



Arrowg+ard Blue Plus® Protection

Clinical References

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The Arrow® CVC with Arrowgard Blue™ Protection from Teleflex, is the first antimicrobial-impregnated catheter that uses both chlorhexidine and silver sulfadiazine to impregnate the entire indwelling surface length of the catheter. Our catheter's proven effectiveness against CVC-related infection is well-documented by more than 20 years of multiple studies. Time and again, research demonstrates chlorhexidine and silver sulfadiazine are efficacious in suppressing microbial colonization, and that reducing infections can reduce hospital costs.

Next generation Arrow® CVCs with Arrowgard Blue Plus® Protection provide continuous protection both outside and inside the catheter, including extension line and hubs. The concentration of chlorhexidine is three times higher than Arrow® CVCs with Arrowgard Blue™ Protection. The Arrowgard Blue Plus® Protection is designed to continuously protect the subcutaneous catheter tract, killing organisms in harder-to-reach areas that are not influenced by skin preps and external dressings.

This clinical reference guide provides a list of studies using Arrowgard Blue Plus® Protection, along with a brief synopsis of each one. For additional information, please visit Arrowgard.com and contact your Teleflex Vascular sales representative.

For additional information visit Arrowgard.com

Prolonged Antimicrobial Activity of a Catheter Containing Chlorhexidine-Silver Sulfadiazine Extends Protection Against Catheter Infections *In Vivo*.

Source: *Antimicrobial Agents and Chemotherapy*. 2001; 45 (5): 1535-1538.

Authors: Bassetti SM, Hu J, D'Agostino RB, and Sherertz RJ.

This study evaluated the relative efficacy of an experimental anti-infective central venous catheter manufactured by Arrow International in preventing infection by *Staphylococcus aureus* in catheterizations of long duration, as compared to a first generation anti-infective catheter. Researchers looked at whether the higher chlorhexidine content of the new catheter, as well as its extended release design, would prolong the catheter's antimicrobial activity. The experimental catheter (with Arrowgard Blue Plus® Protection) is impregnated with three times the chlorhexidine content of a conventional catheter with Arrowgard Blue™ Protection. Although the zone of inhibition around the experimental catheter was only slightly smaller than that around the conventional catheter, the experimental catheter produced a much longer half-life of antimicrobial activity, both *in vitro* (≥ 34 vs. 6 days) and *in vivo* (≥ 7 vs. 2 days). The greater efficacy of the second generation catheter was especially pronounced when inoculation of *S. aureus* was delayed by two days. The extended anti-infective activity on the external surface of the new catheter from Arrow International offers improved efficacy in preventing infection, especially in catheterizations of longer duration.

Comparison of Microbial Adherence to Antiseptic and Antibiotic Central Venous Catheters Using A Novel Agar Subcutaneous Infection Model.

Source: *Journal of Antimicrobial Chemotherapy*. 2003; 52 (3): 389-396.

Authors: Gaonkar TA and SM Modak.

In order to circumvent the problems associated with *in vivo* animal studies, researchers developed an agar subcutaneous infection model that simulates the rat subcutaneous infection model, for use in evaluating the effectiveness of antimicrobial catheters. The study examined the efficacy of catheters with Arrowgard Blue Plus® Protection impregnated with chlorhexidine and silver sulfadiazine. Catheters with Arrowgard Blue Plus® Protection impregnated with chlorhexidine and silver sulfadiazine with higher levels of chlorhexidine; minocycline-rifampicin (MR) catheters; and silver catheters against several bacterial strains. Catheters with Arrowgard Blue Plus® Protection were superior to the other types in preventing adherence, colonization, and subsequent infection, particularly when compared to minocycline-rifampicin catheters and silver catheters. The new agar model may be valuable in predicting the *in vivo* efficacy of antimicrobial catheters in preventing infection.

Efficiency Of Chlorhexidine-Silver Sulfadiazine-Impregnated Venous Catheters At Subclavian Sites.

Source: *American Journal of Infection Control*. 2015; 43:711-714

Authors: Lorente L, Lecuona M, Jiménez A, Santacreu R, Raja L, Gonzalez O, Mora M.

A retrospective study included patients admitted to the intensive care unit at Hospital Universitario de Canarias (Tenerife, Spain) who had a subclavian venous catheter. The subclavian vein is typically associated with the lowest rate of infection, and this study looked at the effectiveness of CHSS-impregnated catheters at this insertion site. Patients with CHSS catheters (n = 353) had a lower incidence density of CRBSI (2.12 vs 0 out of 1,000 catheter-days; P = .02) and lower CVC-related cost per catheter-day (€3.35 ± €3.75 vs €3.94 ± €9.95; P = .002) than those with standard catheters (n = 518). CHSS-impregnated catheters were associated with a lower risk of CRBSI than standard catheters when controlling for catheter duration. CHSS-impregnated catheters were also associated with a lower CVC-related cost per catheter day than standard catheters. CHSS-impregnated catheters may be efficient in preventing CRBSI in patients with subclavian venous access.

Cost-effectiveness analyses show that chlorhexidine-silver sulfadiazine (CHSS)-impregnated catheters reduce catheter-related bloodstream infection (CRBSI) and central venous catheter (CVC)-related costs. However, no studies have reported the efficiency of CHSS-impregnated catheters for venous access when the risk of CRBSI is low; for example, at the subclavian site. This study determined the cost of a CVC, diagnosis of CRBSI, and antimicrobial agents to treat CRBSI; authors did not consider the cost of increased hospital stay.

Activity of Antiseptic and Antibiotic Treated CVCs against Five Candida Pathogens.

Source: American Society of Anesthesia 2009 Poster

Authors: Steinke E, Spangler D, Rosenblatt J, Schaadt R, Sweeny D, and Zuenko G.

When tested alone and in combination, Minocycline (M) and Rifampin (R) showed no inhibitory activity at concentrations less than or equal to 512 mg/mL against five *Candida* strains which play significant roles in CLABSIs. *In vitro* zone of inhibition studies with CVCs containing the M-R combination showed some reduced growth but no clear ZOI against the same *Candida* species as well as *C. tropicalis*. Chlorhexidine (CH) and Silver-Sulfadiazine (SSD) were both inhibitory against all *Candida* strains tested, and were not antagonistic to one another when combined. CH was significantly more potent than SSD against all species of *Candida* tested. CVCs treated with the CH-SSD combination produced measurable ZOIs against the same *Candida* strains and against *C. tropicalis*. Measured ZOIs for both antimicrobial catheters against *S. Epidermidis* as well as *C. parapsilosis*.

Cost/Benefit Analysis of Chlorhexidine-Silver Sulfadiazine-Impregnated Venous Catheters for Femoral Access.

Source: *American Journal of Infection Control*. 2014; 42: 1130-112

Authors: Lorente L, Lecuona M, Jiménez A, Lorenzo L, Diosdado S, Marca L, Mora M.

A prospective, observational, cohort study of patients admitted to the intensive care unit (ICU), Hospital Universitario de Canarias (Tenerife, Spain), who received 1 or more femoral venous catheters. The femoral vein is typically associated with a higher rate of infection, and this study looked at the effectiveness of CHSS-impregnated catheters at this insertion site. The study included 64 CHSS-impregnated catheters and 190 standard catheters. CHSS-impregnated catheters were associated with a lower incidence of CRBSI, controlling for catheter duration, than standard catheters (0 vs 8.61 CRBSI per 1,000 catheter-days, respectively). CHSS-impregnated catheters were associated with lower CVC-related cost per day than standard catheters (€2.92 ± €1.77 vs. €18.22 ± €53.13, respectively). Survival analysis showed that CHSS-impregnated catheters were associated with increased CRBSI-free time compared with standard catheters. The use of CHSS-impregnated catheters reduced the incidence of CRBSI and immediate CVC related costs in the femoral venous access.

Previous cost-effectiveness analyses have found that the use of chlorhexidine-silver sulfadiazine (CHSS)-impregnated catheters is associated with decreased catheter-related bloodstream infections (CRBSI) and central venous catheter (CVC)-related costs. However, in these analyses, the CVC related cost included the increase of hospital stay. The aim was to determine the immediate CVC-related cost (including only the cost of CVC, diagnosis of CRBSI and antimicrobials for the treatment of CRBSI) of using a CHSS or a standard catheter in femoral venous access.

In Vitro And In Vivo Efficacy of Catheters Impregnated with Antiseptics or Antibiotics: Evaluation of the Risk of Bacterial Resistance to the Antimicrobials in the Catheters.

Source: *Infection Control and Hospital Epidemiology*. October 2001; 22 (10): 640-646.

Authors: Sampath LA, Tambe SM, Modak SM.

This trial evaluated the efficacy of an antiseptic catheter containing silver sulfadiazine and chlorhexidine on the external surface and chlorhexidine in the lumens (Arrowgard Blue Plus® Protection) as compared to an antibiotic catheter impregnated with minocycline and rifampin on its external and luminal surfaces. The antiseptic catheter with Arrowgard Blue Plus® Protection was shown to be more effective than the antibiotic catheter in preventing infection by *Candida* species and *Pseudomonas aeruginosa*. In addition, antiseptic catheters with Arrowgard Blue Plus® Protection were more effective when challenged by antibiotic-resistant organisms.

Safety and Efficacy of an Improved Antiseptic Catheter Impregnated Intraluminally with Chlorhexidine.

Source: *Journal of Infusion Nursing*. 2001; 24 (6): 395-403.

Authors: Sampath LA, Saborio DV, Yaron I, Modak S.

Investigators examined the safety and efficacy of a catheter with Arrowgard Blue Plus® Protection compared to a standard antiseptic catheter. In both *in vitro* and *in vivo* studies, the catheter with Arrowgard Blue Plus® Protection was shown to be significantly more effective in preventing luminal colonization than a standard antiseptic catheter. Colonization in untreated control catheters was measured at 67% and in standard antiseptic catheters at 40%; however, none of the catheters with Arrowgard Blue Plus® Protection became colonized. This success is attributed to increased levels of chlorhexidine on the outer surface and the introduction of chlorhexidine on the luminal surfaces. The higher levels of chlorhexidine on the outer surfaces make catheters with Arrowgard Blue Plus® Protection especially effective in preventing infections in long-term catheterizations (≥14 days).

Evaluation of Antiseptic-Impregnated Central Venous Catheters for Prevention of Catheter-Related Infection in Intensive Care Patients.

Source: *Diagnostic Microbiology and Infectious Disease*. 2000; 38 (1): 1-5.

Authors: Sheng WH, Ko WJ, Want JT, Chang SC, Hsueh PR, Luh KT.

An investigation of 235 catheterizations in surgical intensive care units showed that Arrow® antiseptic catheters impregnated with chlorhexidine and silver sulfadiazine provided safe protection against catheter-related infections. In the control group of standard catheters, the colonization rate was 20 per 100 catheters, vs a rate of 8 per 100 for the group that used Arrow® antiseptic catheters. Compared to the control group, the antiseptic catheters were five times less likely to produce catheter-related infection. The Arrow® impregnated catheters were especially effective against colonization by gram-positive cocci and fungi.

Adequacy of a New Chlorhexidine-Bearing Polyurethane Central Venous Catheter for Administration of 82 Selected Parenteral Drugs.

Source: *Annals of Pharmacotherapy*. 2000; 34 (10): 1109-1116.

Authors: Xu QA, Zhang Y, Trissel LA, Gilbert DL.

This study examined the effectiveness of the antiseptic central venous catheter with Arrowg+ard Blue Plus® Protection in delivering 82 parenteral medications. Researchers evaluated whether the anti-infective agents in the catheter compromised the delivery or effectiveness of the drugs in question, and whether the medications affected the amount of chlorhexidine removed from the internal lumens and delivered to the patient. Most of the drugs were delivered in excess of 97% of their initial concentrations, demonstrating that drug interactions are unlikely. None of the 82 medications caused substantial increases in chlorhexidine removal and delivery.

Activity of Antibacterial Impregnated Central Venous Catheters Against *Klebsiella Pneumoniae*.

Source: *Intensive Care Medicine*. 2002; 28 (4): 438-432.

Authors: Yorganci K, Krepel C, Weigelt JA, Edmiston CE.

This *in vitro* study assessed the performance of antiseptic catheters in reducing adherence, persistence, and colonization of *Klebsiella pneumoniae*. Researchers found that the catheter with Arrowg+ard Blue Plus® Protection demonstrated stronger bactericidal properties when compared to other types of catheters. In addition, the catheter with Arrowg+ard Blue Plus® Protection significantly reduced bacterial colonization due to its ability to inhibit adherence and persistence of infectious organisms. A catheter with Arrowg+ard Blue Plus® Protection is effective in eliminating *K. pneumoniae* from its surfaces for at least 21 days.

Antimicrobial Efficacy of Chlorhexidine-Silver Sulfadiazine and Minocycline-Rifampin Central Venous Catheters on Bacterial and Fungal Biofilm.

Source: Association for Vascular Access (AVA) 2011 Poster # 51

Authors: Gupta N, Steinke E, Patel-Giare K, Irish S.

This trial was designed to compare effectiveness of Chlorhexidine Silver-Sulfadiazine (CH-SSD) and Minocycline-Rifampin (MR) CVCs on a young and mature biofilm consisting of Methicillin Resistant *Staphylococcus aureus* (MRSA), *Pseudomonas aeruginosa* (PA) and *Candida albicans* (CA). The results demonstrated the effectiveness of CH-SSD catheter against biofilm of fungi, gram-positive and gram-negative bacteria. There was a noted resistance to colonization of microorganisms in the biofilm form. The MR catheter demonstrated effectiveness against gram-positive biofilm, but were limited in activity against gram-negative and fungal biofilm. Colonization resistance of microorganisms in biofilm was also limited.

Prevention of Intravascular Catheter-Related Infection with Newer Chlorhexidine-Silver Sulfadiazine-Coated Catheters: A Randomized Controlled Trial.

Source: *Intensive Care Medicine*. 2004; 30: 837-843.

Authors: Brun-Buisson C, Doyon F, Sollet J, Cochard J, et al.

A prospective, multi-center, randomized, double-blind clinical study of 397 patients was performed at 14 university-affiliated hospital ICUs in France from June 1998 to January 2002 using antimicrobial catheters with Arrowgard Blue Plus® Protection and uncoated Arrow® CVCs (control).

The data showed that the use of the central venous catheters with Arrowgard Blue Plus® Protection were associated with a strong trend toward reduction in infection rates. The colonization rate was 3.7% (catheters with Arrowgard Blue Plus® Protection) versus 13.1% (control) which is equivalent to 3.6 versus 11 per 1,000 catheter days, $p=0.01$. Catheter-related infections (bloodstream infection) were 4 (catheters with Arrowgard Blue Plus® Protection) versus 10 (control), which is equivalent to 2 versus 5.2 per 1,000 catheter-days, $p=0.10$. Both groups were similar in number, insertions sites, types of catheter(s) used and duration of catheterization.

Effect of a Second-Generation Venous Catheter Impregnated with Chlorhexidine and Silver Sulfadiazine on Central Catheter-Related Infections.

Source: *Annals of Internal Medicine*. October 2005; 143 (8): 570-580.

Authors: Rupp M, Lisco S, Lipsett P, Perl T, et al.

A prospective, multi-center, randomized, double-blind, controlled clinical study of 780 patients performed at nine university affiliated hospitals in the United States from July 1998 to June 2001 using antimicrobial catheters with Arrowgard Blue Plus® Protection showed that these catheters were less likely to be colonized at the time of removal compared to control (uncoated) catheters (9.3% [13.3] versus 16.3% [24.1] colonized catheters per 1,000 catheter-days, $p<0.01$).

The rate of definitive catheter-related bloodstream infection was 1.24 per 1,000 catheter-days (CI, 0.26 to 3.26 per 1,000 catheter days) for the control group versus 0.42 per 1,000 catheter days (CI, 0.01 to 2.34 per 1,000 catheter days) for the catheter with Arrowgard Blue Plus® Protection group ($p=0.6$). No conclusion can be reached regarding prevention of CRBSI. It appears that the study was underpowered because of an overestimation of the prevalence of CRBSI.

Patient groups had similar demographic features, clinical interventions, laboratory values and risk factors for infection. The study demonstrates that the second-generation antiseptic catheter is effective in preventing microbial colonization and, in the group studied, is not associated with excess adverse events, hypersensitivity, or emergence of antimicrobial antiseptic resistance.

Extension Lines of Antimicrobial Central Venous Catheters: An *In Vitro* Comparative Assessment of Antimicrobial Activity.

Source: Association for Vascular Access (AVA) 2007 Poster

Authors: Spangler D, Steinke E, Moss S and Rosenblatt J.

Chlorhexidine-Silver Sulfadiazine (CH-SSD) catheter extension lines consistently reduced adherence of all challenge organisms. Log₁₀ reductions with CH-SSD as compared to untreated controls were as follows: *C. albicans* 4, *E. faecalis* >5, *S. epidermidis* >6, and *S. aureus* and *P. aeruginosa* >7. Minocycline-Rifampin (MR) extension lines were ineffective at preventing adherence of *C. albicans*, *E. faecalis*, and *P. aeruginosa*. Some anti-adherent activity was seen with MR lines against *S. epidermidis* and *S. aureus*, but results were quite variable, indicating an inconsistent effect. Silver Carbon Platinum (SCP) extension lines were not effective at preventing adherence of any of the five challenge organisms. Extension lines from the CSS catheter were the only lines included in this study that showed broad spectrum efficacy in preventing the adherence of all 5 test organisms.

Chlorhexidine-Silver Sulfadiazine-Impregnated Venous Catheters Save Costs.

Source: *American Journal of Infection Control*. 2014; 42: 321-324

Authors: Lorente L, Lecuona M, Jiménez A, Santacreu R, Raja L, Gonzalez O, Mora M.

A prospective, observational, cohort study of patients admitted to the intensive care unit (ICU), Hospital Universitario de Canarias (Tenerife, Spain), who received 1 or more internal jugular venous catheters. The study included 245 CHSS-impregnated catheters and 391 standard catheters. CHSS-impregnated catheters were associated with a lower incidence of CRBSI, controlling for catheter duration, than standard catheters (0 vs 5.04 CRBSI per 1,000 catheter-days, respectively). CHSS-impregnated catheters were associated with lower CVC-related cost per day than standard catheters (€3.78 ± €4.45 vs €7.28 ± €16.71, respectively). Survival analysis showed that CHSS-impregnated catheters were associated with increased CRBSI-free time compared with standard catheters. The use of CHSS-impregnated catheters reduced the incidence of CRBSI and immediate CVC related costs in the internal jugular venous access.

Previous cost-effectiveness analyses have found that the use of chlorhexidine-silver sulfadiazine (CHSS)-impregnated catheters is associated with decreased catheter-related bloodstream infections (CRBSI) and central venous catheter (CVC)-related costs. However, in these analyses, the CVC-related cost included the increase of hospital stay. The aim was to determine the immediate CVC-related cost (including only the cost of CVC, diagnosis of CRBSI, and antimicrobials for the treatment of CRBSI) of using a CHSS or a standard catheter in internal jugular venous access.

Are Antibiotic Resistant “Super Bugs” a Real Challenge to Antimicrobial Central Venous Catheter Performance?

Source: Association for Vascular Access (AVA) 2014 Poster R5

Authors: Gupta N, Weber H, Moss S, and Giare-Patel K.

The study showed that most antibiotic resistant “super bugs” proved to be challenging to the performance of Minocycline-Rifampin (M-R) and Silver Carbon Platinum (SCP) CVCs but not to the Chlorhexidine-Silver Sulfadiazine (CH-SSD) CVC. The CH-SSD CVC showed the highest effectiveness, followed by MR and SCP CVCs in preventing catheter surface colonization by various “super bugs” tested in the study.

Antifungal Activity of Antiseptic and Antibiotic Treated CVCs Against Five Candida Strains for Seven Days.

Source: Society of Critical Care Medicine 2010 Poster 303

Authors: Steinke E and Rosenblatt J.

In vitro zone of inhibition studies with CVCs containing the Minocycline-Rifampin (M-R) combination showed some reduced growth but no clear ZOI against the Candida strains at day 1. Testing for recovery of adherent organisms on *C. krusei* challenged catheter segments (a more apparently inhibited Candida strain), showed significant numbers of adherent organisms on the M-R catheter at day 1 but less than the number on an untreated control catheter. The Chlorhexidine-Silver Sulfadiazine (CH-SSD) catheter produced clear, measurable ZOIs against all Candida strains for the full 7-day course of this study.

Efficacy Comparison of Three Different Antimicrobial Central Venous Catheters in Reducing Microbial Colonization.

Source: Association for Vascular Access (AVA) 2012 Oral presentation session number G104-1

Authors: Weber H, Moss S, and Gupta N.

Three antimicrobial CVCs were tested by a Colonization Reduction Test. The Chlorhexidine-Silver Sulfadiazine (CH-SSD) CVCs proved most efficacious in reducing microbial colonization on both the external and internal surfaces. The Minocycline-Rifampin (M-R) lacked consistent efficacy across range of microorganisms tested for both internal and external catheter surfaces. The Silver Carbon Platinum (SCP) CVCs demonstrated the least amount of efficacy of the 3 catheter technologies tested.

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For more information, please visit teleflex.com.

Rx only

Contraindication: Use of Arrowg+ard Blue Plus® antimicrobial catheter technology is contraindicated for patients with known hypersensitivity to chlorhexidine, silver sulfadiazine and/or sulfa drugs.

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