Role of Peripherally Inserted Central Catheters in Home Parenteral Nutrition: A 5-Year Prospective Study

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Abstract

Background: Home parenteral nutrition (HPN) has become a common therapy, with tunneled central venous catheters (CVCs) being preferred for its administration. Peripherally inserted central catheters (PICCs) are not currently recommended for long-term HPN, although evidence to support this statement is scarce. The authors aimed to evaluate the outcomes of HPN, focusing on CVC-related complications. *Materials and Methods:* All patients attended at the authors' center for HPN from 2007–2011 were prospectively included. HPN composition aimed at 20–35 kcal/kg/d, 3–6 g/kg/d of glucose, 1.0 g/kg/d of amino acids, and <1 g/kg/d of lipids. HPN was infused in an intermittent schedule, mostly at night. Catheter-related bloodstream infections (CRBSIs) were confirmed with positive semi-quantitative or quantitative culture of the catheter or simultaneous differential blood cultures drawn through the CVC and peripheral vein. *Results:* Seventy-two patients received HPN, with 79 implanted CVCs (48 PICCs, 10 Hickman, and 21 ports). Mean catheter-days were 129.1 for PICCs, 98.5 for Hickman, and 67.7 for ports ($P = .685$). When analyzing CRBSIs, ports had 44, Hickman had 20, and PICC had 0 episodes per 1000 catheter-days ($P = .078$). Only PICCs showed less incidence of CRBSIs vs ports ($P = .043$). Multivariate logistic regression, correcting by catheter-days, patients' age and sex, underlying disease, and type of catheter, showed that only catheter-days ($P = .031$) was a predictor for CRBSIs ($P = .007$, Nagelkerke $R = = 0.246$). *Conclusion:* PICCs are similar in terms of catheter-related complications to other CVCs for the administration of HPN, especially for oncology patients with HPN lasting <6 months. (*JPEN J Parenter Enteral Nutr*. XXXX;xx:xx-xx)

Keywords

home parenteral nutrition; peripherally inserted central catheter; central venous catheter; catheter-related infection

Clinical Relevancy Statement

The finding that peripherally inserted central catheters (PICCs) were similar in this study to other central venous catheters (CVCs) for home parenteral nutrition (HPN) in terms of infections and other complications, when patients are supported by a highly specialized unit including an intravenous therapy team (ITT), may change current practice when choosing a CVC for HPN. This may be particularly true for the oncologic patient and when parenteral nutrition is expected to last <6 months, as supported by our results. Moreover, although only a small number of patients required HPN for >6 months in our study, PICCs and other CVCs did not differ in terms of catheter-related complications in this subgroup of patients.

Introduction

Parenteral nutrition (PN), although initially used in hospitalized patients, has become a common therapy for patients at home and is known as home PN (HPN).[1,2] Current HPN national registries in North America have recorded 400 patients/y with this therapy in Canada[3] and 324 patients/y in the United States[4,5] for the past year. The prevalence of HPN is about 1.5 per million inhabitants in Spain, and the most frequent indication is short intestine syndrome and active cancer.[6,7] The largest group of patients is between 40 and 60 years of age, with only 10%–20% children.[2,6,7] At the present time,

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prognosis and survival in the medium and long term are higher with HPN than with an intestinal transplant, so this must be reserved for those patients presenting severe complications with PN.[8] The standardization of care and the development of good education programs may contribute to an improvement in the results, with emphasis on the caregiver, who may be an important contributor to the quality of life in these patients.[9,10]

Current guidelines for the choice of central venous access for HPN state that a tunneled central catheter is preferred over other central catheters.[1,11] Accordingly, almost two-thirds of patients have received PN through a tunneled catheter, and one of the most frequent complications is catheter-associated blood infection.[7,12] Although peripherally inserted central catheters (PICCs) have shown a diminished rate of catheter-related infections in some hospitalized patients, such as intensive care unit (ICU) patients and children,[13,14] this has not yet been proven for HPN. In fact, current guidelines do not recommend PICCs for long-term HPN.[1] In contrast, a previous study has shown that patients with PICC for HPN had a statistically significant increase in catheter-related infections as compared with other central venous catheters (CVCs).[15] Patients in this study were followed for 12 months or until PN was discontinued. However, the study was retrospective, and catheter-related infection was defined as a positive blood culture either before or within 48 hours after a catheter was removed. Therefore, false-negative results may have occurred with the consequence of missing some patients with associated infectious complications.[15]

On the other hand, our personal experience has shown that PICCs may be a good alternative to tunneled central catheters for HPN in selected cases,[16,17] especially if patients are supported by a highly specialized team that may reduce its complications, as reported previously.[18] The aim of this study was to prospectively evaluate the outcomes of a cohort of patients with HPN attended at our center for the past 5 years, focusing on the central catheter employed and its related complications, after a highly specialized team (including an intravenous therapy team [ITT]) was implemented at our center.

Patients and Methods

Studied Cohort

All patients attended at the Hospital Universitario Ramón y Cajal for HPN from 2007–2011 were prospectively included. At our center, a specialized team that includes an ITT takes care of these patients. The ITT, which was created at our center in 2006, was integrated into the Department of Clinical Nutrition and was fully operative by the end of that year. Therefore, we started this prospective study right after all the protocols were designed and all the personnel were adequately trained to give the best care to HPN patients, not only regarding their artificial nutrition but also their venous accesses. The Ethics Committee of the Hospital Ramón y Cajal approved the study, and written informed consent was obtained from the participants.

Composition of PN followed current guidelines.[1] In brief, we prepared PN at our hospital for individualized formulas, and whenever possible, commercial "ready-to-use" (RTU) bags were also employed. In both cases, we aimed at 20–35 kcal/kg/d, with a proportion of 3–6 g/kg/d for glucose, 1.0 g/kg/d for amino acids, and <1 g/kg/d for lipids, with 7–10 g/d of essential fatty acids. Vitamins and trace elements were also added by the hospital pharmacy for those patients unable to take these supplements. PN was infused on an intermittent schedule primarily at nighttime. All patients and, when needed, some of their relatives were appropriately trained for adequate manipulation of both the central catheter and PN infusion pumps and connections. After nutrition infusion, patients were instructed to use heparin (3 mL of 20-IU/mL commercial vials) through their catheters. For those active patients who were able to self-care the PICC, a polyethylene extension tube (Vygon Corporation, Montgomeryville, PA) was connected between the PICC and the nutrition system, to avoid rendering them one-handed. Patients came to our unit for follow-up every 15 days at the beginning of the program and every 1–2 months thereafter. A complete blood test was performed, as well as a clinical history and examination. Catheter inspection was also done at the ITT clinic at the same time. Moreover, whenever needed, patients also came to the ITT clinic for revision of their catheter, particularly if they suspected any complication, regardless of whether they had an interview at the clinical nutrition unit.

Central Venous Catheters and Its Related Complications

Choice of CVC was not randomized but based on the patient's responsible physician, always taking into account the underlying disease, the expected duration of HPN, and the possibility of a safe procedure for obtaining a venous access. A Hickman CVC was preferred for those patients with nonmalignant disease who were initially expected to need long-term PN (>6 months of HPN administration). A PICC catheter was indicated for those patients initially expected to need HPN for <6 months, such as those with malignant disease with advanced stages and at least receiving second-line chemotherapy or those with no further treatments in palliative care. Port-a-caths were also used for HPN in those oncologic patients who already had these devices and in whom survival was expected to be short (<6 months) and PN was not contraindicated with concomitant chemotherapy infusion. If the latter was the case, then ports were used for chemotherapy, and a simultaneous PICC was used for HPN. PICC catheters were also indicated in those patients with Hickman or port removal after a complication, especially if it was difficult to obtain these CVCs again for technical reasons. Multilumen catheters were chosen when patients needed additional medication apart from PN, except for small doses of intravenous (IV) analgesia (excluding the aforementioned patients in whom ports were used).

Ports and Hickman catheters were implanted at the Intervention Radiology Department, with fluoroscopy guidance and local anesthesia. PICCs were implanted at the ITT clinic, with local anesthesia and with ultrasound guidance in those patients in whom venous access was not expected to be easy after inspection by a nurse. Most of the implanted PICCs were of silicone composition (Cook Medical, Bloomington, IN; Vygon Corporation; Arrow International, Inc, Reading, PA; Bard Medical, Covington, GA), and some were power-PICCs of polyurethane composition (Bard Medical). Maximal barrier precautions were maintained for all catheter insertions.

Local catheter infections were defined as an exit site infection (defined as redness, swelling, tenderness, with an erythema of more than twice the diameter of the catheter), tunnel infection, or pocket infection. Catheter-related bloodstream infections (CRBSIs) were considered when a patient presented with bacteremia or fungemia in the presence of signs and symptoms of systemic infection, such as fever, chills, and hypotension in the absence of hypovolemia or a cardiac event. A febrile episode in a patient with HPN was regarded as a suspected CRBSI, especially when there was no apparent source for an infection except the catheter itself, and all patients with fevers were told to come to the hospital. Probable CRBSI was diagnosed by 1 or more positive blood cultures obtained from a peripheral vein, when there was no apparent source for the bloodstream infection except the catheter. In addition, CRBSI was confirmed at our center with positive semi-quantitative or quantitative culture of the catheter after its removal, or positive blood cultures were drawn through the CVC and peripheral vein.[19,20]

Statistical Analysis

Results are expressed as means ± SD unless otherwise stated. The Kolmogorov-Smirnov statistic was applied to continuous variables. Logarithmic or square root transformations were applied as needed to ensure a normal distribution of the variables. Comparisons between the different groups at baseline were performed by independent *t* test for continuous variables or the Mann-Whitney *U* test for nonnormal distributed variables and by the χ^2 test or Fisher exact test for discontinuous variables. For more than 2 groups, comparisons were performed by using univariate analysis of variance for continuous variables with Tukey's honestly significant difference (HSD) post hoc test or the Kruskal-Wallis test for nonnormal distributed variables and using the χ^2 test for discontinuous variables, as needed. Multivariate logistic regression was performed to study the effects of multiple independent variables on the occurrence of catheter infection with a Wald backward stepwise modeling strategy. Analyses were performed using SPSS 15 (SPSS, Inc, an IBM Company, Chicago, IL). $P < .05$ was considered statistically significant.

Results

A total of 72 patients have received HPN in the past 5 years, 47 women (65.3%) and 25 men (34.7%), with a 58.46 ± 12.88 (mean ± SD) years of age. PN was prepared at the hospital pharmacy in 54 patients (75%) with an individual prescription, and RTU bags were used for 18 patients (25%). Regarding the patients' underlying disease, 13 were nononcologic patients (18%), and the remaining 59 patients had an underlying malignancy (82%). Specific diagnoses are given in Table 1.

Considering the implanted CVCs, a total of 79 were registered: 48 PICCs, 10 Hickman, and 21 ports. Table 2 summarizes catheter distribution among patients and other characteristics. Ultrasound guidance was employed for 7 PICC insertions. Twenty-eight patients received >3 months of PN, and 11 patients had >6 months of PN.

No episodes of deep vein thrombosis or superficial phlebitis were recorded. Total catheter obstructions requiring removal of the CVC were not found, and there were no partial obstructions requiring fibrinolytic therapy through catheters. One oncologic patient had a PICC removed because of fever with suspected CRBSI, but with negative blood and catheter cultures. Another PICC was later inserted when fever disappeared. A second patient had a port infection with a *Candida* sp with port removal, and a PICC was later inserted for HPN without a known complication thereafter. A third patient with a port had a CRBSI with positive cultures for *Staphylococcus hominis*, and a fourth patient also with a port had a positive culture for negative coagulase *Staphylococcus*. A fifth patient needed a Hickman catheter removal because of a CRBSI with a positive catheter tip culture for *Enterococcus faecalis*. A sixth patient had a Hickman catheter with positive cultures for negative coagulase *Staphylococcus* in the setting of a febrile episode that was resolved by antibiotic administration. Finally, another patient with a port had a febrile episode concurrent with post-chemotherapy neutropenia with negative simultaneous blood cultures from a peripheral vein and the port. All infectious complications are summarized in Table 3. Statistical analysis showed no significant differences in the occurrence of total CRBSIs between different types of catheter ($\chi^2 = 2.066$, $P = .356$) or between 1-lumen catheters vs multilumen ones ($\chi^2 = 0.124$, $P = .661$).

When considering the ratio of all suspected CRBSIs and catheter-days, ports had 59, Hickman had 20, and PICCs had 8 suspected CRBSIs per 1000 catheter-days ($\chi^2 = 4.780$, $P = .092$). When considering the ratio of only confirmed CRBSIs by culture, ports had 44, Hickman had 20, and PICC had 0 episodes per 1000 catheter-days ($\chi^2 = 5.10$, $P = .078$). When analyzing the same variables with a Fisher correction for a pair comparison, only PICCs showed less incidence of confirmed CRBSIs per 1000 catheter-days vs ports (2-tailed Fisher exact test $P = .043$).

Table 1. Underlying Diseases of Included Patients

Nononcologic	**13**
Inflammatory bowel disease	2
Systemic sclerosis with GI involvement	1
Olgilvie's disease	1
Chronic encephalopathy	1
Short intestine with intestinal failure	3
Idiopathic intestinal lymphangiectasia	1
Intestinal amyloidosis	1
Peritoneal fibrosing syndrome	3
Oncologic	**59**
Gastrointestinal neoplasia	
Esophageal cancer[a]	7
Gastric cancer with PC or obstruction	15
Pancreatic cancer with PC or obstruction	5
Intestinal carcinoma with PC	1
Appendicular carcinoma	1
Colorectal cancer with PC	9
Rectal cancer with radiation enteritis	1
Gynecological neoplasia	
Cervix carcinoma with PC	1
Müllerian carcinoma with PC	1
Breast cancer with PC	1
Ovarian cancer with PC	12
Fallopian tube carcinoma with PC	1
Others	
Bladder cancer with PC	1
Bladder cancer with cutaneous fistula	1
Bone sarcoma with PC	1
Sézary lymphoma with GI involvement	1

GI, gastrointestinal; PC, peritoneal carcinomatosis.
[a]Enteral nutrition and/or prosthesis not feasible.

Multivariate logistic regression analysis, correcting by catheter-days, patients' age and sex, type of PN bag, underlying disease (codified as a dummy variable of oncologic vs nononcologic), type of catheter, and the interaction of type of catheter with catheter-days, as well as introducing the occurrence of a CRBSI as the dependent variable, showed that only catheter-days (Wald = 4.647, odds ratio = 1.006, $P = .031$) was retained by the model ($\chi^2 = 9.947$, $P = .007$, Nagelkerke $R^2 = 0.246$).

Discussion

In this study, we have shown that PICCs are similar to other CVCs for HPN in terms of catheter infections and other complications. This is a relevant result as current guidelines state that PICCs cannot be recommended for long-term HPN.[1] Our previous personal experience has shown that PICCs may be a good alternative to tunneled central catheters for HPN in selected cases,[16,17] especially if patients are supported by a highly specialized team, which may reduce their complications.[18,21] We have shown that PICCs may be considered an alternative to other central catheters even in patients with HPN for >3 months and, in selected cases, >6 months. Our results are in agreement with the Australian Society for Parenteral and Enteral Nutrition (AuSPEN) guidelines for home PN patients in Australia and New Zealand that state that PICCs may be considered for HPN up to 12–18 months.[22] Nevertheless, in our setting, there is a highly specialized team including an ITT, integrated in the Department of Clinical Nutrition, which was created just before this study began. Therefore, our results are not applicable to other clinical settings in which a lack of such a specialized team may compromise patients' adequate training regarding the management of HPN and CVC care and the identification of its possible complications.

Our study was not subject to any possible bias regarding patient selection, as every patient in our clinical area who may need HPN is referred directly to our department, as there is no other institution that can offer this service. On the other hand, although ours was a prospective study, a limitation is the lack of randomization when assigning the type of CVC. As stated above, clinical judgment of the responsible clinician guided the choice of the type of CVC. Nevertheless, this did not result in any bias regarding catheter-days, and in fact, PICCs catheter-days were similar to those with other CVCs. Furthermore, after multivariate analysis, no effect of the type of catheter was found on the occurrence of CRBSI, and only catheter-days were a predictor for the latter. This emphasizes that the choice of a PICC for HPN may be as good an alternative as tunneled CVC.

Another limitation is the small number of patients with HPN for >6 months, mainly due to the large proportion of oncologic patients included in this study, although there was no difference in the proportion of type of catheter assigned in this group of patients. Although HPN for oncologic patients with short life expectancy is controversial, current European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines state that patients with incurable cancer may enter an HPN program if they are unable to meet their nutrition requirements by the oral or enteral route and there is a risk of death due to malnutrition. Furthermore, the guidelines also state that stopping oncological treatment is not a contraindication for HPN.[1]

A previous study showed that patients using PICCs for HPN had a significant increase in catheter-related infections as compared with other central venous access devices.[15] Patients were followed for 12 months or until PN was discontinued, but the study was retrospective, and catheter-related infection was defined as a positive blood culture either before or within 48 hours after catheter removal. Therefore, false-negative results may have occurred in this study.[15] This contrasts with our methodology, as we performed a prospective study in which patients were told to always communicate any event regarding a possible catheter-related complication, and whenever a febrile episode occurred, the patient was referred to our center

Table 2. Type of Catheters Employed for Home Parenteral Nutrition (n = 79)

	PICCs (n = 48)	Hickman (n = 10)	Ports (n = 21)	*P* Value
Sex				
Female	29 (55.7)	7 (13.5)	16 (30.8)	
Male	19 (70.4)	3 (11.1)	5 (10.5)	.426
Underlying disease				
Oncologic	40 (62.5)	4 (6.3)	20 (31.2)	
Nononcologic	8 (53.3)	6 (40.0)	1 (6.7)	.001
Type of catheter				
One lumen	40 (63.5)	2 (3.2)	21 (33.3)	
Multilumen	8 (50.0)	8 (50.0)	0	<.001
Catheter-days[a]	60 ± 129	62.5 ± 148	53 ± 66	.685
Duration, mo				
<3	21 (52.5)	4 (10.0)	15 (37.5)	
>3	19 (67.8)	4 (14.3)	5 (17.9)	
>6	8 (72.8)	2 (18.3)	1 (0.9)	.253

Data are absolute number (%) except where otherwise indicated. PICC, peripherally inserted central catheter.
[a]Median ± interquartile range.

Table 3. Catheter Complications for Home Parenteral Nutrition

Type of Catheter	Infectious Complication	Microorganism	Antibiotic Therapy
Ports (n = 21)	CRBSI (n = 3)	*Candida albicans* *Staphylococcus homini*	Amphotericin B[a] and port removal Ceftazidime[a]
		Staphylococcus epidermidis	Vancomycin[a] and port removal
	Neutropenic fever (n = 1)	Negative cultures	Empiric vancomycin and cefotaxime
Hickman (n = 10)	CRBSI (n = 2)	Negative coagulase *Staphylococcus* and *Actinomyces*	Vancomycin and meronem[a]
		Enterococcus faecalis	Piperacillin-tazobactam[a]
PICCs (n = 48)	Suspected CRBSI (n = 1)	Negative cultures	Empiric cefepime

CRBSI, catheter-related bloodstream infection; PICC, peripherally inserted central catheter.
[a]Culture antibiogram-guided antibiotic therapy.

for evaluation, where blood and/or catheter cultures were taken as needed to confirm or refute CRBSI.

A recent multicenter study that explored the complications of HPN concluded that line infections were the most important complication.[23] They found an incidence of 3.6 per 1000 catheter-days, and this number increased when considering patients with a multiuse CVC to 11.6 per 1000 catheter-days. In that study, PICCs were employed in only 2 adults (exclusively dedicated for HPN) and 1 child (multilumen PICC also for IV fluids and drugs), and the complications of these devices were not specifically reported.[23] These results are comparable to ours, as we found no confirmed CRBSI with PICCs and 8 suspected CRBSIs per 1000 catheter-days. Although our numbers were a little higher for Hickman and ports, they were not significantly different from those found with PICCs in the multivariate analysis.

Another recent study[24] compared the complication rates of 2 types of PN bags for hospitalized patients: the exposure cohort received PN in a commercial multichamber bag (n = 4669), whereas the comparison group received PN prepared by

a pharmacy (n = 64,315). The results showed that the incidence of CRBSI was diminished in patients receiving PN by the administration of multichamber bags. We could not confirm this result, as the type of PN bag had no influence on the incidence of CRBSI in our patients, as shown by multivariate analysis. However, PN outcomes may clearly be different between HPN and hospitalized patients. Another explanation could be that our sample size was not large enough to detect differences in outcomes between different types of bags.

PICCs may also have the disadvantage, because of their exit position, of rendering the patient one-handed, which may make self-care difficult.[22] We have overcome this problem with silicone extension sets, which have had no impact on the rate of infections. Nevertheless, quality of life was not measured in these patients, so this is another limitation of our study that should be addressed in future trials.

In conclusion, we have shown that PICCs are similar to other CVCs for HPN in terms of infectious and other complications, when patients are supported by a high specialized team, including an ITT. This may be particularly true for the oncologic patient and when PN is expected to last for <6 months. Although we found similar results for HPN lasting for >6 months, the small sample size in this subgroup of patients may preclude generalization of our results. Future clinical trials should be conducted as to definitively confirm these results.

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