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ORIGINAL RESEARCH / *ÖZGÜN ARAŞTIRMA*

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Surveillance Results of Catheter-Associated Urinary Tract Infections in Intensive Care Units: A Three-Year Analysis

Yoğun Bakım Ünitelerimizdeki Kateter İlişkili Üriner Enfeksiyon Sürveyans Sonuçları: Üç Yıllık Analiz

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ABSTRACT *Objective:* Catheter-associated urinary tract infections (CAUTI) are among the most common hospital-acquired infections. Therefore, the proper placement and maintenance of urinary catheters is important in infection control. This study aimed to emphasize the change in CAUTI rates according to years, distribution of factors, and effect of education.
Material and Methods: This retrospective study was conducted between January 1, 2016, and December 31, 2018. Data from hospital records and follow-up forms were collected from 3,399 patients in the anesthesia/reanimation intensive care unit (ICU) and 1,207 patients in the internal medicine ICU. CAUTI was diagnosed according to the criteria of the Center for Disease Control and Prevention. Effects of corrective preventive actions, unit-based training, physical condition improvements, and number of beds on the infection rates were examined.
Results: A higher number of unit-based training sessions, hand hygiene attention, increased number of certified nurses, in-service training of allied personnel, infection-control team improvements, and ICU bed arrangements were found to decrease CAUTI. The internal medicine ICU rate in 2016 was 12.77, and CAUTI decreased to 0.39 in 2018. In addition, the anesthesia/reanimation ICU rate was 7.29 in 2016, and CAUTI decreased to 1.08 in 2018. Instrument utilization rates were determined to be below the average in Turkey in both ICUs. Considering the 3-year distribution of factors in ICUs, Escherichia coli was the most common infectious agent.
Conclusion: Factors, such as patient awareness, bacterial characteristics, trained staff, regular inspections, and cooperation between the research control committee and ICU team are of vital importance 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. Kateter ilişkili enfeksiyonlar hastane enfeksiyonlarının önemli bir kısmını oluşturmaktadır. Üriner kateterlerin doğru yerleştirilmesi ve bakımı enfeksiyon kontrol uygulamalarında önemli bir konudur. Çalışmada yıllara göre CAUTI oranlarının değişimi, faktörlerin dağılımı ve eğitimin etkisinin vurgulanması amaçlanmıştır.
Gereç ve Yöntem: 1 Ocak 2016–31 Aralık 2018 tarihleri arasında anestezi/reanimasyon YBÜ'den 3399 ve dahiliye YBÜ'den 1207 hasta dahil edilerek elde edilen veriler üzerinden retrospektif bir çalışma yapılmıştır. Kateter ilişkili üriner sistem enfeksiyonu tanısı, Hastalık Kontrol ve Önleme Merkezi (CDC) tanımlarına göre belirlenmiştir. Tüm hastaların verileri hastane bilgi yönetim sistemi ve enfeksiyon kontrol komitesi hasta izlem formlarından elde edilmiştir. Bunun yanı sıra düzeltici önleyici faaliyetlerin, birim bazlı eğitimlerin, fiziki şartlardaki iyileştirmelerin, yatak sayılarının enfeksiyon hızının azalmasına etkisi irdelenmiştir.
Bulgular: Çalışma sonucunda; birim bazlı eğitim saatlerinin arttırılması, el hijyeni uyumuna özen gösterilmesi, sertifikalı hemşire sayısının artırılması, temizlik personeli eğitimi, enfeksiyon kontrol ekibinin iyileştirilmesi ve birimlerde yatak düzenlemesi yapılması ile Kİ-İYE oranlarında gerileme olduğu saptanmıştır. Dahiliye YBÜ'de 2016 yılında Kİ-İYE hızı 12,77 iken 2018 yılında Kİ-İYE hızının 0,39'a gerilediği görülmüştür. Anestezi/reanimasyon YBÜ'de Kİ-İYE hızı 2016 da 7,29 iken 2018 yılında bu oranın 1,08'e düştüğü görülmüştür. Her iki YBÜ'de araç kullanım oranının Türkiye ortalamasının altında olduğu belirlenmiştir. Yoğun bakım ünitelerindeki üç yıllık etken dağılımı göz önüne alındığında; en sık etkenin E.coli olduğu ortaya çıkmıştır.

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Sonuç: Yoğun bakım ünitelerinde invaziv araç kullanımına bağlı gelişen enfeksiyonların önlenmesinde, hasta ve bakteri özelliklerin 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-originated 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-originated 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). CAUTIs, which are an important problem in intensive care units, can be reduced with infection control measures and trainings. In this study, it was aimed to evaluate the three-year rates of CAUTI, rates of using 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.

Material and Method

Our study was designed and performed with active surveillance data collected by the infection control committee based on the patients' reports and laboratory findings. The study was performed with those followed-up in both ICUs in the anesthesia/reanimation and the internal medicine departments of a tertiary hospital with 1500 beds for more than 48 hours over three years between 1st January 2016 and 31st December 2018. The records of a total of 3399 patients from the anesthesia/reanimation ICU including 25 beds, three of which were allocated for isolation, and of 1207 patients from the internal medicine ICU with eight beds were kept on a daily basis (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. During the study period, we strieved to assign sufficient number of different nurses and allied medical staff, even if not at an ideal level, in order to care for the patients in case of an empty bed in the isolation area. Active surveillance data were accumulated by the infectious diseases specialist and the infection control nurse via daily visits to both ICUs under the criteria of the Center for Disease Control and Prevention (CDC) in 2016 (2) and the national healthcare-related infection surveillance standards released in 2017 (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.

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 41-hour training sessions were performed by focusing on unit- and field-based training programs for ICUs (Table 2).

Regular training programs on such entites 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. The number of unit-based training sessions was increased to 27 hours in 2018. 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 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 on infection control were enrolled into certificate programs.

The collected data were recorded on the patients' files on a daily basis 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 infection control committee (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 intensive care units. The deficiencies identified during daily visits to intensive care units 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 in the implementation stages of ICU over the years,
- Improvements in physical conditions
- Measures and training activities to reduce catheter-originated urinary infections,

Whether the use of 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 catheter 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 ≥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 the informed observations during daily visits with the inclusion of all staff in ICU. The following formulae were used in the

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	2392	2350	30	12,77	1,25 CI[¥] (0,98-1,03)	0,98	1,87	1242	6557	6314	46	7,29	1,01 CI (0,98-1,03)	0,96	0,37
2017	364	2467	2394	13	5,43	1,24 CI (1-1,05)	0,97	1,95	1146	8258	8111	22	2,71	1,03 CI (1-1,05)	0,98	0,8
2018	495	2622	2561	1	0,39	1,26 CI (1,01-1,06)	0,98	0,06	1011	8386	8338	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): Standart infection ratio, [¥]Confidence interval, [+]Rate of invasive instrument-related HI (ITRHI): (Number of ITRHI/number of days for invasive instrument) x 1000

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

	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

calculations of compliance rate with hand hygiene and CAUTI.

- ***(Number of appropriate hand hygiene observations/ number of total hand hygiene observations) x 100***
- ***Rate of hospital infections (HI): (Number of hospital infections/number of in-patients) x 100***
- ***Rate of invasive instrument-related HI (ITRHI): (Number of ITRHI/number of days for invasive instrument) x 1000***
- ***Rate of interventional instrument use rate (IUR): Number of days for use of invasive instrument/number of hospital stay days***
- ***Standard infection ratio (SIR): Number of infections observed/number of expected infections***

The standard Infection rate (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 infection than expected, and if SIR <1.00, it means less infection detected than expected.

The study approval was obtained from the ethics committee of Van Training and Research Hospital, University of Health Sciences on 16th May 2019.

Results

A total of 4606 patients were followed-up in the internal medicine and anesthesia/reanimation ICUs in 2016, 2017 and 2018. The number of the patients' hospital stay days and the infection rates by years are presented in Table 1. Given the number of the patients and the days of using invasive instruments in ICUs where we investigated, standardized instrument use rate (SIUR) and invasive instrument use rate (IUR) were found to be low. In 2016, however, CAUTI rates were determined as 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 the compliance of 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 CIUSI 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 personnel 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).

By expanding the area per patient in ICUs over the years, novel arrangements have been achieved in the areas allocated per patient. It was also detected that the arrangements, training programs and inspections helped CAUTI rates be decreased in ICUs. Considering the three-year distribution of the agents, Escherichia coli was found to be the most common factor, and Klebsiella species was observed as the second most frequent in 2016 and 2018, while Acinetobacter baumannii became prominent in 2017 (Table 3).

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)

Discussion

Intensive care settings are the units requiring multidisciplinary cooperation and designed for the patients' needs of support at the advanced level with special physical conditions and also to meet the needs for the staff (6). Patients followed-up in ICUs become vulnerable to health-related infections due to such widespread invasive interventions as urinary catheters, mechanical ventilation, central catheter insertions and accompanying diseases (7). Urinary infections are among the most common types of hospital infections, and 70-80% of urinary infections can be attributed to permanent urinary catheter use (8).

In the article where Al-Helali et al. 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 (9). 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 a preservative care for patients with urinary incontinence and to give a comfortable care in terminal patients,*

Under the criteria of the European Center for Disease Prevention and Control (ECDC) report, the second most widespread healthcare-related infection in Europe (31.2% of all infections) has been reported as urinary infections (11). In the studies by Jahani-Sherafat et al., 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 as 8.99 per 1000 catheter days, and 82.9% (151 out of 182) of the infections were associated with urinary catheters (12). Moreover, in a point prevalence study by Leblebicioglu et al. in 13269 patients from 29 Turkish hospitals, the rate of UTI was reported as 1.7% in prevalence, and most of UTIs (65.3%) were stated to be associated with urinary catheters (13). Another study involving 12 hospitals and performed by Gaid et al. reported that CAUTI ranked second with 28.4%, and the mortality rate was 36.9% due to CAUTIs (14). However, in the thrre-year study by Cukurova et al., the rate of CAUTIs was found to rank third with 19.8% (15). In light of such findings, CAUTI as the second most common hospital-originated infection in ICUs was examined in our study. Upon the investigation of CAUTI rates in the internal ICU, the rates are seen between 50 to 75 percentile in Turkey over three years (5); however, when compared with SIUR rates, IUR rates were below the expected level. Although invasive IURs were low in our study, our SIURs in 2016 were found >1.00. It is seen that the rates of infections decreased between 25 to 50 percentile, and that SIURs fell below one percentile thanks to the adjustments performed over the years. The rates in the anesthesia/reanimation ICU showed that IURs were between 25-50 percentile, there was a correlation between SIURs and IURs, CAUTI rates decreased between 25 to 50 percentile in three-year period, and SIURs were also < 1.00 (5). Our IURs in both clinics seem to be consistent with the average rates in Turkey. 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 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 a three-year period (Figure 1).

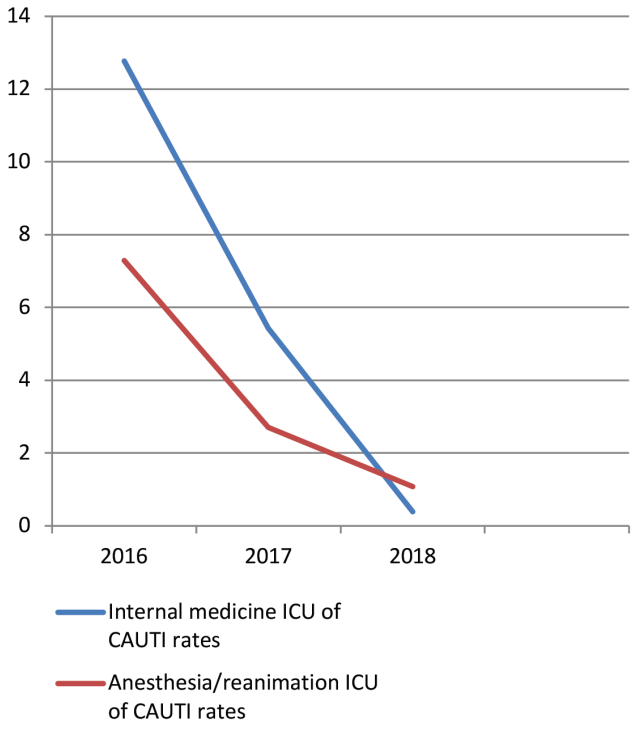

Figure 1. Change of CAUTI velocity in units by years

Among the quality poicies to be designed in order 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 porgrams 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. detected that CAUTI rates decreased consistently at each stage (14.92, 7.34, 3.78 and 1.10/1000 catheter per day, respectively), and also stated that the rate of urinary catheter use was reduced from 74.6% to 44.2% (16). Even so, in a prospective study performed by Navao et al. 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 (17). In the same study, a 76% reduction was achieved in CAUTI rates at the end of the study, compared to those at initial (17). In the study by Altınısık et al., 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 (18). The effect of compliance with infection control practices in invasive applications performed on patients followed in intensive care units 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 are predominantly witnessed in hospital-originated urinary infections (19). Causative microorganisms can originate from the patient's own flora, such as colon, vagina, meatus, etc. in CAUTIs. 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 factor in CAUTIs (21). In their study investigations nosocomial infections, Sabra et al. emphasized that UTI was 25.3%, and E.coli (47.7%) was the most common agent leading to UTIs (22). However, in the study performed to decrease CAUTIs in ICUs by Dizbay et al., candida species were found as the most widespread agent (57%), and E. coli was defined to be 2% (10). In the study by Ozer-Balin et al., candida species (33.3%) were reported as the most common agents causing CAUTIs in ICUs (23). 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, although Klebsiellaspp. in 2016 and 2017, and A.baumannii in 2017 were seen as the second most common agents (Table 3).

Hospital infections are among the inreasing health challenges throughout the world (24). It is likely to achieve a great success in the hospital infection control programs with the trained healthcare staff, use of appropriate isolation techniques and effective infection control practices, as well as surveillance practices (23). In many cases, urinary catheters have been inserted in inappropriate indications, and healthcare practitioners are often unaware that the patients have urinary catheters, causing the longer use of urinary catheters inappropriately (9). In patients undergoing insertion of 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 to be 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 patients' 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).

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 on a regular base, 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 ethics committee of Van Training and Research Hospital, University of Health Sciences on 16th May 2019 (decision no: 2019/10).

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Data Collection and Process: E.E., Literature Search: D.B., A.H.S., Writing: M.S.S.

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