



# Vancomycin Administration Through a Novel Midline Catheter: Summary of a 5-Year, 1086-Patient Experience in an Urban Community Hospital

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## Abstract

**Background:** The 2016 Infusion Therapy Standards of Practice no longer require that low pH (<5) medications be administered via central venous access devices. Nevertheless, the practice of placing PICCs for vancomycin administration often persists.

**Purpose:** To demonstrate the safety and efficacy of intravenous vancomycin administration through a short and long term midline catheter.

**Methodology:** A retrospective chart review was performed on 1086 patients who received intravenous vancomycin through a midline catheter.

**Results:** There were no catheter-associated bloodstream infections and no deep vein thromboses. Phlebitis occurred rarely (0.6%), as did benign infiltrations (1.2%). There were no extravasation injuries.

**Conclusions:** These outcomes summarize more than 5 years of experience administering intravenous vancomycin (4 mg/mL) safely and cost-efficiently through a nontrimmable midline catheter.

**Keywords:** Vancomycin, midline, vesicant

## Introduction

The decision to place a central line (ie, central venous catheter or peripherally inserted central catheter [PICC]) inevitably entails life-endangering risks.<sup>1-3</sup> It is well established, for example, that central line-associated bloodstream infection (CLABSI) rates for both central venous catheters and PICCs range from approximately 2 per 1000 to 5 per 1000 catheter-days in hospitalized patients, and that mortality from such infections can be as high as 25%.<sup>4</sup> Moreover, occurrence of silent deep vein

thrombosis (DVT) from PICCs ranges from 27.2%-71.9%, posing the risk of pulmonary embolism and heightening the risk of infection.<sup>5,6</sup> Despite these risks, and the fact that the Infusion Nurses Society (INS) 2016 Infusion Therapy Standards of Practice no longer list pH as a criterion for central line placement, many clinicians persist in placing central lines solely for the administration of mildly acidic medications.<sup>7,8</sup> There seems to be persisting confusion over the importance of dilution, rather than pH, as a factor in the etiology of infusion thrombophlebitis.<sup>9-11</sup>

Vancomycin, for example, continues to be cited frequently as the indication for central line placement, despite the fact that 5 peer-reviewed, published articles and 2 scientific posters attest to the relative safety of administering vancomycin via peripheral intravenous catheters, including midlines.<sup>12-18</sup> Moreover, not 1 patient of the almost 2000 patients enrolled in these multiple studies sustained a single significant vancomycin-related extravascular tissue injury.

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**Table 1. Sample Characteristics**

<b>N</b>	<b>Male/ female (%)</b>	<b>Average age (y)</b>	<b>Midline location upper arm/forearm (%)</b>	<b>Vancomycin dosage range (g QD-BID)</b>	<b>Vancomycin duration range (d)</b>	<b>Vancomycin duration average (d)</b>
1086	47/53	73.6	99.8/0.2	0.5-2.0	1-25	7.5

Apparently, old habits—even those with no evidence-base—die hard.<sup>19</sup>

This article summarizes the 5-year, 1086-patient experience of the vascular access team (VAT) at New York Presbyterian Hospital, Queens (NYPQ), in connection with vancomycin administration through a unique, power-injectable midline catheter (Powerwand, Access Scientific, San Diego, CA). Before this report, we published preliminary data on both short-term (< 6 days) and long-term (up to 25 days) vancomycin administration via the study midline.<sup>12,18</sup>

## Methods

### Midline Method of Placement

All midlines were inserted according to the manufacturer's directions for use, by fully credentialed VAT-registered nurse personnel, using the accelerated Seldinger technique and ultrasound guidance.<sup>20</sup> Preparation included 2% chlorhexidine skin antisepsis; aseptic technique with either maximum or partial-body sterile barrier protection; sterile mask, cap, gloves, and gown; and, following insertion, chlorhexidine-impregnated sponge and transparent semipermeable dressing. Vessels of choice for midline catheter placement included the basilic, brachial, and cephalic veins of the upper arm. Veins in the midforearm region were used only if upper arm veins were deemed clinically inappropriate.

### Care and Maintenance

All midline catheters were flushed with 10 cc normal saline every 8-12 hours and otherwise maintained in accordance with the INS Infusion Therapy Standards of Practice.<sup>7</sup>

### Vancomycin Dosage and Dilution

NYPQ pharmacy routinely dilute vancomycin to 4 mg/mL. Doses of 1 g were administered via infusion pump over 60 minutes; other vancomycin doses were administered at commensurate rates.

### Retrospective Chart Review

Chart records from 2011 to June 2016, on 10,078 midline patients, were reviewed to determine whether intravenous vancomycin—regardless of dosage or duration—was administered at any time during midline use. Records of those patients who had received vancomycin through the midline were then perused for evidence of phlebitis, infiltration/extravasation, upper extremity DVT, and catheter-associated bloodstream infection.

Phlebitis was considered to be present if 1 or more of the following indicators were included in the medical record chart:

the written diagnosis of “phlebitis” or “thrombophlebitis” by a nurse or physician; any of the signs or symptoms from the Infusion Therapy Standards Phlebitis Scale<sup>7</sup>; or a grade of 1-4, using the Phlebitis Scale,<sup>7</sup> in the nursing or physician notes.

Infiltration was considered to be present if 1 or more of the following indicators were included in the medical record chart: the written diagnosis of “infiltration” by a nurse or physician; evidence of measured arm swelling, not attributed to generalized edema, in the area of infusion; or ultrasound evidence of extravascular tissue infiltration. (Note: A standard rating tool for infiltration is not used routinely at NYPQ.)

DVT, by which is meant symptomatic DVT, was considered to be present if 1 or more of the following indicators were included in the medical record chart: the written diagnosis by a nurse or physician of “DVT” or “deep vein thrombosis” in the midline vessel, with or without a duplex ultrasound report of a DVT; or clinical findings consistent with symptomatic DVT, along with duplex ultrasound confirmation in the midline vessel.

Midline-associated bloodstream infection was considered to be present if 1 or more of the following indicators were included in the medical record chart: a written diagnosis by a nurse or physician of “bloodstream infection” or “BSI” attributed to the midline catheter or a positive blood culture within 48 hours of removal of the midline catheter without attribution to another source.

## Results

The records of 1086 patients were reviewed, each having received intravenous vancomycin via the study midline. This represents 10.8% of all patients who received midline catheters during the study period. Forty-five percent of patients received vancomycin for < 6 days, 55% of patients received vancomycin for 7-14 days, and 5% of patients received vancomycin for 15-25 days.

Vancomycin doses ranged from 0.5-1.0 g, once or twice daily. Duration of vancomycin treatment ranged from 1-25 days. The average duration of vancomycin therapy was 7.5 days.

Fifty-three percent of patients were women and 47% were men. The average age was 73.6 years. More than 96% of patients received more than 1 antibiotic agent, as well as other intravenous medications, through the midline catheter (Table 1).

One thousand eighty-four midline catheters were placed in 1 of 3 deep veins of the upper arm; only 2 midlines were placed in the cephalic vein of the midforearm. There were 10 (0.92%) midlines removed for reasons that were not cited in the patient

record; none of these charts contained radiology reports of upper-arm DVT.

A total of 6 (0.6%) patients were determined to have phlebitis. The day of diagnosis ranged from Day 2 to Day 11, with the average day of diagnosis being Day 6. Fifty percent of these cases occurred within the first 6 days, 50% occurred between Day 7 and Day 14, and no cases of phlebitis occurred between Day 15 and Day 25 of vancomycin administration.

A total of 13 patients (1.2%) were diagnosed as having had infiltrations. Of these, none were diagnosed grade III or IV, or deemed to require plastic surgery consultation or other advanced treatments. The day of diagnosis ranged from Day 3 to Day 15, with the average day of diagnosis being Day 8.6. Thirty-one percent of these cases occurred within the first 6 days; 54% occurred between Day 7 and Day 14; and 15% of infiltrations occurred between Day 15 and Day 25 (Table 2). It was not possible to determine from the records whether the infiltrations occurred while vancomycin was being administered or at some time between doses.

Ten patients had “leaking” noted on their charts. All 10 were referred to radiology for evaluation using duplex ultrasonography. None of them was determined to have DVT. **Because many of these leaks are believed to have occurred at the catheter-tubing junction, it is worth noting that since the midline manufacturer changed to a new securement device—which is specifically designed to prevent catheter and tubing leaks (ZPad, Amparo Medical Technologies, Placentia, CA)—we have had no further complaints of leakage.**

No patients receiving intravenous vancomycin through the midline catheter were diagnosed as having symptomatic upper extremity DVT.

None of the patients in this review were diagnosed as having had a midline-associated bloodstream infection (Table 2). This finding, namely zero catheter-associated bloodstream infections, was consistent throughout the more than 10,000 patients who have so far received this midline device, regardless of diagnoses or medications. Further, to date only 1 patient has presented with a culture positive for *Staphylococcus* at the midline insertion site (local site infection).

### Discussion

During the past 5 years at NYPQ, 1086 aging patients with complex medical problems received intravenous vancomycin for 1-25 days via the study midline device. Total complications were 2.7%, with no DVTs and no catheter-associated bloodstream infections. In other words, 1067 patients were administered intravenous vancomycin via the study midline without any vascular complications.

Phlebitis occurred at a frequency of 0.6%—considerably lower than the 2011 INS Infusion Therapy Standards pH restrictions would have led one to expect. Benign infiltrations also occurred, although rarely (1.2%). There were no extravasations and therefore no tissue injuries. Clearly, vancomycin—when diluted to 4 mg/mL and delivered via the study midline device through the deep vessels of the upper arm—is not a vesicant.<sup>21</sup>

**Table 2. Complications**

Days	1-6	7-14	15-25	Total
Sample size	488 (45)	543 (50)	55 (5)	1086
Phlebitis	3 (0.3)	3 (0.3)	0	6 (0.6)
Infiltration	4 (0.36)	7 (0.64)	2 (0.18)	13 (1.2)
Extravasation	0	0	0	0
Deep vein thrombosis	0	0	0	0
Bloodstream infection	0	0	0	0

Values are presented as n (%).

Contrast these outcomes with the predictable consequences our patients would have had if PICCs had been mandated for all vancomycin administrations. At the low end of the reported PICC-associated bloodstream infection rate, approximately 16 patients in our cohort would have had catheter-associated bloodstream infections, and 1 or 2 of these patients quite possibly would have died.<sup>1,22</sup> The unreimbursable cost of treating 16 patients with CLABSI would have been \$896,000.<sup>23</sup> Compare this with the actual hard-cost savings of \$97,740 (1086 patients × \$90 savings per procedure) that resulted from using the study midline catheter instead of a PICC for vancomycin administration.<sup>12</sup>

This study encompasses 8145 catheter-days of vancomycin administration via the study midline catheter. Coupled with those cases already in the literature, there are now more than 10,000 catheter-days recorded in peer-reviewed journals attesting to the safety of vancomycin administration via peripheral intravenous catheters, including midlines.<sup>12-18</sup> In those studies, infusion thrombophlebitis ranged from 0.3%-23%.<sup>13-15</sup> The study midline consistently performs at the lower end of this phlebitis range (0.0%-0.6%).<sup>12,17,24</sup> Moreover, its published bloodstream infection rate, which now encompasses more than 19,000 catheter-days, remains zero.<sup>12,17,18,23,25,26</sup>

In light of these data, and recent changes in Standards of Practice,<sup>27</sup> intravenous vancomycin can no longer be considered a valid indication for central venous access. The data show conclusively that the midline catheter we have used for more than 5 years at NYPQ can deliver short- and long-term vancomycin safely and efficiently. The combination of a skilled VAT, the right midline catheter, and proper medication dilution are all contributing factors to these successful outcomes.

### Limitations

This was a retrospective study and, therefore, its principal imperfection is the absence of rigor that accompanies a randomized prospective trial. Clearly, a large-scale multicenter randomized trial comparing PICC vs midline administration of intravenous vancomycin is appropriate. A small-scale randomized study with confirmatory results has already been

published.<sup>12</sup> Nevertheless, in the absence of such a multicenter trial, and especially given the large size of the present investigation, the preponderance of evidence supports the proposition that vancomycin (4 mg/mL) can be safely and efficiently administered via a midline catheter.

A second design defect arises from the fact that grading scales for phlebitis and infiltration were not routinely used. Because of this, our definitions were intentionally broadened—including the mere reference of signs or symptoms of either complication. If anything, this should have resulted in overcounting the number of such complications. As we noted, 10 charts did not include reasons for line discontinuation; conceivably, a relatively small number of these incidents may have been missed.

Although we acknowledge these imperfections, our study represents conditions and activities typical of most busy urban hospitals and, hopefully, will contribute significantly to risk mitigation for hospitalized patients receiving intravenous vancomycin.

### Disclosures

The authors have no conflicts of interest to disclose.

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