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Assessment of Healthcare Associated Infections in a Medical Intensive Care Unit

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Abstract

Objective: This study was undertaken to assess the current status of healthcare associated infections (HAIs) in our institution during a 2-year period in relation to causative agents and their distribution, use and duration of invasive mechanical ventilation, and infection rate and incidence in comparison with national data.

Methods: Patients admitted to Medical ICUs of Meram State Hospital between 1st Jan 2019 and 31st Dec 2020 wereincluded. During a 2-year period a total of 47 patients were diagnosed with HAIs based on Centers for Disease Control and Prevention (CDC) and National Nosocomial Infection Surveillance Network (NNISN) criteria.

Results: During 6041 follow-up days for 922 patients admitted to ICU, a total of 47 HAIs cases were detected. The most common types of HAIs included healthcare-associated pneumonia in 21 patients (45.6%) and other infections of the respiratory system in 12 patients (26.1%). The most common causative agent was Acinetobacter baumannii, which was found in 27 patients (50.9%).

Conclusion: HAIs is an unavoidable condition in ICUs owing to a number of factors such as frequent use of invasive devices, prolonged length of admission, and increased number of complications. One of the major health targets in healthcare facilities is to control an manage HAIs. Avoidance from unnecessary catheterizations, timely removal of invasive catheters, increased adherence to infection control measures, prevention of inappropriate antibiotic use, compliance with isolation procedures, and initiation of appropriate antibiotherapy based on documentation of causative organisms will significantly reduce HAIs incidence.

Key words: Healthcare-associated infection, surveilance, pneumonia.

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Dahiliye Yoğun Bakım Ünitesinde Gelişen Sağlık Hizmeti İlişkili Enfeksiyonların Değerlendirilmesi

Öz

Amaç: Çalışmada Dahiliye yoğun bakım ünitesinde (YBÜ) iki yıllık süreçte takibi yapılan hastalarda gelişen sağlık hizmeti ilişkili enfeksiyonları (SHİE), etkenleri ve dağılımları değerlendirmek, invaziv alet kullanım gün, enfeksiyon hız ve oranları ile ilişkili sürveyans verileri ulusal veriler çalışma sonuçlarının karşılaştırılması ile hastanenin mevcut durumunun ortaya konulması amaçlanmıştır.

Yöntemler: Çalışmaya Konya Eğitim ve Araştırma Hastanesi Dahiliye YBÜ'lerde 01.01.2019 -31.12.2020 tarihleri arasında takip edilen hastalar dahil edildi. Bu süreçte toplam 47 SHİE tanısı aldı. SHİE tanıları Center for Disease Control and prevention (CDC) ve Ulusal Hastane Enfeksiyonları Sürveyans Ağı (UHESA) tanı kriterlerine göre koyuldu.

Bulgular: Dahiliye YBÜ'de 922 hastanın 6041 hasta günü takibinde 47 SHİE saptandı. En sık rastlanan SHİE %45,6 (21) ile sağlık hizmeti ilişkili pnömoni, % 26,1'i (12) ise solunum sistemi diğer enfeksiyonları idi. SHİE gelişen hastalarda en sık saptanan etken Acinetobacter baumannii olup 27 hastada (%50.9) görülmüştür.

Sonuç: Yoğun bakım ünitelerinde invazif girişimlerin sıklığı, uzun hasta yatışı, yatan hastaların daha fazla komplike olması gibi nedenlere bağlı sağlık hizmeti ilişkili enfeksiyonlarının görülmesi kaçınılmazdır ve hastanelerin ciddi önem taşıyan sağlık hedeflerinden biri de bu durumu kontrol etmek ve yönetmektir. Gereksiz kateter takılmasına izin verilmemesi, invaziv kateterlerin mümkün olduğunca erken çıkarılması, infeksiyon kontrol önlemlerine uyumun arttırılması, uygunsuz antibiyotik kullanımının önüne geçilmesi, izolasyon önlemlerine uyulması ve etken mikroorganizmalar dokümante edilerek uygun antibiyotik tedavisinin başlanması SHİE insidansını önemli ölçüde azaltacaktır.

Anahtar kelimeler: Sağlık hizmeti ilişkili enfeksiyonlar, sürveyans, pnömoni.

INTRODUCTION

Healthcare associated infections (HAIs) are infections that are not present or incubating at the time of admission, and they may sometimes be acquired in the hospital and occur after discharge[1]. HAIs are particularly more common in immunocompromised patients or patients with comorbid conditions admitted to intensive care units, and management of these patients represents a major therapeutic challenge. HAIs are associated with significant increases in morbidity, mortality, and treatment costs. HAIs are a major determinant of the health service quality in a given healthcare facility[2]. Every case of HAIs is considered a medical error that could have been prevented by adherence to essential infection control measures[3]. A good knowledge of the microbiological flora of the hospital and their antibiotic susceptibility is required for HAIs prevention. This can be achieved via local surveillance policies aimed at reducing hospital infections. Surveillance is defined as "ongoing

systematic collection, analysis, interpretation, and sharing of the data with the interested parties to develop appropriate preventive actions for a disease, condition, or event"[4]. Several surveillance programs have been translated into Turkish language. HAIs develop in approximately 20% to 25% of the patients admitted to ICU. The most common infections appear to be urinary tract infections, pneumonia, and primary bloodstream infections5. Currently, HAIs represent a major health problem for inpatient care, particularly in facilities such as ICUs where high-risk patients are admitted[1]. In the study, it was aimed to evaluate the causes and distributions of healthcare-associated infections, which developed in patients followed up in the Internal Medicine Intensive Care Unit (ICU), to reveal the current status of the hospital by comparing the surveillance data related to the invasive device use days, infection rate and rates, and the results of the national data study.

METHODS

A total of 922 patients admitted to medical ICU of Meram State Hospital between 1st Jan 2019 and 31st Dec 2020 were included. Data collected during this period by the infection control nurses and consultation notes of infectious disease specialists were retrospectively evaluated. Patients aged > 18

years were diagnosed based on Centers for Disease Control and Prevention (CDC) and National Nosocomial Infection Surveillance Network (NNISN) criteria6. Samples for microbiological cultures were collected according to results of physical examination findings. In patients with a body temperature of > 38°C, blood cultures were repeated. Depending on examination findings, catheter, urine, tracheal aspiration, and bronchoalveolar lavage cultures were obtained. Blood and other samples were incubated in a fully automated BACTEC blood culture device (Becton Dickinson, Diagnostic Instrument System, Spark, USA). Samples with possible growth were inoculated into eosin-methylene blue (EMB) agar and 5% sheep blood agar. All petri dishes were incubated at 35 ± 2°C for 24 hours at normal environment. Typing of isolated bacterial colonies with no lactose fermentation and negative oxidase test results was performed with a VITEK 2 Compact® device (BioMérieux, France). Results of microbiological cultures were assessed in relation to physical examination findings, biochemical and hematological test results, and radiological findings. A total of 47 HAIs cases were detected over a 2-year period. After May 2020, only COVID-19 patients were admitted to our ICU.

The rate of invasive device associated infections was estimated. Ventilator associated pneumoniae (VAP) rate was calculated as follows: VAP number / ventilator days x 1000. Central line associated bloodstream infection (CLABSI) rate was calculated as follows: CLABSI number / central venous catheter days x 1000. The catheter-associated urinary tract infection (CA-UTI) rate was calculated as follows: CA-UTI days / days of urinary catheterization x 1000. Finally, the device use rate was based on the following formula: days with invasive device / patient days.

The study protocol was approved by the local ethics committee on 15th Oct 2021 (Decision no: 2021/022). The study procedures were carried out in accordance with the principles of Helsinki Declaration.

Statistical Analysis

Data were analyzed using SPSS software, version 20.0 (SPSS Inc., Chicago, IL, USA). Numerical variables were expressed as mean ± standard deviation, and categorical variables were presented as number and percentage.

RESULTS

A total of 6041 admission-days of 922 patients admitted to a 9-bed capacity medical ICU were retrospectively analyzed. Of these patients, 47 were diagnosed with HAIs (26 female, 55.3%; 21 male, 44.7%), and their median age was 76.9 years. The median duration of ICU stay was 29.3 days. Table 1 shows the diagnoses at admission, comorbid conditions, and risk factors in HAIs patients.

Table I: Diagnoses at admission, comorbid conditions, and risk factors in patients with HAIs.

Diagnosis at admission	n (%)
COVID-19 pneumonia	6 (13.04%)
Cerebrovascular disease	6 (10.87%)
Acute renal failure	5 (8.70%)
Pneumonia	4 (6.52%)
COPD	3 (4.35%)
Malignancy	3 (4.35%)
GIS bleeding	2 (4.35%)
Cardiac arrest	2 (4.35%)
DM	2 (4.35%)
Sepsis	2 (4.35%)
Epilepsy	2 (4.35%)
Acute cholecystitis	1 (2.17%)
Cardiac failure	1 (2.17%)
Other	14 (28.26%).
Comorbid conditions	
Chronic renal failure	8 (27.59%)
Hypertension	4 (13.79%)
COPD	3 (10.34%)
Malignancy	3 (10.34%)
DM	2 (6.90%)
Coronary artery disease	2 (6.90%)
GIS bleeding	2 (6.90%)
Cardiac failure	2 (6.90%)
Cerebrovascular accident	2 (6.90%)
Psychiatric disorder	1 (3.45%)

COPD: chronic obstructive pulmonary disease, DM: diabetes mellitus.

Table 2 shows the duration of the use of invasive devices, and the number and rate of infection over a 2-year period in the ICU. Table 3 shows the risk factors in HAIs patients.

Table II: Duration of the use of invasive devices, and the number and rate of infection

	Duration of use (days)	Rate of use		Number of infections	Rate of infections
Central venous catheter (CVC)	3051	0.51	CLABSI	11	3.61
Urinary catheterization (UC)	5866	0.97	CA-UTI	0	0
Mechanical ventilation (MV)	2160	0.36	VAP	1	0.46

Table III: Risk factors in HAIs patients

Central venous catheterization (CVC)	43 (16.8%)
Urinary catheterization	38 (14.8%)
Mechanical ventilation	36 (14%)
Peripheral arterial catheterization	36 (14%)
Total parenteral nutrition	33 (12%)
Transfusion	31 (11.8%)
Nasogastric tube placement	14 (5.6%)
Peripheral venous catheterization	12(4.7%)
Tracheostomy	8 (3.3%)
Hemodialysis	7 (3%)

The most common types of HAIs included healthcare associated pneumonia in 21 patients (45.6%), and other infections of the respiratory system in 12 patients (26.1%). The most commonly isolated organism in these patients was Acinetobacter baumannii, which was detected in 27 patients (50.9%). Table 4 shows the causative organisms and their distribution in HAIs patients.

Table IV: The causative organisms and their distribution in HAIs patients

HAIS	Causative Organism	N (%)
Healthcare associated pneumonia diagnosed using specific laboratory findings	*Acinetobacter baumannii* (65%) *Klebsiella pneumonia* (25%) *Pseudomonas aeruginosa* (10%)	21 (45.6)
Other infections of the respiratory system	*Acinetobacter baumannii*(60%) *Klebsiella pneumonia* (33.3%) *Pseudomonas aeruginosa* (6.7%)	12 (26.1)
Central line associated infection	*Candida parapsilosis* (25 %) *Klebsiella pneumonia* (25%) *Acinetobacter baumannii* (25%) *Enterococcus faecium* (8.33 %) *Pseudomonas aeruginosa* (8.33%) *Candida spp*. (8.33%)	10 (21.7)
Ventilator associated pneumonia	*Klebsiella pneumonia* (50%) *Pseudomonas spp*. (50%)	1 (2.2)
Soft tissue infection	*Klebsiella pneumonia* (100%)	1 (2.2)
Healthcare associated pneumonia diagnosed clinically	-	1 (2.2)

DISCUSSION

Advances in medical technology and care quality in ICUs have resulted in reduced mortality and morbidity. However, patients admitted to ICUs still have an increased risk of nosocomial infections due to weakened immunity, as a result of a number of factors including invasive diagnostic and therapeutic procedures, underlying medical conditions, and commonly administered treatments (e.g. sedatives, antacids, H2 receptor antagonists, and immunosuppressive treatments)[7]. Furthermore, increased lifespan in communities is associated with longer durations of ICU stay, again increasing the risk of microbial colonization and subsequent infection. Varying rates of ICU infections may be observed between different ICU units of the same institution. In one study by Akalın et al. examining nosocomial infections, the observed incidence of infection was 14.2% in a medical ICU and 11.2% in a surgical ICU[8].

Based on the national nosocomial infections surveillance network (NNISN) 2020 report on causative organisms and antibiotic resistance, the rate and density of HAIs were 0.58 and 0.90.8 In our study, the surveillance data for medical ICU encompassing 2019 and 2020 showed a nosocomial infection rate of 5.1 and density of 7.78[9]. Pneumonia is the most common type of HAIs in ICUs, with a reported VAP incidence of 40.7% to 52.5%[10-12]. On the other hand, the most common type of ICU infection in Ak et al.'s and Akalın et al.'s studies was bacteriemia, with respective incidence rates of 36.3% and 34.4%[8,13]. In our medical ICU, pulmonary infections were the most common type of infection, followed by CLABSI. Therefore, the healthcare associated pneumonia diagnosed on the basis of specific laboratory findings was the most common HAIs type[14]. According to 2020 report of National Nosocomial Infections Surveillance Network (NNISN), the rate of mechanical ventilator use in the anesthesiology and reanimation units of hospitals across Turkey was 0.57, and the rate of VAP was 4[15]. While our results were comparable with NISN 2020 data in terms of mechanical ventilator use, VAP occurred at a lower frequency. Possible explanations for this observed difference include differences in patient profiles and bed capacities across ICUs in Turkey, change in the status of our institution from a general hospital to SARS-COV2 pandemic hospital as well as the practice of incubation following development of respiratory failure. Also, patients with pulmonary involvement were highly represented in our population, and definition of VAP fraction of inspired oxygen (FiO2) and when the increase and decrease in positive end expiratory pressure (PEEP) values were followed, the stages of change could not be recorded because the mechanical ventilator settings of the intubated patients were adjusted from 100 mm/Hg after intubation, and the VAP diagnostic criteria could not be met. Therefore, the proportion of patients diagnosed with healthcare associated pneumonia might have increased. According to NNISN 2020 report regarding anesthesia and reanimation units in hospitals affiliated with the Turkish Ministry of Health, the CVC use rate was 0.58, CLABSI rate was 3.9, urinary catheter use rate was 0.97, and CA-UTI rate was 1.1 15. A comparison of our observation with those of NNISN 2020 report showed similar CVC and urinary catheter use rates, while CLABSI and CA-UTI rates were lower. These data suggest that intensive care units should be regularly inspected and the required precautions are taken during catheterization procedures.

Microorganisms responsible for ICU infections may exhibit varying antibiotic susceptibility over time and between hospitals, and even between different ICU units of the same hospital. In a point prevalence study involving 1.265 participating in ICU centers from 75 countries (EPIC II), 62% of the isolates were

gram negative, 47% were gram positive, and 19% were fungi[14]. In some studies from our country, gram negative bacteria were the most common causative organisms[15], as opposed to others reporting that gram positive bacteria (8) were the most common. Also, the most commonly isolated pathogen was P. aeruginosa in some centers[16], while it was A. baumannii in others[17]. The distribution of causative agents in healthcare associated infections according to NNISN 2020 report from Turkey is as follows: Klebsiella spp. 19.2%, Acinetobacter spp. 17.6%, E.coli 8.6%, and Candida spp. 7%[18]. However, the most commonly isolated pathogens in our study included A. baumannii in 50.9%, followed by K. pneumoniae (30.1%), P. aeruginosa (9.5%), and Candida spp. (1.9%). Catheter associated infections in our unit were caused by K. pneumoniae (25%), C. parapsilosis (25%), and A. baumanni (25%).

An examination of the distribution of causative organisms according to infection site showed that gram negative bacteria including Acinetobacter spp., P. aeruginosa, K. pneumoniae and E. coli were the most common causative organisms in VAP and UTI, and gram positive bacteria such as, KNS, S. aureus and enterococcii were more common in BSI and SSI[19-22]. NNISN 2020 report from Turkey shows that Acinetobacter spp. was the most common organism in pneumonia and VAP (43.2% and 33.2%, respectively), while Klebsiella spp. was the most common organism in CLABSI. Again in the same report, Candida spp. were reported in 17.6% of the cases with CLABSI[18]. Similarly, in our study Candida spp. was the second most common (25%) organism in CLABSI. In our study, Acinetobacter was seen more frequently than other pathogens. Acinetobacter appears to be a major problem in our intensive care unit, possibly due to a number of factors including inappropriate antibiotic use, lack of de-escalation based on culture results, and lack of adequate infection control measures. The fact that this pathogen is at the forefront suggests that during the SARS-COV2 pandemic, hospitalization of patients with viral pneumonia and routine antibiotic therapy may be effective in Acinetobacter colonization. Therefore, if antibiotic prophylaxis is required, especially in viral pneumonias, it is extremely important to give a minimum of time to prevent damage to the existing flora and to pay attention to infection control measures.

Also, Acinetobacter appears to be significant problem in our ICU, probably due to a number of factors such as inappropriate use of antibiotics, unnecessary and prolonged prophylaxis, lack of de-escalation based on culture results, and lack of adequate infection control measures.

CONCLUSION

Despite increased awareness among healthcare professionals and development of better guidelines, healthcare associated infections may be considered somehow inevitable in ICUs owing to frequent use of invasive procedures, prolonged admissions, and more complicated course of diseases, necessitating implementation of appropriate control and management policies. Avoidance from unnecessary use of catheters, earliest possible removal of invasive catheters, increased adherence to infection control measures, prevention of inappropriate antibiotic use, compliance with isolation measures, and documentation of causative organisms when initiating appropriate antibiotic treatment are important considerations to reduce HAIs incidence significantly. At the same time, it is extremely important to avoid unnecessary and long-term antibiotic prophylaxis in patients with viral pneumonia.

Author Contributions

All authors have been involved in the preparation of the manuscript. All authors have read and approved

the manuscript. The corresponding author has full access to data and has the right to publish this paper.

Ethics Committee Approval: The study protocol was approved by the local ethics committee on 15th Oct 2021 (Decision no: 2021/022). The study procedures were carried out in accordance with the principles of Helsinki Declaration.

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