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Management of Hospital In The Home (HITH) Peripherally Inserted Central Catheters: A Retrospective Cohort Study

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Abstract

Worldwide, there has been a shift in health care delivery, with an increasing emphasis on avoiding hospital admissions and providing treatment such as intravenous antibiotics for patients at home, using peripherally inserted central catheters (PICCs). However, there is inadequate data to demonstrate if rates of PICC failure are similar for hospital inpatients, currently understood to be between 7% and 36%, than those cared for at home. The objective of this study was to identify prevalence, dwell time, and complications associated with PICCs in the home setting. This single-center, retrospective cohort study of adults treated by the “Hospital in the Home” (HITH) program in Queensland, was conducted between June 1, 2017 and June 15, 2018. Clinical data were collected for patient and PICC characteristics. Variables were described as frequencies and proportions, means and standard deviations, or medians and interquartile ranges. In total, 304 patients treated by HITH during this timeframe, and 164 (54%) patients with 181 PICCs were included in this study. These patients were predominately male (n = 105, 64%), with a mean age of 54 years. The most common reason for admission was a wound infection and/or bone infection (n = 120, 33%). Most PICCs were single lumen (n = 120; 67%), inserted in the basilic vein (n = 137; 80%) by nurses (n = 122; 67%). Peripherally inserted central catheter failure occurred in 10% (n = 19); the most common complications were dislodgement (n = 9; 5%) and thrombosis (n = 4; 2%). There were no confirmed catheter-related blood stream infections. Peripherally inserted central catheter failure rates are similar between hospitalized inpatients and those cared for at home.

Keywords

peripherally inserted central catheter, PICC, HITH, Hospital in the Home

Introduction

Worldwide, there has been a shift in methods of health care delivery, with an increasing emphasis on avoiding hospital admissions and providing health care for patients in their own home.[1,2] An example of this type of service in Queensland, Australia is Hospital in the Home (HITH), which provides a coordinated multidisciplinary program of direct clinical care for patients who would traditionally have been admitted to hospital.[1,3] As part of this program, each patient requires a minimum daily intervention or assessment comparable to inpatient hospital care.[4] The provision of HITH is thought to be cost-saving and reduce adverse events associated with a hospital admission, as well as have increased benefits to patient rehabilitation.[1] With most developed countries experiencing a growing demand for inpatient hospital care for an increasing and aging population, HITH provides a potential opportunity to improve efficiencies of health care service, as well as provide patients with more choices in how they receive their health care.[4]

The most common service provided by the HITH program is the delivery of intravenous (IV) antibiotics for conditions such as cellulitis, urinary tract infections, or pneumonia.[3] As a result, most patients in the HITH setting have a vascular access device (VAD) in place to deliver intravenous therapy (IVT) outside the traditional hospital setting.[5] A VAD that is commonly used for home IVT is the peripherally inserted central catheter (PICC).[6-8] This device is recommended for

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patients who are expected to receive treatment for more than or equal to 15 days[9] and its use in the home is informed by international guidelines such as the Infusion Therapy Standards of Practice by the Infusion Nurses Society.[10]

Currently, there is extensive literature about PICC use in hospitals,[10,11] with PICC failure reported to be between 7% and 36%[11-13] and potentially life-threatening catheter-associated bloodstream infections occurring in up to 8.6% of patients.[9,11,14-16] Although studies have been conducted assessing the use and complications associated with PICCs in the community setting, they have particularly focused on patients with a cancer diagnosis, or patients who suffer from conditions which impair food intake, therefore requiring home parenteral nutrition; these factors may place these patients at higher risk of PICC complications than HITH patients.[17-19]

This study is important, as it informs health services who are reviewing or considering establishing a HITH program of the prevalence; duration of PICC dwell; and the reason IVT is being delivered by a HITH service, to better inform service planning and delivery. Ascertaining causes and frequency of PICC failure enables improved patient outcomes, as well as aiding in prioritizing and planning future research in HITH.

Methods

Study Design and Participants

This retrospective cohort study was conducted within the HITH setting of a large tertiary hospital in Queensland, Australia. Adult patients cared for by HITH, between June 1, 2017 and June 15, 2018, were included in this study. Ethics exemption was obtained from the hospital (approval ID: HREC/18/QRBW/128).

PICC Care and Maintenance

Peripherally inserted central catheters were inserted by clinical nurses, radiographers, and radiologists following skin decontamination with a Solu-Prep™ Antiseptic Swab (2% chlorhexidine gluconate in 70% isopropyl alcohol; 3M, St Paul, MN, USA). Three different PICCs were used: BioFlo® PICC (AngioDynamics Inc, Queensbury, NY, USA); Arrow® (Teleflex, PA, USA), and PowerPICC®Solo2 (Bard/Becton Dickinson, SCL, USA). A Smart-Site™ needle-free valve (Becton Dickinson, Rolle, CH) was addedand all PICCs were flushed with a manually prepared 10 mL of saline 0.9% before and after the administration of medication. The standard PICC dressing was either a bordered chlorhexidine-impregnated polyurethane dressing (Tegaderm™, 3M, St Paul, MN, USA), or a standard polyurethane dressing (IV3000™, Smith and Nephew, Hull, UK), in conjunction with a securement device (StatLock™ PICC Plus Stabilization, Bard/Becton Dickinson, Covington, GA, USA).

Data Collection

Clinical data were recorded on a purpose-built PICC Line Management Tool by HITH Registered Nurses who visited the patients daily. A research nurse collated this information with other relevant variables (eg, PICC outcomes such as infection) from integrated electronic medical records. Data were entered directly into a central excel spreadsheet and included patient characteristics (eg, age and gender), site assessment (eg, redness, swelling, and tenderness), PICC characteristics (eg, number of lumens and vein of insertion), and PICC failure from complications such as partial or complete catheter dislodgement; catheter occlusion where aspiration or infusion was not possible[20] suspected and confirmed local or catheter-related bloodstream infection[21] and venous thrombosis involving deep veins of the arm.[22]

Data Analysis

Data were downloaded to Stata 15 (StataCorp., College Station, TX) for data management and analysis. Patient and device variables were described as frequencies and proportions, means and standard deviations, or medians and interquartile ranges. Peripherally inserted central catheter failure incidence rates were calculated, and a Kaplan–Meier survival curve was plotted. Hazard ratios of failure considering participant, device, and treatment characteristics (predictors) at baseline were calculated using univariable Cox regression. Predictors at $p < .2$ (likelihood ratio test) were eligible to be entered in the multivariable model. The number of predictors in the multivariable model was not allowed to exceed the 1:10 (number of predictors vs number of failures) ratio.

Results

Patient and PICC Characteristics

In total, 304 patients were cared for by HITH during this period. Of these, 164 (54%) patients with 181 PICCs were included in this study. Patients were predominately male (n = 105, 64%) with a mean age of 54 years and being treated for a wound infection and/or bone infection (n = 120, 33%; Table 1). Most PICCs were single lumen (n = 120, 67%), placed in the basilic vein (n = 137, 80%), in the right arm (n = 121, 69%) by a nurse (n = 139, 79%). The median PICC dwell was 23 days (interquartile range = 12-35), with 12% (n = 20) of PICCs in place for ≤7 days. Similar numbers of PICCs were inserted throughout the seasons of the year (autumn n = 39; spring n = 48; summer n = 44; and winter n = 50)

PICC Complications

The outcome of PICC removal was available for 180 catheters (<1% missing data; Table 2). Peripherally inserted central

Table 1. Participant and Treatment Characteristics.

	No. (%)[a]
Per patient analysis (n = 164)	
Age, y[b]	54.3 (17.0)
Males	105 (64)
BMI[b]	28.7 (8.5)
Per device analysis (n = 181[a])	
Admitting team	
Orthopaedic	40 (22)
Vascular	22 (12)
Medical	22 (12)
Oncology/hematology	19 (11)
Ears, nose, and throat	15 (8)
Other	63 (35)
Other infection or condition	
Bone infection	59 (33)
Wound (including ulcer) infection	40 (22)
Wound and bone infection	8 (4)
Respiratory condition/infection	16 (9)
Cellulitis	13 (7)
Urinary tract infection	10 (6)
Other	35 (19)
PICC type (n = 174)	
PowerPICC	121 (70)
Arrow	47 (27)
BioFlo	6 (3)
Side of insertion: right (n = 176)	121 (69)
Number of lumens (n = 178)	
One	120 (67)
Two	57 (32)
Three	1 (1)
Vein (n = 171)	
Basilic	137 (80)
Other	34 (20)
Inserted at	
Nurse-led insertion team	122 (67)
Department of Medical Imaging	53 (29)
Other hospital	5 (3)
Other	1 (1)
Inserted by (n = 176)	
Nurse	139 (79)
Radio/sonographer	32 (18)
Doctor	5 (3)
Was trimmed (n = 175)	106 (61)
Antibiotic at insertion	174 (96)
Season	
Autumn	39 (22)
Spring	48 (27)
Summer	44 (24)
Winter	50 (28)
External length of catheter, cm (n = 172)[c]	5.0 (3.0-9.0)

Note. BMI = body mass index; PICC = peripherally inserted central catheter.
[a]Unless otherwise noted.
[b]Mean (standard deviation) shown; BMI = body mass index.
[c]Median (25th to 75th percentiles).

Table 2. Outcomes.

	No. (%)[a]
Reason for removal (n = 180)	
Treatment completed	162 (90)
Dislodged (partial or accidental)	9 (5)
Thrombosis	4 (2)
Occlusion	0 (0)
Suspected BSI	2 (1)
Suspected local infection	1 (1)
Other failure	2 (1)
PICC failure (n = 180)	18 (10)
Device-days	4,217
Failure incidence rate (95% CI)	4.27 (2.69-6.77)

Note. BSI = bloodstream infection; PICC = peripherally inserted central catheter; CI = confidence interval.
[a]Unless otherwise noted.

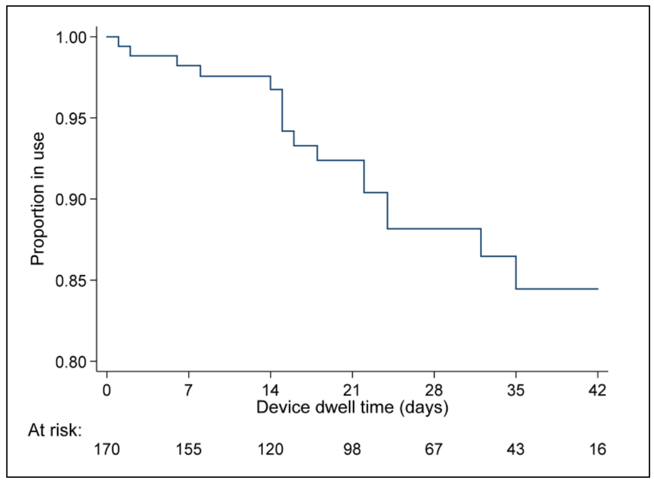

Figure 1. Kaplan–Meier estimate of failure at removal.

catheter failure from any cause occurred in 10% (n = 18) of catheters or 4.2 per 1,000 catheter days (Figure 1). The most common reason for failure was partial or complete dislodgement of the catheter (5%). Two patients' (1%) PICCs were removed due to suspected bloodstream infection; however, there were no confirmed catheter-related bloodstream infections. The univariate analysis found no statistically significant predictors of catheter failure at the $p < .05$ level; predictors with a $p < .2$ were included for multivariable modeling; however, none demonstrated significance ($p \leq .05$; Table 3).

Discussion

This study adds valuable insight for PICC use and maintenance within HITH, adding to the previous paucity of research literature in this area. Our findings confirm that there is growing demand for PICCs in the community for patients requiring IVT at home with more than half of all

Table 3. Cox Regression of Failure at Removal (n = 170).

	Univariable
Age (at first event, 1 year increment)	1.01 (0.98-1.04)
BMI (1 increment)	1.05 (0.98-1.12)*
Female sex (ref. male)	0.94 (0.33-2.68)
Season (ref. autumn)	
Spring	1.63 (0.32-8.26)
Summer	1.07 (0.18-6.44)
Winter	2.13 (0.44-10.3)
Admitting team (ref. orthopaedic)	
Vascular	1.55 (0.37-6.42)
Medical	1.09 (0.21-5.58)
Other	0.74 (0.24-2.23)
Infection/condition: other (ref. osteo/wound)	0.24 (0.05-1.09)*
PICC type: other (ref. Bard)	0.50 (0.14-1.76)
Number of lumens: other (ref. one)	0.64 (0.23-1.79)
Side of insertion: left (ref. right)	1.15 (0.40-3.33)
Vein: other (ref. basilic)	0.40 (0.08-1.86)
CVAD trimmed (ref. no)	2.28 (0.74-7.02)*
Inserted by: other (ref. nurse)	0.40 (0.09-1.78)
Inserted at: other (ref. Wattlebrae)	0.58 (0.19-1.77)
Length of catheter (external, 1 cm increment)	0.93 (0.82-1.05)

Note. Hazard ratio and 95% confidence interval shown; BMI = body mass index; ref. = reference category; PICC = peripherally inserted central catheter; CVAD = central venous access device.
$^{*}p < .20$.

patients having one of these devices, thereby increasing the scope of care and skills required by HITH nurses.

We found that the PICC median dwell time was over 3 weeks. However, 12% (n = 20) dwelled for less than 1 week. This suggests that more consideration could be given to VAD selection. A multispecialty expert panel developed an appropriateness guide for VAD selection,[9] recommended that patients with expected therapy for 6 to 14 days should be considered for a Midline catheter rather than a PICC.[9] As Midline catheters do not need to be inserted in a procedure room such as a Department of Medical Imaging, or require x-ray confirmation, the adoption of this device could have significant cost savings for health services[23,24] and prevent patients having lengthy delays waiting for available time for PICC insertion.

In our study, we found that 1 in 10 PICCs failed prior to the completion of IVT. This failure rate is not dissimilar to a recent randomized controlled trial comparing different PICC securement and dressings within the same health district's inpatient hospital population, which reported a 10% PICC failure rate for patients receiving standard care.[12] It is also comparable to results from an observational study of pediatric outpatients receiving IV antibiotics, which reported a PICC failure rate of 8%.[25] In contrast, an observational study of adult cancer outpatients found a PICC failure rate of 17.5%,[6] demonstrating that high-risk populations such as these may still experience a higher rate of PICC failure in the outpatient setting.

The highest cause of failure in our study was catheter dislodgement (5%); this is often a result of poor attachment of the catheter to the skin, which can lead to dislodgement due to pressure on the external element of the PICC from drag or catching on environmental structures.[11] This dislodgement rate was similar to that reported in inpatient populations (5.4%-8%).[11,12,26] A recent Cochrane review confirmed that there was inadequate research to determine the current best method/s for securing PICCs to reduce dislodgement and other complications.[27] Securement of PICCs has been identified as a concern within both the inpatient and outpatient population and is a focus of ongoing international research.[28]

In comparison to recent pilot randomized controlled trials in the inpatient population of the same health district which reported catheter-associated blood stream infection rates of between 2.0%[29] and 2.5%[12], our study had no confirmed bloodstream infection. This contrasts to a systematic review which reported that PICCs used for outpatients, including home antimicrobial therapy, had a higher catheter-related bloodstream infection rate (3.5%, n = 2,813) than hospital inpatients (2.4%, n = 625).[30] However, the outpatient studies included in this review are more than 15 years old and possibly do not reflect modern PICC materials, dressings, or improved clinical practices.

Another serious PICC complication, thrombosis, was not identified in patients included in this study. Flushing practices were in line with the health districts policies for both HITH and inpatient care; therefore, this is unlikely to have influenced this outcome. The patient and PICC characteristics in the HITH population however may have influenced this lower incidence of complications. In particular, our study found there was a low representation of patients receiving cancer care treatment (11%, n = 19); a population known to have a doubled risk of thrombosis.[19] To be appropriate for care at home, patients also needed to be medically stable; this may have likewise accounted for the low incidence of commonly acquired serious health care complications such as thrombosis and bloodstream infection.

Conclusion

With an increasing burden on already stretched health care budgets, avoiding hospital admission is considered an important goal for many hospitals.[1] The equivalent PICC failure rates between inpatient and HITH population, as well as higher patient satisfaction when cared for at home,[1] confirms the benefit of an HITH service. Furthermore, this study has identified that the highest cause of PICC failure was catheter dislodgement; there is a need for future research in the area to focus on the dressing and securement of PICCs in HITH.

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Author Contributions

Nicole Marsh, Emily Larsen, Sam Tapp, and Claire M. Rickard were involved in study conception, protocol design, and were applicants for grant funding. Margarette Sommerville collated the data, and Gabor Mihala was the data analyst. All authors were involved in the interpretation of results, preparation of manuscript, and approved the final manuscript.

Declaration of Conflicting Interests

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