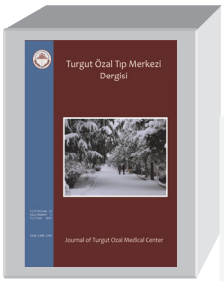
ORİJİNAL MAKALE/ORIGINAL ARTICLE
J Turgut Ozal Med Cent 2015:22(1):29-33



Journal Of Turgut Ozal Medical Center
www.jtomc.org

An Evaluation of Catheter-Related Bloodstream Infections in Intensive Care Units

Adem Köse[1], Latife Mamıkoğlu[2]

[1]Manavgat State Hospital, Department of Infectious Diseases and Clinical Microbiology, Antalya, Turkey
[2]Akdeniz University, Faculty of Medicine, Department of Infectious Diseases and Clinical Microbiology, Antalya, Turkey

Abstract

Aim: This study aims to study the risk factors that are related with the development of bloodstream infections in the patients hospitalized in intensive care units (ICUs).

Materials and Methods: We have prospectively examined the risk factors and microbiologic analyses of 18 patients with catheter-related blood stream infections (CR-BSI) who were selected from among 300 patients at ICU with central venous catheters (CVC) for 12 months (between August 2011 and August 2012).

Results: The mean duration of the catheterization was 15,19±5,977 days. The sensitivity and specificity of the time factor for receiving positive signal from cultures of CVC and blood samples were 88.8% and 93%, respectively. The CR-BSI attack rate was 20.9%. Metabolic disorders, duration of hospitalization in ICU, urinary catheterization, longer length of CVC duration, and whether CVC was used for other tests were found to be significant risk factors for the development of CR-BSI ($p<0,001$). Methicilin-resistant coagulase-negative staphylococcus (MRCNS) was detected in 6 (33.3%) cases while *Acinetobacter baumanii* was detected in 2 (11.1%) cases and polymicrobial agents were detected in 5 cases (27.7%). We also detected the following bacteria in 1 (5,6%) patient (for each) *Pseudomonas aeruginosa*, diphteroid bacilli, *Aeromonas veronii,* methicillin-susceptible *Staphylococcus aureus,* and *Klebsiella pneumoniae*.

Conclusion: In this study, metabolic disorders and CVC related factors were determined as risk factors for CR-BSI development. Taking these preventable factors into consideration and proper use of infection control measurements will provide significant decrease in CR-BSI rates. However, there is need for new scientific approaches on the diagnosis, treatment, and prevention for CR-BSI.

Anahtar Kelimeler: Central Venous Catheter; Catheter-Related Bloodstream İnfection; Intensive Care Unit, Bacteremia.

Yoğun Bakım Ünitelerinde Gelişen Kateter İlişkili Kan Dolaşım Enfeksiyonlarının İrdelenmesi

Özet

Amaç: Bu çalışmada, yoğun bakım ünitelerinde (YBÜ) yatan hastalarda gelişen kateter ilişkili kan dolaşımı infeksiyonları ile ilişkili risk faktörlerinin araştırılması amaçlanmıştır.

Gereç ve Yöntemler: Bir yıllık sürede (Ağustos 2011-Ağustos 2012) yoğun bakım ünitelerinde takip edilen ve santral venöz kateter (SVK) takılan 300 hastada gelişen 18 kateter ilişkili kan dolaşımı infeksiyonu (KİKDİ) olgusundaki risk faktörleri ve mikrobiyolojik analizleri prospektif olarak araştırılmıştır.

Bulgular: Santral venöz kateterlerin takılı kalma süreleri ortalama 15,19±5,977 gündü. KİKDİ gelişen hastalarda SVK ve kan kültürlerinin sinyal pozitifleşmesinde zaman faktörünün duyarlılığı (sensitivity) %88,8, özgüllüğü (specifity) %93,0 olarak bulundu. KİKDİ atak oranı %20,9 olarak belirlendi. Metabolik bozukluklar, YBÜ yatış süresi, üriner kateterizasyon, SVK takılı kalma süresi ve çok amaçlı kullanılması KİKDİ gelişimi için anlamlı risk faktörleri ($p<0,001$) olarak belirlendi. Altı (%33,3) olguda metisilin-dirençli koagülaz-negatif stafilokok (MRKNS), 2 (%11,1) olguda *Acinetobacter baumanii*, birer (%5,6) olguda *Pseudomonas aeruginosa*, difteroid basil, *Aeromonas veronii*, metisilin-duyarlı *Staphylococcus aureus* (MSSA) ve *Klebsiella pneumoniae* ve 5 (%27,7) olguda polimikrobiyal etkenler saptandı.

Sonuç: Çalışmamızda, metabolik bozukluklar ve SVK kullanımına bağlı nedenlerin KİKDİ gelişiminde önemli faktörler olduğu saptanmıştır. Bu faktörlerin çoğunlukla önlenebilir olması, infeksiyon kontrol önlemlerinin doğru kullanılması ile KİKDİ oranlarında önemli düşüş sağlayacaktır. Ancak yine de KİKDİ tanımlanması, tedavisi ve korunma ile ilgili olarak yeni bilimsel yaklaşımlara ihtiyaç vardır.

Anahtar Kelimeler: Santral Venöz Kateter; Kateter-İlişkili Kan Dolaşımı İnfeskiyonu; Yoğun Bakım Ünitesi; Bakteriyemi.

INTRODUCTION

Because of the dense patient population, intensive care units apply more intravenous catheters than any other units (1). An important complication of intravenous catheter applications in critically ill patients is the development of a potential infection (2). Local cellulitis, septic thrombophlebitis, abscess formation, catheter-related bloodstream infection (CR-BSI), metastatic infections (osteomyelitis, endophthalmitis, arthritis, lung abscess, brain abscess), and endocarditis are among the major infectious complications of intravascular catheters (3).

The average incidence of CR-BSI in intensive care units ranges from 1,8 to 5,2 in 1000 catheter days (4). Therefore, CR-BSI is regarded as an important cause of nosocomial bacteria and for this reason it is often associated with longer duration of hospital stay, increased costs of treatment, and high morbidity and mortality (5). Determination of central venous catheter

infection rates and their risk factors are very significant in prevention and reducing the frequency of bloodstream infections (1).

This study aims at determining the relationship between the ICU patients to whom we administered CVC and CR-BSI attacks they developed as well as the risk factors associated with ICU stays and CVC.

MATERIALS and METHODS

Patients:

In this study, we have prospectively examined 300 patients who were admitted to the intensive care unit of Akdeniz University Hospital between August 2010 and August 2011 and to whom we placed CVC. We have only included those patients at 18 years of age and above whose CVC remained implemented during their hospital stay. Patients younger than 18, those who were monitored at ICU in other centres or were implemented CVC in other units, or those patients who had previously been to centres where CVC is commonly used such as dialysis and chemotherapy units or to other intensive care units (neonatal, pediatrics, coronary ICU) were excluded from the study. All 300 patients were grouped according to 'Health Care Associated Infections Identification Guide' published in 2008 by the Centres for Diseases Control and Prevention (CDC) (6). Accordingly, the control group was made of patients who did not have reproductive factors in the semiquantitative culture of their catheter tips, whose blood cultures were negative in terms of reproduction, and those who did not receive clinical CR-BSI diagnosis and adopted the thought of colonization (n=195).

Determining the Risk Factors:

The patient-associated factors (age, comorbid diseases, use of TPN, neutropenia, malignancies, organ failures, rheumatic diseases, transplantations, traumas) and ICU/CVC-associated factors (length of hospital stay, catheter type) were identified as possible risk factors. Our patients were followed with active surveillance methods based on clinical observation and laboratory data.

Microbiological Diagnosis:

We monitored the catheter insertion site and its surroundings in terms of signs of local infection during the time the catheter remained implemented. The semiquantitative culture was applied with roll on plate method. In addition, we simultaneously took quantitative blood culture samples from one end of the catheter and a peripheral vein. We determined the duration of time in which we detected positivity in the qualitative blood samples that we simultaneously obtained from the catheter lumen and peripheral vein. To assess the bacteria in the catheter lumen, we applied culture sampling following catheter sonication; these samples were incubated at 35°C for 48-72 hours and then their microorganism reproduction was recorded as "colony-forming unit" (cfu). Samples with 10^3 cfu bacteria per millilitre are labelled as infected catheter; in these samples, bacteremia was considered to be catheter induced. Blood cultures were studied on a BACTEC 9240 (Becton Dickinson, USA) fully automated blood culture system. The active antibiotic resistance was performed by disk diffusion method (Oxoid/UK).

Statistical Analysis:

The obtained data were statistically analysed by using SPSS (Ver-16.0, SPSS Inc., USA) software. Parametric test assumptions were studied by "Student's t-test" while the difference between the two matching samples were analysed by using "variance analysis." In cases when the parametric test assumptions failed, we applied "Mann-Whitney U," "Wilcoxon signed rank "and" Kruskall Wallis" tests. In order to determine the differences in the analyses, we employed a significance level of 95% (or α=0,05 as the margin of error).

RESULTS

During the course of our study, 105 patients in the study group developed 121 BCI attacks. 68 of these episodes were defined as "primary bacteremia." In addition to the clinical findings, 18 patients with active breeding of >15cfu/ml in their semiquantitative culture of the catheter tips and with microorganisms having the identical antibiotic resistance patterns in their central venous catheters, blood cultures, and catheter tips were identified as CR-BSI cases.

The mean duration in which the patients remained implemented with central venous catheters was 15,19 ± 5,977 days. In the 18 CR-BSI patients, according to the positivity of the blood samples simultaneously taken from CVC and a peripheral vein, the sensitivity of time factor was 88,8%, while the specificity of time factor was 93,0%. The episode rate in 18 patients who developed CR-BSI was 20,9%.

The parameters which were found with statistically significant in the development of CR-BSI episodes are presented in Table 1.

The following parameters were not found to be statistically significant (p>0.05) in the development of CR-BSI episodes: TPN use, advanced age, gender, CVE history, presence of a neurological disease or sequels, presence of COPD, neutropenia, hypertension, the presence of CVC-related complications, previous CVC insertion story, differences in anatomical regions where CVC was inserted, medical units that fitted CVC and whether these units implemented CVC under elective or emergency conditions, ICU admission history, diabetes (monitored), chronic liver disease, coronary artery disease or other heart diseases, and steroid use.

We detected gram-negative bacteria reproduction in 5 patients and gram-positive bacteria reproduction in 8 patients in the culture samples. The remaining five patients had reproductions of mixed pathogens, including gram positive and negative factors. The factors in reproduction and their sensitivities are shown in Table 2 in relation to the patients.

Table 1. The risk fcators that were found to be statistically significant for CR-BSI development in the 18 patients.

Risk Factor	Variable	P (<0.005)
Hyperglisemia (present)	12 (%66.6)	0.002
Hypoalbuminemia (present)	12 (%66.6)	0.026
Urinary Catheherisation Duration(days)	23.56±12.645	0.001
CVC imsertion time (hospitalization day)	4,06 ± 9,459	0.0011
The amount of time CVC remained inserted (days)	13,11 ± 4,391	0.0001
Multi-purpose CVC usage	13 (%72.2)	0.002
ICU stay (days)	27,17 ± 17,896	0.001

Table 2. Antibiotic susceptivity of the factors that simultaneously developed in the catheters and bloood samples of CR-BSI patients.

Patient No	Unit	Factor	Antibiogram Susceptivity Result
1	CVS ICU	*1. E. faecalis* *2. CNS* *3.C. albicans*	1. Genta **R**, Ampicillin, Streptomycin **S** 2. Methicillin **R** 3. Fluconazole **S**
2	CS ICU	*1. A. baumannii* *2. E. Cloacae*	1. **S:** Colistin, TMP, Tigecycline 2. **S:** Amikacin, Cipro, Cephotaxime, Cefepime, Genta, Imipenem, Levofloxacin, Sef/sub, TMP, Pip/tazo
3	R 1	*Difteroid basilli*	Susceptibility not examined.
4	R 2	*1. A. baumannii* *2. Acinetobacter spp.*	1. **S:** Colistin 2. **S:** Colistin, TMP, Tigecycline
5	R 2	*P. aeruginosae*	**S:** Amikacin, AZT, Ceftazidime, Cipro, Genta, Imipenem, Levo, Meropenem, Sef/sub, TMP, Pip/tazo
6	R 1	*CNS*	Methicillin **R**
7	R 2	*A. baumannii*	**S:** Amikacin, Colistin, Sef/sub
8	R 1	*CNS*	Metisillin **R**
9	R 2	*1. P.aeruginosae* *2. E.cloacae*	1. **S:** Amikacin, AZT, Ceftazidime, Cipro, Genta, Imipenem, Levofloxacin, Meropenem, Sef/sub, TMP, Pip/tazo 2. **S:** Amikacin, Cipro, Cefepime, Genta, Imipenem, Levo, TMP
10	R 2	*K. pneumoniae*	**S:** Amikacin, Cephotaxime, Cefepime, Cefoxitin, Cipro, Genta, Imipenem, SAM, Sef/sub, TMP, Pip/tazo
11	CVS ICU	*S. aureus*	Methicillin **S**
12	R 1	*CNS*	Methicillin **R**
13	R 1	*CNS*	Methicillin **R**
14	R 2	*A. baumannii*	**S:** Ceftazidime, Cipro, Colistin, Genta, Imipenem, Meropenem
15	DICU	*CNS*	Methicillin **R**
16	R 2	*1. S. epidermidis* *2. A. baumannii*	1.Methicillin **R** 2. Colistin **S:**
17	R 2	*Aeromonas veronii*	**S:** Ceftazidime, Cipro, Cefepime, Genta, Levo, TMP, Pip/tazo
18	CVS ICU	*S. warnerii*	Methicillin **R**

Abbreviations: S: susceptible; R: resistant; Genta: gentamicin; TMP: trimetoprim-sulfametoxazol, Cypro: ciprofloxacin, AZT: aztreonam, sef/sub: cefoperazone-sulbactam, pip/tazo: piperacillin-tazobactam, SAM: ampicillin-sulbactam.

DISCUSSION

CVCs are the most common cause of nosocomial infections; as of today, they are the third most common nosocomial infection types with an incidence rate of 14% (7, 8). CVCs are reported to constitute 40% of all bacteraemia, and 50% of nosocomial bacteremia (5). When diagnosed and treated in early stages with protective measures taken, these infections are clinical situations that can reduce morbidity and mortality rates (9, 10).

The culture positivity rate in CVCs ranges from 6 to 24%. In a multicenter study conducted in France, the positivity rate of blood cultures taken from the catheter was found to be 24%; according to this study, this rate varies between 5% and 47% among other centres included in the research (11). In this study, we have examined the episodes of 18 CR-BSI patients in the intensive care unit of an eminent research and training university hospital for a one-year period. Throughout the study period, the frequency of CR-BSI episodes among 86 primary bacteraemia cases was 20.9%. Studies show that incidence rate of CR-BSI attacks varies from 2% to 10% among other primary bacteraemia cases. However, reports also indicate that this rate increases up to even %40 in high-risk patient groups such as patients with advanced ages, burns, and organ transplantation and trauma histories (12).

Today, hospitals recommend that inserted catheters should be used up to 15-20 days unless patients develop complications. In this study, the patients in the study group remained with inserted catheters for 15.19 ± 5.977 days. Our statistical analysis has shown that there is a risk factor for CR-BSI when patients remain with inserted catheters for a long time (Table 1). Other risk factors for the development of CR-BSI in our study were found to be long ICU stay, long durations of time urinary catheters remain implemented, late CVC insertion, and long periods of time CVCs remain inserted. The statistically significant relationship between the total length of time catheter remains inserted and CR-BSI suggests that the proposed rules for asepsis may not have been followed during the time catheter remains inserted though the implementation of the catheter may have complied with the procedures for asepsis and that there might have been deficiencies in terms of the catheter insertion conditions. We believe that late insertion of the catheter as a risk factor indicates that this has caused an increase in the length of intensive care unit stay; this may have been caused by contamination during catheter insertion resulting in an increase in skin contamination rates of pathogens.

Öncü et al.'s 12-monthprospective study (13) has reported the CR-BSI rate to be 16,7% in a university hospital. They have also suggested that duration of catheterisation and catheter insertion area are among significant risk factors for the development of CR-BSI. The same study also argues that there are significant differences between catheters inserted into the jugular vein and catheters inserted in the subclavian region in terms of their effect on CR-BSI development (22,7% and 11,9%, respectively).

In our study, we detected metabolic disorders in 121 (40.3%) of our patients. Hyperglycaemia was the most common metabolic disorder in the ICU patients included in our study. The fact that hyperglycaemia has a negative effect on neutrophil functions, phagocytosis, and cytokine activity while it also provokes the growth of microorganisms may be regarded as the reason behind this result. Recent studies have shown that aggressive treatments to keep blood glucose levels at 80-110 mg/dl do not actually have any positive effects on long-term mortality though such approaches are reported to have reduced the risk of bacteremia development (14).

In our study, we have determined that presence of hypoalbuminemia is effective on the formation of CR-BSI attacks; in this respect, our study affirms the results of Kritchevsky et al.'s extensive research (15). A 2006 study conducted in Zonguldak Karaelmas University Training, Research, and Practice Hospital to examine bacteremia/BSI risk factors has found TPN use as an important risk factor (16). In this study, microorganisms that were found to be active are as follows (in order of their frequency): CNS, S. aureus, Enterococcus spp., Candida spp., Klebsiella spp., and P. aeruginosa, respectively. CNS was the responsible factor behind CR-BSI in 60% of TPN patients who remained with inserted CVCs for a long time (17).

Studying our 18 CR-BSI patients in terms of the distribution of active factors, we found out that CNS bacteria were the most common pathogens (27.8%). We believe that this high frequency rate is a result of patients' skin flora. Considering the sensitivity of these factors, we discovered that they were all methicillin-resistant, which is an important evidence that makes us think that these bacteria are nosocomial. While one of the two A. baumannii isolates was susceptible to all antibiotics, the other was resistant to amikacin, colistin and cefoperazone/sulbactam, ceftazidime, cefepime, quinolines, and carbapenems.Each one of the P. aeruginosa and K. pneumoniae strains were found to be sensitive to all antibiotics. Moreover, one of the isolated E. cloacae was found to be able to produce inducible beta-lactamase (Table 2).

The surveillance studies show that the most commonly produced factors in CR-BSI are CNS, S. aureus, aerobic gram-negative bacilli, and C. albicans. Although the distribution of the active factors is well known, determining antibiotic resistance patterns, especially in empirical treatment, is also important. In the treatment of CR-BSI, which can cause serious morbidity and mortality, every hospital should assess their own factor distribution and resistance rates, and, as it was the case in our study, plan the empirical therapy according to the resistance profile if the centre has high rates of resistance (13).

In conclusion, our study has put forward that some of the mistakes we have observed in CVC applications as well as uncontrolled metabolic problems constitute significant risk factors for the development of CR-BSI. We believe that bringing new regulations and corrective attempts will lead to a decline in the development of CR-BSI. Apart from reducing the incidence of CR-BSI, such studies will significantly contribute to the reduction of economic loss and infection related deaths.

This study is a part of Adem Köse's speciality dissertation which was submitted to and accepted by the Department of Infectious Diseases and Clinical Microbiology, Faculty of Medicine, Akdeniz Univeristy.

REFERENCES

1. Seifert H, Jansen B, Widmer AF, Farr BM. Central –Venous Catheters. In: Seifert H, Jansen B, Farr BM (eds). Catheter-Related Infections. 2th ed. New York: Marcel Dekker 2005;293-326.
2. Mermel LA. Prevention of intravascular catheter-relatedinfections. Ann Intern Med 2000;132:391-402.
3. Beekman ES, Henderson KD. Infections Caused by Percutaneous Intravascular Devices. In: Mandell GL, Bennett JE, Dolin R (eds). Principles and Practice of Infectious Diseases. 6th ed. Philadelphia. Elsevier, Churchill Livingstone 2010;3697-715.
4. O'Grady NP, Alexander M, Dellinger EP. Guidelines for the prevention of intravascular catheter-related infections. MMWR Recomm Rep 2009;51:1-29.

5. Glover S. Bru-Brisson C. Infections associated within travascular lines, grafts and devices. Infect Dis 2010;19:125-36.
6. Horan TC, Andrus M, Dudeck MA. CDC/NHSN surveillance definition of healthcare–associated infection and criteria for spesific types of infections in the acute care setting. Am J Infect Control 2008;36(9):655.
7. Eggimann P, Pittet D. Overview of catheter-related infections with special emphasis on prevention based on educational programs. Clin Microbiol Infect 2002;8:295-309.
8. Fraenkel DJ, Rickard C, Lipman J. Can we achieve consensus on central venous catheter-related infections? Anaesth Intensive Care 2000;28:475-90.
9. Matthew R. Goede, Craig M, Cooper S. Catheter-related blood stream infection. Surg Clin N Am 2009;89:463-74.
10. Mary C. Barsanti, Keith F, Woelt JE. Infection prevention in the intensive care unit. Infect Dis Clin N Am 2009;23:703-25.
11. David KW, Jeanne EZ, Alexis M, Michael J, Victoria F. Primary blood stream infections in ICU patients. Clin Infect Dis 2001; 33: 1329-35.
12. Bakır M. Kateter infeksiyonlarının epidemiyolojisi, etyoloji ve patogenez. Ankem Dergisi 2000;14(4):456-9.
13. Öncü S, Özsüt H, Yıldırım A, Ay P, Çakar N, Eraksoy H, Çalangu S. Central venous catheter related infections: risk factors and the effect of glycopeptide antibiotics. Ann Clin Microbiol Antimicrob 2003;27;2:3.
14. Kritchevsky SB, Barbara I, Braun, LK, Edward SW, Steven LS, Michael FP, Cheryl L. The impact of hospital practice on central venous catheter-associated bloodstream infection rates at the patient and unit level: a multicenter study. Am J Med Qual 2008;23:24.
15. Baruönü F. Merkezi yoğun bakım ünitelerinde yatan hastalarda gelişen nazokomiyal kan dolaşımı infeksiyonları ve bu infeksiyonların gelişimine neden olan risk faktörlerinin belirlenmesi. Zonguldak Karaelmas Üniversitesi Tıp Fakültesi, İnfeksiyon Hastalıkları Anabilim Dalı Uzmanlık Tezi, Zonguldak, 2009.
16. Opilla M. Epidemiology of blood stream infection associated with parenteral nutrition. Am J Infect Control 2008;36:5-8.

Received/Başvuru: 27.05.2014, Accepted/Kabul: 02.06.2014

Correspondence/İletişim

Adem KÖSE
Manavgat Devlet Hastanesi, İnfeksiyon Hastalıkları ve Klinik Mikrobiyoloji Kliniği, ANTALYA, TÜRKİYE
E-mail: akose0744@hotmail.com

For citing/Atıf için

Kose A, Mamikoglu L. An Evaluation of catheter-related bloodstream ınfections in ıntensive care units. J Turgut Ozal Med Cent 2015;22:29-33 DOI: 10.7247/jtomc.2014.2157