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INTEGRATIVE REVIEW ARTICLE

EVIDENCE FOR CARE OF SHORT-TERM CENTRAL VENOUS CATHETERS: INTEGRATIVE REVIEW

EVIDÊNCIAS PARA O CUIDADO DE CATETER VENOSO CENTRAL DE CURTA PERMANÊNCIA: REVISÃO INTEGRATIVA

EVIDENCIA PARA LA ATENCIÓN DE ENFERMERÍA CON CATÉTER VENOSO CENTRAL PARA ESTANCIA DE CORTA DURACIÓN: REVISIÓN INTEGRADORA

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ABSTRACT

Objective: to seek evidence on strategies for nursing care with the short-term central venous catheter in adult patients. **Method:** integrative review in order to answer the research question << *What is the evidence for central venous catheter care on nursing the adult patient?* >>. The search covered the Latin American and Caribbean Literature on Health Sciences and the National Library of Medicine of the United States. The instrument included: research theme, overall objective, methodology, level of evidence of results, sample/subjects, intervention, control, results and conclusions. For critical analysis, it was proceeded a methodological evaluation followed by discussion on the articles. **Results:** 22 articles were included. **Conclusion:** with the iatrogenic potential of the insertion and the use of a central venous catheter, the healthcare team must commit to patient safety. **Descriptors:** Nursing; Central Venous Catheterization; Infection; Critical Care.

RESUMO

Objetivo: buscar evidências científicas sobre estratégias de cuidado de enfermagem com o cateter venoso central de curta permanência em pacientes adultos. **Método:** revisão integrativa com o propósito de responder a questão de pesquisa << *Quais as evidências para o cuidado ao cateter venoso central pela enfermagem no paciente adulto?* >>. A busca abrangeu a Literatura Latino-Americana e do Caribe em Ciências da Saúde e Biblioteca Nacional de Medicina dos Estados Unidos. O instrumento abrangeu: tema da pesquisa, objetivo geral, metodologia empregada, nível de evidência dos resultados, amostra/sujeitos, intervenção, controle, resultados e conclusões. Para análise crítica, procedeu-se avaliação metodológica seguida de discussão dos artigos. **Resultados:** incluíram-se 22 artigos. **Conclusão:** diante do potencial iatrogênico da inserção e uso de um cateter venoso central, a equipe de saúde deve comprometer-se com a segurança do paciente. **Descritores:** Enfermagem; Cateterismo Venoso Central; Infecção; Cuidados Críticos.

RESUMEN

Objetivo: buscar evidencia sobre estrategias para la atención de enfermería con catéter venoso central para estancia de corta duración en pacientes adultos. **Método:** revisión integradora con el fin de responder a la pregunta de investigación << *¿Cuál es la evidencia para el cuidado del catéter venoso central en la enfermería del adulto?* >> La búsqueda abarcó la Literatura Latinoamericana y del Caribe en Ciencias de la Salud y la Biblioteca Nacional de Medicina de los Estados Unidos. El instrumento incluye: Tema de investigación, objetivo general, metodología, nivel de evidencia de los resultados, la muestra/sujetos, intervención, control, resultados y conclusiones. Para el análisis crítico, se procedió evaluación metodológica seguida de una discusión de los artículos. **Resultados:** 22 artículos fueron incluidos. **Conclusión:** con el potencial iatrogénico de la inserción y el uso de un catéter venoso central, el equipo de salud debe comprometerse a la seguridad del paciente. **Descriptor:** Enfermería; Cateterización Venosa Central; Infección; Cuidados Críticos.

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INTRODUCTION

The Central Venous Catheter (CVC) is a technological resource widely used by patients in critical health, treated at the Intensive Care Unit (ICU). However, its use entails the performance of special care for maintenance in order to prevent complications related to it. It is noteworthy that the nurse needs to understand the technology and be able to train his staff in the correct use of the catheter in order to minimize risks associated with the device.

Short-term catheters are indicated in cases where the therapy has estimated duration between 10 and 14 days.¹ These devices are widely used because of the range of indications and the ease of puncture.¹⁻² Among the complications related to it, stand out: Primary Bloodstream Infection (BSI), infection at the insertion site; thrombosis and bad positioning.¹⁻²

With the widespread use and complications related to CVC, nursing should provide a lot of care related to the device from the moment of insertion to the removal of the catheter. A large number of catheter-related technological devices are available on the market, so the choice of the best practice for preventing complications becomes complex. The Evidence-Based Practice (EBP), which consists of the judicious use of valid and relevant evidence to assist the professional in making decisions³, is a methodology that assists decision making.

Thus, the objective was to seek evidence on strategies for nursing care with short-term central venous catheter in adult patients.

METHOD

Integrative review of literature, which allows general conclusions about a particular area of study, through synthesis of multiple published studies.⁴ It is developed in six phases: definition of the research question, definition of inclusion and exclusion criteria, data search, data and results analysis, interpretation of the results and synthesis of the review.⁵

Based on the research question << *What is the evidence for central venous catheter care on nursing the adult patient?* >>, a search for articles in the databases of Latin American and Caribbean Literature in Health Sciences (LILACS) and National Library of Medicine of the United States (PubMed) was held in July 2011.

The selection of articles obeyed PICO⁶ strategy, and the descriptors selected were selected as follows: P - Adult OR Middle Aged OR Critical Care; I - Catheters OR Catheterization OR Central Venous Catheterization; C - not applicable; O - Infection OR Hospital Infection OR Catheter-related Infection. In both databases the groups of descriptors were crossed, according to Boolean logic, initially with 'P' AND 'I' AND 'O' and then only with 'I' AND 'O'. The second search was necessary to cover a larger number of studies.

The selected articles were fully read for data collection through an instrument containing: research theme; overall objective, methodology, level of evidence of the results (Figure 1), sample/subjects, intervention, control, results, and conclusions.

Upon reading the abstracts of the articles it was applied an inclusion criteria: published between 2001 and 2011, in Spanish, English or Portuguese, available online for free; related to nursing; related to short-term central venous catheter. Articles concerning hemodialysis, pulmonary artery, and pediatric and elderly patients-related catheters were excluded.

For critical analysis, it was proceeded a methodological evaluation followed by a discussion of selected articles, procedure performed by three researchers and ended only in obtaining consensus on the Featured Content.

Level	Strength of evidence
I	At least one systematic review of multiple well-designed randomized controlled studies.
II	At least one controlled clinical trial, randomized, well-designed.
III	Well-designed clinical trial without randomization, of studies of only one group of before and after, cohort, time series, or case-control studies type.
IV	Non-experimental studies for more than one research center or group.
V	Opinions of respected authorities, based on clinical evidence, descriptive studies or reports of expert committees.

Figure 1. Levels of evidence⁷

RESULTS

The final sample was composed of 22 studies. For data analysis, themes were grouped into the following categories: risk factors for complications; strategies for

infection prevention; maintenance of the device; and cost-effectiveness analysis.

Five articles were identified regarding risk factors for complications associated with CVC related to patients and the device (Figure 2).

Authors, Year	Design (Evidence)	Sample	Intervention	Results and Conclusions
Netto et al., 2009 ⁸	Retrospective descriptive (V)	37 patients	Not applicable (N/A)	Infection rate of 3.6/1,000 catheters-day. 17 of the 37 infected CVC were inserted into the subclavian vein, 13 in the jugular vein and seven in the femoral vein. Hyperthermia was the most found infectious signal (89.2%), followed by purulent secretion (27%) and hyperemia (18.9%).
Mesiano, Merchán-Hamann, 2007 ⁹	Prospective cohort (III)	630 subjects	N/A	Nine cases of BSI (1.5%). 38°C fever (45.4%), double-lumen CVC with permanence > 21 days were more related to BSI (62.5%), with increased length of hospitalization by 3.5 times.
Dimick et al., 2006 ¹⁰	Retrospective observational (V)	260 patients and 854 CVC	N/A	Results indicate significant reduction in the risk of colonization when using mono lumen CVC, for one single purpose, inserted into the subclavian vein and maintained by a specific multidisciplinary team.
Harter et al., 2002 ¹¹	Randomized Clinical Trial (RCT) (II)	233 patients with CVC (120 study and 113 control)	Insertion of CVC coated with silver	BSI in 21.2% of uncoated catheters and in 10.2% of those coated with silver (p < 0.011). There was no difference in the incidence of thrombosis in both groups (1/120 and 3/113). CVC coated with silver is not a risk factor for thrombosis, however it reduces rates of BSI.
Kehr, Castillo and Lofourcade, 2002 ¹²	Literature review (V)	N/A	N/A	Age > 70 years old and baseline disease are risk factors related to the patient. Risk factors dependent on the hospital are: lack of medical expertise in catheter insertion, not using maximum protection barriers, prolonged time of catheter permanence, catheter material, number of lumens, site of insertion, skin colonization, dressings and infusion of TPN. Risk factors: longer duration of CVC insertion procedure, greater number of puncture attempts, triple lumen CVC, inserted into jugular.

Figure 2. Risk factors for complications. LILACS and PubMed, 2011.

The thematic "strategies for infection prevention" was found in most articles, and includes measures such as: use of

impregnated catheters; educational interventions; insertion care, among others (Figure 3).

Authors, Year	Design (Evidence)	Sample	Intervention	Results and Conclusions
Calvo, 2007 ¹³	Literature review (V)	N/A	N/A	Strong evidence: formal training and strict following of rules for insertion and manipulation; avoid using the femoral vein; minimal manipulation of the connections; use of chlorhexidine gluconate (CHG) for skin antisepsis; coverage of the catheter with sterile dressing after insertion; active surveillance of BSI; equipment replacement every 72 hours for infusions; removal of the catheter after ending indication of use.
Pronovost et al., 2006 ¹⁴	Prospective cohort (III)	103 ICUs in the United States	Training and awareness of staff for bundle recommendations.	BSI global average rate decreased from 2.7/1000 to zero/1000 days of catheter in the period up to three months after training (p ≤ 0.002). Benefit was maintained with 66% reduction in the BSI rate in 16-18 months. Intervention was modestly more effective in small hospitals (<200 beds).
Gowardman et al., 2005 ¹⁵	Prospective observational (V)	272 patients and 305 CVC	Policy for early removal of the CVC and educational intervention	Reduction of average permanence time from 8.1 to 5.1 days, of the rate of CVC reinsertion at 7% and of the risk of BSI. The policy was effective in reducing the catheter permanence time, without clinically harming the patient.
Yücel et	Multicenter	223 patients	Insertion of triple	There was catheter colonization in 5.1% of coated

al., 2004 ¹⁶	RCT (II)	using CVC for the first time (105 control and 118 study)	lumen CVC coated with miconazole and rifampicin	catheters and in 36.2% of uncoated catheters (p < 0.001). Five cases of BSI when using coated catheters, compared to 18 in the control group (p < 0.002). Coated catheters remained with colonization rate of 10% for 14 days, while uncoated catheters present colonization rate of 70% for 14 days (p < 0.001).
Brenner et al., 2003 ¹⁷	Consensus (V)	N/A	N/A	Strong evidence: education for catheter insertion and manipulation. Recommendation: polyurethane catheters in the subclavian vein; with fewer lumens; maximum sterile barrier for insertion; disinfecting the skin with CHG solution; insertion ostium coverage with sterile dressing, however, there is no difference between gauze or transparent dressing; dressing should be replaced when dirty, wet or loose; replacing catheters every 72 hours, when infusing TPN or blood products every 24 hours; disinfection of connections with 70% alcohol before use. Impregnated catheters are indicated when other measures are not effective in reducing BSI.
Authors, Year	Design (Evidence)	Sample	Intervention	Results and Conclusions
Bong et al., 2003 ¹⁸	RCT (II)	268 patients and 270 CVC (128 study and 142 control)	Insertion of mono lumen CVC coated with iontophoretic polyurethane silver	Catheter permanence average time of 12 days. Colonization in 36.7% of coated catheters and in 33.8% of those uncoated (p 0.72). 18 cases of infection (6.6%): 11 (7.7%) in the control group and seven (5.5%) in the intervention group (p=0.51). The use of CVC coated with iontophoretic silver brought no significant reduction in colonization or BSI.
Hanna et al., 2003 ¹⁹	Before and after (III)	Clinical ICU: 653 patients before and 764 after; surgical ICU: 1,128 before and 1,585 after.	Use of catheter impregnated with minocycline-rifampin in the second period of the study (uncoated catheter in the first period)	Reduction of morbidity and the number of days of hospitalization in both ICU with BSI reduction from 3.2 to 0.6/1,000 patients-day (p < 0.001); local infection decreased from 1.8 to 0.12 (p < 0.001). The use of impregnated catheter is associated with significant reduction of nosocomial bacteremia, resulting in savings of US\$ 1,450 in a year.
Kehr, Castillo and Lofourcade, 2002 ¹²	Literature review (V)	N/A	N/A	There is no need to perform the procedure in the operating room, but the use of maximum protection barriers is needed. Recommendation: impregnated catheter when stipulated permanence time is > 7 days; maintaining the integrity of the skin around the CVC insertion site; not applying antibiotic ointments at the catheter insertion site. There is no significant difference between the use of gauze and tape dressings and transparent dressings. TPN may be a source of catheter colonization.

Figure 3. Strategies for infection prevention

Care for proper maintenance of the device is essential to ensure patient safety and has been addressed in most of the articles surveyed. Figure 4 briefly presents the

collected data (Figure 4).

Authors, Year	Design (Evidence)	Sample	Intervention	Results and Conclusions
O'Grady et al., 2011 ²⁰	Guideline (I)	N/A	N/A	Strong evidence: avoiding using the femoral vein for CVC and preferring the subclavian vein; using ultrasound for catheter insertion; using catheters with fewer lumens and connections; continuing education for catheters choice, insertion and maintenance; removing the catheter as soon as it is no longer essential; replacing the catheter as soon as possible if aseptic technique was not complied with at the time of insertion; washing hands before and after handling with the catheter; changing the insertion site dressing aseptically and with sterile gloves; using maximal sterile barrier and skin antisepsis with 0.5% CHG before CVC insertion; using sterile gauze dressing (diaphoretic patient with bleeding or exudate) or transparent, with exchange in case of moisture, dirt, or poor fixation; not using creams or oils based on antimicrobial at catheter insertion; not wetting the catheter during bathing; using dressing impregnated with CHG in sectors where BSI rates remain high even after adopting the measures described above; visually monitoring and palpating the catheter insertion site; using coated catheters for permanence time > 5 days; prophylaxis systemic antimicrobial is contraindicated; not replacing catheter routinely; not changing the catheter by guide.
Villins et al., 2009 ²¹	Prospective cohort (III)	1,125 patients 483 open system 642 closed system	N/A	55% reduction in the odds of acquiring BSI when used closed infusion system.
Timsit et al., 2009 ²²	Multicenter RCT (II)	1,636 patients	CHG-impregnated dressings.	BSI overall rate of 0.6/1,000 in CHG dressing versus 1.4/1,000 CVC days (P = .03). BSI reduction (0.40/1,000 versus 1.3/1,000 CVC days). CHG dressing was not associated with bacterial resistance. Severe contact dermatitis was observed in eight patients. The use of CHG dressing prevented one BSI every 117 CVC. CVC colonization rates were 10.4/1,000 CVC days for dressing changes every 3 days and 11/1,000 for every seven trading days.
Bleasdale et al., 2007 ²³	Crossover (III)	836 patients	Daily body hygiene with wipes with 2% CHG for 28 weeks.	During intervention, subjects were significantly less vulnerable to BSI (4.1 x 10.4 infections/1,000 patients-day). CHG protection against BSI was apparent after five or more days in the ICU, showing a simple and effective measure for reducing BSI.
Mimoz et al., 2007 ²⁴	RCT (II)	481 catheters	Solution containing 0.25% CHG, 0.025% benzalkonium chloride, and 4% benzyl alcohol for antisepsis. Control made with 5% povidone-iodine in 70% alcohol solution.	CVC using CHG were less colonized than those using iodine [P=.002]; incidence of 9.7 vs. 18.3/1,000 CVC days. The use of CHG solution reduces the colonization of CVCs, with the benefit of no additional cost.
Wall et al., 2005 ²⁵	Descriptive (V)	630 CVC	Sensitization of staff for preventive measures for BSI.	Reduction of BSI rate from 7.0/1,000 CVC days to 3.8/1,000 CVC days.
Carrer et al., 2005 ²⁶	RCT (II)	82 patients	Four intervention groups: Maximal sterile barriers and gauze dressing; Maximal sterile barriers and transparent dressing; Sterile barriers and gauze dressing; Sterile barriers and transparent dressing.	The use of maximal precaution barriers reduces approximately 1/3 of the likelihood of colonization and therefore can be routinely used. As for the dressing choice there seems to be insignificant impact on the BSI rate.
Coopersmith et al., 2004 ²⁷	Before and After (III)	99 patients before / 78 after	Observation of the CVC puncture and maintenance techniques by the multidisciplinary team.	Reduced use of saline lock from 70% to 24% (p < .001), absence of the date in the dressing from 11% to 21% (p <.001); increased use of sterile barrier from 50% to 80% (p 0.29) and hand hygiene from 17% to 30% (p 0.99). Infection rate

ChaiyakunApruk et al., 2002 ²⁸	Meta-analysis (I)	8 RCT	Antisepsis with CHG x PVPI solution	before 3.4/1,000 and after 2.8/1,000 catheter days (p 0.40). 50% reduction in catheter-related colonization and infection when using CHG.
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Figure 4. Evidence regarding the maintenance of CVC

It is noteworthy that some articles have addressed topics relating to risk factors for complications and measures for prevention of infection, the results of which were presented

separately in Figures 1 and 2. Regarding cost-effectiveness of proposed interventions, only one article has addressed this issue (Figure 5).

Authors, Year	Design (Evidence)	Sample	Intervention	Results and Conclusions
Halton et al., 2010 ²⁹	Cost-effectiveness (N/A)	N/A	N/A	Bundle with respect to coated catheter is cost effective when costing less than US\$ 24,880 per ICU in 18 months. If the cost exceeds this, one should use only impregnated catheter. When the impregnated CVC is not an option, the bundle should cost less than US\$ 94,559 per ICU. If the cost exceeds this threshold, there should be used uncoated and no bundle catheter.

Figure 5. Cost-effectiveness

DISCUSSION

The use of CVC in hospitals represents a breakthrough for clinical practice, however, it is related to a number of infectious and noninfectious complications, the former being of greater importance for the high morbidity and mortality related to it.²

Risk factors for complications involve the patient and the catheter. Regarding risk factors for infectious complications involving the patient, we can mention elderly (above 70 years) and baseline disease (V).¹² However, the main factors relate to the catheter, starting from the moment of its insertion . The insertion of the device requires medical experience and use of maximal sterile barriers, and their absences are important risk factors for infection. Professional experience is related to the fact that the greater the duration of CVC insertion procedure and the number of puncture attempts, the greater the risk of infectious complications (V)¹². This fact is controversial, because studies show that multiple punctures during catheter insertion are not associated with an increased risk of BSI (V).¹³

The use of maximal sterile barrier (cap, mask, sterile gown, sterile gloves and broad sterile drapes) (I)²⁰ for catheter insertion is crucial, given that it decreases by a third the likelihood of colonization of the device (II).²⁶ Provided that maximal sterile barrier is used, there is no need to perform the procedure in the operating room (V).¹²⁻³

The choice of the site of insertion is fundamentally important, since insertion in the internal jugular is a risk factor for colonization and infection, compared to subclavian insertion, due to the proximity to the respiratory tract and difficulty of immobilization (II, V).^{10,12,17} It should be

avoided to insert central devices in the femoral vein (I, V).^{13,17,20} As for the number of lumens, triple lumen CVCs represent higher risk and should be used mono lumen whenever possible (I, II, V).^{10,12,17,20} Moreover, the catheter must be used for one purpose only (II).¹⁰ Parenteral nutrition may be a source of catheter colonization, however the most important in prevention is preparing the solution with strict aseptic technique (V).¹²

The catheter permanence time for an average of five days is a risk factor for colonization (II).¹⁰ While the extended time catheter permanence, for more than 21 days, is a risk factor for infection (III, V).^{9,12}

The material the catheter is made of interferes with the catheter colonization rates and BSI, and the consensus is that polyurethane is the safest material for patients (V).¹⁷ Regarding the use of catheters impregnated with antimicrobial or antiseptic solution, its use is indicated as a secondary measure to control the BSI rate after other measures have been ineffective (V)¹⁷, or for catheters with permanence time longer than five days (I, V).^{12,20}

Studies of strong scientific evidence (II, III) demonstrate the effectiveness of catheters impregnated with miconazole and rifampicin to reduce colonization and BSI rates.^{16,18} Regarding catheters coated with silver, studies are controversial because a RCT has demonstrated reduction on infection rates (II)¹¹, while in another there was no significant reduction on colonization or BSI (II).¹⁸

Regarding non-infectious complications, thrombosis stands out. ECR evaluated catheter coated with silver as a risk factor for thrombosis, in comparison with the uncoated catheter. There was no difference in the incidence of thrombosis in the two groups, demonstrating that the CVC coated with silver

is not a risk factor for thrombosis, however it is related to reduced rates of BSI (II).¹¹

The use of antibiotic ointments at the catheter insertion site is not recommended for bringing greater risk of *Candida spp* infection (V).¹² Routinely replacing the catheter for guidewire is contraindicated (I, V).^{13,20} Signals and symptoms of catheter-related infection most commonly reported are: Fever (38°C) (III)⁹, hyperaemia and purulent secretions (V).⁸

There is a consensus in the international literature that the early removal of the catheter is essential to reduce complications related to it, without being associated with increased rates of reinsertion of the device and the patient's clinical deterioration (I, V).^{13,15,20}

Studies with rigorous methodology and strong level of evidence confirm that health teams training and education are keys in preventing infectious complications (I, III),^{14,20} such as: observation of the healthcare team in order to check compliance to international recommendations (V)²⁷ and teams training combined with real-time surveillance (III, V).^{13,25}

Cost benefit analysis in deploying a bundle, essentially educational strategy (handwashing, maximal sterile barrier, antisepsis with CHG, selection of the site of insertion and early removal), concluded that, at a cost of US\$ 24,880 for implementation during 18 months in an Australian intensive care service, the bundle is cost effective regarding the use of impregnated catheters.²⁹

After the device insertion, it should be covered with sterile dressing. The following dressings can be used: gauze and tape, transparent polyurethane or impregnated with CHG film. There is no evidence proving better BSI control when comparing gauze and tape and transparent polyurethane, however, it is recommended gauze dressing to diaphoretic patients, given the absorptive capacity of the material (I, V).^{17,20}

Impregnated dressings, however, are differential in combating skin colonization and subsequent BSI. Those impregnated with CHG demonstrate to prevent one every 117 infections related to the device (II).²² The dressing change is recommended whenever it becomes dirty, loose or wet; and in addition, every 48 hours for gauze dressings, and every seven days for transparent and impregnated dressings (I).²⁰

Another international recommendation is implementing body hygiene on patients with CVC using 2% CHG degerming (I)²⁰, due to its

protective effect regarding BSI for patients staying at ICU longer than five days (III).²³

Commonly used solutions for skin antisepsis, both at insertion and dressing, are derived from iodine or CHG. When both are compared, however, it is clear (I, II) that skin antisepsis with CHG alcohol solution significantly reduces catheter colonization rate, therefore it is worldwide recommended.^{20,24,28}

After the first 14 days of use of the device, the main route of contamination is the intraluminal, being recommended the replacement of infusion catheters and their connections every 72h (V)¹³ or 96h (I)²⁰ in order to prevent microorganisms access. In case of catheters used for lipid emulsions or blood products, switching must be performed every 24h (I, V).^{17,20} When compared to closed and open infusion systems, it is known that during the use of closed infusion systems patients are at lower risk of acquiring BSI (III).²¹

A recently published study demonstrates that Brazilian researchers have been making an effort aiming at BSI reduction, as evidenced by the increasing number of publications related to the subject in the last years and the encouragement of ANVISA to implement preventive and control measures,³⁰ such as those cited in this review.

CONCLUSION

Given the iatrogenic potential involved in the insertion and use of a central venous catheter, the healthcare team must commit to patient safety. Continuous professional updating on the subject and institutional incentive for teams to be trained and empowered to deal with the device are part of a set of actions that will reduce risks related to CVC.

In addition, maintaining asepsis is the fundamental principle guiding actions, whether by using maximal sterile barriers for insertion, sterile dressings and connections exchanging; by reducing the microbial skin load with the use of antiseptics; or by countering the proliferation of bacteria on the catheter tip with impregnated catheters.

The measures presented in this review have demonstrated, in specific contexts, results worthy of replication by reducing rates of infection and colonization. Many of the studied actions are low cost, enabling the implementation of these services in intensive care, where central venous catheters are mostly frequently used.

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