

# Infection control related to central venous catheter impregnated with antiseptics: an integrative review\*

CONTROLE DE INFECÇÃO RELACIONADA A CATETER VENOSO CENTRAL IMPREGNADO COM ANTISSÉPTICOS: REVISÃO INTEGRATIVA

CONTROL DE INFECCIÓN RELACIONADA CON CATÉTER VENOSO CENTRAL IMPREGNADO CON ANTISÉPTICOS: REVISIÓN INTEGRADORA

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## ABSTRACT

The use of central venous catheter is pointed out as a risk factor to blood stream infection. The objective of this study was to reach scientific evidence on infection control related to central venous catheter impregnated with antiseptics, used in hospitalized adult patients. Studies were selected from the LILACS, CINAHL and MEDLINE databases. Nine articles were selected by means of integrative literature review. The publications on the use of catheters impregnated with antiseptics showed statistically significant differences regarding the reduction of microbial colonization; however, only one study showed reduction in the occurrence of infection. The analysis of the studies revealed there is a need for further research in different patient populations in order to obtain general conclusions.

## DESCRIPTORS

Cross infection  
Infection control  
Catheterization, central venous  
Bacteremia  
Evidence-based medicine

## RESUMO

O uso de cateter venoso central é apontado como um dos principais fatores para infecção da corrente sanguínea. Objetiva-se, neste estudo, buscar evidências científicas sobre o controle de infecção relacionada ao cateter venoso central impregnado com antissépticos utilizado em pacientes adultos hospitalizados. Para seleção dos estudos, foram utilizadas as bases de dados LILACS, CINAHL e MEDLINE. Totalizaram-se nove artigos por meio da revisão integrativa da literatura. As publicações acerca da utilização de cateteres impregnados com antissépticos mostraram diferença estatisticamente significativa quanto à redução da colonização microbiana. Entretanto, apenas um estudo demonstrou redução na ocorrência da infecção. Diante das análises dos estudos, há necessidade de pesquisas adicionais em diferentes populações de pacientes com a finalidade de efetuar generalizações.

## DESCRITORES

Infecção hospitalar  
Controle de infecções  
Cateterismo venoso central  
Bacteremia  
Medicina baseada em evidências

## RESUMEN

El uso de catéter venoso central es señalado como uno de los principales factores de infección de la corriente sanguínea. El estudio objetivo buscar evidencias científicas sobre control de infección relacionada con catéter venoso central impregnado con antisépticos utilizado en pacientes adultos hospitalizados. Para seleccionar estudios se utilizaron las bases de datos LILACS, CINAHL y MEDLINE. Se totalizaron 9 artículos mediante revisión integradora de literatura. Las publicaciones referidas a utilización de catéteres impregnados con antisépticos mostraron diferencias estadísticamente significantes en lo referente a reducción de colonización microbiana, mientras apenas un estudio demostró reducción de ocurrencia de infección. Ante el análisis de los estudios, existe necesidad de investigaciones adicionales en diferentes poblaciones de pacientes con la finalidad de efectuar generalizaciones.

## DESCRIPTORES

Infeción hospitalaria  
Control de infecciones  
Cateterismo venoso central  
Bacteriemia  
Medicina basada en evidencia

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## INTRODUCTION

Infections associated to health care are a serious problem posing a global challenge, especially considering the variability of diagnoses and therapeutic procedures.

More specifically, vascular catheter (VC)-related infections are worrisome due to the severity and lethality involved<sup>(1-2)</sup>. VC etiology is complex and multifactorial. Studies have highlighted that aspects calling for greater attention include: the clinical conditions of the patients, catheter type, composition, insertion technique, location, the frequency of handling the system, and the duration.

The use of antiseptics has been investigated as one of the possibilities of changing properties of the surface of the device and reducing catheter microbe colonization. Acknowledging this possibility has, over the last decades, implemented the use of antiseptic-impregnated catheters<sup>(1-3)</sup>.

This study was performed using evidence based practice (EBP), as its approach allows for a systematic use of the best available evidence to evaluate options and make decisions when providing comprehensive patient care<sup>(4)</sup>.

In this sense, the main objective established for this study was to search evidence on the association between the use of antiseptic-impregnated central venous catheter (CVC) and the reduction of bloodstream infection (BSI).

## METHOD

This is an integrative literature review that permits to summarize previous studies and establish conclusions based on a thorough analysis of the methodological outline and results regarding the investigated theme<sup>(5-6)</sup>.

The following question was used to guide this study: *What evidence is available in the literature on infection control related to central venous catheter without cuff, non-tunneled, of short permanence, antiseptic-impregnated, used in hospitalized adult patients?*

Searches were performed on the Latin-America and Caribbean Health Sciences Literature (LILACS), Medical Literature Analysis and Retrieval System on-line (MEDLINE), and Cumulative Index to Nursing and Allied Health Literature (CINAHL) databases, using the following keywords: infection control and central venous catheter.

The inclusion criteria were: articles available in full; use of central venous catheter without cuff, not tunneled,

short permanence, antiseptic-impregnated in hospitalized adult patients; indexed in the abovementioned databases; published in English, Spanish, or Portuguese, between 1996 and 2006, with evidence levels I and II, according to Ganong<sup>(5)</sup> and with Stetler classification<sup>(6)</sup>.

## RESULTS AND DISCUSSION

Nine articles on antiseptic-impregnated CVC were found, seven (77.8%) of which corresponded to randomized controlled trials (evidence level II), and two (22.2%) to meta-analyses (evidence level I). All articles were in English. Chart 1 shows a summary of the main aspects analyzed in the articles.

The researchers of the randomized clinical trials evaluated the effectiveness of using CVC impregnated on the external surface with chlorhexidine and silver sulfadiazine as to the reduction in catheter-related infections<sup>(7-12)</sup>.

The studies demonstrated that most patients were under a high risk of catheter-related infection. As to the number of lumens, most corresponded to double- and triple-lumen. In this context, a meta-analysis demonstrated that those with multiple lumens were most prone to infection compared to those with single lumen<sup>(13)</sup>.

As to the mean catheter permanence time, the period ranged between 7.8 to 8.4 days and 14.3 to 16.6 days. In this reference, some authors reported these catheters were effective only if used for approximately 10 days; and that, after this period, infection is mostly intraluminal. Furthermore, the bactericide effect of the devices was limited to the surface of catheters, not extending to the lumens<sup>(14-15)</sup>.

Only one study made reference to using a guidewire to change catheters in the same insertion site. It should be highlighted that some researchers do not recommend changing the CVC periodically with the purpose of reducing infection, and accepted using the guidewire only in cases of bad functioning if there is there no evidence of infection<sup>(16-17)</sup>.

Four studied recommended using the aseptic technique for CVC insertion, whereas two articles did not specify using individual protection equipment, but reported the rigor of asepsis when inserting the device. The preparation for CVC insertion (using overalls, gloves and sterile fields, caps and masks) is well documented in the study and supported by experts<sup>(18-21)</sup>.

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**Chart 1** - Summary of the articles on central venous catheter without *cuff*, non-tunneled, of short permanence, antiseptic-impregnated used in hospitalized adult patients as per authorship, objective, outline and main results.

Authorship	Study Objective	Outline	Results
Pemberton, L. B. et al. <sup>(13)</sup>	To determine the effectiveness of antiseptic-impregnated and regular CVC on reducing insertion site infection and catheter-related sepsis.	Randomized Clinical Trial	The catheter-related sepsis rate was 02 (6%) in the experimental group, and 03 (8%) in the control group; and insertion-site infection was identified in 04 catheters (10%) of the experimental group, and in 04 (12%) of the control group. No statistically significant differences were found for catheter-related sepsis.
George, S. J.; Vuddamalay, P.; Boscoe, M. J. <sup>(14)</sup>	To compare the bacteria colonization incidence of catheters impregnated with chlorhexidine and silver sulfadiazine and catheters without antiseptic coverage	Randomized Clinical Trial	The results from the catheter-tip cultures evinced positive results for 25 (71%) of the 35 patients from the control group, against only 10 (23%) of the 44 patients of the experimental group, $p < 0.002$ versus $p < 0.05$ . The use of antiseptic-impregnated catheters reduced catheter tip colonization.
Veenstra, D. L.; Saint, S.; Saha, S.; Lumley, T.; Sullivan, S. <sup>(36)</sup>	To evaluate the efficiency of CVC impregnated with chlorhexidine and silver sulfadiazine in preventing catheter colonization and catheter-related bloodstream infection (CRBSI).	Meta-analysis	The summary odds ratio for colonization was 0.44 ( $P < .001$ ), indicating a significant reduction in colonization associated to antiseptic-impregnated catheters. Studies that examined CRBSI showed a summary odds ratio of 0.56 ( $P = .005$ ). The antiseptic-impregnated CVC appear to be efficient in reducing the incidence of catheter colonization.
Sheng, W. H.; et al. <sup>(15)</sup>	To compare the efficiency between CVC with and without antiseptics in preventing catheter-related infection (CRI) and colonization.	Randomized Clinical Trial	None of the patients showed hypersensitivity, local or systemic toxicity. The antiseptic-impregnated catheter reduced infection incidence, but there were no statistically significant results. As to catheter colonization, 09 in the experimental group were colonized against 25 in the control group ( $p = 0.006$ to $p < 0.05$ ). As to CRBSI, experimental group (01 catheter) and control group (2 catheters), $p = 0.53$ . Patients with antiseptic-impregnated catheters showed a smaller risk to bacteria colonization.
Stoiser, B. et al. <sup>(16)</sup>	To establish the possible benefits silver-ion-impregnated CVC.	Randomized Clinical Trial	Contamination episodes occurred in 10 patients of the experimental group and 14 of the control. Six patients (12%) in the experimental group showed signs of infection, three of which were related to the catheter; against 10 patients of the control group (21%), with three relating to the catheter. There were no differences in the groups regarding catheter-related systemic infection rates. The study did not find statistically significant benefits for using silver-ion-impregnated catheters.
Geffers, C.; Zuschneid, I.; Eckmanns, T.; Rüden, H.; Gastmeier, P. <sup>(37)</sup>	The analyze the methodological quality of individual controlled randomized clinical trials about catheters impregnated with chlorhexidine and silver sulfadiazine and their effects on CRI	Meta-analysis	Summary odds ratio of the information from the 11 studies did not provide statistically significant results; however, there appears to be a tendency of benefits from impregnated catheters in the prevention of CRI. The quality of the studies did not affect the results; Information such as permanence time and use of antibiotics should be included in the studies, and methodological flaws should be avoided.
Richards, B.; Chaboyer, W.; Bladen, T.; Schluter, P. J. <sup>(17)</sup>	To establish the effectiveness of CVC impregnated with chlorhexidine and silver sulfadiazine.	Randomized Clinical Trial	Colonization episodes occurred in 14 (5.9%) patients of the antiseptic-impregnated catheter group, and in 30 (13.5%) of the group using catheters without antiseptics ( $p < 0.01$ to $p = 0.05$ ). However, regarding the bacteremia rate per 1000 catheters-day there were no differences between the groups (0.98 group with impregnated catheters and 3.38 for catheters without antiseptics). Catheter colonization was significantly smaller in the impregnated catheter group
Jaeger, K. et al. <sup>(18)</sup>	To establish the efficiency of CVC impregnated with chlorhexidine and silver sulfadiazine	Randomized Clinical Trial	Colonization episodes occurred in 05 (9.8%) patients of the experimental group and 09 (16.4%) of the control group ( $p = 0.035$ to $p = 0.05$ ). One patients of the experimental group has CRBSI against eight in the c control group ( $p = 0.02$ ). Antiseptic-impregnated catheters reduce colonization.
Ostendorf, T. et al. <sup>(19)</sup>	To investigate catheters impregnated with chlorhexidine and silver sulfadiazine.	Randomized Clinical Trial	The control group showed higher catheter colonization rates compared to the experimental group, i.e., 33 and 12%, respectively ( $p = 0.1$ to $p = 0.05$ ). As to catheter-related bacteremia, the rates found were 7% in the control group 7% and 3% in the experimental group ( $p = 0.21$ ). Antiseptic-impregnated catheters were effective in reducing bacterial growth and catheter colonization rates.

As to the type of antiseptic solution used, it was observed there was a variability of products and their indication, i.e., iodine solutions at 10% with 1% free iodine, alcohol at 70% or 75%, and aqueous chlorhexidine at 2%. In this respect, researchers evaluated the use of chlorhexidine gluconate at 2% for CVC insertion compared to the iodine solution at 10%, and confirmed a reduction in CRBSI from 11.3 per 1000 CVC/day to 3.7 per 1000 CVC/day. There is vast literature addressing the evaluation of antimicrobial activity of antiseptics; and, has demonstrated the effectiveness of using chlorhexidine gluconate at 2% compared to iodine solutions at 10% or alcohol at 70%<sup>(20-23)</sup>.

As to the CVC insertion site, it was observed that the most common site are the subclavian veins, and the least common are the jugular and femoral veins. Catheters inserted in the internal jugular veins have a higher risk for infection compared to insertions in the subclavian vein, considering its proximity to oropharyngeal secretions. In addition, it also implies greater difficulty to immobilize the catheter. Insertions in the femoral vein should be avoided, considering the high risk of complications such as deep venous thrombosis and infection, especially in incontinent adults<sup>(24-25)</sup>.

Regarding the type of dressings, two studies point at the use of transparent coverings in CVC maintenance, and two dressings, sterile gaze and adhesive tape. It is important to stress that aspects related to dressings are complex and controversial. Furthermore, in cases that include drainage (blood or body fluids) and patients with sudoresis, the gaze dressing is the one preferred<sup>(26-27)</sup>.

As for the adverse events stated in the studies, it was observed that most did not include an evaluation. Although catheter use is an advance in medicine, some factors such as hypersensitivity or anaphylactic reactions, as well as the induction to bacterial resistance and costs, have limited their effective applicability<sup>(28-29)</sup>.

Most studies evinced statistically significant differences regarding the reduction in colonization rates in antiseptic-impregnated catheters; however, only one study found statistically significant differences for CRBSI rates. According to the authors of the meta-analysis<sup>(30)</sup>, catheters impregnated with chlorhexidine and silver sulfadiazine are effective in reducing colonization and CRBSI compared to devices without antiseptics, in groups of patients with a high risk for these infections, submitted to short permanence catheterization. Researchers, however, have stressed that the decision of using these devices should take into consideration the potential reduction in morbidity and mortality, lower costs and the risk of adverse effects.

The other meta-analysis<sup>(31)</sup> did not find any significant odds ratio in the individual evaluation; however, nine of the evaluated studies had a tendency for lower catheter-related infection rates in the experimental group. They explained that the fact of being impregnated with antiseptic only on the external surface, and having been used

for a short period of time could justify the results. Hence, they recommend the elaboration of additional studies to evaluate appropriate culture techniques, which are not influenceable by the action of antiseptics. And, although there were no ideal laboratory methods to diagnose catheter-related infection, there is a need for extra caution in overestimating the results, as well as in explaining the variables, and allocating and masking those involved.

It should be emphasized that in 2002 the CDC recommended using antimicrobial-impregnated CVC in adult patients that required catheterization for more than five days, or in institutions with high rates of infection complications<sup>(25)</sup>.

Furthermore, other authors have discussed on the potential effects of antiseptic substances used to prepared these catheters, roll plate or sonication techniques; stressing the possibility of inhibiting microbial growth, and recommending the use of neutralizing agents when performing the microbiological analysis, so as to avoid false results<sup>(32)</sup>.

## CONCLUSION

By analyzing the studies, it was concluded that using antiseptic-impregnated central venous catheters reduced microbial colonization in six of the nine evaluated studies. Nevertheless, further studies are called for to investigate the effectiveness of using these catheters in other patient populations and compared to other types of catheters, considering that most of the studies analyzed in the present integrative review did not show statistically significant differences regarding CRBSI rates.

## REFERENCES

1. Percival SL, Kite P, Eastwood K, Murga R, Carr J, Arduino MJ, et al. Tetrasodium EDTA as a novel central venous catheter lock solution against biofilm. *Infect Control Hosp Epidemiol*. 2005;26(6): 515-9.
2. 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.
3. Brun-Buisson C, Doyon F, Sollet JP, Cochard JF, Cohen Y, Nitenberg G. Prevention of intravascular catheter-related infection with newer chlorhexidine-silver sulfadiazine-coated catheters: a randomized controlled trial. *Intensive Care Med*. 2004;30(5):837-43.
4. Hamer S. Evidence-based practice. In: Hamer S, Collinson G. *Achieving evidence-based practice: a handbook for practitioners*. London: Baillière Tindall; 1999. p. 3-12.
5. Ganong LH. Integrative reviews of nursing research. *Res Nurs Health*. 1987;10(1):1-11.
6. Stetler CB, Morsi D, Rucki S, Broughton S, Corrigan B, Fitzgerald J, et al. Utilization-focused integrative reviews in a nursing service. *Appl Nurs Res*. 1998;11(4):195-206.
7. George SJ, Vuddamalay P, Boscoe MJ. Antiseptic-impregnated central venous catheters reduce the incidence of bacterial colonization and associated infection in immunocompromised transplant patients. *Eur J Anaesthesiol*. 1997;14(4):428-31.
8. Sheng WH, Ko WJ, Wang JT, Chang SC, Hsueh PR, Luh KT. Evaluation of antiseptic-impregnated central venous catheters for prevention of catheter-related infection in intensive care unit patients. *Diagn Microbiol Infect Dis*. 2000;38(1):1-5.
9. Stoiser B, Kofler J, Staudinger T, Georgopoulos A, Lugauer S, Guggenbichler JP, et al. Contamination of central venous catheter in immunocompromised patients: a comparison between two different types of central venous catheter. *J Hosp Infect*. 2002;50(3):202-6.

10. Richards B, Chaboyer W, Bladen T, Schluter PJ. Effect of central venous catheter type on infections: a prospective clinical trial. *J Hosp Infect.* 2003;54(1):10-7.
11. Jaeger K, Zenz S, Juttner B, Ruschulte H, Kuse E, Heine J, et al. Reduction of catheter-related infections in neutropenic patients: a prospective controlled randomized trial using a chlorhexidine and silver sulfadiazine-impregnated central venous catheter. *Ann Hematol.* 2005;84(4):258-62.
12. Ostendorf T, Meinhold A, Harter C, Salwender H, Egerer G, Geiss HK, et al. Chlorhexidine and silver-sulfadiazine coated central venous catheters in haematological patients - a double-blind, randomized, prospective, controlled trial. *Support Care Cancer.* 2005;13(12):993-1000.
13. Dezfulian C, Lavelle J, Nallamothu BK, Kaufman SR, Saint S. Rates of infection for single-lumen versus multilumen central venous catheters: a meta-analysis. *Crit Care Med.* 2003;31(13):2385-90.
14. Haxhe JJ, D'Hoore W. A meta-analysis dealing with the effectiveness of chlorhexidine and silver-sulfadiazine impregnated central venous catheters. *J Hosp Infect.* 1998; 40: 166-8.
15. Raad I. Intravascular-catheter-related infections. *Lancet.* 1998; 351 (9106): 893-8.
16. Powell C, Kudsk KA, Kulich PA, Mandelbaum JA, Fabri PJ. Effect of frequent guidewire changes on triple-lumen catheter sepsis. *J Parenter Enteral Nutr.* 1988;12(5):462-4.
17. Cook D, Randolph A, Kernerman P, Cupido C, King D, Soukup C, et al. Central venous catheter replacement strategies: a systematic review of the literature. *Crit Care Med.* 1997;25(8):1417-24.
18. Mermel LA, McCormick RD, Springman SR, Maki DG. The pathogenesis and epidemiology of catheter-related infection with pulmonary artery Swan-Ganz catheters: a prospective study utilizing molecular subtyping. *Am J Med.* 1991;91(3B):197S-205S.
19. Raad II, Hohn DC, Gilbreath BJ, Suleiman N, Hill LA, Brusco PA, et al. Prevention of central venous catheter-related infections by using maximal sterile barrier precautions during insertion. *Infect Control Hosp Epidemiol.* 1994;15(4 Pt 1):231-8.
20. Young EM, Commiskey ML, Wilson SJ. Translating evidence into practice to prevent central venous catheter-associated bloodstream infections: a systems-based intervention. *Am J Infect Control.* 2006;34(8): 503-6.
21. Posa PJ, Harrison D, Vollman KM. Elimination of central line-associated bloodstream infections: application of the evidence. *AACN Adv Crit Care.* 2006;14(4):446-54.
22. Banton J. Techniques to prevent central venous catheter infections: products, research, and recommendations. *Nutr Clin Pract.* 2006;21(1):56-61.
23. Oliveira AS, Santos VLCG. Uso de iodóforo tóxico em feridas agudas. *Rev Esc Enferm USP.* 2008;42(1):193-201.
24. Merrer J, De Jonghe B, Golliot F, Lefrant JY, Raffy B, Barre E, et al. Complications of femoral and subclavian venous catheterization in critically ill patients: a randomized controlled trial. *JAMA.* 2001;286(7):700-7.
25. Centers for Disease Control and Prevention (CDC). Guidelines for prevention of intravascular catheter-related infections. *MMWR Recomm Rep.* 2002;51 (RR-10):1-26.
26. Maki DG, Stolz SS, Wheeler S, Mermel LA. A prospective, randomized trial of gauze and two polyurethane dressings for site care of pulmonary artery catheters: implications for catheter management. *Crit Care Med.* 1994;22(11):1729-37.
27. Bijma R, Girbes AR, Kleijer DJ, Zwaveling JH. Preventing central venous catheter-related infection in a surgical intensive-care unit. *Infect Control Hosp Epidemiol.* 1999;20(9):618-20.
28. Maki DG, Stolz SM, Wheeler S, Mermel LA. Prevention of central venous catheter-related bloodstream infection by use antiseptic-impregnated catheter. A randomized, controlled trial. *Ann Intern Med.* 1997;127(4):257-66.
29. Oda T, Hamasaki J, Kanda N, Mikami K. Anaphylactic shock induced by an antiseptic-coated central venous catheter. *Anesthesiology.* 1997;87(5):1242-4.
30. Veenstra DL, Saint S, Saha S, Lumley T, Sullivan SD. Efficacy of antiseptic-impregnated central venous catheters in preventing catheter-related bloodstream infection: a meta-analysis. *JAMA.* 1999;281(3):261-7.
31. Geffers C, Zuschneid I, Eckmanns T, Ruden H, Gastmeier P. The relationship between methodological trial quality and the effects of impregnated central venous catheters. *Intensive Care Med.* 2003;29(3):403-9.
32. Schierholz JM, Bach A, Fleck C, Beuth J, König D, Pulverer G. Measurement of ultrasonic-induced chlorhexidine liberation: correlation of the activity of chlorhexidine-silver-sulfadiazine-impregnated catheters to agar roll technique and broth culture. *J Hosp Infect.* 2000;44(2):141-5.