

ARROWGARD® CLINICAL BIBLIOGRAPHY

## ARROWGARD<sup>+</sup> CLINICAL BIBLIOGRAPHY

**The first antimicrobial-impregnated central venous catheter using chlorhexidine, a well-known antiseptic, and silver sulfadiazine, –and the only catheter backed by a decade of effectiveness.**

ARROWgard is the only antimicrobial-impregnated central venous catheter with more than a decade of proven effectiveness against CVC-related infection.

Two antimicrobial agents—chlorhexidine and silver sulfadiazine—are impregnated into the entire indwelling surface length of each ARROWgard catheter.

Considerable research has been conducted and published regarding the efficacy of ARROWgard, chlorhexidine and silver sulfadiazine in suppressing microbial colonization, and their effect on reducing hospital costs. A catheter-related bloodstream infection can prolong hospitalization and substantially add to the cost of hospitalization. In addition, numerous studies have investigated the incidence, impact and control of catheter-related bloodstream infections.

Our next-generation ARROWgard Blue PLUS® catheters give you protection against catheter-related infections both outside and in (including extension lines and hubs). The concentration of chlorhexidine on the outside surface is three times higher than on our original ARROWgard catheters. Chlorhexidine and silver sulfadiazine continuously prep the subcutaneous catheter tract and kill organisms in harder-to-reach areas, away from the influence of skin preps and external dressings.

Following is a listing of major studies in these areas, along with a brief synopsis of each. For additional information on the ARROWgard technology, please contact your Arrow Vascular Access sales representative, or call Customer Service at 800.523.8446 or 610.378.0131.

## ARROWgard CLINICAL BIBLIOGRAPHY

**TITLE: EFFICACY OF ANTISEPTIC-IMPREGNATED CENTRAL VENOUS CATHETERS IN PREVENTING CATHETER-RELATED BLOODSTREAM INFECTION: A META-ANALYSIS.****Journal:** *The Journal of the American Medical Association*. January 1999; 281(3): 261-267.**Authors:** Veenstra D, Saint S, Saha S, et al.**Source Support:** A meta-analysis of 12 studies for catheter colonization, including a total of 2611 catheters and 11 studies for catheter-related bloodstream infections, including a total of 2,603 catheters, was conducted to quantitatively assess the efficacy of chlorhexidine and silver sulfadiazine-impregnated central venous catheters. The meta-analytical techniques used provided a framework to evaluate merits of ARROWgard Blue technology in an unbiased manner. The meta-analysis concluded that central venous catheters impregnated with a combination of chlorhexidine and silver sulfadiazine appear to be effective in reducing both catheter colonization and catheter-related blood stream infections in patients at high risk for catheter related infections. There was an approximately 50% catheter colonization decrease and approximately 60% decrease in CVC-related BSI when ARROWgard Blue was used.**TITLE: PREVENTION OF CENTRAL VENOUS CATHETER-RELATED BLOODSTREAM INFECTION BY USE OF AN ANTISEPTIC-IMPREGNATED CATHETER: A RANDOMIZED, CONTROLLED TRIAL.****Journal:** *Annals of Internal Medicine*. August 1997; 127 (4): 257-266.**Authors:** Maki D, Stolz S, Wheeler S, et al.**Source Support:** Standard triple-lumen polyurethane catheters and chlorhexidine and silver sulfadiazine impregnated catheters were inserted in 158 adult surgical-medical intensive care patients. At removal, local and systemic effects were assessed. Catheter Colonization rates: Standard Central Venous Catheters (SCVC) = 24.1 per 100 catheters; Antiseptic-impregnated Central Venous Catheters (ACVC) = 13.5 per 100 catheters. BSI: SCVC = 7.6 per 1000 catheter days; ACVC = 1.6 per 1000 catheter days. It was concluded that the time noncuffed central venous catheters can be safely left in place is extended with chlorhexidine and silver sulfadiazine-impregnated catheters.**TITLE: USE OF AN ANTISEPTIC-IMPREGNATED CENTRAL VENOUS CATHETER FOR THE PREVENTION OF CATHETER-RELATED INFECTIONS: RESULTS OF A PROSPECTIVE RANDOMIZED TRIAL.****Journal:** *Critical Care Medicine*. January 1997; 25 (1): A84.**Authors:** Collin G.**Source Support:** Antiseptic-impregnated catheters (AIC) and non-impregnated catheters (NIC) were placed in two groups of patients comparable in age, sex, major diagnosis, etc. The AIC group had a statistically significant lower infection rate (2.0% AIC vs. 18% NIC).**TITLE: ANTISEPTIC-IMPREGNATED CENTRAL VENOUS CATHETERS REDUCE THE INCIDENCE OF BACTERIAL COLONIZATION AND ASSOCIATED INFECTION IN IMMUNOCOMPROMISED TRANSPLANT PATIENTS.****Journal:** *European Journal of Anaesthesiology*. 1997; 14: 428-431.**Authors:** George S, Vuddamalay P, Boscoe M.**Source Support:** Thoracic organ transplant patients received either a standard polyurethane catheter or a catheter impregnated with silver sulfadiazine and chlorhexidine. Bacterial colonization occurred in 10 of 44 impregnated catheters and 25 of 35 standard catheters. Concomitant infection by the same organism at another site also was significantly reduced in the impregnated-catheter patients.**TITLE: RETENTION OF ANTIBACTERIAL ACTIVITY AND BACTERIAL COLONIZATION OF ANTISEPTIC-BONDED CENTRAL VENOUS CATHETERS.****Journal:** *Journal of Antimicrobial Chemotherapy*. 1996; 37: 315-322.**Authors:** Bach A, Schmidt H, Bottiger B, et al.**Source Support:** A total of 116 ARROWgard Blue catheters were tested for antibacterial activity in an *in-vitro* bioassay after various periods of IV catheterization. The silver sulfadiazine and chlorhexidine-impregnated catheters were effective in reducing bacterial colonization, which was significantly lower and occurred less frequently.**TITLE: ANTISEPTIC-IMPREGNATED NON-TUNNELED CENTRAL VENOUS CATHETERS: REDUCING INFECTION RISKS AND ASSOCIATED COSTS.****Journal:** *Dialysis & Transplantation*. November 1996; 25 (11): 784-798.**Authors:** Civetta J.**Source Support:** 363 antiseptic-impregnated catheters and 362 standard CVCs with similar dwell times were compared for colonization, significant pathogens, pharmacy costs per patient and total hospital charges per patient. There was significantly less colonization and presence of pathogens and significant dollar savings in patients with the antiseptic-impregnated catheters.**TITLE: DECREASING CATHETER-RELATED INFECTION AND HOSPITAL COSTS BY CONTINUOUS QUALITY IMPROVEMENT.****Journal:** *Critical Care Medicine*. October 1996; 24 (10): 1660-1665.**Authors:** Civetta J, Hudson-Civetta J, Ball S.**Source Support:** The use of chlorhexidine skin preparation, ARROWgard Blue catheters and substituting suspected catheter sepsis for fever as a guide wire exchange indication was studied as a way to reduce the rate of catheter-related infection, patient risks and hospital costs. This method significantly decreased the rate of catheter-related infection and increased the duration of catheterization, decreasing the number of catheters used, resulting in an approximate cost savings of \$210 per patient or a total cost savings of \$4,750 per month.**TITLE: IMPACT OF CHLORHEXIDINE-SILVER SULFADIAZINE-IMPREGNATED CENTRAL VENOUS CATHETERS ON *IN VITRO* QUANTITATION OF CATHETER-ASSOCIATED BACTERIA.****Journal:** *Journal of Clinical Microbiology*. March 1996; 34 (3): 508-511.**Authors:** Schmitt S, Knapp C, Hall G, et al.**Source Support:** Central venous catheters impregnated with silver sulfadiazine and chlorhexidine and standard catheters were investigated in an *in vitro* assay. After 24 hours of incubation, the impregnated catheter was surrounded by a well-defined zone of inhibition, while the non-impregnated catheter was not.**TITLE: DECREASED BACTERIAL ADHERENCE AND BIOFILM FORMATION ON CHLORHEXIDINE AND SILVER SULFADIAZINE-IMPREGNATED CENTRAL VENOUS CATHETERS IMPLANTED IN SWINE.****Journal:** *Critical Care Medicine*. May 1995; 23 (5): 894-900.**Authors:** Greenfield J, Sampath L, Popilskis S, et al.**Source Support:** Non-impregnated control and ARROWgard Blue catheters were inserted intravascularly into swine for 7 days. The catheters were then assessed for bacterial adherence and biofilm formation. The ARROWgard Blue catheters prevented bacterial adherence and biofilm formation, which was evident on the controls, and produced no local or systemic toxicity.

ARROWg<sup>+</sup>ard CLINICAL BIBLIOGRAPHY**TITLE: INFECTION RESISTANCE OF SURFACE MODIFIED CATHETERS WITH EITHER SHORT-LIVED OR PROLONGED ACTIVITY.****Journal:** *Journal of Hospital Infection.* 1995; 30: 201-210.**Authors:** Sampath L, Chowdhury N, Caraos L, et al.**Source Support:** Using a rat subcutaneous model, ARROWg<sup>+</sup>ard Blue catheters were compared with benzalkonium chloride-heparin bonded, hydrophilic coated and control catheters to determine efficacy in reducing the risk of colonization and infection. ARROWg<sup>+</sup>ard Blue catheters were colonized in only 19% of the animals compared to 100% with the other catheters, which also had significant bacterial adherence on their surface. Investigators concluded that the efficacy of ARROWg<sup>+</sup>ard Blue catheters may be due to the initial high rate of kill and prolonged antimicrobial activity.**TITLE: CENTRAL VENOUS PRESSURE (CVP) CATHETER-RELATED BACTEREMIA IN THE INTENSIVE CARE UNITS (ICU).****Journal:** *Infection Control and Hospital Epidemiology.* April 1995; 16 (4)(pt. 2): 38.**Authors:** Jendresky L and Angus G.**Source Support:** Routine surveillance of CVP catheter-related bacteremia in the ICU was performed for a period of one year. After review of CVP catheter practice and procedure, corrective actions were taken to include multidisciplinary procedures on CVP insertion, line changes, dressing and culturing techniques, a new dressing kit and the use of ARROWg<sup>+</sup>ard Blue catheters. These changes resulted in a significant decrease in CVP-related bacteremia and femoral line-related infection, and a decrease in length of stay, mortality and morbidity in the ICU.**TITLE: CHLORHEXIDINE/SILVER SULFADIAZINE COATED CATHETERS: EFFECT OF DURATION OF CATHETERIZATION ON *IN VITRO* ANTIMICROBIAL ACTIVITY.****Journal:** *Critical Care Medicine.* January 1995; 23 (Suppl. 1): A172.**Authors:** Wagle M, Brueggemann A, Doern G, et al.**Source Support:** ARROWg<sup>+</sup>ard Blue catheters were evaluated for duration of antimicrobial activity after removal from patients. There was approximately a 50% decline in *in vitro* inhibition of growth after 4 days, with little decline in growth inhibition thereafter. An ARROWg<sup>+</sup>ard catheter in place for 23 days still showed antimicrobial activity.**TITLE: IMPACT OF ANTISEPTIC IMPREGNATION ON CENTRAL VENOUS CATHETER-ASSOCIATED BLOODSTREAM INFECTIONS.****Journal:** *Infection Control and Hospital Epidemiology.* April 1995; 15 (4)(Pt. 2): 24.**Authors:** Raymond N and Steinberg J.**Source Support:** Over five years, ARROWg<sup>+</sup>ard Blue catheters were phased in and then used exclusively: Period 1, non-impregnated catheters only; Period 2, both available; Period 3, ARROWg<sup>+</sup>ard Blue near exclusive use. A significant reduction in catheter-related bloodstream infections was seen from period 1 to period 3, with a twofold reduction associated with the use of ARROWg<sup>+</sup>ard Blue.**TITLE: EFFICACY OF ANTISEPTIC IMPREGNATED CENTRAL VENOUS CATHETERS (CVCS) IN REDUCING THE RATE OF BLOODSTREAM INFECTIONS (BSIS) IN INTENSIVE CARE UNITS (ICUS) OF A TERTIARY REFERRAL HOSPITAL.****Journal:** *Infection Control and Hospital Epidemiology.* April 1995; 16 (4)(Pt. 2): 24.**Authors:** Lovell R, Corbett J and Lowery G.**Source Support:** For a period of one year, the rate of BSIs for all adults in the ICU was 8.1/1000 catheter-days. During this time, maximal sterile barriers were employed. ARROWg<sup>+</sup>ard Blue catheters were then used over the next 12-month period with a decrease in the BSI rate to 5.2/1000 catheter-days. The surgical ICU decreased BSIs from 8.9 to 4.2 BSI/1000 catheter-days. Over a two-year period, a significant 36% decrease in the BSI rate was realized in all adult ICUs as a result of the use of the antiseptic-impregnated CVCs.**TITLE: EXAMINATION OF ANTIMICROBIAL COATED CENTRAL VENOUS CATHETERS IN PATIENTS AT HIGH RISK FOR CATHETER-RELATED INFECTIONS IN A MEDICAL INTENSIVE CARE UNIT AND LEUKEMIA/BONE MARROW TRANSPLANT UNIT.****Journal:** *Critical Care Medicine.* January 1995; 23 (Suppl. 1): A152.**Authors:** Trazzera S, Stern G, Bhardwaj R, et al.**Source Support:** ARROWg<sup>+</sup>ard Blue catheters were compared with standard central venous catheter duration of insertion and catheter-related sepsis in a group at high risk for catheter-related infections. Catheter colonization rates were significantly higher in the standard group despite a 67% increase in duration of insertion for the ARROWg<sup>+</sup>ard Blue group. The investigators concluded that ARROWg<sup>+</sup>ard Blue catheters can be left in place for a significantly longer duration without an increase in catheter-related sepsis, and considering the morbidity, mortality and high cost of treating catheter-related sepsis, ARROWg<sup>+</sup>ard Blue should be the catheter of choice in this high-risk group.**TITLE: REDUCTION OF BACTERIAL COLONIZATION OF TRIPLE-LUMEN CATHETERS WITH ANTISEPTIC BONDING IN SEPTIC PATIENTS.****Journal:** *Anesthesiology.* September 1994; 81 (3A): A261.**Authors:** Bach A, Böhrer H, Böttiger B, et al.**Source Support:** Twenty-six postoperative septic patients were randomized to receive either an ARROWg<sup>+</sup>ard Blue or an untreated triple-lumen catheter. After 7 days the silver sulfadiazine and chlorhexidine-impregnated catheters showed significant reduction of bacterial colonization of the intravascular catheter segment in septic critical care patients. This study of septic critical care patients suggests that the use of antiseptic-bonded catheters can reduce secondary catheter-related infections by inhibiting bacterial colonization from a primary septic focus.**TITLE: PREVENTION OF BACTERIAL COLONIZATION OF INTRAVENOUS CATHETERS BY ANTISEPTIC IMPREGNATION OF POLYURETHANE POLYMERS.****Journal:** *Journal of Antimicrobial Chemotherapy.* May 1994; 33 (5): 969-978.**Authors:** Bach A, Böhrer H, Motsch J, et al.**Source Support:** Rats were implanted with antiseptic-impregnated catheters and non-antiseptic-impregnated catheters. The rate and magnitude of bacterial colonization was assessed after 3 and 7 days. After 3 and 7 days, the magnitude of bacterial colonization was significantly lower with the antiseptic-impregnated catheters.**TITLE: DOES MODIFICATION OF THE CATHETER SURFACE AFFECT THE INFECTION RATE OF TRIPLE-LUMEN CATHETERS?****Journal:** *Chest.* August 1994; 106 (Suppl.): 176S.**Authors:** Appavu, McKinney G, Bonness M, et al.**Source Support:** Critically ill patients receiving their first CVCs were randomly assigned to receive a standard triple-lumen catheter (group 1), a hydrophilic catheter (group 2) or an ARROWg<sup>+</sup>ard Blue catheter (group 3). The longest stay for an uninfected catheter was 14 days for group 1, 19 days for group 2 and 21 days for group 3. Investigators concluded that the ARROWg<sup>+</sup>ard Blue catheters have the lowest infection rate and remain uninfected for the longest period.

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**TITLE: RESPONSE TO A LETTER TO THE EDITOR.****Journal:** *The Journal of the American Medical Association*. December 1994; 272 (23): 1820.**Authors:** Pittet D.**Source Support:** In Reply — Dr. Heiselman correctly notes that nosocomial bloodstream infections from IV lines can be associated with significant morbidity and economic burden; he also stresses the fact that appropriate time of replacement or removal of IV lines is essential for preventing secondary bloodstream infection.

In our study population, IV lines were responsible for at least 20 (23%) of the 86 episodes of bloodstream infection. The attributable mortality from the infection in this subpopulation was 25% (nine cases vs four controls died). When only matched case-control pairs who survived bloodstream infection (n=11) were considered among patients with infections of IV line origin, cases stayed an additional 6.5 days in the surgical care unit (SICU) (median stay, 15.5 days for cases vs. 9 days for controls); extra costs attributable to the infection averaged \$28,690 per survivor.

**TITLE: COMPARISON OF CATHETER-RELATED BACTEREMIAS USING CHLORHEXIDINE/SILVER SULFADIAZINE IMPREGNATED CENTRAL VENOUS CATHETERS (CSIC) VERSUS NON-IMPREGNATED CATHETERS (NIC).****Journal:** *Infection Control and Hospital Epidemiology*. April 1994; 15 (4)(Pt. 2)(Suppl.): 24.**Authors:** Pfeiffer J, Bennet M and Simpson M.**Source Support:** For a six-month period, only ARROWgard Blue catheters were used in the ICU, with only one bacteremia occurring for 448 catheters compared to 21 nosocomial infections with 839 non-impregnated catheters. Sixty charts were audited with no clinical evidence of catheter-related infection and on 20 catheter tips cultured, there was no growth. Average cost saved during the trial was \$50,000.**TITLE: PREVENTION OF CATHETER-RELATED INFECTIONS BY ANTISEPTIC BONDING.****Journal:** *Journal of Surgical Research*. 1993; 55: 640-646.**Authors:** Bach A, Bohrer H, Motsch J, et al.**Source Support:** In 40 laboratory rats, ARROWgard Blue and control catheters were implanted and assessed after either 3 or 7 days. The data obtained suggest that ARROWgard Blue catheters may substantially decrease the magnitude of catheter-related microbial colonization and subsequent catheter-related infections.**TITLE: PREVENTION OF CATHETER-RELATED COLONIZATION BY SILVER-SULFADIAZINE-CHLORHEXIDINE (SSC) BONDING: RESULTS OF A PILOT STUDY IN CRITICAL CARE PATIENTS.****Journal:** *Programs & Abstracts of the ICAAC, American Society of Microbiology*. Oct 1993. Abstract 1621.**Authors:** Bach A, Geiss M, Geiss HK, et al.**Source Support:** In 40 postoperative cardiac surgical patients, either ARROWgard Blue or untreated single-lumen catheters were inserted into the jugular veins, removed after seven days, divided into intracutaneous and intravenous segments and cultured. There was a significantly lower incidence and level of bacterial colonization of catheter tips (intravenous) with the ARROWgard Blue patients. The researchers concluded that migration of bacteria along the catheter into the bloodstream can be diminished by antiseptic bonding.**TITLE: PREVENTION OF CENTRAL VENOUS CATHETER-ASSOCIATED INFECTION IN BURN PATIENTS WITH ANTISEPTIC CATHETER AND VITACUFF®.****Journal:** *Presentation at the American Burn Association 25th Annual Meeting, Cincinnati, OH*. 1993.**Authors:** Leclair J, Markmann D, Meek M, et al.**Source Support:** Triple lumen antiseptic-impregnated catheters with VitaCuff (VC) not routinely exchanged over a guide wire and standard triple-lumen catheters exchanged over a guide wire were investigated in burn patients. It was concluded that antiseptic-VC catheters are associated with a decreased incidence of catheter colonization and appear to be associated with a reduced incidence of BSI. BSI/1000 catheter days: Antiseptic-VC = 2/267 (7.5%), SC = 13/583 (22.3%).**TITLE: SURFACE ANTIMICROBIAL ACTIVITY OF HEPARIN-BONDED AND ANTISEPTIC-IMPREGNATED VASCULAR CATHETERS.****Journal:** *Journal of Infectious Diseases*. 1993; 167: 920-924.**Authors:** Mermel L, Stolz S and Maki D.**Source Support:** Heparin-bonded pulmonary artery catheters and ARROWgard Blue catheters were investigated in an *in vitro* assay. The ARROWgard Blue catheters exhibited greater antimicrobial activity against a wide variety of potential pathogens. When exposed to serum for 24 hours, heparin-bonded catheters lost >50% of their antimicrobial activity, while ARROWgard Blue catheters were minimally affected.**TITLE: A STUDY OF AN ANTISEPTIC IMPREGNATED CENTRAL VENOUS CATHETER FOR PREVENTION OF BLOODSTREAM INFECTION****Journal:** *Program and Abstracts of the 33rd ICAAC, American Society of Microbiology*. October 1993. Abstract 1624**Authors:** Clemence M, Jernigan J, Titus M, et al.**Source Support:** For over a period of one year, patients in medical and surgical intensive care units received ARROWgard Blue catheters unless they were sulfa allergic or already had a CVC in place. A 60% reduction in the rate of primary bloodstream infections was realized in the ICUs while the rate in the rest of the hospital remained constant.**TITLE: DEVELOPMENT AND EVALUATION OF A NEW POLYURETHANE CENTRAL VENOUS ANTISEPTIC CATHETER: REDUCING CENTRAL VENOUS CATHETER INFECTIONS.****Journal:** *Infections in Medicine*. June 1992; 9: 23-29.**Authors:** Modak S and Sampath L.**Source Support:** ARROWgard Blue and unimpregnated control catheters were subcutaneously implanted in rats, followed by contamination of the insertion site. The degree of contamination was significantly lower in the ARROWgard Blue group, with only 20% colonization after 10 days, compared to 100% in the control group.**TITLE: ARROWGARD ANTISEPTIC SURFACE—TOXICOLOGY REVIEW.****Journal:** Monograph. Reading, PA: Arrow International, Inc. 1992.**Authors:** Farber T.**Source Support:** Although hypersensitivity reactions are known to occur when patients are exposed to silver sulfadiazine and chlorhexidine, only minute quantities of these agents are released from the antiseptic catheter. Thus, the possibility that such reactions would occur through the use of this catheter is quite remote. Allergic reactions to silver are rare and are associated with a long duration of exposure at levels considerably higher than that seen with this antiseptic catheter. Hypersensitivity reactions to sulfadiazine are seen in one to two percent of patients. Sulfonamide sensitivity reactions are least likely to develop if the daily dose of sulfonamide is below two grams or blood levels are below 5000 µg/dl.

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The level of sulfadiazine in the blood of catheterized patients would not exceed eight µg/dl in a worst-case scenario, i.e., if all the sulfadiazine in the catheter was released all at once and distribution of the sulfadiazine to other body compartments did not occur. Thus, there is little or no theoretical likelihood that patients would be sensitive to this level of exposure. Lastly, no adverse effects of a toxicologic nature have been associated with the clinical use of this antiseptic catheter in spite of the fact that the catheter has been placed in patients sensitive to sulfonamides but who were unaware of their sensitivity.

**TITLE: ARE ANTIBACTERIALLY IMPREGNATED CATHETERS COST-EFFECTIVE?**

**Journal:** *Critical Care Medicine*. 1996; 24 (Suppl. 1): A45.

**Authors:** Booth F, Cohen I, Kerins R, et al.

**Source Support:** Over a period of eight months, 363 ARROWg<sup>+</sup>ard Blue catheters and 362 non-impregnated catheters were inserted into patients. When hospital charges were compared between the two groups, despite lack of demographic differences, overall charges were significantly less for the ARROWg<sup>+</sup>ard Blue. The use of impregnated triple-lumen central venous catheters (IC) is associated with both a reduction in pharmacy charges of \$1221.00 and in hospital charges of over \$8,000.00 per patient. If substantiated, these observations imply a potential annual saving of (360x8000x3) or over \$8,000.00 for an incremental expenditure of \$50,000.00.

**TITLE: INCIDENCE OF CATHETER COLONIZATION AND CATHETER-RELATED INFECTION WITH AN ANTISEPTIC IMPREGNATED TRIPLE-LUMEN CATHETER.**

**Journal:** *Critical Care Medicine*. 1994; 22 (Suppl. 1): A115.

**Authors:** Ramsay J, Nolte F, and Schwarzmann S.

**Source Support:** Patients without neutropenia or suspected bloodstream infection were randomized to receive an ARROWg<sup>+</sup>ard Blue or a standard triple-lumen catheter. No routine catheter changes were permitted and, after removal, the distal 5cm and intracutaneous segments of the catheters were cultured and peripheral blood cultures for suspected bacteremia were done. Hospital wide, significantly fewer ARROWg<sup>+</sup>ard Blue catheters were colonized and there were fewer catheter-related bloodstream infections.

**TITLE: EVALUATION OF A TRIPLE-LUMEN CENTRAL VENOUS HEPARIN-COATED CATHETER VERSUS A CATHETER COATED WITH CHLORHEXIDINE AND SILVER SULFADIAZINE IN CRITICALLY ILL PATIENTS.**

**Journal:** *Intensive Care Medicine*. 2004; 30 (4): 633-638.

**Authors:** Carrasco MN, Bueno A, de las Cuevas C, Jimenez S, Salinas I, Sartorius A, Recio T, Generelo M, Ruiz-Ocana F.

**Source Support:** Researchers investigated catheter colonization and catheter-related bloodstream infections in 260 tri-lumen central venous catheters placed in 180 ICU patients. This was the first study to examine the relative efficacy of heparin-coated catheters and catheters coated with chlorhexidine and silver sulfadiazine. The incidence of colonization was 23.5 and 11.5 episodes of catheter colonization per 1,000 catheter-days, respectively, for heparin-coated catheters and Arrow's silver sulfadiazine-coated catheters. The incidence of catheter-related bloodstream infections per 1,000 catheter-days was 3.24 in heparin-coated catheters and 2.6 in chlorhexidine and silver sulfadiazine-coated catheters. The study showed a substantially lower rate of colonization (particularly by fungi and gram-positive cocci) in Arrow chlorhexidine and silver sulfadiazine-coated catheters as compared to heparin-coated catheters.

**TITLE: DECREASING CATHETER COLONIZATION THROUGH THE USE OF AN ANTISEPTIC-IMPREGNATED CATHETER: A CONTINUOUS QUALITY IMPROVEMENT PROJECT.**

**Journal:** *Chest*. June 1999; 115 (6): 1632-1640.

**Authors:** Collin GR.

**Source Support:** In a two-phase clinical trial, researchers evaluated the effectiveness of the ARROWg<sup>+</sup>ard antiseptic-impregnated catheter (AIC) vs. a non-impregnated catheter (NIC) in preventing catheter colonization and catheter-related bloodstream infection (CR-BSI) in trauma patients. Results showed that 25 of the 139 NICs placed in 60 patients became colonized, compared to colonization of just two of the 93 AICs placed in 55 other patients. The colonization rates were 24.68/1,000 catheter days in the NIC group and 2.27/1,000 catheter days in the AIC group. The CRBSI rates were 3.9.5/1,000 catheter days (NIC) and 1.14/1,000 catheter days (AIC). After hospital policy was updated to require the use of ARROWg<sup>+</sup>ard AICs in all trauma patients, researchers assessed the effectiveness of this change in reducing infection. In the 213 AICs placed in 101 patients, the colonization rate was 3.8/100 catheters (4.52/1,000 catheter days), and the CR-BSI rate was 1.0/100 catheters (0.6/1,000 catheter days). The use of ARROWg<sup>+</sup>ard AICs yielded an 89% reduction in catheter colonization and a 71% reduction in CRBSI.

**TITLE: COMPARISON OF MICROBIAL ADHERENCE TO ANTISEPTIC AND ANTIBIOTIC CENTRAL VENOUS CATHETERS USING A NOVEL AGAR SUBCUTANEOUS INFECTION MODEL.**

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

**Authors:** Gaonkar TA and SM Modak.

**Source Support:** 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 ARROWg<sup>+</sup>ard chlorhexidine and silver sulfadiazine impregnated catheters; ARROWg<sup>+</sup>ard chlorhexidine and silver sulfadiazine impregnated catheters with higher levels of chlorhexidine; minocycline-rifampicin (MR) catheters; and silver catheters against several bacterial strains. ARROWg<sup>+</sup>ard catheters 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.

**TITLE: PREVENTING COMPLICATIONS OF CENTRAL VENOUS CATHETERIZATION.**

**Journal:** *New England Journal of Medicine*. 2003; 348 (12): 1123-1133.

**Authors:** McGee, DC and MK Gould.

**Source Support:** This review of methods to prevent complications of central venous catheterization recommends that antimicrobial-impregnated catheters (AIC) be considered in all cases where catheterization is required. The authors note that AICs are especially effective when the institutional rate of catheter-related bloodstream infections is higher than two percent; this is the threshold at which chlorhexidine and silver sulfadiazine-impregnated catheters may reduce overall costs. Clinical studies show that the use of catheters impregnated with chlorhexidine and silver sulfadiazine lowers the rate of catheter-related bloodstream infections from 7.6 infections per 1,000 catheter-days (4.6% of catheters) to 1.6 infections per 1,000 catheter-days (1.0%). A cost-effectiveness study showed that using these anti-infective catheters would decrease direct medical costs by \$196 per catheter inserted.

## ARROWgard® BLUE PLUS CLINICAL BIBLIOGRAPHY

**TITLE:** *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.*

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

**Authors:** Sampath LA, Tambe SM, Modak SM.

**Source Support:** 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) as compared to an antibiotic catheter impregnated with minocycline and rifampin on its external and luminal surfaces. The ARROWgard Blue PLUS antiseptic catheter was shown to be more effective than the antibiotic catheter in preventing infection by *Candida* species and *Pseudomonas aeruginosa*. In addition, ARROWgard Blue PLUS antiseptic catheters were more effective when challenged by antibiotic-resistant organisms.

**TITLE:** *SAFETY AND EFFICACY OF AN IMPROVED ANTISEPTIC CATHETER IMPREGNATED INTRALUMINALLY WITH CHLORHEXIDINE.*

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

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

**Source Support:** Investigators examined the safety and efficacy of the ARROWgard Blue PLUS compared to a standard antiseptic catheter. In both *in vitro* and *in vivo* studies, ARROWgard Blue PLUS 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 ARROWgard Blue PLUS catheters 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 ARROWgard Blue PLUS especially effective in preventing infections in long-term catheterizations (≥14 days).

**TITLE:** *PROLONGED ANTIMICROBIAL ACTIVITY OF A CATHETER CONTAINING CHLORHEXIDINE-SILVER SULFADIAZINE EXTENDS PROTECTION AGAINST CATHETER INFECTIONS IN VIVO.*

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

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

**Source Support:** 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 (ARROWgard Blue PLUS) is impregnated with three times the chlorhexidine content of a conventional ARROWgard Blue catheter. 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.

**TITLE:** *EVALUATION OF ANTISEPTIC-IMPREGNATED CENTRAL VENOUS CATHETERS FOR PREVENTION OF CATHETER-RELATED INFECTION IN INTENSIVE CARE PATIENTS.*

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

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

**Source Support:** 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.

**TITLE:** *ADEQUACY OF A NEW CHLORHEXIDINE-BEARING POLYURETHANE CENTRAL VENOUS CATHETER FOR ADMINISTRATION OF 82 SELECTED PARENTERAL DRUGS.*

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

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

**Source Support:** This study examined the effectiveness of the ARROWgard Blue PLUS antiseptic central venous catheter 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.

**TITLE:** *ACTIVITY OF ANTIBACTERIAL IMPREGNATED CENTRAL VENOUS CATHETERS AGAINST KLEBSIELLA PNEUMONIAE.*

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

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

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

**TITLE:** *PREVENTION OF INTRAVASCULAR CATHETER-RELATED INFECTION WITH NEWER CHLORHEXIDINE-SILVER SULFADIAZINE-COATED CATHETERS: A RANDOMIZED CONTROLLED TRIAL.*

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

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

**Source Support:** 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 ARROWgard Blue PLUS antimicrobial catheters and uncoated Arrow CVCs (control).

## ARROWgard BLUE PLUS CLINICAL BIBLIOGRAPHY

The data showed that the use of the ARROWgard Blue PLUS central venous catheters was associated with a strong trend toward reduction in infection rates. The colonization rate was 3.7% (ARROWgard Blue PLUS) 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 (ARROWgard Blue PLUS) 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.

**TITLE: EFFECT OF A SECOND-GENERATION VENOUS CATHETER IMPREGNATED WITH CHLORHEXIDINE AND SILVER SULFADIAZINE ON CENTRAL CATHETER-RELATED INFECTIONS.**

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

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

**Source Support:** 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 ARROWgard Blue PLUS antimicrobial catheters 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 ARROWgard Blue PLUS catheter 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.



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