

Catheter-related Blood Stream Infection in Patients Receiving Long-term Home Parenteral Nutrition: Tertiary Care Hospital Experience in Saudi Arabia

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ABSTRACT

Background/Aim: Parenteral nutrition (PN) is a lifesaving therapy for patients with many severe conditions, including intestinal failure. Some patients require long-term PN therapy, which makes home parenteral nutrition (HPN) an attractive option to improve the quality of life. Among the most common and serious complications observed in these patients are catheter-related blood stream infections (CRBSIs). The aim of our study is to determine the frequency of CRBSI among patients receiving long-term HPN. **Patients and Methods:** A retrospective chart review was conducted for patients enrolled in the HPN program between 2006 and 2012. Data on the demographic characteristics, indications and duration of PN therapy, catheter type, number of admissions because of CRBSI, and blood culture results were recorded. **Results:** Eight pediatric patients were included (mean age of 3.5 years at the start of HPN). Microvillus inclusive disease was noted in 50% of these patients, and 75% of them received HPN under parents' care. CRBSI resulted in 60 admissions with a median of 182 days of hospital stay and 74 changes of central venous catheters. The rate of CRBSI was 2.9 per 1000 catheter days. *Staphylococcus* species were the most prevalent pathogens (32%), followed by *Klebsiella pneumoniae* (5%). **Conclusion:** In this small group of HPN patients, the BSI rate was 2.9 infections per 1000 catheter days, and most common causative organisms were *Staphylococcus* species. We believe that a well-established training program for caregivers can reduce the rate of infectious complications associated with long-term PN support.

Key Words: Catheter-related bloodstream infection, central venous catheter, children, home parenteral nutrition, intestinal failure, parenteral nutrition

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In clinical practice, parenteral nutrition (PN) is a life-saving therapy for many patients, including those with intestinal failure and chronic diarrhea. Some of these patients are dependent on PN to maintain their nutrition and growth. Prolonged hospitalization for administration of PN is not favourable in such cases because of the increased risk of nosocomial infections and the resultant poor quality of life and financial burden; this makes home parenteral nutrition (HPN) an attractive option.

The most common and serious complication of HPN is catheter-related blood stream infection (CRBSI).^[1] It contributes to high rates of morbidity and mortality, increased rate of hospitalization, and subsequent increased costs of medical treatment.^[2] Patients' own skin and their caregivers' hands are the major sources of infection. As a result, most of the CRBSIs are caused by gram-positive bacteria found in the skin's normal flora, such as coagulase-negative Staphylococci (mostly *Staphylococcus epidermidis*); however, other causative pathogens may be involved, including gram-negative organisms or even polymicrobial organisms.^[1,3]

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Tokars *et al.* undertook a prospective evaluation of the risk factors for bloodstream infection (BSI) in 827 patients receiving home infusion for 1 year. The rate of BSI in this population was 0.99 per 1000 catheter days. They found that one of the strongest risk factors for BSI was receipt of PN (HR, 4.1; CI, 2.3–7.2), with a rate of BSI of 1.71 per 1000 catheter days.^[4] Similar results were obtained by Elfassy *et al.* in a retrospective review of 155 HPN patients. The rate of BSI in this study ranged between 1.4 and 2.0 infections per 1000 catheter days. Furthermore, the pathogenic organisms identified were similar to those found in hospitalized patients, with the most common organisms being coagulase-negative *Staphylococcus aureus* and *Klebsiella pneumoniae*.^[5]

Among patients receiving HPN, factors that are associated with BSI include poor patient hygiene; insertion of the central venous catheter under emergent conditions; and, to a lesser extent, the severity of illness and duration of central venous catheterization.^[2] On the other hand, proper hand hygiene and maximal barrier precautions during insertion of the central venous catheter are associated with a low incidence of BSI.^[2]

In an epidemiologic study of patients who received long-term HPN between 2002 and 2005, CRBSI was found to occur in 44.9% of the patients receiving HPN. Surprisingly, although the rate of CRBSI was found to be relatively high, the mortality related to it was zero during the study period.^[6]

The HPN program at King Faisal Specialist Hospital and Research Center (KFSHRC), Riyadh, Saudi Arabia was started officially in 2004. Patients' caregivers were taught how to independently manage the patients' central venous access device (CVAD), administer PN through the central line, and add other additives to the PN bag; hospital nurses may also be involved for the home care of certain patients. Discharge to a home setting is achieved after the caregiver demonstrates competency in self-management of the CVAD. Further patient care, including regular follow-up visits and management of any patient-related issues such as HPN complications, are the responsibility of the hospital-based multi-disciplinary team. Although the number of patients integrated in this program is small, our service is considered pioneering in our geographical area since we are the first team to have implemented the HPN program in Saudi Arabia. To our knowledge, there is no local study addressing the epidemiology or etiology of CRBSI as one of the serious complications of HPN. The aim of our study is to determine the rate of CRBSI in patients receiving long-term HPN.

METHODS

This is a retrospective, chart review study on patients who received long-term HPN between January 2006 and

December 2012 at KFSHRC. The patients' data were collected from both medical records and hospital-integrated clinical information system (ICIS) after approval by the Office of Research Affairs (ORA) at our institution.

The demographic and clinical data of the patients, including age, gender, documented height, weight, head circumference, HPN indication, PN type (continuous or cyclic), infusion frequency, caring methods, catheter type, number of total admissions, and number of admissions due to CRBSI were obtained by reviewing the patients' medical charts. Microbiological cultures and sensitivity, nutritional assessment parameters, including levels of C-reactive protein (CRP), albumin and pre-albumin, were collected from the hospital ICIS. All patients who received HPN between January 2006 and December 2012 and had documented dates for line insertion (s), duration of PN, and follow-up at KFSHRC were included in this study.

The primary objective of our analysis was to determine the rate of CRBSIs per 1000 catheter days. CRBSIs are defined as laboratory-confirmed bloodstream infection where central line was in place for more than 48 hours. The diagnosis of CRBSI was made on the basis of the following criteria defined by the Infectious Diseases Society of America (IDSA) 2009. The patient has an identified pathogen from one or more blood cultures and the organism cultured from blood is not related to an infection at another site. The patient has at least one of the following signs or symptoms: fever ($>38^{\circ}\text{C}$), chills, or hypotension and positive laboratory results that are not related to an infection at another site and the same skin contaminant is cultured from two or more blood cultures drawn on separate occasions.^[7]

The secondary objectives were to identify the common causative pathogens in our patient population, evaluate the possible occurrence of antibiotic resistance over time, and identify any potential factors that might increase the risk of CRBSI.

Results are expressed as frequencies and percentages for the various categorical variables. BSIs are reported as the number of infections per 1000 catheter days. The data were analysed with the Statistical Package for Social Sciences (version 14.0 for Windows, SPSS, Chicago, IL).

RESULTS

Study population and patient characteristics

Eight pediatric patients aged 1–8 years were included in the study. The majority of patients had a tunnelled catheter dedicated to HPN only. The most common indications for HPN were microvillus inclusive disease (50%), followed by tufting enteropathy, short bowel syndrome, and chronic diarrhea of

unknown etiology. All the patients were receiving 2 in 1 PN and soybean-based fat emulsion (Lipofundin® MCT/LCT 20%) on daily basis for 12–16 hour/day. Six patients (75%) were receiving HPN under parents' care. During the study time period, a total of 74 catheters were inserted (60 Hickman, 7 port-A-cath, 7 PICC). The total number of hospital admissions due to CRBSI was 3–13 times, with a median length of hospital stay of 182 days. Long admission period was needed for the completion of antimicrobial therapy and central venous catheter replacement in some cases, in addition to other reasons including social issues for some patients [Table 1].

CRBSIs

CRBSIs were the reason for 60 hospital admissions, with a median of 182 days of hospital stay and 74 replacements of central venous catheters [Figure 1]. The rate of CRBSI was found to be 2.9 per 1000 catheter days (range, 1.17–5.1). In all, 112 pathogens were isolated; *Staphylococcus* species (*S. aureus*, *S. hominis*, *S. epidermidis*) were the most prevalent pathogens [32% (*n* = 36) of all CRBSI episodes], followed by *Klebsiella pneumoniae* [5% (*n* = 6) of all CRBSI episodes] [Table 2]. Resistance to Oxacillin was observed in 20% of the cases of staphylococcus infection. No relation was found between the rate of BSI and type of HPN care provider (i.e. parents or nurse) [Figure 2].

DISCUSSION

To our knowledge, this is the first local study addressing the epidemiology of CRBSI as a serious complication of HPN.

Infections are well-recognized and well-documented in the literature as a serious complication of PN. Many risk factors have been identified that can increase the possibility of infections including the central venous access, the duration of PN, and catheter type.^[1] Previously published BSI rates in subjects receiving HPN range between 0.74 and 3 per 1000 catheter days.^[8-10] In our study, the rate of BSI was comparable to those reported in previous studies at 2.9 per 1000 catheter days (range, 1.17–5.1). Although rates were similar, the small number of patients in our study will limit the generalizability of this finding.

Buchman *et al.* conducted a retrospective review of 527 HPN patients; they found that 60% of sepsis cases were caused by

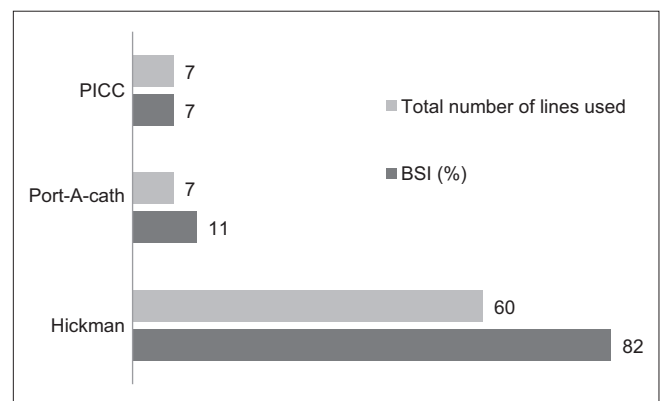


Figure 1: Relationship between the rate of blood stream infection, type, and frequency of central line used

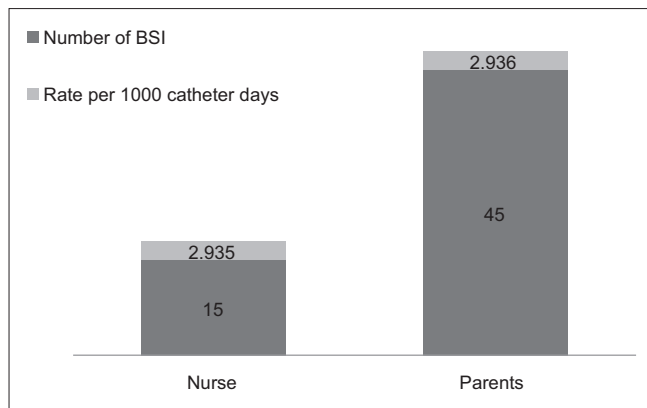
Patient number	Sex	Age when HPN started (year)	Indication for PN	Catheter type	Number of catheters used	HPN care provider	Frequency of HPNN (times/week)	Duration of PN infusion (h/day)	Duration of PN (years)	Number of hospital admission due CRBSI	Length of hospital stay (days)
1	Female	3	Chronic diarrhea (unknown etiology)	Hickman	11	Parents	7	14	6	6	66
2	Female	2	Tufting enteropathy	Hickman	13	Parents	7	12	3	9	204
3	Female	5	Microvillus inclusive disease	Hickman	9	Parents	7	16	10	13	690
4	Male	3	Microvillus inclusive disease	Hickman	9	Parents	7	16	9	3	233
5	Male	8	Chronic diarrhea (unknown etiology)	PICC	7	Parents	7	15	13	4	160
6	Male	1	Microvillus inclusive disease	Hickman	11	Parents	7	16	6	10	274
7	Male	5	Microvillus inclusive disease	Hickman	7	Nurse	5	12	10	8	95
8	Female	4	Short bowel syndrome	Port-A-catheter	7	Nurse	7	14	9	7	106

HPN: Home parenteral nutrition, PN: Parenteral nutrition, CRBSI: Catheter-related blood stream infection, PICC: Peripherally inserted central catheter

Table 2: Characteristics of the 112 pathogens isolated in the 60 total bloodstream infections

Organism	Number of isolate (%)
<i>S. epidermidis</i>	19 (16.96)
<i>S. aureus</i>	9 (8.04)
<i>S. hominis</i>	8 (7.14)
<i>K. pneumoniae</i>	6 (5.36)
<i>S. hemolyticus</i>	5 (4.46)
<i>E. faecalis</i>	4 (3.57)
<i>S. capitis</i>	4 (3.57)
<i>E. coli</i>	3 (2.68)
<i>S. warneri</i>	2 (1.79)
<i>E. faecium</i>	1 (0.89)
<i>E. coli</i> (ESBL)	1 (0.89)
Others*	50 (44.64)
Total	112 (100)

*Including noncommon organism as *C. glabrata*, *E. cloacae*, *E. hermanni*, *S. marcescens*, *E. coli*: *Escherichia coli*, *S. epidermidis*: *Staphylococcus epidermidis*, *S. aureus*: *Staphylococcus aureus*, *S. hominis*: *Staphylococcus hominis*, *K. pneumoniae*: *Klebsiella pneumoniae*, *S. hemolyticus*: *Streptococcus hemolyticus*, *E. faecalis*: *Enterococcus faecalis*, *S. capitis*: *Staphylococcus capitis*, *S. warneri*: *Staphylococcus warneri*, *E. faecium*: *Enterococcus faecium*, *C. glabrata*: *Candida glabrata*, *E. cloacae*: *Enterobacter cloacae*, *E. hermanni*: *Escherichia hermanni*, *Se. marcescens*: *Serratia marcescens*, ESBL: Extended-spectrum beta-lactamase

**Figure 2: Relationship between the rate of blood stream infection and type of home parenteral nutrition care provider**

a gram-negative organism, 26% by a gram-positive organism, and 12% were polymicrobial in origin.^[1] In our study, gram-positive organisms were the most common infecting pathogens, with 20% of the observed staphylococcal infections resistant to Oxacillin. In addition, we found that 45% of the organisms cultured were uncommon as *Enterobacter cloacae*, *Serratia marcescens*, *Candida glabrata*, *Salmonella* species, and *Escherichia hermanni*. These findings revealed the complicated nature of the BSIs in this patient population.^[1] Therefore, regular monitoring of the predominant pathogenic organisms for CRBSI in patients receiving HPN is important for adjusting the empiric treatment strategy, which should be based on the local epidemiology data.

The rate of infection in HPN population is high for various reasons. As previously described, the most common source of the infection is the central venous catheter, which is required for long-term PN administration. In an attempt to decrease the incidence of BSIs, particularly in patients expecting to have long-term HPN, various catheters have been developed. In a systematic review of 200 studies, BSIs were found to occur at a rate of 1.0 (0.8–1.2) per 1000 catheter days for patients with PICC lines receiving home treatment. Tunnelled non-medicated catheters, such as Hickman lines, have a BSI rate of 1.7 (1.2–2.3) per 1000 catheter days. The intravascular device with the lowest rate of BSIs was subcutaneously implanted venous ports, with a BSI rate of 0.1 (0–0.1) per 1000 catheter days. However, none of these studies included patients receiving PN, and therefore, the results must be interpreted with caution.^[11] In our study, the rates of BSI did not differ between the different types of catheters in terms of the number they have been used. The Hickman line was associated with the highest rate of BSI (2.4 per 1000 catheter days), with a total of 49 identified BSIs. A possible explanation for this high observation is that 75% of our patients were receiving their HPN through Hickman line; thus, excluding a real cause–effect relationship.

Buchman *et al.* retrospectively reviewed the incidence and risk factors for the development of CRBSI in 143 patients (18 children and 125 adults) who received HPN infusion at least twice weekly for at least 2 years. A total of 147 CRBSIs had occurred at a rate of 0.13 per catheter year (0.35 per 1000 catheter days). The authors observed an increased frequency of CRBSI in association with increased HPN infusion frequency, but only among children. This may suggest the possibility that parents or other caregivers might pay less attention to proper catheter care techniques when the procedure requires more time on a weekly basis.^[12]

Surprisingly, no relationship was observed between the rate of BSI and type of HPN care provider (i.e., parents or nurse) in our study, which could be underestimated by the small number of patients. However, the extensive training provided to patient's caregivers by our hospital's PN team in order to manage the patient's CVAD before the patient's discharge was a crucial factor.

Our work has certain limitations; first, the small number of patients enrolled in the HPN program, which was limited by the availability of hospital personnel and facilities, in addition to cultural perceptions and community barriers in Saudi Arabia. A second limitation was the prolonged duration of hospital admission, not due to CRBSI alone, which limits the clear interpretation of the impact of CRBSI on the duration of hospitalization. Because of these limitations, we would expect to have imprecise number of BSIs in our patient population, although practically, we

have observed similar BSI rates in HPN populations in the previous literature. Despite these limitations, our study does provide valuable information because this is the first data on the HPN program from our geographical area; our results are expected to facilitate future assessment of the epidemiology and risk factors for developing BSI.

CONCLUSION

CRBSI is a common complication of PN. In this small group of HPN patients, the BSI rate was 2.9 infections per 1000 catheter days, and the most common causative organisms were *Staphylococcus* species. We believe that a well-established training program for the caregivers can reduce the rate of infectious complications associated with long-term PN support.

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Conflicts of interest

There are no conflicts of interest.

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