

## Incidence and risk factors for bloodstream infections stemming from temporary hemodialysis catheters

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**Aim:** Catheter-related bloodstream infection (CR-BSI) is considered as an important complication of hemodialysis catheters. The purpose of this prospective study was to evaluate the incidence and risk factors of temporary hemodialysis catheter-related bloodstream infection.

**Materials and methods:** Prospective data related to temporary hemodialysis catheters inserted in our institution were collected for duration of three years. The risk factors of CR-BSI of patients between the CR-BSI group and the control group were compared.

**Results:** A total of 248 temporary hemodialysis catheters were inserted in 201 patients and remained in situ for a cumulative total of 5192 catheter days. There were 3254 dialysis sessions. CR-BSI was found in 63 cases. CR-BSI rate was 12.1/1000 catheter-days and 19.4/1000 dialysis sessions. In multivariate analysis, acute renal disease (OR = 2.29), administration of antibiotics at the time of catheterization (OR = 2.09), insertion in the femoral vein (OR = 2.14), emergency situation for catheter insertion (OR = 2.41), high number of catheter manipulation (OR = 2.49), and inadequate hand hygiene prior to catheter manipulations (OR = 3.02) were found to be risk factors of CR-BSI. The most frequently isolated microorganisms were coagulase-negative staphylococci (31.3%), *S. aureus* (26.9%), *Enterococcus* spp. (10.4%), and *Pseudomonas aeruginosa* (9.0%).

**Conclusion:** This prospective study of temporary hemodialysis catheters has shown high rates of infectious complications. The education of both the patients and medical staff in prevention of CR-BSI is important.

**Key words:** Hemodialysis, temporary hemodialysis catheters, catheter-related infection

### Geçici hemodiyaliz kateterlerinden kaynaklanan kan dolaşımı infeksiyonlarının risk faktörleri ve insidansı

**Amaç:** Kateter ilişkili kan dolaşımı infeksiyonu (KİKDİ) hemodiyaliz kateterlerinin önemli komplikasyonu olarak sayılmaktadır. Bu prospektif çalışmanın amacı geçici hemodiyaliz kateterleri ile ilişkili kan dolaşımı infeksiyonlarının risk faktörleri ve insidansını değerlendirmektir.

**Yöntem ve gereç:** Kurumumuzda takılan geçici hemodiyaliz kateterleri ile ilişkili prospektif bilgiler üç yıllık sürede toplandı. KİKDİ risk faktörleri gelişen grup ve kontrol grubunda karşılaştırıldı.

**Bulgular:** İkiyüzbir hastaya toplam 248 geçici hemodiyaliz kateteri takıldı ve 5192 kateter günü takip edildi. Hastalara 3254 dializ seansı uygulandı. Atmışüç vakada KİKDİ tespit edildi. KİKDİ hızı 12.1/1000 kateter günü ve 19.4/1000 dializ seansı idi. Çok değişkenli analizde akut böbrek yetmezliği (OR = 2,29), kateterizasyon sırasında antibiyotik alıyor olma (OR = 2.09), kateterin femoral vene takılması (OR = 2.14), acil şartlarda kateter takılması (OR = 2.41), yüksek sayıda kateter manüplasyonu (OR = 2.49) ve kateter manüplasyonu öncesi yetersiz el hijyeni (OR = 3.02) KİKDİ risk faktörleri olarak bulundu. En sık izole edilen mikroorganizmalar coagulase-negative staphylococci (% 31,3), *S. aureus* (% 26,9), *Enterococcus* spp. (% 10,4) ve *Pseudomonas aeruginosa* (% 9) idi.

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**Sonuç:** Bu prospektif çalışma geçici hemodiyaliz kateterlerin infeksiyöz komplikasyonlarının yüksek oranlarda olduğunu göstermektedir. KİKDİ'yi önlemede hem hasta hemde sağlık çalışanlarının eğitimi önemlidir.

**Anahtar sözcükler:** Hemodiyaliz; geçici hemodiyaliz kateterleri; kateter ilişkili infeksiyon

## Introduction

Hemodialysis continues to be an important treatment option for patients with end-stage renal disease. An essential component of dialysis practice is the use of temporary or semi-permanent hemodialysis catheters, which are often complicated by mechanical or infectious complications resulting in patient morbidity or premature catheter removal (1, 2).

Bacteremic infections are the major cause of morbidity and mortality in chronic hemodialysis patients (3). Catheter-related bloodstream infections (CR-BSI) are the most significant complication of hemodialysis catheters, occurring in 3.4-18.2 episodes/1000 catheter days (2, 4-7). The development of CR-BSI is facilitated in the presence of certain potential risk factors such as the presence of an underlying disease, poor patient hygiene and poor hygiene of the medical staff, inexperienced medical attendant inserting the catheter, insertion site and method of catheter insertion, duration of catheterization, cumulative number of catheter manipulation and high number of hemodialysis runs (8-11). Moreover, CR-BSI often result in serious systemic infections, including endocarditis, osteomyelitis, epidural abscess, septic arthritis, and even death (12).

The aim of this prospective study was to evaluate the incidence and risk factors of CR-BSI in patients with temporary hemodialysis catheters.

## Methods

Prospective data were collected on all temporary hemodialysis catheters inserted at the Karadeniz Technical University Hospital, Trabzon, Turkey, between October 2003 and October 2006 inclusive. The risk factors of CR-BSI in temporary hemodialysis catheter of patients between the CR-BSI group and the control group who did not develop CR-BSI were compared.

Temporary hemodialysis catheters were inserted into the acute or chronic renal disease patients. The patients were followed for the duration of their stay in place and data about the signs of inflammation on the catheter sites were obtained daily and surveyed for bloodstream infections by an infection control team. Following data were prospectively collected by an infection control team member and nurses in charge of clinics: age, sex, underlying disease, dates of hospital admission and discharge, date and site of catheter insertion, hand hygiene and use of maximal sterile barriers for insertion and maintenance, patient hygiene, duration of catheterization, number of catheter manipulations (high number of catheter manipulation  $\geq 3$ /day), number of hemodialysis runs, administration of antibiotics at the time of catheterization, occurrence of complications, and date of removal of the catheter. Infection control team members and nurses-in-clinics observed and noted the hand hygiene state before every manipulation including palpation of the catheter insertion the replacement, insertion, accession, and repairing or dressing of the area. Patient hygiene status (good or poor) was determined subjectively on the basis of clinical and infection control team assessment of the patient. Emergency catheter insertion is defined as the insertion of temporary hemodialysis catheter either in the emergency unit or in another clinic for medical reasons. Catheterization by inexperienced personnel is that the temporary hemodialysis catheter insertion process is carried out by the inexperienced doctors such as first year residents.

CR-BSI was defined as to Centers for Disease Control and Prevention (CDC) criteria (9). Blood samples of 3 to 7 ml drawn simultaneously from central venous catheter and peripheral veins were cultured and then the differential positivity times of cultures were evaluated. After aseptic catheter removal, a 4-cm segment from the tip section of each catheter was cultured using the sonication technique. Cultures yielding  $10^3$ cfu or more colonies were recorded as positive (13). Identification of the causative micro-organisms was performed using the

automated Scepter system (Becton Dickinson, USA) and classical methods.

### Statistical analysis

Descriptive statistics was performed for all the studied variables. Conformity of the data obtained in measurements to the normal distribution was analyzed with the Kolmogorov Smirnov test. Data that are in conformity with normal distribution were analyzed with Students-t test, and data not conforming to normal distribution were analyzed with the Mann Whitney-U test. Logistic regression analysis was used to assess whether risk factors for the development of CR-BSI were independent. Data obtained by measurements were given as mean  $\pm$  standard deviation. Data obtained by counting were however given as percentages (%), and the analyses were performed by Chi-square test. Results of the analysis were presented as P values, Odds Ratio (OR), and 95% confidence interval (95% CI). The level of statistical significance was accepted as  $P < 0.05$ .

### Results

A total of 248 temporary hemodialysis catheters were inserted in 201 patients (59.4% male and 40.6% female) and remained in situ for a cumulative total of 5192 catheter days. There were 3254 dialysis sessions. A total of 63 CR-BSI were found during the study period. CR-BSI rate was 12.1/1000 catheter-days and 19.4/1000 dialysis sessions.

Univariate analysis revealed that cumulative number of risk factors, acute renal disease, diabetes mellitus, administration of antibiotics at the time of catheterization, insertion in the femoral vein, emergency situation for catheter insertion, high number of catheter manipulation, poor patient hygiene, inadequate hand hygiene prior to catheter manipulations were associated with an increased risk of CR-BSI (Table 1).

In multivariate analysis, acute renal disease (OR = 2.29), administration of antibiotics at the time of catheterization (OR = 2.09), insertion in the femoral vein (OR = 2.14), emergency situation for catheter insertion (OR = 2.41), high number of catheter manipulation (OR = 2.49), and inadequate hand hygiene prior to catheter manipulations (OR = 3.02) were found to be risk factors of CR-BSI (Table 2).

Sixty-seven microorganisms were isolated as etiologic agents for the CR-BSI (Table 3). Forty-seven (70.1%) gram-positive cocci, 18 (26.9%) gram-negative bacilli, 2 (3.0%) *Candida albicans* were isolated as the cause of CR-BSI. The most frequently isolated microorganisms were coagulase-negative staphylococci (31.3%), *Staphylococcus aureus* (26.9%), *Enterococcus* spp. (10.4%), and *Pseudomonas aeruginosa* (9.0%). Polymicrobial microorganisms were isolated in 2 cases.

### Discussion

Intravascular catheters play a major role in the etiology of nosocomial blood stream infections (9, 10). Temporary catheters in hemodialysis patients are the most common and significant cause of blood stream infections (2, 3, 14). CR-BSI is noted for their high cost and increasing morbidity and mortality (2, 3, 6, 9) that have been reported to increase the death risk in hemodialysis patients (15).

Various studies report that the incidence of CR-BSI varies from 3.4 to 18.2 in 1000 catheter days in patients with temporary hemodialysis catheters (4-7). Although the rate of CR-BSI obtained during our study is similar CR-BSI rates in the literature, the CR-BSI rate is higher than expected. The cause of this high CR-BSI rate may be attributed to the presence of higher numbers of risk factors in each patient with infection ( $P < 0.0005$ ). Also, the factors responsible for the high CR-BSI rate may be addressed as emplacement of catheter to femoral vein, prior antibiotic use, emergency insertion of catheter, high number of catheter manipulation, poor hygiene related to patient or medical staff, absence of maximal sterile barrier precautions, and multiple hemodialysis applications. Multiple risk factors in the same patient also increase the rate of CR-BSI (16). In our study, the presence of more than five risk factors increased significantly the likelihood of having CR-BSI ( $P < 0.0005$ ).

While some of the studies in the literature suggest that concomitant renal disease and surgical intervention, hematological malignancies, neutropenia lasting longer than 8 days and presence of AIDS have a role in the development CR-BSI, some others claim that concomitant diseases do not have a

Table 1. Risk factors of CR-BSI in temporary hemodialysis patients (univariate analysis).

Risk factors	CR-BSI n = 63	Control group n = 185	P	OR	95% CI
Age	59.2±15.7	56.3±14.9	0.063		
Sex(male/female)	34/29	105/80	0.700	0.89	0.48-1.65
Number of risk factors	6.5±1.9	4.9±1.6	<0.0005		
> 5 risk factors	41 (65.1)	64 (34.6)	<0.0005	3.52	1.86-6.72
Acute renal disease	19 (30.2)	27 (14.6)	0.01	2.53	1.22-5.23
Co-morbid diseases					
Malignancy	9 (14.3)	18 (9.7)	0.442	1.55	0.60-3.91
Diabetes mellitus	15 (23.8)	23 (12.4)	0.049	2.20	1.00-4.82
Surgical intervention	12 (19.0)	24 (13.0)	0.329	1.58	0.69-3.58
Antimicrobial usage	37 (58.7)	70 (37.8)	0.004	2.34	1.25-4.37
Steroids usage	8 (12.7)	16 (8.6)	0.489	1.54	0.57-4.08
Immunosuppressive therapy	6 (9.5)	20 (10.8)	0.960	0.87	0.30-2.44
Duration of catheterization	21.6±10.6	20.7±11.0	0.587		
Catheter location					
<i>V. subclavia</i>	17 (27.0)	73 (39.5)	0.104	0.57	0.29-1.11
<i>V. jugularis</i>	12 (19.0)	43 (23.2)	0.605	0.78	0.36-1.67
<i>V. femoralis</i>	34 (54.0)	69(37.3)	0.02	1.97	1.06-3.66
Emergency situation for catheter insertion	20 (31.7)	30 (16.2)	0.014	2.40	1.18-4.88
Catheterization by inexperienced personnel	31 (49.2)	79 (42.7)	0.369	1.30	0.70-2.40
High number of catheter manipulation	43 (68.3)	96 (51.9)	0.035	1.99	1.05-3.82
Inadequate hand hygiene	43 (68.3)	89 (48.1)	0.009	2.32	1.22-4.44
Maximal sterile barriers precaution	43 (68.3)	101 (54.6)	0.08	1.79	0.94-3.42
Poor patient hygiene	23 (36.5)	33 (17.8)	0.004	2.65	1.34-5.25
Mortality	8 (12.7)	17 (9.2)	0.578	1.44	0.53-3.78

Table 2. Risk factors of CR-BSI in temporary hemodialysis patients (multivariate analysis).

Risk factors	P	OR	95% CI
Acute renal disease	0.034	2.29	1.13-4.04
Diabetes mellitus	0.206	1.69	0.75-3.82
Antimicrobial usage	0.024	2.09	1.10-3.95
Femoral catheter	0.020	2.14	1.13-4.04
Emergency situation for catheter insertion	0.021	2.41	1.15-5.07
High number of catheter manipulation	0.009	2.49	1.25-4.93
Inadequate hand hygiene	0.001	3.02	1.53-5.95

Table 3. Microorganisms isolated from CR-BSI.

Microorganisms	n	%
Gram positive microorganisms	47	70.1
Coagulase-negative staphylococci	21	31.3
<i>S.aureus</i>	18	26.9
<i>Enterococcus</i> spp.	7	10.4
<i>Bacillus subtilis</i>	1	1.5
Gram negative microorganisms	18	26.9
<i>P.aeruginosa</i>	6	9.0
<i>Acinetobacter</i> spp.	4	6.0
<i>Klebsiella</i> spp.	2	3.0
<i>E.coli</i>	5	7.5
<i>Alcaligenes xylosoxidans</i>	1	1.5
<i>Candida albicans</i>	2	3.0

role in CR-BSI development (1, 17-21). Renal disease requiring acute dialysis brings about higher rates of bacteremia (17). In our study, the CR-BSI rate in patients with acute renal disease and diabetes mellitus was higher in univariate analysis. In multivariate analysis, acute renal disease was found to increase CR-BSI 2.29 times. This may be related to the presence of multiple risk factors, catheter insertion in emergency situations, frequency of hemodialysis, frequency of manipulations, and lack of precautions for the prevention of CR-BSI.

Although there are reports showing that the use of glycopeptides has been beneficial, prophylactic antibiotic use for the prevention of CR-BSI is not suggested (9, 22-24). Therefore, no prophylactic antibiotics are used for the catheterization process in our hospital. However, in the current study, the patients on antibiotics for other medical reasons were compared with non-antibiotics takers, and the result indicated that the CR-BSI rate in the patients on antibiotics was significantly higher (OR = 2.09, 95% CI = 1.10-3.95; P = 0.024). This high rate may be explained either by unhygienic procedures applied due to false feeling of safety stemming from the use of antibiotics during the catheterization or by the selected microorganisms resistant to the antibiotics used.

The risk of developing an infection may vary with the site of insertion. It is highest in the femoral vein, lower in jugular vein and the lowest in subclavian vein (10, 11, 25). This may be explained by the density of

skin flora which is scarce in the subclavian area as compared to femoral or jugular insertion areas (9, 10). In our study, the CR-BSI rate in catheters located in femoral was higher in univariate analysis. In multivariate analysis, CR-BSI in catheters inserted in femoral site was determined to be 2.14 times greater than CR-BSI in catheters inserted other sites (OR = 2.14, 95% CI = 1.13-4.04; P = 0.02).

Infection risk increases with insertion of catheter in emergency conditions. It is not easy for medical staff to strictly apply the infection control precautions under emergency conditions. Ideally such catheters should be replaced within 24 hours (9-11). We determined that CR-BSI increased in emergency situations for catheter insertion. CR-BSI in temporary hemodialysis catheters inserted in emergency conditions was determined to be 2.41 times greater than CR-BSI in catheters inserted under elective conditions (OR = 2.41, 95% CI = 1.15-5.07; P = 0.021).

Poor patient hygiene is another important risk factor for increased CR-BSI (1, 8). Likewise, univariate analysis results showed that poor hygiene of the patient was an important factor on the rate of CR-BSI.

Attention paid to hand hygiene and conformity to aseptic techniques during the insertion; care and manipulation of intravascular catheters are known to be effective precautions against CR-BSI (9, 26-28). It is possible to obtain hand hygiene with water-free alcohol based products or antibacterial soap (9, 27, 29). Our results demonstrate that the incidence of CR-BSI was increased by inadequate hand hygiene before catheter manipulations (OR = 3.02, 95% CI = 1.53-5.95; P = 0.001). One important finding of our study concerned the frequent manipulation of catheters is that frequent catheter manipulation led to an increase in the CR-BSI rate (OR = 2.49, 95% CI = 1.25-4.93; P = 0.009).

The microorganisms causing CR-BSI mostly originate from skin flora and the most commonly isolated microorganisms are gram-positive microbes (9, 30). Recent epidemiological studies have shown that in hemodialysis patients the majority of *S.aureus* isolates originate from the endogen flora of the patient (31).

In conclusion, this prospective study shows that temporary hemodialysis catheters are associated with

a high rate of infectious complications. Compliance with infection control precautions causes a significant decrease in the rate CR-BSI (14, 28, 31). In view of the high frequency of infectious complications of temporary hemodialysis catheters the most effective

method of prevention seems to be the promotion of the infection control precautions that should be emphasized by educating and training the health providers.

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