Hemodialysis Catheter-Related Infections in the Pediatric Age Group. A Single Center Study

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ABSTRACT:

BACKGROUND:

Central venous catheter is one of the modalities of hemodialysis access, which has many complications. The common complication of the use of central venous catheter (CVC) in hemodialysis is infection.

OBJECTIVE:

To study the rate, causative agents and associated risk factors of central venous catheter related infections in pediatric patients on hemodialysis in a single center study for better prevention of this complication.

PATIENTS & METHODS:

A single-center prospective study was conducted in Al- Zohoor hemodialysis center in Central Child Teaching hospital, Baghdad, Iraq during six months from 1st of July to 31th of December 2018. The files of all patients with central venous catheter of pediatric age group below 16 years old were studied. The micro-organisms that were isolated from the swab culture of central venous catheter and the blood cultures were identified and tested for antibiotic susceptibility by using the manual procedure which takes 48h.

RESULTS:

Thirty cases were included in the study. 19 cases were males and 11 cases were females. In males, 8 (42.1%) cases were diagnosed with central venous catheter- related infection (CVC-RI) exit site swab culture. In females, 3 (27.3%) cases were diagnosed with CVC-RI. Regarding age group, ages from 1-5 years were2 cases, only 1(50.0%) case was positive exit site swab, ages from 6-10 years were 15 cases, only 4 (26.7%) cases were positive, ages from 11-15 years were 13 cases, only 6 (46.2%) cases were positive exit site swab. Regarding sites of central venous catheter (CVC), in the Jugular site, the total number of cases was 24 cases, only 7 (29.2%) cases were positive exit site swab. In the femoral site, the total number of cases was 4 cases, only 2 (50%) cases were positive exit site swab, the subclavian were 2 cases, and were positive in 2(100%) cases. The organisms obtained from CVC-RI were (Pseudomonas, 16.7%, staph.aurus, 13.3%, pseudomonas & staph.aurus & mixed organisms, 3.3%). About the gender, blood culture was positive in (5.3%) in males, and in females (9.1%), p =0.685. The blood culture was positive only in the age group 6-10 years (13.3%), p =0.343. C-reactive protein was positive in (25%).

CONCLUSION:

Higher C- reactive protein (CRP) illustrated a significant association with positive blood culture in this study (P < 0.05). Pseudomonas and Staph.aurus were the most common pathogens in this study, and the ages between 6-10 years were more prone to infection than other ages.

KEYWORDS: Hemodiaiysis, Central venous catheter, Infection.

INTRODUCTION:

End stage renal disease (ESRD) represents the state in which a patient's renal dysfunction has progressed to the point at which homeostasis and survival can no longer be maintained with anative kidney function and a maximal medical management. At that time, replacement therapy (dialysis or renal transplantation) becomes necessary [(1)(2)]. Dialysis is a complement to transplantation which may be needed before or between transplants but not an alternative to transplantation.

Dialysis is defined as the process of removing excess water, solutes and toxins from the blood. Types of dialysis are many, one of them is hemodialysis.

Regarding hemodialysis, the ideal hemodialysis access provides maximal blood flows with

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the ability to be accessed repeatedly with the fewest complications. In chronic hemodialysis, there are three types of access available: arteriovenous fistula (AVF), arteriovenous graft (AVG), and CVCs.

Most commonly used vascular access at all ages and genders is the cuffed **CVC**, providing suitable access for long-term dialysis [3].

The preferred site for the placement of CVC is the right internal jugular vein, with tip at the caval atrial junction or in the right atrium [3].

Another preferred sites are the right external jugular vein, the left internal and the external jugular veins, the subclavian veins, the femoral veins and trans lumbar access to the inferior vena cava.[3,4]

Most problems that are facing the CVC is an infection which is the major cause of catheter loss, morbidity and mortality in patients with end-stage renal disease with chronic hemodialysis[5,6]. Infection in vascular catheters may be at the exit site, subcutaneously or in the catheter [7].

The factors increasing the risk of catheter infection include exit site and/or tunnel infection or contamination of the hub, failure of aseptic technique, frequent need to access the catheter during dialysis and long duration of use, use of non-tunneled rather than tunneled lines, immunosuppression, hypoalbuminemia, diabetes, and nasal and cutaneous colonization with Staphylococcus aureus.[8,9,10,11]

Identifying CVC-RI risk factors is important for setting prevention policies. The risk factors include duration of CVC, diabetes mellitus, old age, and low levels of hemoglobin and serum albumins.[12,13,14,15,16,17,18,19]

Bacteremia is defined as a positive blood cultures in a patient with signs of infection. It was confirmed as catheter-related when the bacterial organism that is isolated from the blood is the same in catheter exit site swab, or when the signs of bacteremia have resolved shortly after the removal of the catheter and no other source was found. **Exit site infection** is defined as a purulent discharge from the exit site or when other signs of inflammation have occurred (redness, pain and swelling) together with a positive culture from the tip of the catheter.[20]

AIM OF THE STUDY:

The aim is to study the rate, the causative agents and the risk factors for central venous catheter related infection (CVC-RI) & catheters related blood stream infections (CRBSI) in AL-ZOHOOR hemodialysis department, for better preventing this serious complication.

PATIENTS AND METHODS:

This study was retrospective conducted in Al-Zohoor hemodialysis center in Central Child Teaching hospital for six months from 1st of July to 31st of December 2018. A total number of cases that admitted in this period were 35 patients five cases were excluded from the study, because 2 cases were on AVF, 2 cases died before completing the study and follow up, and 1 case referred for renal transplantation, so the remaining were 30 cases, 19 (63.3%) males and 11 (36.7%) females, were included in this study and were followed up for CVC-RI, A questionnaire was used which included; the patients age, the sex, .the risk factors; site type and duration of the catheter's insertion; and causes of removal of the catheter, and sent for routine investigations like (CBC, CRP, exit site swab culture, nasal swab, & s. albumin).

Inclusion criteria was central venous catheter inserted more than 48 h (temporary & permanent).while the exclusion criteria was an Arterio-venous fistula access used for hemodialysis.

The insertion of CVC approximately all done in Ghazy Al-hariri hospital for surgical specialties by referral mechanism and return to our center. The type of catheter that used was Tunneled Cuffed Catheters (Tcc). In our center, the CVC was observed for signs or symptoms of infection and changing the dressing after each dialysis. Heparin used for all patients, and antibiotics locked may be used in many suspected cases of infection (vancomycin & ceftazidim), and local nasal antibiotic like Fucidic acid ointment. The base line of investigations for all patients were done after 48hrs from the insertion of the catheter include CBC, nasal culture, swab culture from the exit site, then the investigations were done monthly, or when there was suspicion, or symptoms of infection, like fever; chills; redness; tenderness; or pus discharge from the CVC exit site. Patients' data were: age, sex and associated comorbidities like (immunosuppression, diabetes and malignancy), prior to antibiotic use and the date of insertion of CVC, the site of insertion, insertion duration, and causes of removal the CVC, were collected by the direct questionnaire or from files. The blood culture was done when CRBSI was suspected. Both Peripheral and central blood cultures were done in our hospital lab.

CVC-RI: is a positive semi quantitative culture of a segment of an intravascular catheter (which is more than 15 colony-forming units).

CRBSI: it is the presence of one or more positive blood cultures and a positive culture of the catheter tip, whereby the same organism is isolated and not related to another infection site [21] .

CRBSI was confirmed when central and peripheral blood cultures were positive. This was done by taking a sample of blood about 2ml put on a sterile container containing liquid about 18ml according to the ratio used in our lab (1:9), called brain heart infusion broth and immediately cultured in three media (blood, MacConkonkey, and chocolate agar) in a manual procedure for 48h. When the culture was positive, then antibiotic sensitivity test was done.

Nasal swab also had been done routinely for all the patients monthly to know if there was any correlation between nasal pathogen and CVC infection. CBC, and CRP (which considered positive >6 mg/dl), also were done for them.

Statistical analysis

Statistical package was that for social sciences version 24 (SPSS v24) that was used to analyze data. Continuous variables are presented as means with a standard deviation and the discrete variables are presented as numbers and percentages.

Chi-square of independence and fishers exact test was used as appropriate to test the significance of the association between the discrete variables. At 0.05 the level of significance was set.

RESULTS:

This study is dealing with thirty patients; all of them were with CVC and were followed up. The CVC in all cases inserted more than 48hrs, 12 cases were studied immediately after 48hrs of insertion of CVC and included in the study through the six months, except for 2 cases, the CVC inserted in the last 10 days but included in the study because achieved the inclusion criteria, and the remaining 18 cases; the CVC inserted before starting the study. The 2 cases that inserted in ≤10 days, all types of their cultures were negative (nasal swab, exit site swab, and blood culture).

Patients and CVC data:

Characteristics of patients and CVC are summarized in Table 1. Our studied sample was children with predominant male sex [male (19;63.3%), female (11; 36.7%)]. Commonest age group was 6-10 years (15;50%), 11-15 years (13;43.3%)]. Comorbidities, which was only one observed with immunocompromised 3.3%. Duration of CVC [≤10 days (2; 6.7%); >10 days (28; 93.3%)], sites (jugular (24; 80%); subclavian (2; 6.7%); femoral (4; 13.3%)], and uses of CVC [temporary (29; 96.7%) or permanent (1; 3.3%)]. suspicion of infection or proven infection by blood culture.

Table 1: Demographic features of studied samples.

Variable	Category	N=30	100.0%
Gender	Male	19	63.3%
	Female	11	36.7%
Age	1- 5 y	2	6.7%
	6 - 10 y	15	50.0%
	11 - 15 y	13	43.3%
Comorbidity	Observed	1	3.3%
	Not Observed	29	96.7%
CVC duration > 10 days	Yes	28	93.3%
	No	2	6.7%
Site of CVC	Jugular	24	80.0%
	Femoral	4	13.3%
	Subclavian	2	6.7%
CVC use	Temporary	29	96.7%
	Permanent	1	3.3%

Regarding laboratory findings in sampled children in hemodialysis

The result summarized in Table 2. For WBC was elevated >11.000 in 14 (46.7%). CRP was positive in 8 (26.7%). Albumin was <2.5 gm/dl in 19 (63.3%),. Anemic patients about 25 (83.3%), Nasal swab culture was positive in 3 (10%). CVC exit site swab culture was positive in 11 (36.7%). Regarding the blood culture was positive in 2 (6.7%).

Table 2: Laboratory findings of studied group.

Variable	Category	N=30	100.0%
WBC count	≤ 11000	16	53.3%
	> 11000	14	46.7%
Albumin Level	< 2.5 g/dl	19	63.3%
	≥ 2.5 g/dl	11	36.7%
Anemic	Yes	25	83.3%
	No	5	16.7%
C-Reactive Protein	Positive	8	26.7%
	Negative	22	73.3%
Nasal Swab Culture	Positive	3	10.0%
	Negative	27	90.0%
CVC Swab Culture	Positive	11	36.7%
	Negative	19	63.3%
Blood Culture	Positive	2	6.7%
	Negative	28	93.3%

Regarding swab culture of CVC exit site results: This is summarized in Table 3. The total number of positivity of swab culture was 11 cases (36.7%). In the male, it was positive in 8 cases (8 of 19, 42.1%), in female was positive in 3 cases (3 of 11, 27.3%). Regarding age group, ages from 1-5 years were positive in 1 case (1 of 2, 50.0%), ages from 6-10 years were positive in 4 cases (4 of 15, 26.7%), ages from 11-15 years were 6 cases (6 of 13, 46.2%). Regarding sites of CVC, in Jugular; it was positive in 7 cases (7 of 24, 29.2%), femoral was positive in 2 cases (2 of 4, 50%), Subclavian, 2 cases (2 of 2, 100%). Temporary 11 cases (11 of 29, 37.9%).

Table 3: Prevalence of positive cultures for CVC swabs (CVC - RI).

Variables		CVC Swab Culture Positive	
		NO.	%
Gender	Male	8/19	42.1%
	Female	3/11	27.3%
Age	1- 5 y	1/2	50.0%
	6 - 10 y	4/15	26.7%
	11 - 15 y	6/13	46.2%
Site of CVC	Jugular	7/24	29.2%
	Femoral	2/4	50.0%
	Subclavian	2/2	100.0%
CVC use	Temporary	11/29	37.9%
	Permanent	0/1	0.0%

Regarding the organism obtained from CVC-RI: (by swab from exist site of the CV line and blood culture samples from central vein).
The organisms of CVC-RI (summarized in table 4) were [pseudomonas; 5 (16.7%), staph.aurus; 4 (13.3%), p, pseudomonas & staph.aurus; 1 (3.3%), pseudomonas & staph.aurus & mixed organisms; 1 (3.3%)]. Mixed organism means either E.coli, Klebsiella pneumonia, staph.epidermis, or Acinetobacter baumanii. No growth 19 (63.3%).

Table 4: Identified organisms for cultured media.

Outcome of Cultures	N=30	100.0%
Identified organisms	11	36.7%
Pseudomonas	5	16.7%
Staph. Aurus	4	13.3%
Pseudomonas & Staph aurus	1	3.3%
Pseudomonas & Staph aurus & mixed organisms	1	3.3%
No growth	19	63.3%

Regarding rate of infection for sampled children on hemodialysis, the result summarized in Table 5. We noticed that the rate of infection in the same patient during the study was:

Table 5: Rate of infections for sampled children on hemodialysis.

Rate of Infection	N=30	100.0%
None	18	60.0%
Once	7	23.3%
Twice	3	10.0%
Thrice	2	6.7%

Regarding the Prevalence of positivity of blood culture according to studied variables, only comorbidity and CRP has statistically significant correlation with blood culture positive result.

Table 6: Correlation between positive blood culture results & multiple variables of studied group.

		Total Sample	Blood Culture Positive	
Variables	Category	N	N	%
Gender P = 0.685	Male	19	1	5.3%
	Female	11	1	9.1%
Age P=0.343	1- 5 y	2	0	0.0%
	6 - 10 y	15	2	13.3%
	11 - 15 y	13	0	0.0%
Comorbidities P < 0.001	Present	1	1	100.0%
	Not present	29	1	3.4%
CVC Duration > 10 days P = 0.696	Yes	28	2	7.1%
	No	2	0	0.0%
Site of CVC P = 0.765	Jugular	24	2	8.3%
	Femoral	4	0	0.0%
	Subclavian	2	0	0.0%
CVC use P = 0.786	Temporary	29	2	6.9%
	Permanent	1	0	0.0%
Nasal Swab Culture P = 0.051	Positive	3	1	33.3%
	Negative	27	1	3.7%
CVC Swab Culture P = 0.685	Positive	11	1	9.1%
	Negative	19	1	5.3%
C-Reactive Protein P = 0.015	Positive	8	2	25.0%
	Negative	22	0	0.0%
WBC count P = 0.922	≤ 11000	16	1	6.3%
	> 11000	14	1	7.1%
Albumin Level P = 0.265	< 2.5 g	19	2	10.5%
	≥ 2.5 g	11	0	0.0%
Anemic P = 0.513	Yes	25	2	8.0%
	No	5	0	0.0%

DISCUSSION:

The CVC access is one of the most important modality for hemodialysis and has many complications. The CVC-RI is still the most important problem that interfaces the patients with ESRD in the world. So in this study, we focus on many factors that increase the rate of infection and compare it with the world and its relation to systemic infection.

Regarding the gender, the CVC-RI shows the male proportion was higher than female (42.1% versus 32.9%), which goes with Carmo et al reporting the predominance of male[22], while in CRBSI; the female proportion was higher than male (9.1% versus 5.3%), which is against the Carmo et al study but observed in study done by Tapping et al[23], that shows female are more susceptible for systemic infection.

Regarding the age group, CVC-RI shows the smaller age group (<6 years), are more

affected than >10 years, and the ages >10 years are more than age group 6-10 years (50%versus 46.2% versus 26.7%), while in CRBSI shows only the age group 6-10 years are more affected than others (13.3%). This result is founded in Mahdi et al[24], and this is against other studies because the susceptible to infection increases with decreasing age group in children[25], and this may be returned to our sample more common in the age group between 6-10 years.

Regarding the site of CVC, the study shows CVC-RI was more in Subclavian than Femoral and Jugular (100% versus 50% & 29.2%); against Lemaire et al[18] & Fabio et al[26], which may be due to less uses of subclavian and Femoral access in our sample, while in CRBSI shows more in Jugular (8.3%), similar result done by Jean et al[27], while other studies show higher in Femoral site like Lemaire et al[18]

Regarding the nasal swab relation with blood-stream infection, the study shows; the risk of blood-stream infection increases when it is positive than when it is negative (33.3% versus 3.7%), as in Fabio et al[26], but is not considered one of the significant risk factors for CRBSI.

Regarding laboratory findings, although the study shows, higher CRP level, lower hemoglobin level, lower albumin level, and higher level of WBC count contribute to increasing rate of CRBSI, only higher CRP level significant and this is unlike the results in Fabio et al & Jean et al[26][27], that show all this laboratory findings significant in increasing the rate of infection.

In this study, there was a catheter exit site infection in 36.7% of cases, with higher predominance of the gram-negative rods (16.7%), Pseudomonas aeruginosa. This is not consistant with study done by Qureshi et al[28], and against other studies like, Lemaire et al[18], Nabi et al[13], Fabio et al[26], Sanavi et al[29], & Douglas et al[30] which show staph.aureus. This may be due to the small sample.

Regarding the CVC duration, the study showed, when the duration was longer, the rate of infection increased (7.1%) as in Lemaire et al[18], but was not significant in the risk factors of CRBSI, as in Mahdi et al[25].

Regarding comorbidities like immunocompromised, the study shows if the patient had these factors, the incidence of CRBSI is 100%, which was the same in Lemaire et al[18], Mahdi et al[24] & Fabio et al[26].

So this study goes with Mahdi et al[24] that is the children are in low infection rates in CRBSI.

CONCLUSION:

Higher CRP illustrated a significant association with positive blood culture in this study. Pseudomonas and Staph.aurus were the most common pathogens in this study, and the ages between 6-10 years were more prone to infection than other ages.

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