A Descriptive Study of Vascular Access Devices Among Adult and Pediatric Home Infusion Patients

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ABSTRACT

Introduction

The Infusion Nurses Society recommends selecting the optimal vascular access device (VAD) for the therapy plan. These recommendations are primarily driven to identify peripheral vs. central vascular access based on infusate properties, the frequency and duration of infusions, unique patient features, and resources available. The objectives of this study are to describe the utilization of VADs in the home infusion setting and identify trends in specific medication treatments and patient populations.

Methods

This study is a descriptive, retrospective review of patient data collected by the National Home Infusion Foundation for its benchmarking program. Throughout 2021 and 2022, 12,968 patient cases were de-identified and submitted using a formatted Excel® file. The patient cases were to include status at discharge, age, type of VAD, and if applicable adverse drug reaction. For the patient case to be eligible for this study, VAD, patient age, and therapy type data had to be included. The data was analyzed using IBM Analytics Software, Statistical Product and Service Solutions. Frequency and percentages were determined for patient age group and therapy type while cross tabulation analysis was used to gain an in-depth understanding of the VAD usage for the different home infusion therapies.

Results

The final data set included 10,967 patient cases and was analyzed to determine the patient demographics, most common type of home infusion VAD, and the type of devices used with the different therapy types. In almost two-thirds (n=7,193) of the patient cases, a peripherally inserted central catheter (PICC) was used as the therapy access device. A midline was used as the VAD in 13.12% of the cases, and a peripheral access device in 8.59% of the cases.

Conclusion

In this study of VAD utilization in the home infusion setting, PICC was reported in two-thirds of all patients included. When analyzed by therapy type, PICC was reported as the primary VAD for the administration of parenteral nutrition, anti-infectives, and inotrope therapies. The high utilization of PICCs in this study validates its selection for medication administration in the home site of care.

Introduction

The home setting is well established as a safe, clinically effective, and cost-saving alternative for infusion therapy administration.[1] Patient outcomes confirm no increase in adverse events, and clinical outcomes are equally as good as those of other sites of care.[2] Additionally, patients report home as the preferred site of care due to improved well-being and better quality of life.[1] Home infusion organizations facilitate these optimal outcomes through the utilization of best practices, therapy standards of care, guidance from pertinent professional organizations, and outcome monitoring. Recognizing the need for standardized data, the National Home Infusion Foundation (NHIF) created an industry-wide quality data program to assess current practices and to establish a national reference point for performance and clinical metrics to improve the quality and efficiency of patient care.[3]

Within the ever-expanding array of infusion therapies provided in the home, one common denominator is that most patients require a vascular access device (VAD) for therapy administration. Home infusion clinicians' knowledge regarding the considerations evaluated in selecting the most appropriate VAD makes them ideal contributors to this process. However, this contribution is limited when the VAD is placed prior to a patient's admission to home infusion services or the finalization of the infusion therapy plan. As VADs should not be replaced unless clinically indicated, it is possible that changes in treatment plans may require extended use of an existing VAD that had not been anticipated.[4]

The Infusion Nurses Society (INS) recommends selecting the optimal VAD for the therapy plan.[4] These recommendations are primarily driven to identify peripheral vs. central vascular access based on infusate properties, the frequency and duration of infusions, unique patient features, and resources available. The goal of selection is to use the least invasive and smallest device that lasts for the duration of therapy while prioritizing the preservation of vessel health.[4] Per the *Infusion Therapy Standards of Practice,* therapies administered via the peripheral route are to be evaluated for irritant or vesicant properties, be physiologically similar to blood (to reduce vessel damage), and have dextrose concentrations ≤10%, and protein limited to 5%.[4] Although the *Standards* do not provide definitive limits on pH or osmolarity for peripheral administration, researchers identify the highest risk of vessel damage occurring with solutions >600 mOsm/L and pH <4 or >9, and osmolarities as low as 450 mOsm/L have a moderate risk of vessel damage.[5] Unless clinically indicated, VADs should not be routinely replaced due to changes in therapy unless the new therapy requires central infusion compared to using an existing peripheral VAD.[4] Table 1 provides the INS recommendations for types of VAD based on solution properties and anticipated duration of treatment.

In order to optimize patient outcomes, home infusion providers rely on outcome studies. Currently, there is a dearth of information on outcomes associated

TABLE 1 | Vascular Access Devices Used in Home Infusion

Vascular Access Device Type	Recommendations for Use
Short and long peripheral vascular access device	For administration of solutions that are isotonic with a physiologically similar pH and osmolarity with an anticipated duration of ≤4 days. A peripheral access device may remain appropriate for longer durations if clinically indicated and free from complications. Avoid infusions with extremes in pH and/or osmolarity to reduce vascular damage.
Midline peripheral vascular access device	For solutions appropriate for peripheral administration with an anticipated duration of 5-14 days. A midline may remain appropriate for longer durations if clinically indicated and free from complications. Continuous vesicants are not administered via a midline.
Central vascular access device	For therapies with durations >14 days, solutions not appropriate for peripheral administration, complex infusion regimens, and for insufficient peripheral venous access for planned intermittent or periodic treatment.

Reference: Nickel B, Gorski LA, Kleidon T, Kyes A et al. Infusion Therapy Standards of Practice, 9th Edition. J Infus Nurs,(2024). 47(1S),S1-S291.

with VAD type and utilization specific to the type of individual therapies in the home infusion populations. This descriptive study of current VAD practices provides information into current practices and helps identify opportunities to improve processes that facilitate best practices to realize the best patient outcomes. Accordingly, the objectives of this study are to describe the utilization of VADs in the home infusion setting and identify VAD trends in specific patient populations.

Methodology

This study was a descriptive, retrospective review of patient data collected by NHIF for its benchmarking program. Patient VAD data has been collected by the NHIF and stored in its data repository since 2021 as part of an industry-wide benchmarking initiative. All home infusion provider locations are invited to participate in NHIF data programs, which collect and report data quarterly. Throughout 2021 and 2022, 12,968 patient cases were de-identified and submitted to the NHIF Benchmarking Program using a formatted Excel® file and an instruction manual that included how to code the data and definitions of terms. The patient cases were to include status at discharge, age, type of venous access device, and adverse drug reaction if applicable. However, not all cases included the entire requested information. For the patient case to be eligible for this study, VAD, patient age, and therapy type data had to be included.

The data was analyzed using IBM Analytics Software, SPSS. Frequency and percentages were determined for patient age group and therapy type while cross tabulation analysis was used to gain an in-depth understanding of the VAD usage for the different home infusion therapies.

Results

The 2021 and 2022 NHIF benchmarking program provided 12,968 home infusion patient cases representing 26 unique home infusion providers across the United States. Of these cases, 11,265 included therapy type, VAD, and age data. After a review of the data set, the research team determined that enteral and subcutaneous infusions are not administered using a VAD. As a result, these patient cases (n=298) were deleted from the data set. The final data set included 10,967 patient cases and was analyzed to determine the patient demographics, most common type of home infusion VAD, and the type of VADs that are used with the different therapy types.

Patient Demographics

In this study, the mean home infusion patient age was 59.26 (SD=17.36) with a range of 0-100 years.

In almost two-thirds (n=7,193) of the patient cases a peripherally inserted central catheter (PICC) was used as the therapy access device. A midline was used in 13.12% of the cases, and a short peripherial intravenous catheter (short PIVC) in 8.59% of the cases. As shown in Figure 1 and Table 2, there are other access devices that are used in home infusion setting.

FIGURE 1 | Home Infusion Vascular Access Devices (n=10,967)

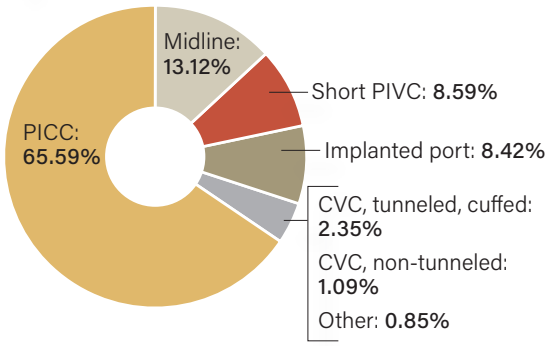

TABLE 2 | Home Infusion Vascular Access Devices (n=10,967)

	Frequency	Percent
PICC	7,193	65.59
Midline	1,439	13.12
Short PIVC	942	8.59
Implanted port	923	8.42
CVC, tunneled, cuffed	258	2.35
CVC, non-tunneled	119	1.09
Other	93	0.85
Total	**10,967**	**100.00**

To gain a more in-depth understanding of the types of home infusion VADs that are used for the various therapy types and to show the relationship between therapy type and VAD, cross tabulation analysis was conducted. The most common anti-infective VAD was a PICC and was used by 72.69% of the patients. A PICC was also the most common for the parenteral nutrition patients with 68.88% using this type of VAD. An implanted port was used 87.74% of the time for the administration of anti-neoplastic chemotherapy and 37.57% of the time for hydration therapy, while a short PIVC was predominately (91.82%) used for biologics administration.

Discussion

These results show PICC was the primary VAD utilized in the home infusion setting for a variety of intravenous medication therapies. A PICC was reported in 65.69% of all patients included in this study, followed by midline, short PIVC, and implanted port at 13.12%, 8.59%, and 8.42%, respectively. The INS standards provided recommendations for types of medications administered to the level of central venous or peripheral venous access.[4] The results of this research added an analysis of medication therapy type divided by central and peripheral VADs and further described the prevalence by types of central VAD and peripheral VAD for each medication therapy. Providing data on the prevalence of specific central and peripheral VADs by therapy or treatment shows details of actual utilization that supports the current standards of practice.

The research in this study reported data on utilization that highlighted which VADs were selected for each home infusion therapy. The results showed evidence of following recognized standards and guidelines.[6,7] Published guidelines for selecting VAD for administering parenteral nutrition focused on complications and VAD infection rates in a variety of central VADs. The safety profile of PICC VADs was addressed, and the selection of a PICC for parenteral nutrition was emphasized.[5] The study findings reported here found PICC was the most common VAD used for administering parenteral nutrition in home infusion patients, followed by implanted port. Additionally, our research showed PICC was the most common VAD for anti-infective home infusion therapy. Even though guidelines from the Infectious Diseases Society of America (IDSA) make no recommendation for the choice of VAD for outpatient anti-infective therapy (OPAT), they acknowledged the need for central VADs and accepted midlines for use in shorter courses of OPAT.[6] This study found the primary therapy associated with midline VAD was anti-infective therapy.

Previous studies that published data on VAD by therapy type reported variables related to outcomes, such as safety and complication rates between 2 or more types of central VADs, but did not include prevalence data for individual VADs by therapy type.[6-11] Prior research showed implanted ports being preferred for the administration of chemotherapy.[7-9] In our research, an implanted port was the most commonly reported for anti-neoplastic chemotherapy and hydration therapy. Many studies reported on variables to use in decision-making for the selection of VAD, and our study provided patient-level detail reinforcing that clinical judgments were aligned with best practices and current evidence.

Study limitations included a low sample size for immune globulin and pain therapies. Strong VAD conclusions and inferences should not be made for these 2 therapy types. The second limitation was the possibility of data entry errors made by the provider locations submitting data to the benchmarking initiative. Since data errors are a well-documented part of medical datasets, prior to conducting the data analysis, the data was checked for entries that were not consistent with the data entry guide. If an unacceptable code was used, the data cell was deleted. If the data entry error involved using an acceptable code, the error would be difficult to recognize and remediate.

Conclusions

In this study of VAD utilization in the home infusion setting, PICC was reported in two-thirds of all patients included. When analyzed by therapy type, PICC was reported as the primary VAD for the administration of parenteral nutrition, anti-infectives, and inotrope therapies. The high utilization of PICC VADs in this study validates its selection for medication administration in the home site of care.

References

1. Polinski JM, Kowal MK, Gagnon M, Brennan TA, Shrank WH. Home infusion: Safe, clinically effective, patient preferred, and cost saving. *Healthc (Amst).* 2017;5(1-2):68-80. Epub 20160429. doi: 10.1016/j.hjdsi.2016.04.004. PubMed PMID: 28668202.
2. Haines DJ, Simpson M. Rate of discontinuation from home infusion therapy due to adverse drug reactions and unplanned hospitalization – A pilot study. INFUSION NHIF Research Supplement, September/October 2021; 2-7.
3. Sullivan C, Haines DJ. Setting the bar – Establishing industry standards through benchmarking. INFUSION, July/August 2018; 23(4):26-33.
4. Nickel B, Gorski L, Kleidon T, Kyes A, DeVries M, Keogh S, et al. Infusion Therapy Standards of Practice, 9th Edition. *J Infus Nurs*. 2024;47(1S Suppl 1):S1-S285. doi: 10.1097/NAN.0000000000000532. PubMed PMID: 38211609.
5. Manrique-Rodriguez S, Heras-Hidalgo I, Pernia-Lopez MS, Herranz-Alonso A, Del Rio Pisabarro MC, Suarez-Mier MB, et al. Standardization and Chemical Characterization of Intravenous Therapy in Adult Patients: A Step Further in Medication Safety. *Drugs R D.* 2021;21(1):39-64. Epub 20201221. doi: 10.1007/s40268-020-00329-w. PubMed PMID: 33346878; PubMed Central PMCID: PMC7937591.
6. Kovacevich DS, Corrigan M, Ross VM, McKeever L, Hall AM, Braunschweig C. American Society for Parenteral and Enteral Nutrition Guidelines for the Selection and Care of Central Venous Access Devices for Adult Home Parenteral Nutrition Administration. *JPEN J Parenter Enteral Nutr.* 2019;43(1):15-31. Epub 20181019. doi: 10.1002/jpen.1455. PubMed PMID: 30339287.
7. Norris AH, Shrestha NK, Allison GM, Keller SC, Bhavan KP, Zurlo JJ, et al. 2018 Infectious Diseases Society of America Clinical Practice Guideline for the Management of Outpatient Parenteral Antimicrobial Therapy. *Clin Infect Dis.* 2019;68(1):e1-e35. doi: 10.1093/cid/ciy745. PubMed PMID: 30423035.
8. van den Bosch CH, Spijkerman J, Wijnen M, Hovinga I, Meyer-Wentrup FAG, van der Steeg AFW, et al. Central venous catheter-associated complications in pediatric patients diagnosed with Hodgkin lymphoma: implications for catheter choice. *Support Care Cancer.* 2022;30(10):8069-79. Epub 20220701. doi: 10.1007/s00520-022-07256-3. PubMed PMID: 35776186; PubMed Central PMCID: PMC9512752.
9. Yeow M, Soh S, Yap R, Tay D, Low YF, Goh SSN, et al. A systematic review and network meta-analysis of randomized controlled trials on choice of central venous access device for delivery of chemotherapy. *J Vasc Surg Venous Lymphat Disord.* 2022;10(5):1184-91 e8. Epub 20220330. doi: 10.1016/j.jvsv.2022.03.007. PubMed PMID: 35367407.
10. Capozzi VA, Monfardini L, Sozzi G, Armano G, Butera D, Scarpelli E, et al. Peripherally Inserted Central Venous Catheters (PICC) versus totally implantable venous access device (PORT) for chemotherapy administration: a meta-analysis on gynecological cancer patients. *Acta Biomed.* 2021;92(5):e2021257. Epub 20211103. doi: 10.23750/abm.v92i5.11844. PubMed PMID: 34738565; PubMed Central PMCID: PMC8689318.
11. Christensen LD, Holst M, Bech LF, Drustrup L, Nygaard L, Skallerup A, et al. Comparison of complications associated with peripherally inserted central catheters and Hickman catheters in patients with intestinal failure receiving home parenteral nutrition. Six-year follow up study. *Clin Nutr.* 2016;35(4):912-7. Epub 20150728. doi: 10.1016/j.clnu.2015.06.009. PubMed PMID: 26269383.