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ORIGINAL RESEARCH / *ÖZGÜN ARAŞTIRMA*

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The Three Years Surveillance Results of Catheter-associated Urinary Infections in Intensive Care Units

Yoğun Bakım Ünitelerindeki Kateter İlişkili Üriner Enfeksiyonların 3 Yıllık Sürveyans Sonuçları

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ABSTRACT *Objective:* Catheter-associated urinary tract infections (CAUTI) are among the most common hospital-acquired infections. This manuscript's goal is to focus on the change in CAUTI rates according to years, and the effect of education.
Materials and Methods: In this study, conducted between 2016 and 2018, surveillance data of patients followed in the anesthesia/reanimation intensive care unit (ICU) and the internal medicine ICU were used. During the data analysis period, 3,399 patients in the anesthesia/reanimation ICU and 1,207 patients in the internal medicine ICU were followed up. The effects of physical changes and training in clinics on the CAUTI ratio were investigated.
Results: As a result of the changes made in internal medicine and anesthesia/reanimation ICUs between 2016 and 2018, it was observed that there was a significant decrease in CAUTI rates. While in both units in 2016, the CAUTI rate was above the Turkey average, in 2018, as a result of the changes made, it was observed that the CAUTI rate fell below the Turkey average.
Conclusion: Patient mindfulness, bacterial strain, education of staff, regular visits, and cooperation between the infection control committee and ICU team are important to prevent infections caused by the use of invasive tools in ICUs.
Keywords: Infection, intensive care unit, nosocomial infections, urinary catheterization

ÖZ *Amaç:* Kateter ilişkili üriner enfeksiyon, sağlık tesislerinden hastalara geçen en yaygın enfeksiyonlardandır. Üriner kateterlerin doğru yerleştirilmesi ve bakımı enfeksiyon kontrol uygulamalarında önemli bir konudur. Çalışmada yıllara göre kateter ilişkili üriner sistem enfeksiyonu (ÜSİ-KAT) oranlarının değişimi ve eğitimin etkisinin vurgulanması amaçlanmıştır.
Gereç ve Yöntem: 2016-2018 yılları arasında yapılan bu çalışmada, anestezi/reanimasyon yoğun bakım ünitesinde ve dahiliye yoğun bakım ünitesinde takip edilen hastaların sürveyans verileri kullanıldı. Verilerin incelendiği dönemde anestezi/reanimasyon yoğun bakım ünitesinde (YBÜ) bulunan 3,399 hasta ile YBÜ bulunan 1,207 hasta takip edildi. Kliniklerde yapılan fiziki değişikliklerin ve eğitimlerin ÜSİ-KAT oranları üzerindeki etkileri araştırıldı.
Bulgular: Dahiliye ve anestezi/reanimasyon YBÜ'lerinde 2016-2018 yıllarında yapılan değişiklikler sonucunda, ÜSİ-KAT hızlarında belirgin düşme olduğu görüldü. Her iki ünitede 2016 yılında ÜSİ-KAT hızı Türkiye ortalamasının üzerinde iken 2018 yılında yapılan değişikliklerin sonucunda ÜSİ-KAT hızlarının Türkiye ortalamasının altına düştüğü görüldü.
Sonuç: YBÜ'lerde invaziv araç kullanımına bağlı gelişen enfeksiyonların önlenmesinde, hasta ve bakteri özelliklerinin bilinmesinin yanı sıra; personel eğitimleri, denetimler ve enfeksiyon kontrol komitesinin yoğun bakım ekibi ile iş birliği içinde olması önem arz etmektedir.
Anahtar Kelimeler: Enfeksiyon, yoğun bakım ünitesi, nozokomiyal enfeksiyon, üriner kateter

Introduction

Hospital-acquired infections are among the significant causes of morbidity and mortality in developing countries, and 5-10% of the patients admitted to acute care hospitals are known to have one or more healthcare-related infections (1). Hospital-acquired urinary tract infections are the most common healthcare infections accounting for more than 30% of the infections reported by acute care facilities (2). It is estimated that 15-25% of hospitalized patients have at least one urethral catheter inserted during their hospitalization, and there has been an increase in the frequency of use of urethral catheters in recent years (3). Hospital-acquired urinary infections are associated with urinary catheters, which are frequently used in intensive care units (ICUs) to drain urine, monitor the amount of urine, and facilitate patient care (4). Catheter-associated urinary tract infections (CAUTIs), which are an important problem in ICUs, can be reduced with infection control measures and training. This study, it was aimed to evaluate the three-year rates of CAUTI, rates of using a urinary catheter, and the distribution of causative agents of CAUTI in two different ICUs, the departments of internal medicine and anesthesia/reanimation in our hospital.

Materials and Methods

Our study was designed and performed with active surveillance data collected by the infection control committee (ICC) based on the patient's reports and laboratory findings. The study was performed with that followed-up in both ICUs in the anesthesia/reanimation and the internal medicine departments of a tertiary hospital with 1,500 beds for more than 48 hours over three years between 1st January 2016 and 31st December 2018. The records of a total of 3,399 patients from the anesthesia/reanimation ICU including 25 beds, three of which were allocated for isolation, and of 1,207 patients from the internal medicine ICU with eight beds were kept daily (Table 1). In our hospital, while the internal medicine ICU serves as the secondary care unit, the anesthesia/reanimation ICU is utilized as the tertiary care unit, and one nurse has been allocated to give care for an average of three patients in both units. The patients with isolation indications are transferred to the isolation area in the anesthesia/reanimation ICU. A cohort was applied for the patients who could not be admitted to the isolation department, and a separate staff and nurse were allocated to be different from the staff and nurses caring for other patients. Active surveillance data were obtained through daily visits by infection control nurses. The diagnosis of hospital infection (HI) was made by infection control physicians. In 2016, the hospital-acquired infection criteria of the Center for Disease Control were used. After 2017, it was replaced by the Turkish Ministry of health's invasive device infection surveillance standards (5).

In 2016, four infection nurses used to work actively in ICC in our hospital, and the number of infection nurses was incompatible with the number of beds and the bed occupancy rate in our hospital. With the arrangements in 2017 and 2018, the number of nurses in ICC was increased to seven, and infection control nurses were made to be involved in activities in the fields.

Regular training programs on such entities as hand hygiene, isolation measures, separation of wastes at the source, and urinary catheter care were arranged and given to the staff working in the units by the infection control nurse and the physician. In addition, apart from routine practices in 2018, a certification program was held for the allied health staff in our hospital. Through the certification training programs held in ICUs of our institution in 2017-2018, seven of 14 nurses in the ICU of the internal medicine department and 16 of 33 nurses in the anesthesia/reanimation ICU were provided to receive certificates. In addition, the nurses having no certificates in infection control were enrolled in certificate programs.

The collected data were recorded on the patients' files on daily by the infection control team. The data were classified as quarterly periods by years, and the evaluations were performed both within the years and on an annual basis. CAUTI rates were informed to the responsible physician and the nurses of the relevant ICUs in three-month periods by the ICC. Based on the average infection rates of other same-class hospitals in Turkey, regulatory and preventive activities were initiated in clinics with an infection rate above the target values determined in our own ICUs. The deficiencies identified during daily visits to ICUs were used to determine the content of regulatory and preventive activities.

The activities carried out in this context are as follows:

- Alterations in the number of beds and the implementation stages of ICU over the years,
- Improvements in physical conditions,
- Measures and training activities to reduce catheter-originated urinary infections,

Table 1. Urinary catheter surveillance findings of intensive care units

	Internal medicine ICU								Anesthesia/reanimation ICU							
	Number of patient	Patient day	Instrument use day	Number of infection	CAUTI	SIUR	IUR	SIR	Number of patient	Patient day	Instrument use day	Number of infection	CAUTI	SIUR	IUR	SIR
2016	348	2,392	2,350	30	12.77	1.25 CI (0.98-1.03)	0.98	1.87	1,242	6,557	6,314	46	7.29	1.01 CI (0.98-1.03)	0.96	0.37
2017	364	2,467	2,394	13	5.43	1.24 CI (1-1.05)	0.97	1.95	1,146	8,258	8,111	22	2.71	1.03 CI (1-1.05)	0.98	0.8
2018	495	2,622	2,561	1	0.39	1.26 CI (1.01-1.06)	0.98	0.06	1,011	8,386	8,338	9	1.08	1.04 CI (1.01-1.06)	0.99	0.79

CAUTI: Catheter-associated urinary tract infections, SIUR: standardized instrument use rate, IUR: instrument use rate, SIR: standard infection ratio, CI: confidence interval, ICU: intensive care unit
+Rate of invasive instrument-related HI (ITRHI): (Number of ITRHI/number of days for invasive instrument) x1000

Whether the use of a urinary catheter was necessary or not was decided by the responsible physician for ICUs. Requirements for catheters were questioned every day, and when it was felt the use of catheters should be ended, urinary catheters were removed from those to be followed up without catheter.

In the diagnosis of CAUTI, the following criterion was proposed by CDC as the criteria in 2016: "The CAUTI is a urinary infection that develops in the patient due to the use of a urinary catheter within the last 48 hours." According to the national healthcare-related infections surveillance guide of 2017, the definition used in the diagnosis of CAUTI was as follows: "The condition of urinary infection is the development of an infection in the patient undergoing a foley catheter insertion for longer 48 hours or 24 hours after the foley catheter was withdrawn, or the growth of at most two different microorganisms in the urine culture and at least either with $\geq 10^5$ CFU/mL of bacteria."

The module of standardized instrument use rate (SIUR) was used for calculating the rates. In addition, compliance data of the staff for hand hygiene were obtained through informed observations during daily visits with the inclusion of all staff in the ICU. The following formulae were used in the calculations of compliance rate with hand hygiene and CAUTI.

• (Number of appropriate hand hygiene observations/ number of total hand hygiene observations) x100,

• Rate of HIs: (Number of HIs/number of in-patients) x100,

• Rate of invasive instrument-related HI (ITRHI): (Number of ITRHI/number of days for invasive instrument) x1000,

• Rate of interventional instrument use rate (IUR): Number of days for use of the invasive instrument/number of hospital stay days,

• Standard infection ratio (SIR): Number of infections observed/number of expected infections.

The SIR is calculated using the observed infection rate and the predicted infection rate, and this calculation is based on a value of 1.00. If SIR =1, the observed and predicted infection numbers are the same. If SIR >1.00, it means more infections than expected, and if SIR <1.00, it means fewer infections detected than expected.

The study approval was obtained from the Clinical Research Ethics Committee of University of Health Sciences Turkey, Van Training and Research Hospital, on 16th May 2019 (decision no: 2019/10). Patients and/or their first-degree member of someone's/the family were informed about the study and informed consents were obtained.

Statistical Analysis

The SPSS Version 20.0 program was used for the statistical analyses. A descriptive evaluation was done.

Results

A total of 4,606 patients were followed-up in the internal medicine and anesthesia/reanimation ICUs in 2016, 2017 and 2018. The number of patients' hospital stay days and

the infection rates by year are presented in Table 1. Given the number of patients and the days of using invasive instruments in ICUs where we investigated, SIUR and invasive IUR were found to be low. In 2016, however, CAUTI rates were determined as the 90 percentile in the internal medicine and anesthesia/reanimation ICUs. As a result of the training programs held by ICC, the rates of CAUTI in 2018 were seen below the average of Turkey (Table 1).

A marked decrease was observed in CAUTI rates as a result of three-year efforts in both ICUs. It was determined that compliance with unit-based hand hygiene had a pace at the same rate on average by years. With the help of hand hygiene training programs given to the staff, the reduction of hand hygiene compliance rates was prevented.

As a result of the three-year study, a significant decrease was observed in CAUTI rates in both ICUs. In both units, it was determined that compliance with hand hygiene increased at the same rate over the years. It was observed that the hand hygiene training programs given to the each person individually and collectively during the process affected the hand hygiene compliance rates positively. For example, in 2016, the rate of compliance with hand hygiene in the anesthesia reanimation unit increased significantly in 2017 and 2018 in parallel with the increase in training hours (Table 2). When the training programs aimed at reducing the rate of CAUTI in ICUs in our hospital were analyzed, the changes were performed in the training programs given collectively across the hospital, regardless of the units, twice a year by ICC in 2016. In 2017-2018, it was observed that 45-hour training sessions were performed by focusing on the unit- and field-based training programs for ICUs (Table 2).

By expanding the area per patient in ICUs over the years, novel arrangements have been achieved in the areas allocated per patient. In addition, it was determined that regulations, training programs, and inspections were effective in reducing CAUTI rates in ICUs. When the three-year distribution of the factors was examined, it was determined that *Escherichia coli* was the most common factor in 2016 and 2018, and *Klebsiella* species was the second most common. In 2017, *Acinetobacter baumanii* was prominent (Table 3).

Discussion

Intensive care settings are the units requiring multidisciplinary cooperation and are designed for the patients' needs of support at the advanced level with special physical conditions and also to meet the needs of the staff (6).

Table 2. Hand hygiene compliance rates of intensive care units and content of regulatory and preventive activities

	Internal medicine ICU			Anesthesia/reanimation ICU		
	Hand hygiene compliance rate	Education hour	Number of CRPA	Hand hygiene compliance rate	Education hour	Number of CRPA
2016	84.47	2 hours	7	75.56	2 hours	10
2017	87.43	6 hours	3	81.1	8 hours	6
2018	89.41	5 hours	4	86.4	22 hours	16

CRPA: Content of regulatory and preventive activities, ICU: intensive care unit

Table 3. Three-year CAUTI of agent distribution in intensive care units

	Internal medicine ICU			Anesthesia/reanimation ICU		
	2016 (n, %)	2017 (n, %)	2018 (n, %)	2016 (n, %)	2017 (n, %)	2018 (n, %)
Escherichia coli	5 (15.15%)	6 (50%)	0	10 (20.8%)	5 (23.80%)	4 (40%)
Klebsiella spp.	4 (12.12%)	0	0	6 (12.5%)	1 (4.76%)	3 (30%)
Acinetobacter baumannii	5 (15.15%)	1 (8.33%)	0	6 (12.5%)	9 (42.85%)	2 (20%)
Enterococcus spp.	5 (15.15%)	2 (16.66%)	1 (100%)	5 (10.41%)	2 (9.52%)	0
Pseudomonas aeruginosa	2 (6.06%)	0	0	3 (6.25%)	0	1 (10%)
Proteus mirabilis	0	2 (16.66%)	0	1 (2.08%)	1 (4.76%)	0
Others	12 (36.36%)	1 (8.33%)	0	17 (35.41%)	3 (14.28%)	0
Total	33 (99.99%)	12 (99.98%)	1 (100%)	48 (99.95%)	21 (99.97%)	10 (100%)

ICU: Intensive care unit, CAUTI: catheter-associated urinary tract infections

Patients followed in ICUs become more vulnerable to infections due to such invasive procedures and comorbidities (7). Urinary tract infections are among the most common HIs. The source of this infection in 80% is long-term urinary catheter use (8). In the article where Al-Helali et al. (9) examined CAUTI-related risk factors in 2004, such factors as hospitalization longer than three weeks, first admission to ICU, number of urinary catheters, and urinary catheter exposure for more than three days were reported to increase the risk of CAUTI. The indications of use and insertions of urinary catheters are tabulated as follows (10):

- Treatment of urinary obstruction,
- Monitoring the amount of urine in critical patients,
- The presence of open wounds in the sacral or perineal region to support urological surgery,
- To provide preservative care for patients with urinary incontinence and to give comfortable care in terminal patients.

In the reports of The European Center for Disease Prevention and Control, it was declared that the second most common health-related infection in Europe (31.2% of all infections) is urinary tract infections (11). In the studies by Jahani-Sherafat et al. (12), where the instrument-related infection rates were evaluated in ICUs of six different hospitals in Iran, CAUTI was found to be the most common instrument-related infection at 8.99 per 1,000 catheter days, and 82.9% (151 out of 182) of the infections were associated with urinary catheters. Moreover, in a point prevalence study by Leblebicioglu et al. (13) in 13,269 patients from 29 Turkish hospitals, the rate of UTI was reported as 1.7% in prevalence, and most UTIs (65.3%) were stated to be associated with urinary catheters. Another study involving 12 hospitals and performed by Gaid et al. (14) reported that CAUTIs ranked second at 28.4%, and the mortality rate was 36.9% due to CAUTIs. However, in the three-year study by Çukurova et al. (15), the rate of CAUTIs was found to rank third at 19.8%. When the CAUTI, SIR, and SIUR rates in both of our ICUs were compared with the Turkish data (5), it was seen that our SIUR rates were <1.00, and our CAUTI rates were below the Turkish average, depending on the regulations made. In terms of the three-year infection rates in our study, a significant decrease is seen in our rates. The data in 2016 demonstrated that the use of catheters was low although CAUTI rates were high despite low IURs. The situation shows that the problems were present, related to urinary catheter insertion, nursing care, and allied medical staff in our units. It was observed that CAUTI rates decreased with the training programs and the supervision by the infection control nurse and the physician over three years period (Figure 1).

Among the quality policies to be designed to improve the proper use of urinary catheters and reduce CAUTI rates are the controls of performance feedback, including in-service training, hand hygiene, catheter care and proper use of catheters (2). In the four-stage study where the training programs including such entities as the use of urinary catheters, and aseptic application techniques, the evaluations on daily patients' lists, and the weekly meetings with the team to assess the infection status were investigated, Menegueti et al. (16) detected that CAUTI rates decreased consistently at each stage (14.92, 7.34, 3.78 and 1.10/1,000 catheter per day, respectively), and also stated that the rate of urinary catheter use was reduced from 74.6% to 44.2%. Even so, in a prospective study performed by Navoa-Ng et al. (17) to investigate the use of infection package procedures that were determined to reduce CAUTI rates, training programs, surveillance, feedback reports for CAUTI rates, and the effects of feedback for the performance of infection control measures in ICUs of two separate hospitals, it was observed that hand hygiene compliance rate, which was 53.23% at initial, reached 78.21% at the end of the intervention period, and that the rates of urinary catheter involvement on the thighs and the hanging urinary bladder also reached 88.84% and 92.28%, respectively. In the same study, a 76% reduction was achieved in CAUTI rates at the end of the study, compared to those at the initial (17). In the study by Altınışık et al. (18), in terms of changing CAUTI rates, the researchers found decreases of 21.35% in the general surgery ICU and 22.8% in the internal medicine ICU thanks to the regulatory and preventive activities. The effect

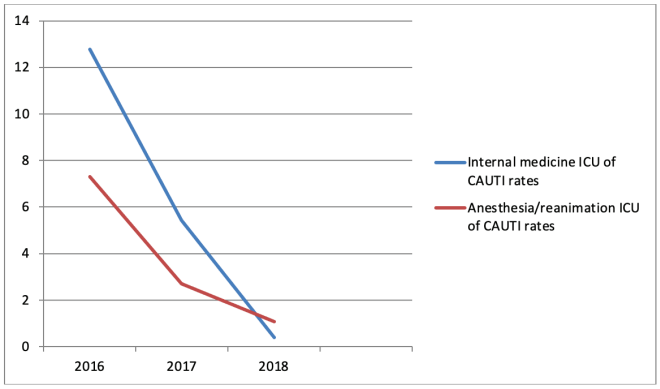

Figure 1. Change of CAUTI velocity in units by years
CAUTI: Catheter-associated urinary tract infections, ICU: intensive care unit

of compliance with infection control practices in invasive applications performed on patients followed in ICUs can be directly related to the decline in infection rates. In our study, it is seen that increasing the number of nurses and allied medical staff in ICUs, the improved physical conditions, and the improvements in in-service training of the staff led to a significant decrease in CAUTI rates (Table 1).

Gram-negative bacteria in the patient's flora are the most common agent of hospital-acquired urinary infections (19). Among the in-patients, contamination may also result from the healthcare workers' hands or via the decontaminated instruments (20), and *E. coli* is the most common agent in CAUTIs (21). In their study investigations of nosocomial infections, Sabra and Abdel-Fattah (22) emphasized that UTI was 25.3%, and *E. coli* (47.7%) was the most common agent leading to UTIs. However, in the study performed to decrease CAUTIs in ICUs by Dizbay et al. (10), candida species were found as the most widespread agent (57%), and *E. coli* was defined to be 2%. In the study by Özer-Balın and Aktaş-Şenol (23), candida species (33.3%) were reported as the most common agents causing CAUTIs in ICUs. In this study, it was determined that gram negatives were at the forefront in CAUTI agents, similar to other studies. When the three-year changes of CAUTI-induced agents were assessed in our study, *E. coli* was seen as the most common agent (Table 3).

HIs are among the increasing health challenges throughout the world (24). It is likely to achieve great success in the HI control programs with the trained healthcare staff, use of appropriate isolation techniques and effective infection control practices, as well as surveillance practices (23). It has been observed that in many cases, urinary catheters are inserted in inappropriate indications and healthcare workers are often unaware of this practice, and accordingly, urinary catheters are used for longer periods inappropriately (9). In patients undergoing insertion of a urinary catheter, the procedure of sterilized continuous closed-system is the most important rule of preventing infections (20). The recommendations proposed by guidelines should be taken into account in the prevention of urinary catheter infections. Ensuring catheters are administered in appropriate indications and to be used at necessary periods, taking the alternative procedures to permanent catheters into account for selected eligible patients, providing optimal hand hygiene status before and after catheter insertion and when performing any intervention in catheter itself or surrounding area, and giving responsibility merely to properly-trained staff with knowledge on the technique of the insertion and maintenance of aseptic catheters are important practices in the prevention of CAUTIs. In addition, in-service training efforts and patient follow-up should be implemented by the infection control physician and/or the nurse without ignoring such recommendations as paying attention to the use of aseptic technique and sterilized equipment while inserting urinary catheters in acute care hospitals, providing the maintenance of the closed drainage system of the catheter insertion through aseptic technique, ensuring that the urine flow is not interrupted, and not performing routine bladder washing with antimicrobials (2,25).

Conclusion

In conclusion, in addition to the experience and specialty of the staff in ICC on patients' characteristics and bacterial properties in the prevention of CAUTIs in ICUs, it is important to train the staff of ICUs regularly, perform daily unit-based inspections, constitute a rapid notification system about the deficiencies in ICUs and cooperate with the intensive care team.

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Ethics

Ethics Committee Approval: The study approval was obtained from the Clinical Research Ethics Committee of University of Health Sciences Turkey, Van Training and Research Hospital, on 16th May 2019 (decision no: 2019/10).

Informed Consent: Patients and/or their first-degree member of someone's/the family were informed about the study and informed consent were obtained.

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Authorship Contributions

Surgical and Medical Practices: M.S.S., E.E., D.B., A.H.S., Concept: M.S.S., A.H.S., Design: M.S.S., A.H.S., Data Collection and Process: M.S.S., E.E., D.B., Analysis or Interpretation: M.S.S., A.H.S., Literature Search: E.E., D.B., Writing: M.S.S.

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