Evaluation of tow types of dressings used on central venous catheters for hemodialysis*

Avaliação do tipo de curativo utilizado em cateter venoso central para hemodiálise

Evaluación del tipo de curativo utilizado en cateter venoso central para hemodiálisis

Luciene de Fátima Neves Monteiro de Barros[1], Valquíria Grego Arênas[2], Ana Rita de Cássia Bettencourt[3], Solange Diccini[3], Dayana Souza Fram[4], Angélica Gonçalves Silva Belasco[5], Dulce Aparecida Barbosa[5]

ABSTRACT

Objectives: To evaluate the efficacy of two types of dressings used on central venous catheter (CVC) in patients undergoing hemodialysis and to determine the rate of local and systemic bacterial infection when using gauze and micropore dressings or transparent film dressings. **Methods:** This study was a controlled randomized clinical trial with 66 subjects who were equally assigned to two groups (33 subjects per group). Group 1 used gauze and micropore dressings and group 2 used transparent film dressings. Measures consisted of a socio demographic questionnaire, clinical data, and catheter tip and blood culture tests. Subjects remained in the study until removal of the catheter. **Results**: There were no statistically significant differences regarding the types of dressings. Positioning of CVCs at 90 degrees in relation to the skin had higher rate of infections by S. Aureus. **Conclusion:** Although the use of transparent film dressings did not reduce infection, qualitative data analysis suggested that this type of dressing was preferred by the patients and by the health care providers from a university hospital.
Keywords: Central venous catheter; Bandage; Infection; Hemodialysis; *S. aureus*

RESUMO

Objetivos: Avaliar a efetividade de dois tipos de curativos utilizados em cateter venoso central (CVC) em pacientes submetidos à hemodiálise; identificar a taxa de infecção no local de saída e de bacteremia comparando o curativo com gaze e micropore em relação ao filme transparente. **Métodos**: Foi realizado um ensaio clínico randomizado controlado abrangendo 66 pacientes, sendo 33 nos grupos 1 e 2, respectivamente. No Grupo 1 o curativo utilizado foi gaze e micropore e no Grupo 2 filme transparente. Foram coletados os dados sócio demográficos, clínicos e os relacionados às infecções. Os 66 pacientes permaneceram no estudo até a indicação de retirada do cateter que ocorreu nos episódios de infecção quando foram realizadas culturas de óstio e da ponta do CVC e hemocultura quando indicado. **Resultados**: Não houve diferença estatística significante quanto ao tipo de curativo e as variáveis estudadas. Os CVC posicionados a 90º em relação a pele apresentaram maior taxa de infecção por *S. aureus*. **Conclusão:** O uso do filme transparente não proporcionou redução de infecção, porém a análise qualitativa deste tipo de curativo teve melhor aceitação pelos pacientes e profissionais da Unidade de Diálise de um Hospital Universitário.
Descritores: Cateter venoso central; Curativo; Infecção; Hemodiálise; *S.aureus*

RESUMEN

Objetivos: Evaluar la efectividad de dos tipos de curativos utilizados en cateter venoso central (CVC) en pacientes submetidos al hemodiálisis; identificar el índice de infección en el local de salida y de bacteremia comparando el curativo con gaza y micropore el con al filme transparente. **Métodos**: Fue realizado un ensayo clínico randomizado controlado. En el Grupo 1 el curativo utilizado fue gaza y micropore y en el Grupo 2 filme transparente. Fueron colectados los datos sócio demográficos, clínicos y los relacionados a las infecciones. Los 66 pacientes permanecieron en el estudio hasta la indicación de retirada del cateter que ocurrió en los episodios de infección cuando fueron realizadas culturas de óstio y de la extremidad del CVC y hemocultura cuando indicado. **Resultados**: Fueron incluídos 33 pacientes en cada grupo. No hubo diferencia estadística significante cuanto al tipo de curativo y las variables estudiadas. Los CVC posicionados a 90º en relación a la piel presentaron mayor índice de infección por *S. aureus*. **Conclusión:** El uso del filme transparente no proporcionó reducción de infección, sin embargo el análisis cualitativo de este tipo de curativo tuvo mejor aceptación por los pacientes y profesionales.
Descriptores: Cateter venoso central; Curativo; Infección; Hemodiálisis; *S.aureus*

* *Study developed in Dialysis Unit at Hospital São Paulo - São Paulo (SP), Brasil.*

[1] *Master in Health Science, at Universidade Federal de São Paulo - UNIFESP - São Paulo (SP) - Brazil.*

[2] *Master in Health Science, at Faculdade de Medicina da Universidade de São Paulo - USP - São Paulo (SP) - Brazil.*

[3] *PhD in Health Science. Associate Professor at the Nursing Department, Universidade Federal de São Paulo - UNIFESP - São Paulo (SP) - Brazil.*

[4] *Master student at the Nursing Post graduation Program, Universidade Federal de São Paulo - UNIFESP - São Paulo (SP) - Brazil.*

[5] *Post PhD in Nephrology. Associate Professor at the Nursing Department, Universidade Federal de São Paulo - UNIFESP - São Paulo (SP) – Brazil.*

Corresponding Author: **Dulce Aparecida Barbosa**
R. Napoleão de Barros, 754 - Vila Clementino - São Paulo - SP
CEP. 04024-002 E-mail: dulce.barbosa@unifesp.br

INTRODUCTION

The central venous catheter-associated bloodstream infection is the major cause of morbidity and mortality in renal disease patients undergoing hemodialysis. With the increase in elderly, diabetic and debilitated patients receiving hemodialysis, central venous catheter use as the first choice of venous access has become more common, with the inherent and inevitable risk of mortality associated with this procedure[1-3].

The infectious process can be restrict to the catheter implantation site or evolve to systemic infections. The most frequent microbiological agents in this infection are *Staphylococcus aureus* and coagulase-negative *staphylococcus*. These infections represent the second major cause of death among patients undergoing hemodialysis[4-5].

Catheter dressing used in hemodialysis follow the same guidelines of central venous catheter dressing. Gauze or sterile transparent films are recommended to dress the site of catheter insertion. One of the sterile transparent film dressing used is Tegaderm™ that consists of a thin polyurethane membrane coated with a layer of hypoallergenic latex-free adhesive. The dressing, which is permeable to both water vapor and oxygen, is breathable and impermeable to micro-organisms providing an effective barrier to external contamination. The transparency allows continuous visualization of the insertion site without removing the dressing. It requires less frequent changing than traditional gauze dressings, minimizing scarring and speeding up the nursing care period and hospital costs[5-7].

From this considerations and because of the reduced number of published articles about this subject, the present study aimed to access the effectiveness of two types of dressing used in central venous catheter (CVC) in patients receiving hemodialysis; identifying the infection rate in the catheter exit site and bacteremia episodes comparing gauze and micropore dressing with sterile transparent film.

METHODS

This is a randomized controlled clinical trial carried out from September 2007 to June 2008 in the Dialysis Unit at Hospital São Paulo and it was approved by the Research Ethics Committee of Universidade Federal de São Paulo under # 1301/06 and after they written consent was obtained. Patients with end-stage renal disease starting hemodialysis treatment using central venous catheter were included. Patients with acute renal failure undergoing femoral venous catheter were excluded.

A random list of dressing was used to divide 66 patients in two groups (33 in group 1 and 33 in group 2). The sequences of dressings were kept in a locked envelope. If the patient was eligible for the study, the envelope containing dressing sequences was open and the following indicated intervention was performed:

- Control Group (Group 1 or G1): traditional dressing with sterile gauze and hypoallergenic micropore 50 mm x 10 m, from 3Mâ permeable to both water vapor and oxygen, after the catheter insertion site disinfection with 10% alcoholic povidone-iodine solution.

- Study Group (Group 2 or G2): catheter insertion site disinfection with 10% alcoholic povidone-iodine solution, using a sterile transparent film 8.5cm x 10.5cm (Tegaderm IV 3Mâ São Paulo).

The Control group dressings were replaced at each dialysis section and those from the study group were changed every seven days or as needed. Clinical assessment for signs of infection at catheter insertion site was observed in each hemodialysis section in both groups.

Mahurkar Dual Lumen catheter (Quinton Instruments Co. Bothell. WA) was inserted by staff nephrologists in internal jugular vein[8]. The catheters were sutured to the skin and the position was radiographically determined. After catheter insertion, accredited nurses from the Dialysis Unit dressed the site with rigorous aseptic technique.

Patients' clinical and socio-demographic characteristics and specific complications related to the catheter were recorded.

Patients were included only once in the study and they were followed-up until the occurrence of some kind of complication such as: humidity, bleeding, catheter entry point infection, death, change in address, switch type of dialysis, catheter change or allergy that prevented patients from continuing with the group. All patients were monitored for catheter-related infections, which was the main variable assessed in the present study.

Catheter- related bacteremia due to *S.aureus* was considered when the following criteria were met:

a) one or more positive blood cultures (from peripheral veins) for *S.aureus* during catheter stay; b) fever >37.8°C with shivering; c) data from clinical examination, chest X-Ray, laboratory assessment and microbial analysis that did not suggest other source of *S.aureus* bacteremia; d) positive culture for *S.aureus* in catheter tip. Diagnosis of catheter-related *S.aureus* bacteremia was considered likely when criteria *b, c* and *d* were met and there were no other focus of infection that could have caused fever.

Catheter exit site infection was defined if there were: phlogistic signs of pericatheter infection and *S.aureus* colonization in the material collected from the catheter exit site.

Laboratory methodology used to analyze the detection, culture and identification of the microorganisms samples together with antibiotic

susceptibility was performed according to the National Committee for Clinical Laboratory Standards guidelines[9].

Besides routine laboratory tests (creatinine, urea, hematocrit, calcium, inorganic phosphorous and others) indicated for patients with renal chronic disease under dialysis, culture samples were obtained in the following sites and situations: from the skin surrounding the catheter, from the skin and tip of the catheter after its removal, and also blood culture obtained from a peripheral vein whenever fever or episodes of bacteremia were suspected.

Blood collection was performed by the nursing staff from HSP Nephrology Unit, using a technique standardized by the Committee for Hospital Infection Control[10].

Cultures of the skin surrounding the catheter were obtained with alginate swabs eluted in Ringer's lactate and placed on tubes containing 2ml of Triptic Soy Broth (TSB, OXOID). After catheter removal the terminal segment of a catheter tip is rolled across the surface of a Rodac plate (6 cm diameter), previously prepared with Blood Agar (Columbia Agar with 5% Sheep Blood) and evaluated using semi-quantitative culture technique[11].

Catheters that presented over 15 colony-forming units per plate were considered as significantly infected and microorganism culture and identification through classical laboratorial essays were performed.

The blood cultures were analyzed through an automated method for identifying microbiological agents (BACTEC system) in the central laboratory from HSP. The microbiologists processed the samples without knowing how patients were allocated in the study. After incubation under 35 ºC for 18 to 24 hours, the samples (of the skin surrounding the catheter) inserted into TSB medium were cultivated on blood agar plate and Manitol Salt Agar (OXOID). After 24 hours, the plates containing skin specimens and catheter tip were examined to evaluate bacteria colonies growth and processed to be identified.

Hemolytic colonies gram-positive cocci, catalase producers, "Staphy-latex" positive (coagulase and A protein positive, DIFCO) were identified as *S. aureus*. If there were no colonies on the plate, the cultures were replated and after 72 hours of incubation the result was considered negative if new colonies were not formed. In positives colonies identification and antimicrobial sensitivity tests were performed. Oxacillin susceptibility was determined by the disk diffusion test containing 1 µg of oxacillin[9,12]. Identification and performance of sensitivity tests were carried out using Walk/Away (Baxter) automated system was utilized

RESULTS

One hundred and fifty two patients were analyzed and 66 met the inclusion criteria. There were no losses to follow up.

Table 1- Clinical and sociodemographic characteristics of two study groups from – HSP Dialysis Unit –09/ 2007 to 06/2008

Characteristics	Study (n=33)	Control (n=33)	P Value
Gender			0.804
Female	14 (42.4%)	15 (45.5%)	
Male	19 (57.6%)	18 (54.5%)	
Age			
Years , medium + SD	55.1 ± 12.7	51.3 ± 14.8	
Color			0.622
White	18 (54.5%)	16 (48.5%)	
Others	14 (42.4%)	18 (54.5%)	
Education			0.952
Illiterate	2 (6.1%)	3 (9.1%)	
Primary school	14 (42.4%)	15 (45.5%)	
High School	7 (21.2%)	7 (21.2%)	
Elementary school	6 (18.2%)	6 (18.2%)	
University	4 (912.1%)	2 (6.1%)	
Underlying Disease			0.096
Glomerulonephritis	2 (6.1%)	2 (6.1%)	
Hypertension	16 (48.8%)	28 (84.8%)	
Diabetes mellitus	7 (21.2%)	2 (6.1%)	
Other diseases	8 (24.2%)	1 (3.0%)	
Laboratory examinations mean + SD			
Creatinine (m g/dL)	6.7 ± 1.9	7,5 ± 2.9	0.167
Urea (mg/dL)	152.1 ± 38.4	152,8 ± 49.7	0.949
Hematocrit (mg/dL)	27.3 ± 4.0	27,3 ± 5.4	0.994
Hemoglobin (mg/dL)	9.3 ± 1.4	8,9 ± 1.8	0.342

Table 2 – Aspects related to the catheter insertion and infection episodes in Dialysis Unit of HSP patients – 09/ 2007 to 06/2008

Characteristics	Study (n=33)	Control (n=33)	P value
Puncture site			0.733
Right jugular vein	27 (81.8%)	29 (87.9%)	
Left jugular vein	6 (18.2%)	4 (12.1%)	
Immediate complications			0.750
None	30 (90.9%)	28 (84.8%)	
Progression difficulty	1 (3.0%)	2 (6.1%)	
Multiple puncture	2 (6.1%)	3 (9.1%)	
Days of stay			0.359
Medium + SD	42.5 ± 20.5	44.0 ± 17.7	
Session number			
Medium + SD	19,5 ± 9.2	19.0 ± 7.7	
Infection			
Yes	4 (12.1%)	3 (3.1%)	
No	29 (87.9%)	30 (90.9%)	
Catheter tip microorganism			>0.999
S. aureus MRSA	1 (3.0%)	-	
S. aureus MSSA	2 (6.1%)	1 (3.0%)	
S. coagulase negative	1 (3.0%)	2 (6.1%)	
Microorg. Blood culture			0.486
S. aureus MRSA	1 (3.0%)	-	
S. aureus MSSA	2 (6.1%)	1 (3.0%)	
S. coagulase	-	2 (6.1%)	
Negative	-	1 (3.0%)	
Implant angle and infection			
0º	1 (25.0%)	3 (75.0%)	>0.999
90º	3 (75.0%)	-	0.014
Cause of withdraw			0.692
Inadequate flow	2 (6.1%)	4 (12.1%)	
Inadvertent withdrawal	-1 (3.0%)	2 (6.1%)	

Table 1 No significant statistical differences on social demographic data (gender, color, education) underlying diseases (glomerulonephritis, hypertension, diabetes mellitus and others) and laboratory tests (creatinine, urea, hematocrit, hemoglobin) were found between the two groups

Table 2 shows variables related to catheter insertion such as: catheter insertion site (right or left jugular vein), immediate complications (difficulty of progression and multiple puncture), duration of stay and number of hemodialysis sessions. There was no statistical difference between the two groups. Differences in the frequency of infections and the type of isolated microorganisms between both groups were not found either. Patients using transparent film dressing and with catheter insertion in a 90 º angle, presented more infections than the control group ($p<0.01$). As for the causes of CVC withdraw for inadequate flow or extrusion, the same distribution was found, with no statistical significance (p=0,692).

DISCUSSION

The use of venous catheters represents a potential source of infections which are considered as a problem with high clinical importance. A recent study showed that in the population starting dialysis (n=106), the most common infection site was the blood stream related with the use of central venous catheter, which corresponds to 50% of the infections compared to other sites[4]. Bacteremia is the most severe catheter-related complication and it may evolve to endocarditis, significantly increasing morbidity and mortality of patients undergoing this therapy. Gram-positive cocci, predominantly *S. epidermidis* and *S. aureus,* are the causes for bacteremia in two thirds of the cases[1, 13-15].

In the present study, the two groups (15.2%) presented infection, among them, 58.3% had a positive culture in the catheter tip and in blood, and 57% of the positive cultures were in the study group with the global infection rate at 10.6%,

A study carried out in Brazil encompassed 51 patients with CVC in the Intensive Care Unit, totaling 57 periods of catheterization. The incidence of local insertion site infection was 21.1% and of bacteremia it was 8.7%. Skin colonization was 32.7% and colonization of connectors was 29.1%. Predominant agent was *S.* coagulase negative. We have concluded that catheter insertion in the internal jugular vein and colonization of connectors increase the risk for catheter-related bacteremia[5].

Authors from a study performed in a University Hospital from the city of São Paulo (Brazil) with 94 patients with CVC for hemodialysis showed that the prevalence of endocarditis in this population was 28% and lethality was 55%[15].

In the present study there were no differences in the positivity of cultures in catheter tip and blood culture in both groups. Most frequently isolated pathogen in the cultures of catheter tip and blood cultures was *S. aureus*, followed by *S.* coagulase negative, with no statistical difference regarding the number of infections in both groups.

Venous catheters are responsible for about 250,000 blood stream infections in hospitalized patients in the United States every year according to the authors from a study with Intensive Care Unit patients carried out from 1998 to 2000. Among 1,263 catheters studied, 26.3% were removed due to colonization; among these catheters 2.7% caused bacteremia (5.9 per 1000 CVC days). Most frequently isolated etiologic agents were *S.* coagulase-negative (n=27), *Enterococcus* (n = 4), and Gram-negative enteric bacilli (n=3). Most insertion sites did not present inflammation signs before removal[16].

In the present study, of the 66 patients studied, 56% were males and 87% of the CVCs were placed on the right internal jugular vein. Mean duration of catheter stay was similar in both groups.

Researchers assessed 107 patients receiving dialysis using central venous catheter, inserted in the following regions: 66 in the right jugular and 41 in the right femoral vein for 2101 days. The main late complication was catheter-related bacteremia. There were 16 episodes of bacteremia, 10 in patients with catheters in the jugular vein and 6 in the femoral vein. *S. aureus* was the most prevalent pathogen. Mean catheter duration before bacteremia episodes was 19.9 for those introduced in the jugular vein and 18.2 for those introduced in the femoral vein. Prolonged use and duration of catheter stay significantly increased the risk for catheter-related bacteremia[17].

The present study showed that in the studied population, the type of dressing did not decrease the incidence of skin infection or bacteremia. However, in the group with transparent film dressing, 50% of the patients who presented infection had catheter implanted at a 90º angle (p=0.01), and greater frequency of infection when compared to the control group with catheter implanted at the same angle. We have not found studies in the literature assessing the variable implant angle of central venous catheter correlating it with infections. Therefore, implant angle is not significantly important in the prevention of infections when transparent film dressing.

Results are in agreement with a study carried out in Canada assessing for six months 58 patients with central venous catheter undergoing dialysis (29 patients in the transparent film dressing and 29 patients in the group with traditional dressing with sterile gauze and hypoallergenic micropore). Authors did not find

statistically significant difference in the incidence of pericatheter skin infection and bacteremia between the groups and there was no impact in patients' quality of life. However, the cost was smaller in the dressings using transparent film[18].

A systematic review comparing gauze and micropore or sterile transparent film dressings listed the incidence of infection, safety of catheter, tolerance to healing material in hospitalized adults and children. There were no evidences in differences between the incidences of infections between the two types of dressings. Authors conclude that there is uncertainty regarding the infection risk in transparent film dressings, suggesting studies with a greater number of patients in the sample to identify the most adequate dressing for central venous catheter[19].

A randomized controlled clinical trial on the application of topical mupirocin 2% in the site where catheter was inserted, in 136 patients, as a prophylaxis for *S. aureus* in patients with CVC for hemodialysis, the authors concluded that there was significant reduction in *S. aureus* skin infection and in bacteremia in patients using mupirocin prophylaxis compared to the control group (gauze and micropore dressing)[13].

Prevention of venous catheter-related infections involves measures related with their implementation, handling, and maintenance. Several authors suggest the following preventive measures: use of tunneled catheters with a cuff, correct handling in catheter insertion and maintenance, periodical training of the nursing staff, use of standard precautions, use of chlorhexidine as antiseptic, use of antibiotic ointments in the insertion site, use of antibiotic solutions in the catheter closure, use of citrate; application of mupirocin nasal, careful assessment of the dressing and exit site of the catheter are measures that can significantly decrease the incidence of infection[6,13,20-22].

The use of transparent film dressing was satisfactorily accepted by part of the patients, especially because of the possibility of a better hygiene without running the risk of wetting the insertion site. As for informal qualitative analysis of patients' and professionals' satisfaction, most preferred transparent film dressing. The number of transparent film dressings (every seven days) was smaller than the number of gauze and micropore dressings (every dialysis session), because of that we suppose that the cost related with the service time of professionals was smaller when transparent film dressing was used. Data should be further studied; another important aspect is the use of transparent film was not feasible for patients with abundant sweating. It is important to stress that regarding the way both dressings were placed, the nursing team considered both types of dressings similar.

CONCLUSION

The use of sterile transparent film is recommended to dress the site of catheter insertion among patients undergoing hemodialysis[4-5].

The use of transparent film in dressings in central venous catheter for hemodialysis did not protect against infections when compared to normal dressings. The group of patients with transparent film dressing and insertion at a 90º angle presented greater episodes of infection compared to the control group. There was no statistically significant difference between the two groups regarding the number of infections to those pathogens isolated in catheter tip cultures and in blood culture. The most frequently isolated pathogen in the cultures of the sites studied was *S. aureus.*

REFERENCES

1. Saxena AK, Panhotra BR. Prevention of catheter-related bloodstream infections: an appraisal of developments in designing an infection-resistant 'dream dialysis-catheter'. Nephrology (Carlton). 2005;10(3):240-8.
2. Pastan S, Sourcie JM, McClellan WM. Vascular access and increased risk of death among hemodialysis patients. Kidney Int. 2002;62(2):620-6. Comment in: Kidney Int. 2003;63(2):767-8.
3. Lentino JR, Baddour LM, Wray M, Wong ES, Yu VL. *Staphylococcus aureus* and other bacteremias in hemodialysis patients: antibiotic therapy and surgical removal of access site. Infection. 2000;28(6):355-60.
4. Barbosa DA, Gunji CK, Bittencourt ARC, Belasco AGS, Diccini S, Vattimo F, Vianna LAC. Co-morbidade e mortalidade de pacientes em início de diálise. Acta Paul Enferm. 2006;19(3):304-9.
5. Diener JRC, Coutinho MSSA, Zoccoli CM. Infecções relacionadas ao cateter venoso central em terapia intensiva. Rev Assoc Med Bras (1992). 1996;42(4):205-14.
6. Pearson ML. Guideline for prevention of intravascular device-related infections: Part I. Intravascular device-related infections: an overview. The Hospital Infection Control Practices Advisory Committee. Am J Infect Control. 1996;24(4):262-77. Review.
7. Gómez Luque A, Huertas Simonet N, Viciana Ramos MI, Moreno Palacios M, Hernández Pardo PE. Profilaxis de las complicaciones infecciosas de los catéteres venosos centrales. Rev Esp Anestesiol Reanim. 2002;49(1):17-27.
8. Seldinger SI. Catheter replacement of the needle in percutaneous arteriography; a new technique. Acta Radiol. 1953;39(5):368-76.
9. National Committee for Clinical Laboratory Standards (NCCLS): Performance Standards for Antimicrobial Disk Susceptibility Tests; Approved Standard. 2006. M2-A4. 5 ed. Villanova, Pa., Wayne.
10. Brasil. Ministério da Saúde. Agencia Nacional de Vigilância Sanitária. Procedimentos laboratoriais: da requisição do exame à análise microbiológica. Brasília: Ministério da Saúde; 2004. Módulo 3.
11. Maki DG, Weise CE, Sarafin HW. A semiquantitative culture method for identifying intravenous-catheter-related infection. N Engl J Med. 1977;296(23):1305-9.
12. Bauer AW, Kirby WM, Sherris JC, Turck M. Antibiotic

susceptibility testing by a standardized single disk method. Am J Clin Pathol. 1966;45(4):493-6.

13. Sesso R, Barbosa D, Leme IL, Sader H, Canziani ME, Manfredi S, et al. *Staphylococcus aureus* prophylaxis in hemodialysis patients using central venous catheter: effect of mupirocin ointment. J Am Soc Nephrol. 1998;9(6):1085-92.
14. Bacuzzi A, Cecchin A, Del Bosco A, Cantone G, Cuffari S. Recommendations and reports about central venous catheter-related infection. Surg Infect (Larchmt). 2006;7 Suppl 2:S65-7.
15. Grothe C, Fram DS, Belasco A, Bettencourt ARC, Vianna LAC, Pignatari AC, Sesso RCC, Barbosa D. Letalidade relacionada à endocardite por *S. aureus* em pacientes em hemodiálise; 2004. In: VIII Encuentro de Investigación en Enfermería, *2004*, Sevilha, Madrid.
16. Safdar N, Maki DG. Inflammation at the insertion site is not predictive of catheter-related bloodstream infection with short-term, noncuffed central venous catheters. Crit Care Med. 2002;30(12):2632-5. Comment in: Crit Care Med. 2002;30(12):2776.
17. Naumovic RT, Jovanovic DB, Djukanovic LJ. Temporary vascular catheters for hemodialysis: a 3-year prospective study. Int J Artif Organs. 2004;27(10):848-54.
18. Le Corre I, Delorme M, Cournoyer S. A prospective, randomized trial comparing a transparent dressing and a dry gauze on the exit site of long term central venous catheters of hemodialysis patients. J Vasc Access. 2003;4(2):55-61.
19. Gillies D, O'Riordan E, Carr D, O'Brien I, Frost J, Gunning R. Central venous catheter dressings: a systematic review. J Adv Nursing. 2003;44(6):623-32.
20. Katneni R, Hedayati SS. Central venous catheter-related bacteremia in chronic hemodialysis patients: epidemiology and evidence-based management. Nat Clin Pract Nephrol. 2007;3(5):256-66.
21. O'Grady NP, Alexander M, Dellinger EP, Gerberding JL, Heard SO, Maki DG, Masur H, McCormick RD, Mermel LA, Pearson ML, Raad II, Randolph A, Weinstein RA; Healthcare Infection Control Practices Advisory Committee. Guidelines for the prevention of intravascular catheter-related infections. Infect Control Hosp Epidemiol. 2002;23(12):759-69.
22. Saxena AK, Panhotra BR. Haemodialysis catheter-related bloodstream infections: current treatment options and strategies for prevention. Swiss Med Wkly. 2005;135(9-10):127-38.