

# Midline Catheters: An Essential Tool in CLABSI Reduction

March 15, 2013

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The confluence of recent economic factors and emerging clinical evidence now makes the use of central venous access devices (CVADs) far less desirable than in the past. Conversely, the same factors and facts greatly enhance the appeal of Midline catheters—catheters measuring 3 to 8 inches in length, inserted in an upper arm vein and with tip location distal to the shoulder.(1,2) Evidence now demonstrates that certain midlines offer patients the possibility of full length of stay infusion therapy, with reduced risk of bloodstream infection and avoidance of repetitive needlesticks for labs and restarts. Thus, in many cases, midlines are becoming the go-to device for safe, uninterrupted intravenous (IV) therapy.

## **Recent Economic Factors**

The principal economic influence is the Centers for Medicare and Medicaid Services' 2008 decision to no longer reimburse certain hospital acquired conditions, including central line associated bloodstream infections (CLABSIs) and iatrogenic air embolism —both real and recurrent complications of central venous access.(3) The cost of CLABSI treatment is estimated at \$32,254 per incident, while the cost of treating insertion-related air embolism is \$71,636.(4,5) Moreover, there are now in place national and state public reporting requirements for CLABSI rates that may cause certain acute care hospitals to be seen in a bad light.

Compounding economic factors include growing concern over the hidden costs of CVADs: specifically, the cost of thrombolytics for treatment of central line occlusion and the costs of X-ray and/or tip-locator technology to determine catheter tip location. According to the Diagnostic Related Groups (DRG) reimbursement structure, these hidden costs do not receive additional payment.

Finally, there is the new CMS incentive—under Medicare's "value-based purchasing" program—to increase patient satisfaction with the inpatient experience. Hospitals showing "better than average" or "most improved" patient satisfaction are eligible for Medicare bonus payments from a pool of \$850 million.

## **Emerging Clinical Evidence**

Add to concerns over unreimbursed costs, the expanding clinical awareness of real risks associated with CVADs. One recent article in the Journal of the American Medical Association, "Problems with Peripherally Inserted Central Catheters," points to bloodstream infection rates in hospitalized patients with peripherally inserted central catheters (PICCs) of 2.79 to 4.79 per 1,000 catheter days.(6) These rates comport with Maki's 2006 meta-analysis of CVAD-related

bloodstream infections: namely, 1.0 to 3.2 BSIs per 1,000 catheter days for inpatient PICCs; and 2.7-4.7 BSIs per 1,000 catheter days for non-cuffed central venous catheters (CVCs).(7)

Infection is not the only dangerous complication of CVAD usage. PICC-related deep vein thrombosis (DVT) rates range from 1 percent to 38.5 percent for symptomatic DVTs;(8,9,10,11,12,13) asymptomatic DVT rates equal 27.2 percent.(14) Less common, but equally dangerous, complications of central venous access include ventricular arrhythmia, cardiac tamponade, superior vena cava syndrome and endocarditis.

Additionally, it was recently reported that following power-injection of CT contrast media, PICCs suffer a 15.4 percent tip dislocation rate, usually into the neck.(15) The adverse consequences of this phenomenon are as yet unknown. The author of the aforementioned JAMA article concludes: “Because hospitalized patients are especially at risk of CLABSI and venous thromboembolism, discrimination in use of PICCs is a necessary and fundamental aspect of CLABSI and venous thromboembolism prevention in this patient population.”(6) The same concern holds true for short CVCs.

Of course, certain infusates invariably require the larger diameter vessel and greater hemodilution of central venous access—e.g., total parenteral nutrition (TPN), certain antineoplastics and continuous vesicants. In such cases, a CVAD may well be the best option. If so, the central line should be placed using ultrasound guidance and maintained in accordance with CDC guidelines and INS standards.(1,2)

So what is a cost-conscious, caring clinician to do when the patient needs reliable venous access and the intended therapy does not require a central line? The average peripheral IV lasts only 44 hours, owing mainly to phlebitis and infiltration.(16,17,18) It is time to consider other options to complete the treatment plan with a safe, extended-dwell vascular access device.

Fortunately, there is a growing evidence base to support the use of midline catheters for delivery of infusates not requiring central venous access.

Let’s look first at available data on bloodstream infections rates with midline catheters. Remember, these catheters are routinely inserted in the upper arm—an area where cutaneous bacterial colonization is significantly less than, say, the neck or hand. In 2006, a meta-analysis by Maki, et. al. reported an overall midline bloodstream infection (BSI) rate of 0.2 per 1,000 catheter-days.(7) These findings have been confirmed by separate groups, testing different midlines, specifically: <1.0 percent reported by Andersen, using an MST-placed BARD midline;19 <1.0 percent by Cummings, using the Arrow midline,(20) and 0.0 percent in three separate reports totaling >2000 catheter-days, using the POWERWAND® midline.(21,22,23) Additionally, a large outcomes analysis demonstrated a systemic infection rate in homecare midlines of 0.9/1,000 catheter days.24 These rates are all significantly lower than bloodstream infections reported for central lines; in fact, they are generally lower than bloodstream infection rates reported for traditional peripheral IV catheters.(7,25,26)

Moreover, since Midlines do not have the terminal tip in a central vein and thus are not Central lines, bloodstream infections associated with midline catheters presently do not require public reporting.

Thrombosis is also significantly less frequent with midlines than CVADs. Recall that the silent DVT rate for inpatient PICCs is 27.2 percent; and the clinically evident DVT rate for PICCs ranges from 1 percent to 38.5 percent. By contrast, the DVT rate associated with midline catheters is consistently <2.0 percent.(19,21,22,23)

These clinical advantages, along with the cost advantages of midline catheters, make their position in the modern VAD armamentarium quite favorable. First, the direct hard dollar cost of midlines is generally less than the cost of PICCs or CVCs. Second, because the tip of the midline resides outside the thorax, it requires neither an X-ray nor expensive tip-location technology following placement. Finally, fewer thromboses mean diminished “hidden costs” of treating secondary complications.

Fewer infections and complications plus lower material costs make midlines tempting. But, can a midline last the full inpatient length of stay?

This is the area in which published evidence yields perhaps the most surprising and favorable results for midlines. For inpatients, PICCs last on average between 7.3 and 16.6 days and complete the intended therapy 71 percent to 87 percent of the time.(12,19,27,28,29,30) Midlines last on average from 7.69 days to 16.4 days and complete the intended therapy 79 percent to 89 percent of the time.(19,21,23,31,32) In other words, with respect to dwell time and completion of therapy rates, midlines perform at least as well as PICCs, if not better.

Are all midlines alike? Does it matter which one I use?

While different brands and types of midlines have tended to demonstrate relatively common outcomes, in certain respects one midline differs greatly from another. Some are inserted using modified Seldinger technique (MST), others are inserted using accelerated Seldinger technique (AST)—an all-in-one method which eliminates the risk of dropped components and inadvertent contamination. Some midlines are made of novel materials, others are made of traditional silicone or polyurethane; some are CT power-injectable, most are not. Finally, some midlines have been studied clinically, providing a foundation for evidence-based practice; others have not. Since the evidence clearly defines a place for midlines as a tool in intravenous therapy, let’s focus on what is known and unknown about each of these devices.

### **Midline Products**

The earliest midlines were IntraCath® devices; they were introduced in the 1950s and intended most often for subclavian access. Rigid materials and indelicate cannulation methods limited the adoption and use of these early midlines.

In the 1980s MenloCare introduced the Landmark® midline catheter, made of a unique material—Aquavene®—that softened once in the bloodstream. Additionally, the cannulation method of the Landmark midline was cleverly designed to provide easy insertion while reducing vessel trauma. Two independent studies showed low bloodstream infection rates with the Landmark midline—0.3 percent and 0.3 per 1,000 catheter days.(33,34) Unfortunately, between 1992 and 1995, an acute hypersensitivity-like reaction became associated with the Landmark midline and attributed, rightly or wrongly, to its novel material and/or insertion technique.(35) Ultimately, the device was withdrawn from the market.

C.R. BARD now offers two different kinds of midlines: MST-introduced midlines, made of either silicone or polyurethane -- these midlines are not power-injectable; and AST-placed, power-injectable, polyurethane midlines, branded POWERGlide®.

BARD's first type of midline (PerQCath®, silicone catheter) was studied over a six-year period at Evangelical Hospital and yielded “less than 1 percent” infection rate, a phlebitis rate that “averaged 2 percent to 7 percent,” and a completion of therapy rate of 86 percent.(19)

The recently-launched POWERGlide offers all-in-one construction (without a dilator) and built-in needlestick safety. The 3.1-inch catheter is made of polyurethane and inserted over a stainless steel guidewire that is shorter than the catheter itself. The catheter is 20 gauge with a flow rate of approximately 40 ml/minute. Whether the POWERGlide catheter can be used for drawing diagnostic blood draws during hospitalization is an unanswered question. In fact, at the present time, the POWERGlide is unsupported by published studies.

Owing to certain design features, the POWERGlide may find its primary utility in the shallower vessels of the forearm. One should note that current data relating to midlines arises from the tip of the catheter being in the upper arm, where blood flow is faster and vessel diameters are larger than in the forearm and hand. Forearm catheter tip placement of midlines—regardless of brand—is thus without an evidence base at the present time.

Presently, Arrow/Teleflex offers a polyurethane midline catheter (3, 4, and 5Fr), not power-injectable and inserted by means of the MST. The product does not include a passive needlestick safety introducer. One observational study of this device (4Fr, single lumen), used for Cystic Fibrosis patients, reported a “lower than 1.0 percent” bloodstream infection rate over a two-year period, and “lower than 2 percent” thrombosis rate. No other complications--such as leakage, phlebitis or infiltration—were addressed.(20) The POWERWAND® initiated the new era of midline design, insertion and use. It offers a unique AST delivery system, with passive needlestick safety and all-in-one (needle-dilator-guidewire-catheter) construction, and a 3.1 inch power-injectable 4Fr and 5Fr catheter made uniquely of ChronoFlex C.

Because the POWERWAND contains a dilator, its echogenic 22g and 21g needles are capable of introducing larger 4Fr and 5Fr catheters with high flow rates (130 ml/minute and 160 ml/minute, respectively). Additionally, the device includes a full-length Nitinol guidewire and passive needlestick safety.

The POWERWAND extended dwell catheter is made of Chronoflex C, a proprietary blend of polycarbonate and polyurethane, and is specially treated so as to be kink-resistant. Multiple centers have reported on the catheter's 60 percent to 84 percent utility for blood sampling throughout the length of stay, resulting in a 98 @ patient satisfaction rating.(21,22,23) POWERWAND is, thus, one of the only midlines to demonstrate the possibility of a one-stick hospitalization, or at least, far fewer needlesticks than they otherwise would have to suffer. Moreover, the POWERWAND data demonstrate a 0.0 percent bloodstream infection rate with the lowest total complication rate and an equal or better completion of therapy rate (89.5 percent) as compared with any VAD yet studied. (21, 22, 23)

There are other brands of midlines. They are generally made of polyurethane or silicone, are inserted by means of the modified Seldinger technique, and generally are not CT power-injectable. (Note: The M/29 Midterm® catheter is the exception here; while also made of silicone, it is inserted through an over the needle, peelable sheath using an internal “stiffening” guidewire; it is pressure injectable.) The authors are unaware of peer-reviewed, published studies specific to these brands.

### **CLABSI Prevention**

Inarguably, the best ways to reduce CLABSIs are to only place central lines where they are absolutely necessary, using ultrasound guidance; when a CVAD is necessary, insert under maximum barrier protection using impeccable sterile technique; and finally, remove central lines as promptly as good clinical care will allow.

There are now reliable, power-injectable midlines that allow for daily blood draws, high flow rates and reduced complications, including very low bloodstream infection rates. These midlines represent a new era of technological innovation and offer evidence-based alternatives to older, less serviceable devices. Use of these midlines will, at times, obviate the need for central venous access and, at other times, hasten the removal of CVCs.(22)

Given the economic pressures on all institutions to decrease CLABSIs (and increase patient satisfaction), and the mounting peer-reviewed, published evidence in favor of midlines, it is hard to imagine a CLABSI reduction program that does not give serious consideration to the expanding role of midline catheters.

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**References:**

1. O' Grady NP, Alexander M, Burns LA, et al. CDC Guidelines for the Prevention of Intravascular Catheter-Related Infections, 2011.
2. Gorski LA, Eddins J, Hadaway L, et al. Infusion Nursing Standards of Practice (Revised 2011). *Infusion Nursing* 2011; 24 (1S):S32.2.
3. Centers for Medicare & Medicaid Services. Hospital-Acquired Conditions (Present on Admission Indicator) [http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HospitalAcqCond/index.html?redirect=/HospitalAcqCond/02\\_Statute\\_Regulations\\_Program\\_Instructions.asp](http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HospitalAcqCond/index.html?redirect=/HospitalAcqCond/02_Statute_Regulations_Program_Instructions.asp)
4. Kim J, Holtom P, Vigen, C. Reduction of Catheter-related Bloodstream Infections through the Use of a Central Venous Line Bundle: Epidemiologic and Economic Consequences. *American Journal of Infection Control* 2011;(39)8:640-646.
5. Centers for Medicare & Medicaid Services 2008. Fact Sheets: CMS Proposes Additions to List of Hospital-Acquired Conditions.
6. Chopra V, Flanders S, Saint S. The Problem with Peripherally Inserted Central Catheters. *JAMA* 2012;(308)15:1527-1528.
7. Maki DG, Kluger DM, Crinch CJ. The Risk of Bloodstream Infection in Adults With Different Intravascular Devices: A Systematic Review of 200 Published Prospective Studies. *Mayo Clin Proc* 2006;81(9):1159-1171.
8. Evans R, Sharp J, Linford L, et al. Risk of Symptomatic DVT Associated with peripherally Inserted Central Catheters. *Chest* 2010;(138):803-810.
9. Stokowski G, Steele D, Wilson D. The Use of Ultrasound to improve Practice and Reduce Complication Rates in Peripherally Inserted Central Catheter Insertions. *J Infusion Nursing* 2009 (May/June); 32 (3): 145-155.
10. Kearns PJ, Coleman S, Wehner JH. Complications of Long Arm-Catheters: A Randomized Trial of Central vs. Peripheral Tip Location. *J Parenter and Enteral Nutr* 1996;20(1):20-24.
11. Yacopetti N. Central Venous Catheter-related Thrombosis. *J Infusion Nursing*. 2008; 31 (4): 241-248.
12. Hughes ME. PICC-Related Thrombosis: Pathophysiology, Incidence, Morbidity and the Effect of Ultrasound-Guided Placement Technique on Occurrence in Cancer Patients. *JAVA*

2011; 16(1):8-18.

13. Vesely T. Management of Catheter Associated Venous Thrombosis. Topic present at: 39th LITE Conference; March 2011; Washington PA.

14. Bonizzoli M, Batacchi S, Cianchi G, et al. Peripherally inserted central venous catheters and central venous catheters related thrombosis in post-critical patients. *Intensive Care Med* 2011;(37):284-289.

15. Lozano LAS, Marn C, Goodman, L. Power Injectable Peripherally Inserted Central Venous Catheter Lines Frequently Flip After Power Injection of Contrast. *Comput Assist Tomogr*; (36)4:427-430.

16. Frey AM, Schears GJ. Why Are We Stuck on Tape and Suture? *J Infusion Nursing* 2006; 29 (1); 34-38.

17. Maki DG, Ringer M. Risk Factors for Infusion-related Phlebitis with Small Peripheral Venous Catheters. *Annals Int Med* 1991; 114:845-854.

18. do Rego Furtado LC. Maintenance of Peripheral Venous Access and Its Impact on the Development of Phlebitis. *J Infusion Nursing* 2011;(34)6:382-389.

19. Anderson NR. Midline Catheters. The Middle Ground of Intravenous Therapy Administration. *J Infusion Nursing* 2004; 27 (5): 313-321.

20. Cummings M, Neville H, McCutcheon et al. Improving antibiotic treatment outcomes through the implementation of a midline: Piloting a change in practice for cystic fibrosis patients. *Journal of Vascular Nursing* 2011 ;(XXIX)1:11-15.

21. Warrington WG, Penoyer DA, Kamps T, et al. Outcomes of Using a Modified Seldinger Technique for Long Term Intravenous Therapy in Hospitalized Patients with Difficult Venous Access. *JAVA* 2012; (17)1;24-31.

22. Castro S, Allison R. Use of Midline (Extended Dwell Peripheral IV) Device Improves Patient Safety and Saves Costs Compared to PICCs. Poster presented at 2012 Association for Vascular Access, Annual Scientific Meeting.

23. Bird D. The Power of Choice: Midline Catheter Improves Patient Safety and Comfort While Increasing Vascular Access Revenue and Productivity. Poster presented at 2012 Association for Vascular Access, Annual Scientific Meeting.

24. Moureau N, Poole S, Murdock MA, et. al. Central Venous Catheters in Home Infusion Care: Outcomes Analysis in 50,470 Patients. *J Vasc Interv Radiol* 2002; 13 (10): 109-116.

25. Trinh T, Chan, Edwards O, et al. Peripheral Venous Catheter-Related Staphylococcus aureus Bactermia. *Infect Control Hosp Epidemiol* 2011;(32)6:579-583.
26. Letter to Editor: Peripheral Venous Catheter-Related Staphylococcus aureus Bactermia. *Infect Control Hosp Epidemiol* 2011;(32)12.
27. Ng PK, Ault MJ, Maldonado LS. Peripherally Inserted Central Catheters in the Intensive Care Unit. *J Intensive Care Med* 1996; 11:49-54.
28. Safdar N, Maki DG. Risk of Catheter-Related Bloodstream Infection with Peripherally Inserted Central Venous Catheters Used in Hospitalized Patients. *Chest* 2005; 128:489-495.
29. Santolucito JB. The Role of Peripherally Inserted Central Catheters in the Treatment of the Critically-ill. *JAVA* 2007; 12(4):208-216.
30. Thiagarajan RR, Bratton SL, Gettmann T, et al. Efficacy of Peripherally Inserted Central Venous Catheters Placed in Noncentral Veins. *Arch of Pediatr Adolesc Med* 1998; 152:436-439.
31. Thomson S. IV Therapy: A Financial Feasibility Study. *Nursing Mgt* 1993; 24(6):68A-68G.
32. Griffiths V. Midline Catheters: Indications, Complications and Maintenance. *Nursing Standard* 2007; 22(11):48-57.
33. Goetz AM, Miller J, Wagener MM et al. Complications Related to Intravenous Midline Catheter Usage. A 2-Year Study. *J Intraven Nurs* 1998;21(2):76-80.
34. Tokars JI, Cookson ST, McArthur MA et al. Prospective Evaluation of Risk Factors for Bloodstream Infection in Patients Receiving Home Infusion Therapy. *Ann Intern Med* 1999;131(5):340-347.
35. Adverse Reactions Associated with Midline Catheters—United States, 1992-1995. *Centers for Disease Control MMWR Weekly* 1996; 45(05):101-103.

## SUMMARY OF MIDLINE INFECTION RATES, FEATURES AND EVIDENCE-BASE

Brand	Published BSI Rate	CT Power-Injectable	Needlestick Safety	All-In-One	High Flow (>120ml/min)*
<b>Landmark®</b>	0.3%, 0.3/1000 catheter/days	No	No	No	N/A
<b>Bard PerQ Cath®</b>	<1%	No	No	No	No
<b>Arrow Midline</b>	<1%	No	No	No	No
<b>POWERWAND®</b>	0.0%	Yes	Yes	Yes	Yes (4Fr & 5Fr)
<b>PowerGlide®</b>	No Data	Yes	Yes	Yes (no dilator)	No
<b>Bard Poly Midline®</b>	No Data	No	No	No	No

\*Saline