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The Journal of the Association for Vascular Access

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Achieving Zero Catheter Related Blood Stream Infections: 15 Months Success in a Community Based Medical Center

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***Abstract**: Achieving Zero Catheter Related Blood Stream Infections: 15 Month Success In A Community Based Medical Center.* ***Background and Purpose**: Catheter related blood stream infection (CRBSI) is a major cause of patient morbidity, mortality, and cost. Lower CRBSI rates would decrease inpatient length of stay.* ***Project**: An innovative central line bundle was developed to reduce CRBSI. An innovative combination of focused nursing practice and product technologies were selected for the bundle and implemented through a defined educational program. Data was collected from thirty-two critical care beds: 16 medical/surgical ICU and 16 Trauma-Neuro ICU beds.* ***Results**: From January 2006 thru March 2007 there were Zero occurrences of CRBSI. Over this 15 month period our PICC insertions increased by 103%, and our interventional radiology referral rate decreased to less than 2%.* ***Implications/Conclusions**: A multimodality bundle, combining nursing practice interventions and technology can successfully decrease the incidence of CRBSI. While some of the bundle components have not been widely researched and instead are based on theory or accepted clinical practice, the early outcome provides a basis for additional study and refinement. It also invites research into the various components of the bundle to evaluate the effect each separate practice and product lends to its success.*

Reducing Catheter Related Blood Stream Infections (CRBSI) is a goal for all clinicians and hospitals and is part of the Institute for Healthcare Improvement (IHI) 100,000 Lives Campaign (Institute for Healthcare Improvement, 2007a). Sutter Roseville Medical Center (SRMC) is a 180 bed acute care, community based, not for profit hospital with thirty-two critical care beds, a thirty-one bed emergency department (70,000 visits) and Level Two trauma center. Our total patient census has remained steady over the past two years having a daily occupancy rate of 143 patients.

CRBSI are common, costly, and potentially lethal (Mermel, 2000). There is a wide range of documented CRBSI rates in the literature, depending on the care setting and patient risk factors. According to the National Nosocomial Infections Surveillance (NNIS) system of the Centers for Disease Control and Prevention (CDC), the median rate of CRBSI in Critical Care Units for all types of catheters ranges from 1.8 to 5.3 per 1000 catheter days (Centers for Disease Control and Prevention, 1998). The average cost of treating a CRBSI ranges from $25,000 to $45,000 per occurrence (O'Grady, Alexander & Dellinger, 2002; Krzywda & Andris, 2005). Catheter related blood stream infection (CRBSI) is a major cause of patient morbidity, mortality and cost. Lower CRBSI rates would decrease inpatient length of stay and improve patient safety and satisfaction. The importance of reducing CRBSI cannot be overstated.

In December of 2005, we were a small team focused on peripheral intravenous (IV) starts and few peripherally inserted central catheter (PICC) insertions. Realizing that this was not a cost-effective service, and not the best use of the skill that our team possessed, it was decided to redirect our focus and expertise towards an advanced vascular access team. The team would take ownership of PICC insertion and maintenance of vascular access devices

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DOI: 10.2309/java.12-4-8

(VAD). This new strategy would advocate our PICC practice, improve patient care, and should decrease our CRBSI rate. This paper will provide an overview of CRBSI, discuss baseline infection control, and describe the institution's PICC data from the year prior to the team's development. Further we will describe the rationale and implementation strategies of the vascular access team, the results for 15 months following implementation, and the discussion of the overall program.

Overview of CRBSI

The major identified causes of CRBSI are bacterial contamination, migration both extraluminally down the catheter track and intraluminally down the fluid pathway and catheter wall adhesion with subsequent biofilm development occurring during colonization (Ryder, 2005). Bacteria most likely to produce CRBSI are the Coagulase Negative *Staphylococci* (*Darniche, Duncan, Ghannoum, Jarvis, Ryder & Tapper*, 2005), *S. epidermidis* (extraluminal), and *S. aureus* (Intraluminal). Other microorganisms associated with CRBSI are *C. albicans*, Methicillin Resistant *S. aureus* (MRSA), *P. aeruginosa*, *E. coli, E. faecalis*, and *K. pneumonia* (Richard, 2001; Crnich & Maki, 2005; O'Grady, Alexander, & Dellinger 2002. Depending on the vascular access device (VAD) and the insertion location, potential extraluminal contamination rates vary. VAD insertion is the first opportunity for bacteria to enter the catheter tract. VAD selection, insertion site selection, skin prep, insertion technique, dressing maintenance, and use of insertion site protection technology are critical to eliminating extraluminal tract contamination. The intraluminal fluid pathway is protected by the IV connector. This device is the primary line of defense for preventing bacteria from entering the fluid pathway. Poor IV connector septum seal integrity provides an environment for bacterial migration (passive and active) into the intraluminal fluid pathway and bacteria adhere to the surface. The presence of intraluminal wall fibrin in the connector and the catheter, resulting from blood draws and reflux, also provide an environment for bacterial adhesion (Timsit,2003). Once bacteria adhere then colonization occurs with subsequent polysaccharide secretion known as biofilm.

Occlusion is the most common non-infectious complication associated with the use of venous access devices. Occlusion has been identified as a risk factor for CRBSI (Krzywda & Andris, 2005; Van Rooden et al., 2005). The exact rate of occlusions may be under reported. Current research reports that up to 50% of all catheters may experience an occlusive complication (Krzywda & Andris, 2005). Occlusions have a mechanical, drug incompatibility or thrombotic origin. Preventing occlusion relies on clinician care and maintenance of the VAD. While there is no definitive research to guide flushing practice on either volume or technique, common practice is 10 mL Normal Saline and push-pause technique (Hadaway, 2006). In order to prevent sudden complete occlusion (CO) there must be a pressure source (fluid infusing or injecting) providing sufficient force to overcome the patient's blood pressure.

A VAD lumen may also become occluded slowly over time resulting in slow fluid flow, or more importantly, inability to withdraw blood. This is commonly referred to as persistent withdrawal occlusion. Acquiring a blood return prior to use is recommended with VAD's to help verify proper catheter placement and patency (McKnight, 2004).

Baseline Data

In 2005, peripheral access was the primary route for intravenous administration used at our facility. In the Critical Care Units, the majority of IV access was peripheral, followed by non-tunneled catheters inserted by a physician and PICCs inserted by the PICC team. The PICC team placed Groshong® catheters (Bard-Access System, Salt Lake City, UT) percutaneously using the Modified Seldinger technique without ultrasound guidance. Catheters were capped with a positive pressure device. Flushing protocol consisted of a positive pressure flush involving clamping the catheter prior to disconnecting the saline or heparin syringe. Normal saline flush was used for Groshong® catheters and all other vascular access devices required normal saline followed by heparin flush solution. Dressings were changed twenty-four hours after insertion and weekly, thereafter. Two percent Chlorhexadine Gluconate/70 % Isopropyl Alcohol Chloraprep® (Medi-Flex Inc. Enturia, Inc. Leawood, KS) and an antimicrobial dressing (BIOPATCH® Disk with CHG, Johnson & Johnson Wound Management, Division of Ethicon, Inc. Somerville, NJ) were used inconsistently, as it was not incorporated into the policies and all staff were not familiar with the product. PICC volume averaged 64 insertions per month ranging from 15 per month to 81 per month. The total PICCs placed by the PICC team in the entire facility in 2005 were 767. The insertion success rate was 92%. Interventional radiology placed the remaining 8%, or approximately 60 PICCs. Nursing staff training consisted of a didactic review of different products, a demonstration of flushing technique and a multiple choice post test. Data available during 2005 was actual incidence of CRBSI house wide. Eleven occurrences of CRBSI were reported.

Bundle Development

Since bundle development is reported in the literature (Institute for Healthcare Improvement, 2007b) as a successful mechanism for providing a structured way for lowering complication rates, this approach was selected. Developing a central line bundle that would meet identified outcomes, including approaches directed at both the extraluminal catheter tract and the intraluminal fluid pathway, was essential to best practice. Success has been achieved in large hospital settings using only behavioral practices (Institute for Healthcare Improvement, 2007c). To achieve success with limited personnel resources, a combination of behavioral practices and product technologies associated with lowering CRBSIs and complete occlusions (CO), that also supported existing nursing practice, were selected. We reviewed site selection, insertion techniques, product use, care and maintenance of VADs and the process of the PICC team's role in educating staff to manage all central venous catheters. In addition, we revised the PICC team's on-going monitoring and management of central lines.

We began this process by reviewing and updating our current policies and procedures and comparing them to the literature. We also needed to determine whether our policies and procedures matched the evolution of products available to PICC teams in early 2006. The addition of Power PICC® (Bard-Access System

Figure 1
Center for Disease Control and Prevention, CRBSI Definition

Code: BSI-LCBI
Definition: Laboratory-confirmed blood stream infection must meet at least one of the following criteria:
Criterion 1: Patient has a recognized pathogen cultured from one or more blood cultures AND organism cultured from blood is not related to an infection at another site.

Criterion 2: Patient has at least one of the following signs or symptoms: fever (>38 degrees Celsius), chills, or hypotension and at least one for the following :
- Common skin contaminant (e.g., diphtheroids, *Bacillus sp*., *Propionibacterium sp*., coagulase-negative *staphylococci*, or *micrococci*) is cultured from two or more blood cultures drawn on separate occasions.
- Common skin contaminant (e.g., diphtheroids, Bacillus sp., *Propionibacterium sp*., coagulase-negative *staphylococci*, or *micrococci*) is cultured from at least one blood culture from a patient with an intravascular line, and the physician institutes appropriate antimicrobial therapy.
- Positive antigen test on blood (e.g., *Haemophilus influenzae*, *Streptococcus pneumoniae*, *Neisseria menigitides*, or group B *Streptococcus*

Reporting Instructions:
- Report purulent phlebitis confirmed with a positive semi-quantitative culture of a catheter tip, but with either negative or no blood culture, as CVS-VASC
- Report organisms cultured from blood as BSI-LCBI when no other site of infection is evident
- Pseudobacteremias are not nosocomial infections.

Salt Lake City, UT), with its expanded capabilities (CVP monitoring, triple lumen, CT compatible, etc.), decreased the demand for physician inserted central venous catheters while increasing the demand for the advanced vascular access team bedside placed PICCs.

We met with product representatives for the multitude of products used in the placement and care of central venous catheters. This included discussions with vendors selling not only PICCs, but antimicrobials, dressing products, barrier products, connectors and ultrasound equipment. We also extensively reviewed the literature and evaluated other best practice models around the country. Bundle selection was based on available research, The Centers for Disease Control and Prevention (CDC) recommendations (1998), new product technology, changes required by the bedside nurse, and ease of use by the end user. Seven practices, three extraluminal and three intraluminal, plus team monitoring were chosen for bundle implementation. CRBSI rates are monitored in the two critical care units. The PICC team maintains data at the time of insertion. The important data needed for comparison before and after bundle implementation would then be available without an added burden to the PICC team. Infection Control uses the CDC definition for intravascular device-related bloodstream infection and laboratory confirmed bloodstream infection must meet at least one of the criteria described in Figure 1.

Rationale and Implementation Strategies

Bundle Implementation

Practice 1: Site Selection with Ultrasound Guided Insertion

Rationale: Our practice prior to 2006 was percutaneous, antecubital PICC placement, using Modified Seldinger technique without ultrasound guidance. Research identified the CRBSI risk by site from best to worse: upper arm being the best, subclavian next, followed by the jugular, and the worse site being the femoral (Timsit, 2003). The difference in normal skin bacteria counts between the subclavian/jugular location and the anticubital fossa is 1,000 fold (10,000 cfu/cm2 vs. 10 cfu/cm2 (O'Grady et al., 2002; Safdar & Maki, 2005).

Evidence has demonstrated increased safety for PICC insertions using ultrasound technology (Moureau, 2006). Venous anatomy is variable and patients deserve efficient and effective outcomes. For complication reduction, one has to reduce the number of insertion attempts. The benefits of Sono-guidance (ultrasound) include, but are not limited to, vein visualization, fewer attempts, fewer complications, patient comfort and lower cost. This method is recommended by the Agency for Healthcare Research and Quality and the American College of Emergency Physicians. This method decreases insertion trauma and increases success rates (Moureau, 2006; Anstett & Royer, 2003).

Implementation: We made ultrasound guided placement a standard of practice for all PICC insertions at our facility. A key factor to increased utilization of PICCs is an early assessment program for appropriate VAD selection within the first 24-48 hours of patient admission. An early assessment program was developed to support and educate staff on selecting the most appropriate VAD upon admission. A hospital wide in-servicing, with ongoing educational support for nursing staff, was implemented to support our early assessment goals and increase physician and clinician knowledge base of appropriate device selection. This resulted in increased PICC referrals. Educational cards were developed, laminated and included in the house-wide inservicing. Three examples of educational cards included: a drug reference card defining Intravenous Nursing Society Standards of Practice (Infusion Nurses Society, 2006) that a drug with a pH <5 or >9 should be administered thru a central line, a card indicating blood withdrawal tips for PICC/Central Lines and a diagnoses card naming a variety of diagnoses that would indicate the need for mid to long term IV therapy. Proactive referral was emphasized instead of waiting until the patient's IV access was exhausted.

Practice 2: Full Barrier Precautions

Rationale: The CDC recommends full barrier precautions with VAD placement.

Implementation: When investigating our practice, we learned that while our PICC team was diligent in following maximal barrier precautions, our physicians and critical care nurses were inconsistent. Problems related to the inconsistencies ranged from

lack of knowledge of specific items required and their location, as well as physician's limited schedules.

To resolve the discrepancies the leadership of the PICC team worked with a committee of regional "sister" hospitals to assemble barrier kits that were acceptable to both nurses and physicians. Infection Control Practitioners, Materials Management department heads, Nurses, Physicians, and Quality Staff came together and agreed on a barrier kit.

Education was provided to the nursing staff regarding changes in the barrier kit. Information regarding changes in the barrier kit was communicated through medical staff committees. A central line insertion check-off list was developed to ensure compliance throughout the hospital with all staff inserting non-tunneled central lines. Support from our medical executive committee and administration empowered nurses to ensure all maximal barrier precautions were followed or the procedure would STOP. This assured the use of maximum barrier precautions in all central lines, not just PICCs placed by the PICC team.

Practice 3: Insertion Site & Dressing Management/Central Line Dressing Kit Revision

Rationale: Skin preparation should consist of a two step process: cleansing the skin followed by an antiseptic (Ryder, 2006). A Chlorhexidine Gluconate (CHG) impregnated foam disc placed around the catheter at the insertion site reduces colonization (O'Grady et al., 2002; Crawford, Fuhr & Rao, 2004) and supported our current weekly dressing change practice minimizing bedside nursing impact. A securement device minimizes catheter movement and significantly reduces active extraluminal bacterial migration (Yamamoto, 2002).

Implementation: The central line dressing kit was revised to include ChloraPrep® (Medi-flex Inc., Enturia Inc., Leawood, KS) alcohol, BIOPATCH® disc with CHG (Johnson & Johnson Wound Management, Division of Ethicon, Inc. Somerville, NJ) and optional Statlock® (Bard Medical Division, Covington, GA). In addition, we deleted the 24-hour gauze pressure dressing change and instead placed the BIOPATCH® and occlusive dressing (3M Tegaderm® Transparent Dressing 3M Health Care Division, St. Paul, MN) directly on the site after central line insertion. "How to" guides for application of ChloraPrep®, BIOPATCH® and a central line dressing change were developed, in-serviced and placed on the units for nursing review.

Practice 4: Connector System

Rationale: Our facility utilized a positive pressure IV connector system. Current research has shown that there are increased CRBSI rates associated with positive pressure connectors (Field, McFarlane, Cheng et al, 2007). Split-septum IV connectors are associated with high occlusion rates (Field, McFarlane, Cheng et al, 2007; Maragakis et al., 2006) and thorough septum surface disinfection is unsuccessful in eliminating surface contamination (Maki, Mermel & Kluger, 2000). In addition, the septum is made of hard plastic and shows increased biofilm growth relative to more hydrophobic materials such as polyisoprene (Cook & Meyer, 2007). Also, increased microbial adhesion rate with subsequent biofilm formation is associated with high connector priming volume and dead space (Cook & Meyer, 2007).

Fig. 2
Central Line Data Collection Instrument

Central Line Data Collection Instrument

Patient Sticker

TNI
ICU
Med
Surg
Tele
Onc
OpIVT

MS with US
MS without US
D without US
IR

Basilic AC
Cephalic AC
Basilic UA
Cephalic UA
Other

Groshong SL
Groshong DL
Power PICC DL
Power PICC TL

Doctor: _____
Room: _____

Right
Left

Measurements:
I: _____
O: _____
Cir: _____

Insertion Date: _____

Complications: None = 0
Phlebitis = 1
Infiltration = 2
Site Infection = 3
Cellulitis = 4
Pain in Site ext. = 5
Limited ROM of ext. = 5
Pain during Infusion = 7
Leaking = 8
Swelling = 9
Occlusion = 10
Occlusion with TPA - 11
Therapy Complete = 12

Occlusion:
None = 0
Not Flushed = 1
Not Clamped = 2
No Green Cap = 3
Other = 4

3

Day	Date	Drsg. Change	#	Comments:	#	Comments:	Date Removed	Initial
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

Implementation: In reviewing all products we made the choice to switch to the InVision-Plus® Neutral® IV Connector System (RyMed Technologies, Inc., Franklin, TN). This connector system is designed with improved patient fluid pathway protection features. The InVision-Plus® Neutral®; with a priming volume of 0.027 mL was demonstrated to be 93% - 99.9% better in reducing the chance for biofilm formation than any other needle-free IV Connector system tested (Cook & Meyer, 2007). The smooth septum surface decreases infection risk by eliminating microscopic contaminants that could cling to ridges on the positive pressure product. Most important to our decision, was the elimination of the need for a clamping sequence requirement, because of the "neutral/zero fluid displacement" feature which prevents repeated blood reflux episodes with connection or disconnection from the IV connector. The clamping sequence had proven in previous months to be an on-going educational challenge in our organization and using a product without this requirement increased our bedside success rate with central line management by nursing staff. This connector system was used on all central lines.

Practice 5: IV Connector Septum Disinfection

Rationale: The CDC recommends cleaning with 70% alcohol or iodophor prior to each connector access. The length of time for swabbing and the correct technique have not been researched. The importance of this simple step cannot be overstated. While nurses

Fig. 3
PICC Team Insertions
Jan 2005 – March 2007

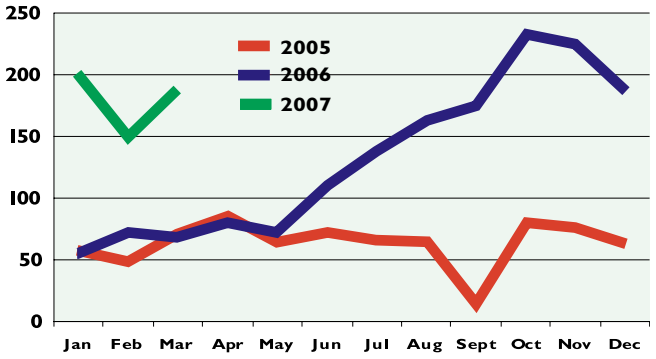
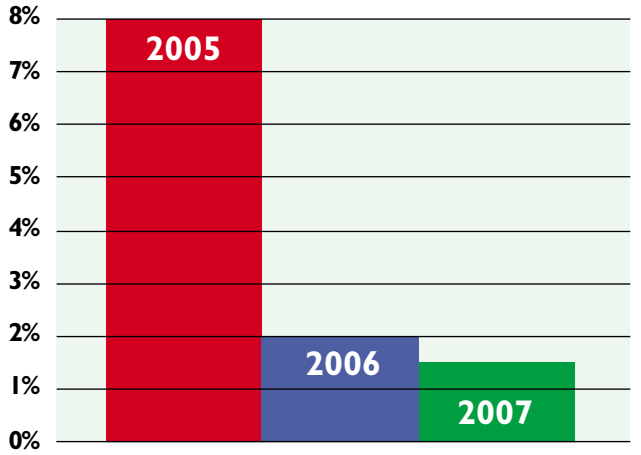


Fig. 4
PICCS Placed in Interventional Radiology



believe this to be a simple, well known, action in nursing practice, and something not requiring deliberate attention, observation of practice revealed considerable variation in the techniques used by nurses. We did not find consistent technique, with variability observed in length of time spent cleansing the connector and inadequate "vigor" applied to the process. This becomes even more critical when one considers the frequency with which connectors are violated, interrupted, changed and manipulated.

Implementation: A clear and defined technique of cleansing the septum connector and clear rules about when the connector should be flushed, and/or changed were developed. The technique was to clean the IV connector septum with 70% isopropal alcohol for 5-10 seconds with a vigorous back and forth motion. Training was provided at the bedside and each nurse was afforded the opportunity to demonstrate the technique on actual patients with concomitant tubing, syringes, flush devices and any other "tool of the trade" related to this process. The same process was applied to all central lines. In addition, connectors were changed after each blood draw and tubing changes.

Practice 6: Flushing Protocol

Rationale: Flushing VADs is critical for cleaning the intraluminal surface and preventing drug incompatibility precipitates.

Implementation: Our facility's VAD flush policy was revised to include flushing all central lines with 10 mL normal saline using a push-pause technique once every 8 hours and PRN, excluding implanted ports and dialysis catheters, which still require heparin flush. A colorful grid was developed to define the type of catheter and the flush volume required prior to medication administration, after medication administration, and for blood withdrawal. These grids were placed on the medication carts for easy nurse reference.

Practice 7: Daily Monitoring of PICCs

Rationale: Continuous monitoring of practice decreases complications and increases bundle compliance (Institute for Healthcare Improvement, 2007b).

Implementation: We developed a data collection tool that addressed the patient, the unit, type of line, insertion site, and complications (Figure 2). Our PICC team takes 100% ownership of all PICCs from routine assessment, to insertion, weekly dressing change, and discontinuing the catheter. From our data collection tool we can evaluate whether we are having problems with a particular catheter, placement technique, particular nursing unit, or other complications listed. This allows the team to intervene early when trends are identified that are not optimal for our patients. We also wanted to provide on-going oversight of nursing practice and be available for real time bedside education and re-education. We limited our monitoring to PICCs, as they were under management of the PICC team.

Results

Hospital wide PICC data acquired at the time of insertion for 2005 (baseline) was compared to the PICC data acquired at the time of insertion during 2006 and the first quarter of 2007. In 2006, 1,558 PICCS were inserted by the PICC nurse team using ultrasound technology. The monthly average was 130 PICCs. The first quarter of 2007 we averaged 175 PICC placements per month for a 15 month total of 2083 PICCs (Figure 3). This is a 103 % increase from PICC insertions in 2005. The implementation of ultrasound use by the PICC nursing team improved the insertion success rate to over 98%. Interventional radiology (IR) referrals averaged 1-2 patients per month in 2006 with a total of 18 insertions in 2006. Less than 2% referral rate to IR continued in the first quarter of 2007 (Figure 4). In 2006, the number of physician placed central lines decreased by approximately 40%. A comparison of 2005 versus 2006 and first quarter 2007 data are provided in Figure 5. Infection control data for CRBSI for 2005 (11 cases) was compared to the infection control data in the intensive care units for 2006 and the first quarter of 2007 (zero cases). This bundle resulting in zero cases of CRBSI for 5 consecutive quarters, January, 2006 through March, 2007 at SRMC can be found in Figure 6.

Discussion

Shifting team focus from percutaneous PICC insertion to ultrasound guided PICC insertion required additional training hours for the PICC nurse. Newly employed nurses were assigned an experienced PICC nurse as their preceptor. Orientation consisted of a review of Intravenous Nursing Society and CDC standards and guidelines, patient medical history, vein assessment, ultrasound placement procedure troubleshooting, and individual case studies.

Fig. 5 Overview of Results

Central Line Descriptors	2005	2006/Ist Q 2007
Average Monthly PICC Volume	60	139
Annual PICC Volume	767	2083
Insertion Success Rate	92%	98%
Interventional Radiology Rate	8%	2%
Insertion Location	Antecubital	Upper Arm, Basilic Vein (preferred)
Insertion Technique SonoSite® (iLook® 25)	Traditional/ Modiifed Seldinger	100% Ultrasound Guided
Maximum Barrier	PICC Team Only	All central lines
Skin Preparation ChloraPrep®	Inconsistent	Consistent
Insertion Site Antimicrobial BIOPATCH®	Inconsistent	Consistent
Line Stabilization Statlock®	Inconsistent	Consistent
Connector InVision Plus® Neutral®	Positive Pressure Device	Neutral Device
RN Training	Annual In-Service Day	One-on-One Training at the bedside
Flushing Protocol	Normal Saline followed by Heparin (positive pressure flush)	Flush 10ml NS every 8 hours and PRN use (push/pause technique)
Dressing	24 hour pressure gauze dressing then weekly	No pressure dressing (exception excessive bleeding) Weekly dressing change
Line Monitoring	Completed q week with dressing change	Completed daily during site checks

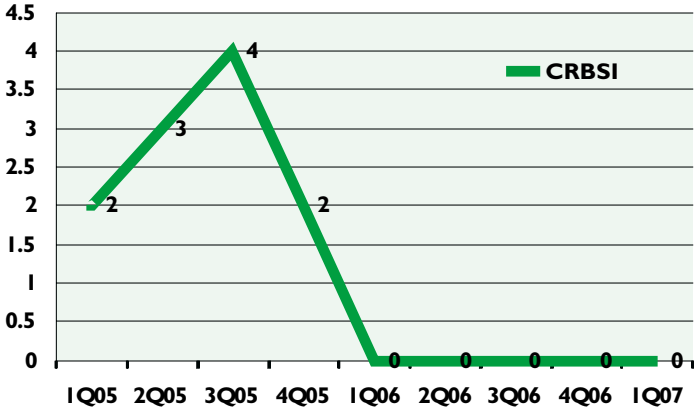
A competency check-off list was developed for all new nursing personnel hired. Competency required a minimum of 3 insertions observed by the lead PICC resource nurse within the four to six week orientation period. PICC competency revalidation for all PICC team members is required on a yearly basis and consists of 3 observed insertions by the lead PICC resource nurse or the clinical manager. PICC nurses continued to develop their expertise through daily clinical opportunities by placing these lines and to expand their knowledge through educational opportunities.

There was initial resistance from nursing staff related to the new flushing policy. The manual flush every eight hours requires additional time. Additional hospital wide in-servicing was time consuming but was determined to be mandatory for a positive outcome success. The addition of the Power PICC® (Bard Access Systems, Salt Lake City, UT) with it's larger internal diameter and being an open ended catheter made our flushing protocol a critical piece of this bundle. The valve of the Groshong® PICC (Bard Access Systems, Salt Lake City, UT) provided a short-term backup if the IV fluid bag was allowed to run dry. "Empty bag" and inconsistent flushing frequencies have been identified as the causes for continued occlusions. Intensive in-servicing to reinforce timely bag replacement was required. Increased surveillance of routine flushing documentation and increased inservicing of the importance of flushing has proven to show occlusions can be decreased but only as a result of diligence and concerted effort by the PICC team and staff nurse.

During initial implementation of the connector Neutral® IV Connector System, there was some nursing resistance due to its different feel with syringe connection. The Neutral® valve has a double microbial barrier which requires not only the septum to be activated but also the internal second microbial barrier. A 45 degree placement of the syringe or tubing luer, push in and twist technique was in-serviced. The additional staff nurse support and in-servicing aided immensely in program success.

At our facility, all seven of the bundle practices were implemented at one time (first quarter of 2006). While a zero CRBSI was achieved and inpatient services were broadened, the preparation and educational support housewide was not only extensive, but weighed heavily on this developing and expanding inpatient PICC team. The commitment, passion, and overall developing expertise of these PICC team members made this bundle and these practices an ongoing success story.

Fig. 6
Quarterly Incidence of CRBSI In ICUs
January 2005-March 2007



Limitations:

Two primary issues occurred during our experience that we continue to improve upon in our facility. First, the inability to correctly capture central line days in 2005 resulted in using the measure of incidence of CRBSI in lieu of incidence of CRBSI divided by central line days. While available for our 2006 data, national comparisons of our starting point in 2005 are difficult. Second, our program began in 2006 with a focus on nurse inserted and managed PICCs. The number of PICCs increased during 2006 and the percentage of PICCs in our ICU's climbed dramatically during that time. However, the daily monitoring process described in this paper began initially with nurse inserted PICCs only. Our implementation of the bundle within our organization extended to all central lines, subsequently resulting in success extending to physician inserted and MD/RN managed lines.

Conclusions

When prevention behavior activities and innovative products are combined, the synergistic effect is greater than when the same strategies are used independently. The products and practices identified in this bundle enhance accepted behavior practices related to central venous catheter (CVC) care and maintenance. While some of the bundle components have not been widely researched and instead are based on theory or accepted clinical practice, the early outcome provides a basis for additional study and refinement. The success of this bundle in preventing CRBSI has improved patient care and promoted advance practice for our PICC nurse team. Essential components to success were staff nurse dedication, physician referrals, administrative support, vascular access nurse specialist dedication and utilization of principles of research and education. Studies are recommended associated with the components of the bundle and to evaluate the effect of both practice and product on the outcome of infection rates.

Dedication / Acknowledgements

This article is dedicated to the memory and honor of nurse Leslie Baranowski who was an inspiration to all whose lives she touched.

A special thankyou to the Sutter Roseville Medical Center Infusion Therapy Team whose diligence, commitment, and passion, made it possible for me to share our success. Additional thank you to Denise Macklin, RN, and Deborah Dix, Director of Cancer Services SRMC, who contributed considerably in the preparation of this manuscript.

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