients.

Variable	*Value*
Age (mean±SD)	62.98±16.54
Male gender, n (%)	341 (56.9%)
Comorbidities, n (%)	
Solid organ malignancy	128 (21.4%)
Haematologic malignancy	105 (17.5%)
Diabetes mellitus	102 (17%)
Chronic neurologic disease	89 (14.9%)
Chronic lung disease	40 (6.7%)
Congestive heart failure	34 (5.7%)
Hemodialysis	28 (4.7%)
Chronic liver disease	7 (1.2%)
Extrinsic factors, n (%)	
Surgical operation	310 (51.8%)
Trauma	28 (4.7%)

Table2. Distrubition of infectionsaccording to the services.

Infections	*Internal medicine services n(%)*	*Surgical services n(%)*	*Haematology n(%)*	*Paliative care service n(%)*	*Total*
Surgical site (n:223)	0 (0%)	223 (100%)	0 (0%)	0 (0%)	223
Urinary tract (n:176)	71 (40.3%)	70 (39.8%)	12 (6.8%)	23 (13.1%)	176
Pneumonia (n: 125)	28 (22.4)	24 (19.2%)	58 (46.4%)	15 (12%)	125
Catheter-related BSI (n:29)*	8 (27.6%)	7 (24.1%)	11 (37.9%)	3 (10.3%)	29
Thrombophlebitis (n:25)	4 (16%)	2 (11.8%)	19 (76%)	0 (0%)	25
Primary BSI (n:17)*	3 (17.6%)	2 (11.8%)	11 (64.7%)	1 (5.9%)	17
Skin and soft tissue (n:17)	4 (23.5%)	6 (35.3%)	2 (11.8%)	5 (29.4%)	17
Meningitis (n:3)	0 (0%)	3	0 (0%)	0 (0%)	3
Throat-mouth (n:3)	0 (0%)	0 (0%)	3 (100%)	0 (0%)	3
Eye (n:1)	1 (100%)	0 (0%)	0 (0%)	0 (0%)	1

*BSI: Bloodstream infections.

Table 3. Distributionof infectionsaccording to infection source and McCabe score.

Infection source	***Survival***	***(McCabe 1) (n:297)***	***(McCabe 2) (n:186)***	***(McCabe 3) (n:136)***	***Total (n:619)***
Surgical site (n:223)	Died	15 (%5.1)	17 (%9.1)	2 (%1.5)	34 (%.5)
	Survived	109 (%36.7)	78 (%41.9)	2 (%1.5)	189 (%30.5)
Urinary tract (n:176)	Died	6 (%2)	8 (%4.3)	11 (%8.1)	25 (%4)
	Survived	93 (%31.3)	44 (%23.7)	14 (%10.3)	151 (%24.4)
Pneumonia (n:125)	Died	18 (%6.1)	10 (%5.4)	28 (%20.6)	56 (%9)
	Survived	29 (%9.8)	11 (%5.9)	29 (%21.3)	69 (%11.1)
Catheter-related BSI & Primary BSI &Thrombophlebitis (n: 71)	Died	2 (%0.7)	2 (%1.1)	17 (%12.5)	21 (%3.4)
	Survived	13 (%4.4)	11 (%5.9)	26 (%19.1)	50 (%8.1)
*Other * (n:24)*	Died	2 (%0.7)	3 (%1.6)	2 (%1.5)	7 (%1.1)
	Survived	10 (%3.4)	2 (%1.1)	5 (%3.7)	17 (%2.7)
Total (n: 619)	Died	43 (%14.5)	40 (%21.5)	60 (%44.1)	143 (%23.1)
	Survived	254 (%85.5)	146 (%78.5)	76 (%55.9)	476 (%76.9)

*Other infection sources: Skin and soft tissue, Meningitis, Throat-mouth, Eye.

Table 4. Distribution of microorganism according to infection sources.

	Surgical site	***Urinary tract***	***Pneumonia***	***Catheter-related BSI & Primary BSI &Thrombophlebitis***	***Other***
E. coli (n: 147)	76 (%51.7)	55 (%37.4)	9 (%6.1)	6 (%4.1)	1 (%0.7)
Klebsiella spp. *(n:96)*	30 (%31.3)	34 (%35.4)	21 (%21.9)	5 (%5.2)	6 (%6.2)
P. aeruginosa (n:76)	29 (%38.2)	26 (%34.2)	12 (%15.8)	3 (%3.9)	6 (%7.9)
A. baumannii (n:63)	18 (%28.6)	12 (%19)	25 (%39.7)	6 (%9.5)	2 (%3.2)
Enterobacter spp. *(n:11)*	6 (%54.5)	5 (%45.5)	0 (%0)	0 (%0)	0 (%0)
S. maltophilia(n:6)	0 (%0)	1 (%16.7)	5 (%83.3)	0 (%0)	0 (%0)
Proteus spp. *(n:11)*	7 (%63.6)	2 (%18.2)	2 (%18.2)	0 (%0)	0 (%0)
Other gram negative bacteria (n:7)	5 (%71.4)	1 (%14.3)	1 (%14.3)	0 (%0)	0 (%0)
Enterococcus spp.*(n:50)*	16 (%32)	25 (%50)	5 (%10)	4 (%8)	0 (%0)
S. aureus (n:18)	6(%33.3)	1 (%5.6)	2 (%11.1)	5 (%27.8)	4 (%22.2)
CNS (n:11)*	2 (%18.2)	0 (%0)	0 (%0)	8 (%72.7)	1 (%9.1)
Streptococcus spp. (n:4)	3 (%75)	0 (%0)	0 (%0)	1 (%25)	0 (%0)
Candida spp. *(n:27)*	1 (%3.8)	12 (%44.4)	0 (%0)	12 (%44.4)	2 (%7.4)
CMV (n:1)	0 (%0)	0 (%0)	1 (%100)	0 (%0)	0 (%0)
Fungal (n:14)	0 (%0)	0 (%0)	14 (%100)	0 (%0)	0 (%0)
No agent isolated (n: 85)	32 (%37.6)	2 (%2.4)	29 (%34.1)	21 (%24.7)	1 (%1.2)

* Other gram negative bacteria *Citrobacte rspp.* & *S.marcessens* & *M. morganii.*

Table 5. Antibiotic susceptibilities of Gram negative microorganisms.

	Ceftriaxonen (%)	***Piperacillin-tazobactam n(%)***	***Meropenem n (%)***	***Amikacin n(%)***	***Colistin n(%)***
E. coli (n:147)	32 (%21.8)	115 (%78.2)	145 (%98.6)	140 (%95.2)	147 (%100)
Klebsiella spp. *(n:96)*	22 (%22.9)	35 (%36.4)	56 (%58.3)	61 (%63.5)	84 (%87.5)
P. aeruginosa (n:76)	-	65 (%85.5)	65 (%85.5)	71 (%93.4)	74 (%97.3)
A. baumannii (n:63)	-	2 (%3.2)	7 (%11.1)	20 (%31.7)	58 (%92.1)
Enterobacter spp.*(n:11)*	4 (%36.4)	8 (%72.7)	11 (%100)	10 (%90.9)	11 (%100)
Proteus spp. *(n: 11)*	7 (%63.6)	9 (%81.8)	9 (%81.8)	8 (%72.7)	-
Citrobacter spp.*(n:3)*	0 (%0)	2(%50)	3 (%75)	3 (%75)	3 (%75)
S. marcessens (n:3)	3 (100%)	3 (100%)	3 (100%)	3 (100%)	-
M. morganii (n:1)	1 (%100)	1 (100)	1 (100%)	1 (100%)	-

Table 6. Antibiotic susceptibilities of Gram positive microorganisms.

	Ampicillin n(%)	***Methicillin n(%)***	***Vancomycin n(%)***	***Streptomycin n(%)***	***Gentamicin n(%)***
E. faecium (n:29)	-	-	23 (%79.3)	11 (%37.9)	14 (%48.3)
E. faecalis (n: 21)	16 (%76.2)	-	20 (%95.2)	7 (%33.3)	8 (%38.1)
S.aureus (n:18)	-	10 (%55.6)	18 (%100)	-	-
CNS (n:11)*	-	2 (%18.2)	11 (%100)	-	-

*CNS: Coagulase negative *Staphyloccoccus.*

Discussion

During the study period, 658402 patient days were examined and a total of 1165 hospital-acquired infection were detected. The overall hospital-acquired infection rate was 0.17%. Of these, 619 (53.1%) occurred in departments other than the intensive care units. The rate of nosocomial infection was 0.10% in units other than the intensive care units. The most common nosocomial infection was surgical site infection followed by urinary tract infection and pneumonia. In the literature, the most common nosocomial infections are reported to be urinary tract infection, pneumonia and surgical site infection, but the incidence varies depending on the health care provider (10-21).

In this study, the distribution of hospital-acquired infections by classification of McCabe was also evaluated. It is noteworthy that in both McCabe class 1 and 2, the most common infection was the surgical site infection, followed by the urinary tract infection. The reason we wanted to use McCabe classification to assess the severity of the underlying disease in this study was for regular surveillance of health care providers and for comparison of these data between healthcare providing centers. Few studies in the literature support this idea (22). The prevalence of HAI was %2.3-10.8 in the European Centre for Disease Prevention and Control point prevalence study which included data from patients treated by primary, secondary and tertiary health care centers in Europe between 2011 and 2012 (22). The prevalence in primary and secondary health care centers was 5% and 7.4% in tertiary care centers. Of the patients, 66.3 were class 1 according to McCabe classification, and 16.1% were class 2 and 5.2% were class 3. The most common hospital - acquired infections were pneumonia and other lower respiratory tract infections (19.4% and 4.1%, respectively), surgical site infection (19.6%) and urinary tract infection (19%). It was thought that comorbid disease characteristics should be included in routine surveillance practice. Other studies from our country were examined and Çelebi et al (19) reported that the rate of infection was 4.28% in a university hospital in 2005, while the most common types and rates of infection in the service were urinary tract infection (0.33%), surgical site infection (0.29%) and bloodstream infection (0.13%). Karahocagil et al (20) reported that the rate of infection in a university hospital in 2009-2010 was 3.5% in hospital-wide, 0.5% in orthopedics, 1.3% in brain surgery and 2.2% in internal medicine. In the 2004-2006 period, Saçar et al (21) reported an overall rate of infection of 3.8-4.1% in the hospital, 3.2-4.2% in internal diseases services, and 2.8-4% in surgical services. But none of these studies have data related to comorbid disease of the patients with HAI. In our study, although the rate of hospital-acquired infections was not studied on unit basis, it was thought that the rate of infection in the services was similar to previous studies. In our hospital, while the overall rate of HAIs is not higher than other centers, 47.9% of hospital-acquired infections are caused by patients with McCabe class 1 who had no concomitant diseases. This suggested that infection control measures should be improved, including physical monitoring and factors related to patient follow-up in the hospital.

The most common microorganisms isolated from hospital -acquired infections were *E. coli*, *Klebsiella* spp. and *P. aeruginosa*. According to the National Hospital - acquired infections Surveillance Network (UHESA) 2017 Agent Distribution and Antibiotic Resistance Summary Report, Enterobacteriaceae family is isolated in 37.3% of all infections, non-fermentative gram-negative bacilli in 34.7% of cases and gram-positive bacteria in 18.8% of all infections hospital-wide. The resistance status of the agents isolated from the hospital is listed in the report: for meropenem and colistin resistance in the *E. coli* strains, it was 4.7-17.2% and 2.1-7%, respectively, while for *Klebsiella* spp. strains it was 34.9-62.3% and 11.8-24.3% respectively. Meropenem and colistin resistance in *P. aeruginosa* strains were 24.4-60.5%, respectively, while meropenem resistance in *Acinetobacter* spp. strains were 94.3-97.4% and colistin resistance was 0.9-3.3% (6). Infections related to resistant strains present difficulties in the treatment of these infections and increase morbidity and mortality in patients with infection. In the literature, it is reported that agents seen in intensive care units were more resistant in hospital-acquired infections, but our study

showed that antibiotic resistance was also important in patients who were treated in services (13-16).

Conclusion

HAIs are important health problems not only in patients in intensive care units but also in patients treated in services. It was thought that the characteristics of the concomitant diseases need to be taken into consideration in evaluating the risk factors and in determining the precautions in preventing hospital-acquired infections. For this reason, accompanying disease characteristics should be included in routine surveillance practice. Managers of healthcare facilities and infection control committees can prevent the development of hospital-acquired infections by better managing patient monitoring factors and physical arrangements and by increasing adherence to the infection control programs, by the help of which morbidity and mortality rates associated with these infections may be reduced.

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