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Factors Involved in Cuffed Catheter-Related Infections in Hemodialysis Patients

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Abstract:

Background and Aims: Dialysis catheter-related infections (CRI) remain a significant cause for morbidity and mortality in hemodialysis patients. We studied factors that predispose hemodialysis patients to CRI.

Methods: This a retrospective case controlled study of hemodialysis patients with a cuffed permanent catheter access conducted over a 12-month period. Those developing CRI acted as the study group and those who remained free of CRI acted as controls.

Patients and catheter variables that were documented included: Chronic Comorbidity Index (CCI), serum albumin level, Kt/V, number of CRI, organism/s isolated, and whether the catheter had to be removed. Significance of differences between the two groups was assessed using two tailed independent test for continuous variables and Chi square for categorical variables.

Results: Fifty-seven study patients and 39 controls were included. There were 107 episodes CRIs. The number of episodes of infection/catheter patients was 1.1 after a mean follow up period of 933 (± 255) days. Number of episodes of infection per 1000 catheter/days was 1.2 and per 100 dialysis sessions was 0.714. Catheter duration was shorter (1040 ± 198 days) in the infected group compared to the control group (1139 ± 275 days, p=0.042). The commonest organism isolated was Staph aureus (35%) followed by Enterobacter cloacae (14.8%). The commonest antibiotic used was vancomycin, followed by gentamycin and ceftazidime. The actuarial catheter survival was markedly less with multiple episodes of infection compared to single episode (p=0.029). A single episode of infection was associated with 9.5% chance of catheter losses as opposed to a 43.3% chance in multiple infections (p=0.0001).

Conclusions: Risk of infection was increased with femoral placement and number of dialysis sessions. The risk of catheter loss with multiple infections is more. The demographic characteristics are not a risk factor for developing infection.

Keywords: Infection, Dialysis catheter, Hemodialysis

Introduction

Central venous catheters usage has become necessary and common devices for dialysis patients in whom using the arteriovenous fistula (AVF) is not possible or is not a definitive access. Central

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have many advantages that include ease on insertion, immediate use, ability to provide access over a period of months, and relative ease of treating thrombotic complications (1). Central venous catheters, however, are associated with serious disadvantages and complications the most common of which include thrombosis, infections, permanent central venous stenosis or occlusion, discomfort, and short lifespan.

Intravenous catheters are one of the most common causes of nosocomial bacteremia, and systemic infections (2). The gram-positive bacteria are the most frequent cultured pathogens (3). The blood culture is the cornerstone in the diagnosis of catheter-related infection (CRI). Clinically, local signs are not necessary to diagnose CRI. To confirm CRI, blood cultures should be taken simultaneously from peripheral blood and from the venous catheter (3). Treatment with antimicrobial agents should be directed by the susceptibility of the isolated pathogen. Tunnel infection and infection by S. aureus and Candida are indications for quick removal of the catheter (3). The use on universal infection control techniques (such as, mask, sterile gloves, cap, gown, and large drape) during insertion and during dialysis minimizes the risk of CRI in the hospital setting (4).

In this study we aimed to identify the factors associated with the increased risk of developing catheter-related infections (CRI) such as age, cause of renal failure, length of time since the insertion of the catheter and the site of catheter placement. It included all patients dialyzing through catheter (96 patients) at King Abdulaziz Medical City, Riyadh from June 2006 through June 2007.

Materials and Methods

This a retrospective case controlled file–review study of all patients who had a permanent vascular catheter. The study was conducted over a 12-month period. Those developing documented CRI (57 patients) acted as the study group and those who remained free of CRI acted as controls (39 patients).

Sample Selection

Through 12 months of study, the patients were selected from the same institution (King Abdulaziz Medical City, Riyadh). All the patients received the same level of care, including aseptic insertion technique, and catheter site dressing as well as the same nutritional and dialysis therapy. All the patients dialyzing through permanent catheters were included in the study (a total of 96 patients).

The patients who developed infection (57 patients) were compared to those who did not develop infection acting as controls (39 patients). Patients are reported to have infection if they develop it during the time of the study, and have been diagnosed clinically and by positive blood cultures. The results were reviewed from the patients' files.

Variables

Patient and catheter-related variables were included in the case control study. Patients variables were age, gender, cause of renal failure, Chronic Comorbidity Index (CCI) date of starting dialysis, serum albumin level (as a surrogate marker for nutritional status), and Kt/V as a measure of dialysis adequacy (Kt/V is defined as the dialyzer clearance of urea (K, obtained from the manufacturer in mL/min, and periodically measured and verified by the dialysis team) multiplied by the duration of the dialysis treatment (t, in minutes) divided by the volume of distribution of urea in the body (V, in mL), which is approximately equal to the total body water) (5). Catheter variables included site of insertion, date of insertion, numbers and dates of CRI, organism/s isolated from the catheter or blood culture, sensitivity, antibiotics given, and whether the catheter had to be changed or not. The indication of change was lack of clinical response within 24 hours of commencement of antibiotic therapy.

Statistics

The data were collected in Microsoft Office Excel file and transferred and analyzed by using SPSS®. Significance of differences between the study and control groups was assessed by Fisher exact test and Chi-square for categorical data. Two tailed independent sample t test for continuous data. A p value less than 0.05 was considered significant.

Ethical aspects

The University Research Committee approved this study on 9th February, 2009

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Results

There were 57 patients in the study group and 39 in the control group. In the infected group, there were a total of 107 episodes of documented CRI (35 patients had a single episode of infection and 22 had multiple episodes of infection). The number of episodes of infection/catheter patients was 1.1 after a mean follow up period of 933 (±255) days. (Median of 877 days and mode of 728 days) (Table1).

The number of episodes of infection per 1000 catheter days is 1.2 and per 100 dialysis sessions were 0.714 (Table 1).

Table 2 compares the demographic data of the study and control groups. It can be seen that the control group is not significantly different from the study group in terms of age, male to female ratio, % of patients with diabetic nephropathy (DN), duration on dialysis, CCI or Kt/V. The only significant difference observed was that the duration since the insertion of the catheter was shorter (1040 ± 198) days) in the infected group compared to the control group (1139 ±275 days, p=0.042). There were also more of the study patients having a femoral catheter compared to the control group.

Table 1. Frequency of CRI

Number of patients with infection (study group)	57
Number of patients free infection (control group)	39
Total number of episodes of Infection	107
Episodes of Infection/patient with a PermCath	1.1 (± 0.8)
Time from catheter insertion to infection (days	189 (± 208)
Mean follow up period (days)	933 (± 255)
Episodes of infection/1000 catheter /days	1.2
Episodes of infection/100 dialysis sessions	0.714

Table 2. Demographic of the study and control groups

	Study Group	Control Group	P value
Age (years)	58.7 (±18.5)	54.1 (±25)	0.3
Males (%)	54.4	61.5	0.5
Percent with DN	56.1	51.3	0.64
Kt/V	1.64 (±0.23)	1.6 (±0.2)	0.4
CCI	4.9 (±1.4)	6 (±3.2)	0.3
Serum Alb (g/L)	38.6 (±8.6)	38.9 (±8.4)	0.8
Duration on dialysis (yrs)	4.7 (±3.3)	4.6 (±3.2)	0.9
Catheter duration (days)	1040 (±198)	1139 (±275)	0.042
Femoral Catheters (%)	8.8	0.0	0.057

Our Kt/V results were excellent as the patients were all on 3 times/week dialysis each lasting at least 4 hours and with an arterial blood flow > 300 mls/min. Thirty percent of the patients were also receiving on-line hemodiafiltration.

Table 3 shows that there was no significant difference between those who got one episode of infection compared to those who suffered more than one within the study group in terms of comorbidity status, age, duration on dialysis, adequacy of dialysis, nutritional status, time from catheter insertion to first infection. Table 3 compares the findings in patients with a single episode of infection to those with multiple episodes.

The chance of losing the catheter after the first episode of infection is 9.5 %. This increases to 43.3 % in any subsequent infection episode (p=0.0001) (Figure 2).

The commonest organism isolated was Staph aureus (35%) followed by Enterobacter cloacae (14.8%), Pseudomonas areogenosa (10.5%) and Klebisella pneumoniae (9.5%).

The commonest antibiotic used was vancomycin, followed by gentamycin and ceftazidime. The actuarial catheter survival is markedly less with multiple episodes of infection compared to single episode (p=0.029) (Figure 1). A single episode of infection is associated with 9.5% chance of catheter losses as opposed to 43.3% in multiple infections (p=0.0001) (Figure 2). Infection occurred in all femoral catheters but in only 57.1% of internal jugular catheters.

Table 3. Comparing the findings in patients with a single episode of infection to those with multiple episodes

	One Episode	>One Episode	P value
CCI	5.30±1.42	3.67±0.58	0.84
Duration on Dialysis (Yrs)	5.38±3.70	3.0±1.00	0.30
Time from Catheter insertion to first infection days)	185±182	191±162	0.90
Age (yrs)	56.4±20.7	61.9±14.7	0.30
Kt\V	1.67±0.22	1.60±0.26	0.30
Serum albumin (g/l)	39.1±8.2	37.8±9.3	0.60
Follow up period (days)	1032±197	1052±202	0.70

CCI, Charlson Comorbidity Index; **STD**, Standard Deviation

Figure 1. Catheter survival in single versus multiple episodes of infection (p=0.029)

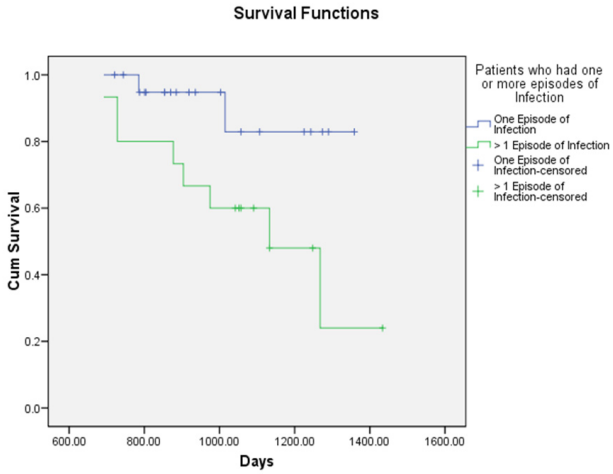
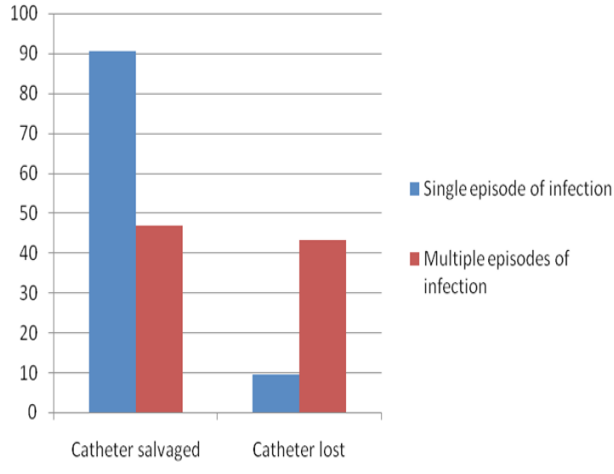


Figure 2. Effect of single versus multiple Episodes of Infection on Catheter Survival (p=0.0001).



Discussion

Several reports have implicated dialysis catheters as the important causes of serious infections in hemodialysis patients. In one study, the rate of bacteremia in patients with catheter ranged from 0.7 to 6.5 episodes per 1000 catheter-days (6). In 1990, Moss et al followed 168 patients dialyzed through catheter over a four year period and reported 0.7 CRI per 1000 catheter-days and a median catheter survival 18.5 months (7). Another study in 1999 by Saad et al in which they followed up 101 patients dialyzing through catheter found that the incidence of CRI was 5.5 episodes per 1000 catheter-days (8). Yet another study mentioned that 30% of patients dialyzed through catheter experience infection over a period of one year (9).

The number of episodes of infection per 1000 catheter days is 1.2 and per 100 dialysis sessions were 0.714. In our study, the incidence was 0.713 episodes per 1000 catheter days and 0.714 episodes of infection per 100-dialysis session which is similar to the incidences reported in these studies.

The bacterial profile in CRI mentioned in many reports (6-9) is very similar to what we found in our study with Staph aureus predominating. In one study the organisms mostly associated with catheter-related infections were coagulase-negative Staphylococci, Staphylococcus aureus, different species of aerobic gram-negative bacilli, and Candida albicans (10). In this paper, they showed that the skin of the exit site is colonized by gram-positive and gram-negative bacteria (10). Contamination of catheter is most often due to improper handling of the catheter hub by the staff and, and by other medical personnel or the patients themselves (6). Microorganisms introduced via the hub migrate through the lumen to the blood circulation. A biofilm can develop in the inner wall of the catheter (11). Once this happens, it is very difficult to eradicate the infection and catheter removal becomes necessary.

In our study, we showed that the most frequent organisms associated with catheter-related infections are Staph aureus (35%) followed by Enterobacter cloacae (14.8%), Pseudomonas areogenosa (10.5%), Klebisella pneumoniae (9.5%), Enterococcus faecalis (9.5%), and MRSA (3.5%). We showed that the bacteria colonized at the exit site of the catheter are the source of the CRI in our patients which is due to the patient's scratching of the site of insertion because of the hot weather.

The therapeutic approach to CRI requires decisions about antibiotic usage and fate of the catheter (12). The therapeutic approach to suspected infection necessitates making a diagnosis confirmed by a culture, followed by administration of empiric antibiotics. Once the microbial sensitivities become available, the right choice of antibiotic should be applied ensuring bacterial eradication (6). The use of empirical antibacterial is based upon local patterns of infection, and depends on the institution's criteria and the sensitivity profile. Vancomycin is often used empirically due to the high prevalence of staphylococcal infections in CRIs (12). Beta-lactam antibiotics are often the first line drug for parenteral treatment of suspected or confirmed methicillin-sensitive S. aureus infections (6). Patients who are allergic to beta-lactams or who are infected by methicillin-resistence S. aureus, vancomycin is the drug of choice (13). In our study the most common used antibiotic is vancomycin (33%) followed by gentamycin (24%). This is consistent with the most isolated organism in our study being S. aureus.

Catheter removal is indicated when the CRI is recurrent, if the patient is very sick or if the response to antibiotics is slow. When a biofilm develops, the use of antibiotics without removal of the catheter is unlikely to eradicate catheter-related bacteremia and therefore is not recommended (14). Other alternatives include catheter exchange over a guide wire with antibiotics, followed by delayed reinsertion (6). However, exchange over a guide wire is preferred in

order to minimize the number of separate procedures required for the patients according to Tanriover et al (14) who reported that the infection-free survival time was comparable in the two approaches. In another report, Mokarzycki et al (15) described rates of patient survival and the cost-effectiveness of management strategies for catheters in clinically mild or asymptomatic bacteremia. They reported that the expected three month survival when comparing the guide wire exchange and immediate catheter removal were similar (93%). Patient survival was lower if antibiotics without catheter exchange or removal were used. Antibiotics plus guide wire exchange were the most cost effective strategy and salvaged up to 88% of catheter sites (15).

In our report, we compared the catheter salvage rates in single versus multiple episodes of infection and found a very significant difference. A single episode of infection is associated with 9.5% chance of catheter losses as opposed to 43.3% in multiple infections (p=0.0001). The actuarial catheter survival is markedly less with multiple episodes of infection compared to single episode (p=0.029). The site of insertion has a significant relationship with CRI (100% of femoral catheter got infected while only 57.1% of internal jugular catheter get infected over the follow up period).

We did not find a significant impact on the incidence of CRIs by age, gender or cause of renal failure. On reviewing the literature we found no data on the effect of these demographic factors on CRIs.

Conclusion

The femoral catheter carries a risk of infection more than with the internal jugular. The risk of infection is increased with the long-standing and increased number of dialysis sessions. The chance to lose the catheter with multiple infections is more. The demographic characteristics are not risk factor for developing infection.

Conflict of interest

None of the authors have any conflict of interest to declare.

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