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Prevention of Infections of Temporary Central Venous Hemodialysis Catheters. What Place for Antibiotic Prophylaxis?

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Summary

Introduction: Infection of central venous catheters is a common complication in hemodialysis. Its prevention is based primarily on strict compliance with aseptic conditions and hygiene measures.

The aim of this work is to demonstrate the value of antibiotic prophylaxis in the prevention of infections of temporary hemodialysis catheters.

Material and Methods: We carried out a tri-centric prospective study spread over a period of 12 years. We have divided the patients into 2 groups: the first includes all patients who receive systemic antibiotic prophylaxis after each dialysis session and the second constitutes the control group and includes all patients who do not receive any antibiotic prophylaxis. We have followed the fate of each hemodialysis catheter from its placement until its removal to detect the appearance of any infection that occurs.

Results: Our study demonstrated efficacy of antibiotic prophylaxis in the prevention of infections of catheters used in hemodialysis with a reduction in severity and prolongation of the duration of use of the catheter without noting any cases of bacterial resistance.

Conclusion: Our study demonstrated the benefit of antibiotic prophylaxis in the prevention of hemodialysis CVC infections, however this attitude must have remained limited to well-considered cases, in particular when temporary CVC is the only vascular approach accessible during several weeks.

Keywords: Hemodialysis Catheters, Infection, Prophylaxis.

Introduction

Temporary central venous catheter (CVC) for hemodialysis is frequently used in daily practice, given the relative ease of placement on the one hand and the possibility of immediate use of this vascular approach. In fact, CVCs represent 7 to 39% of all vascular accesses in hemodialysis according to the authors [1, 2].

Several complications can arise after the installation of a CVC; Infection and thrombosis are the most common and are the leading cause of precipitous ablation of hemodialysis catheters [1-5].

In fact, 1 to 70% of hemodialysis catheters are complicated by a local or systemic infection requiring immediate catheter removal and more or less antibiotic therapy [1-7]. Since these infections can be serious and endanger the patient's life in 8 to 20% of cases [4, 6, 7] and that in some cases CVC is the only vascular approach available, prevention of these infections is essential and should be an integral part of the catheter placement and handling procedures.

The majority of hemodialysis catheter infection prevention measures insist on the general aseptic conditions on the one hand and the nature of the lock used after each manipulation on the other hand [8-11].

The value of aseptic measures is indisputable and uncontroversial [8 - 11]. The use of systematic antibiotic prophylaxis is rarely described in the literature due to the fear of leading to the development of bacterial resistance to antibiotics.

The aim of this work is to demonstrate the value of antibiotic prophylaxis in the prevention of hemodialysis CVC infections.

Material and Methods

We conducted a tri-centric prospective study spread over a period of 12 years from November 2013 to December 2024 including 103 hemodialysis patients treated in three hemodialysis centers: provincial hemodialysis center - Midelt, provincial hemodialysis center August 20 - Azrou and provincial hemodialysis center - Elhajeb.

The patients are distributed into two groups:

-The first group includes all patients who receive systemic antibiotic prophylaxis after each dialysis session from the placement of the venous catheter until its removal.

-The second constitutes the control group and includes all the patients who do not receive any antibiotic prophylaxis.

Placement of CVCs was performed under aseptic conditions and similar hygienic measures in both groups. We insisted on the following measures: washing the hands of the operator and the helper, wearing a gown and sterile gloves and also: bib and callot and use of sterile and single-use equipment.

Principles of Antibiotic Prophylaxis

Aim: obtaining effective antibiotic prophylaxis against the germs most often responsible for infections of hemodialysis catheters, namely gram-positive cocci (staphylococcus epidermidis and staphylococcus aureus) [4, 6, 8, 12] without causing the development of bacterial resistance. We have strictly observed the following principles:

1. Choice of antibiotics efficients against Meti-S staphylococcus and inactive against Meti-R staphylococcus: minor anti-staphylococcal drugs.

2. Synergistic association of three antibiotics.

3. Route of administration: strict intravenous route.

We excluded from the study patients who received antibiotic therapy that has an anti-staphylococcal action, above all: patients on anti-bacillary drugs and patients with rheumatic fever on antibiotic prophylaxis.

So we opted for the following association: **Ampicillin 2g + Flucloxacillin 1g + Gentamicyn 80mg**, administered after each hemodialysis session, in general: twice a week.

The choice of this combination is justified by the fact that these 3 antibiotics are not major antistaphylococcal agents, active against MSSA but not on MRSA, which reduces the risk of causing the development of bacterial resistance.

We have followed the fate of each hemodialysis catheter from its placement until its removal to detect the appearance of any infection that occurs.

Catheter infection is defined as follows:

-**Local infection**: inflammation at the point of emergence, pus and bad odor.

-**Systemic infection**: presence of signs of local infection and a general clinical and biological infectious syndrome.

If infection occurs, a final dose of the same combination of antibiotics is given and the catheter removed immediately with culture from the catheter tip whenever the culture test is available. General antibiotic therapy is only prescribed after catheter removal if the infectious syndrome persists beyond 24 hours.

We studied demographic, clinical and laboratory data for each patient, the fate and total duration of catheter use and the "time" to onset of infection.

The statistical study is carried out using Excel Word 2007 software. The quantitative variables are expressed as means and standard deviation. The qualitative variables are expressed in number and percentage. The statistical analysis is performed by univariate multivariate logistic regression.

Results

The average age of our patients is 52.6 ± 15.5 years with a predominance of men: sex ratio =66/37 =1.78. Among these patients: 31.06% are diabetics, 40.7% are hypertensive, four patients have lupus and three patients are followed for microscopic angiitis.

All patients undergo hemodialysis at the rate of two sessions per week. They are taken care of by the same medical and paramedical team in each center: 69 patients at the provincial hemodialysis center -20 August - Azrou, 14 patients at the provincial hemodialysis center - El hajeb and 20 patients at the provincial hemodialysis center - Midelt.

They benefited from the placement of a total number of 146 CVC, including 42 (28.7%) at the jugular vein and 104 (71.2%) at the right or left femoral vein.

The patients are divided into two groups: (table: I)

Table 1: characteristics of the two groups

	First group56 patients (97 Catheters)	Second group47 patients (49 Catheters)
Average age (years)	49.8 ±16	56±9
Sex ratio (men / women)	1.43	1.64
Diabetes	15 (26.7%)	17(36.2%)
HTA	20 (35.7%)	21 (44.6%)
Lupus	2 (3.5%)	2 (4.2%)
Angiitis	2 (3.5%)	1 (2.1%)
Jugular catheter	29 (29.9%)	12 (26 %)
Femoral catheter	68 (70.1%)	37(74%)
Catheter infection- Jugular catheter - Femoral catheter	**14 (14.4%)**014 (100%)	**27(58.6%)**05 (18.5%)22 (81.5%)
Time to infection (months)	**2.7 ± 1.2**	**2.4±0.97**
Local infection	9 (64.3%)	5 (18.5%)
Systemic infection	5 (35.7%)	22 (81.5%)
Systemic infection requiring antibiotic therapy	0	3(13.6%)
Germ responsible for cases of systemic infection: - Staphylococcus epidermidis methi-S - Staphylococcus epidermidis methi-R - Staphylococcus aureus methi-S -Staphylococcus aureus methi-R resistant to flucloxacillin or gentamycinNegative culture	4 (80%)001 (20%)0	11 (50%)005 (22.7%)6(7.3%)

First group: antibiotic prophylaxis

Includes 56patients, their mean age is 49.8 ± 16 years with a sex ratio = 1.43. These patients benefited from the placement of 97 hemodialysis catheters, including 29 (29.9%) in the jugular vein and 68 (70.1%) in the femoral vein. The average duration of catheter use is 3.3 ± 0.7 months.

Catheter infection occurred in 14 cases, or 14.4% of all catheters in this group. It occurred after an average duration of use of 2.7 ± 1.2 months. It is a local infection in 9 cases (64.2%) and a systemic infection in 5 cases (35.8%). It required catheter removal in all cases with spontaneous disappearance of infectious signs without recourse to systemic antibiotic therapy.

Culture of the catheter tip has shown it to be a staphylococcus in all cases of systemic infection. It is a staphylococcus epidermidis methi-S sensitive to common antibiotics in 4 cases and a staphylococcus aureus methi-R resistant to methicillin and oxacillin but which remains sensitive to flucloxacillin and gentamycin in one case.

We did not observe any adverse effects from this antibiotic prophylaxis except for a single case of hearing loss, probably secondary to gentamicin.

Second group: control

Includes 47 patients, their mean age is 56± 9 years with a sex ratio = 2.35. These patients benefited from the placement of 49 he-

modialysis catheters, including 12 (24.5%) in the jugular vein and 37 (75.5%) in the femoral vein. The average duration of catheter use is 2.5 ± 1.9 months.

Catheter infection occurred in 27 cases, or 55.1% of all catheters in this group. It occurred after an average duration of use of 2.4 ± 0.97 months. It is a local infection in 5 cases (18.5%) and a systemic infection in 22 cases (81.5%). It required removal of the catheter in all cases with spontaneous disappearance of infectious signs in 19 cases and recourse togeneral antibiotic therapy in 3 cases.

Culture of the catheter tip has shown it to be a staphylococcus in all cases of systemic infection. It is a staphylococcus epdermidis methi-S sensitive to common antibiotics in 11 cases and a staphylococcus aureus methi-R resistant to methicillin and oxacillin but which remains sensitive to flucloxacillin and gentamycin in 5 cases. Culture is negative in 6 cases.

Statistical analysis shows that hemodialysis catheter infections are four times less frequent in the group: antibiotic prophylaxis. This difference is statistically significant (p <0.001). (Tables II, III).

Table 2: Statistical analysis by univariate logistic regression

	Catheter infectionN = 41 (28%)34 patients	No catheter infectionN=105(72%)103 patients	Raw OR	CI	*p*
Average age (years)	55.3 ± 10.7	51.4 ± 17.4	1.49	[1.28 ; 8.82]	0.170
Sex ratio	3.85	1.3	1.43	[0.721; 5.88]	0.023
Diabetes	17(50%)	16(15.5%)	3.68	[1.44; 9.08]	**0.014**
Antibiotic prophylaxis	**14 (16.9%)**	**83 (79%)**	**0.110**	**[0.0499;0.301]**	**<0.001**
Catheter duration (months)	2.49 ± 1.50	3.31 ± 2.85	0.822	[0.103; 1.54]	**0.025**

Table 3: Statistical analysis by multivariate logistic regression

	Adjusted OR	*CI*	*p*
Diabetes	3. 38	[1.26; 9.89]	**0.019**
Antibiotic prophylaxis	**0.130**	**[0.0471;0.334]**	**< 0.001**

We also observe that:

-The infection occurs later in the first group compared to the second group (**2.7 ± 1.2** versus **2.4 ± 0.97** months) but this difference is not significant.

- Systemic infection is less frequent in the first group compared to the second (35.7% versus 81.5%)

On the other hand, we also noticed that diabetes is a significant risk factor associated with the occurrence of a catheter infection (p = 0.014). In fact, it increases the risk of developing a catheter infection by 3.38.

Finally, the study showed that infections are more frequent when femoral catheters are inserted. However, the small number of jugular catheters does not allow adequate statistical analysis.

Discussion

Our study demonstrated efficacy of antibiotic prophylaxis in the prevention of infections of CVCs used in hemodialysis with a reduction in severity and prolongation of the duration of catheter use without noting any cases of bacterial resistance. This type of systemic antibiotic prophylaxis has not been described in the literature for separate cases only and not in complete series [12].

This effectiveness of the antibiotic prophylaxis must in no case lead to neglect of the aseptic conditions and hygienic measures during the installation of a central venous catheter and at each manipulation, which constitute the cornerstone of any strategy. Infection prevention [8-11].

Therefore, antibiotic prophylaxis should be reserved for special cases; mainly when temporary CVC is the only vascular access available for several weeks and the unavailability of antibiotic-based locks.

The particularly high frequency of catheter infections in diabetic patients and patients with femoral catheters may guide our decision on antibiotic prophylaxis. It would be advisable to prescribe antibiotic prophylaxis when the CVC will be used for several weeks (the only vascular approach available) and placed in the femoral vein in a diabetic patient (immunocompromised). Some authors have notably reported diabetes and the femoral CVC site as risk factors associated with the onset of catheter infection [13-15], but this association is not always significant [12].

Our study showed the benefit of antibiotic prophylaxis in the prevention of CVC infections, but whenever it is possible to insert a tunnel catheter or wait for the maturation of an arteriovenous fistula, it is better not to prescribe systemic antibiotic prophylaxis and simply follow aseptic measures, because the majority of studies show that the risk of infections of tunneled catheters and arteriovenous fistulas is clearly low compared to the risk of infection of temporary CVC [8, 9, 12-15].

Our study also showed that, thanks to the respect of the general principles of prescription of antibiotics, we were able to prevent the development of bacterial resistance. These general principles are well known:

-Avoid prescribing a single antibiotic and opt instead for a combination of antibiotics: double or better triple combination.

-Avoid prescribing so-called “major” antibiotics such as major anti-staphylococcal drugs and limit themselves to minor anti-staphylococcal drugs.

-Choose antibiotics that are characterized by a synergy of action.

-Administer antibiotics intravenously as this will help to obtain the best serum concentrations.

It should be noted that antibiotic prophylaxis, although it has an interest in the prevention of hemodialysis CVC infections, it increases the cost of patient care. In fact, the cost of the combination of the three antibiotics chosen in our study is estimated at 32.48 Dh according to the purchase prices of the Ministry of Health.

Finally, given the scarcity of data in the literature relating to systemic antibiotic prophylaxis in CVC infections, other larger studies will be necessary to better assess its value.

Conclusion

Our study demonstrated the benefit of antibiotic prophylaxis in the prevention of hemodialysis CVC infections, however this at-

titude must have remained limited to well-considered cases, in particular when temporary CVC is the only vascular approach accessible during several weeks.

Let us insist once again on the strict observance of aseptic conditions and hygienic measures and keep antibiotic prophylaxis in special cases.

Conflict of Interest

None

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