



Applied nutritional investigation

## Predictive factors of catheter-related bloodstream infection in patients receiving home parenteral nutrition



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### ABSTRACT

**Objectives:** The aim of this study was to determine the incidence and predictive factors of catheter-related bloodstream infections (CRBSIs) acquired through a central venous catheter for delivery of home parenteral nutrition (HPN) therapy among a patient population in Thailand.

**Methods:** This retrospective review was conducted with adult patients with intestinal failure who received HPN from October 2002 to April 2014, at Ramathibodi Home Parenteral and Enteral Nutrition Referral Center in Bangkok.

**Results:** Seventy-two patients (45.8% male, mean age  $56.2 \pm 15.7$  y) were included in the analysis. Incidence of CRBSIs was 1.47 per 1000 catheter days. Over the 12-y period, there were 21 CRBSIs among 10 patients. There were 26 pathogens isolated from these CRBSIs, mostly coagulase-negative staphylococci. Univariate Poisson regression analysis revealed that the incidence rate ratio of CRBSIs was significantly higher in patients who used an implanted port (compared with tunneled catheter), alcohol-based povidone-iodine solution as disinfectant (compared with 2% chlorhexidine gluconate in 70% isopropyl alcohol), cyclic HPN infusion (compared with continuous HPN), and hospital-based compound HPN formulations (compared with 3-in-1 commercial formulations). Furthermore, longer duration of HPN (>250 d) was associated with CRBSIs. Multivariate analysis revealed that longer duration of HPN, cyclic HPN, and hospital-based compound HPN were significantly associated with CRBSIs.

**Conclusions:** CRBSI is a significant complication in patients receiving long-term HPN. Individualized therapy with a multidisciplinary team in centers with HPN management expertise is required. Careful selection of the catheter type and HPN formulation for each patient is necessary to best meet patient requirements and minimize HPN-related complications. Strict compliance by patients and caregivers with evidence-based instructions together with supervision by well-trained HPN providers is the most effective strategy to prevent CRBSIs.

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### Introduction

Home parenteral nutrition (HPN) is a lifesaving therapy for patients with intestinal failure [1–5]. Long-term administration of HPN allows patients to survive for prolonged periods of time, improves patient quality of life, and reduces health care costs [6–10]. Placement of a central venous catheter (CVC) is required to deliver total parenteral nutrition (TPN) support. However, CVCs

are associated with potential life-threatening complications, particularly catheter-related bloodstream infections (CRBSIs), which may cause significant morbidity and mortality [11–14]. Previous studies have demonstrated that use of tunneled catheters with a minimum number of lumens and a multidisciplinary approach to HPN decreased the occurrence of CRBSIs [15,16]. Even in an experienced center, CRBSIs still occur with a high incidence [17]. CRBSIs are normally defined clinically as systemic inflammatory symptoms with a positive blood culture from a central and peripheral catheter, with no other apparent source of infection, while receiving HPN [18,19]. Many risk factors associated with CRBSIs have been identified, such as type of HPN, characteristics and site of the infusion device, catheter dwell time, and method of catheter care [16,20–22].

The present study aimed to determine the incidence and possible predictive factors of CRBSIs in patients with intestinal failure receiving HPN at Ramathibodi Home Parenteral and Enteral Nutrition Referral Center of Mahidol University in Bangkok, Thailand.

## Materials and methods

Approval for the present study was obtained from the Institutional Review Board of Ramathibodi Hospital, Mahidol University, Bangkok, Thailand. A retrospective review was subsequently conducted for all patients who received HPN at Ramathibodi Home Parenteral and Enteral Nutrition Referral Center at Ramathibodi Hospital from October 2002 to April 2014. Patient medical records were reviewed for the study. Patients were included if they were  $\geq 15$  y of age, had intestinal failure, and required HPN for  $\geq 2$  mo.

The HPN program is based on a multidisciplinary hospital nutrition support team, including physicians, nurses, pharmacists, dietitians and social workers. The HPN education process begins as soon as the decision to proceed with HPN is made. Patients and caregivers receive written instructions and structured, in-hospital training by a nutrition physician and nurse specialist on all aspects of HPN care, HPN complications, and how to recognize the symptoms and signs of bloodstream infection. During the transition period from the inpatient facility to home, the nutrition nurse specialist provides structured training for patients and caregivers on all aspects of daily monitoring of weight, temperature, intake, and output, as well as monitoring of blood glucose levels. The focus is on teaching the necessary technical skills such as preparing the TPN and adding vitamins, trace elements, and other additives. Emphasis is placed on hand hygiene, the aseptic technique of catheter handling, dressing changes, and blood draws. The average duration of the HPN teaching program is  $\sim 1$  to 2 wk before hospital discharge. To ensure a smooth transition, caregiver training is performed in the real situation to achieve the practical skills during the hospital stay. Follow-up home visits are arranged within 24 to 72 h after hospital discharge. Home visits are made about two to three times per week during the first week then weekly during the first month. Patients are able to contact the nutrition support team via telephone if they have any problems regarding HPN administration or are encountering any complications.

Patients in the present study were initially advised to continuously administer parenteral nutrition (PN) via infusion pump through the CVC (24 h/d). In selected patients, cyclic HPN was administered during the night (16 h/night), to prevent PN-associated liver disease and to facilitate patients being able to work and engage in physical activity during the day. However, some patients or caregivers were unable to use cyclic PN due to the complexities associated with connecting and disconnecting HPN solution bags or flushing at the end of the HPN cycle. Other reasons included the development of metabolic derangements such as hyper- or hypoglycemia in some patients during the time of HPN administration and HPN abrupture. Moreover, some patients could not tolerate the large volume of fluid administration during the HPN cycle. We do not routinely use systemic anticoagulant because of the low incidence of thromboembolism.

Nontunneled, short-term CVCs have been used at our hospital during initial patient assessment or as a bridge between tunneled CVCs. The tunneled CVC or implanted port is inserted before hospital discharge. A chest x-ray is routinely done to ensure the correct position of the tip of the catheter at the right atrial superior vena cava junction. For the present study, data of every inserted CVC was collected, and constituted the accumulated catheter days.

Data obtained included the following:

1. Patient characteristics such as age, sex, underlying diseases, and indications for HPN;

2. Various factors related to HPN infusion, including type, frequency, and duration of HPN administration;
3. Type of CVC, frequency of catheter exit site care, type of disinfectant, and type of exit site dressing; and
4. The number of CRBSIs and microbiologic results.

## Diagnosis of CRBSIs

A diagnosis of CRBSI was made according to guidelines from the Infectious Disease Society of America and the European Society for Clinical Nutrition and Metabolism [18,19]. CRBSI is defined clinically as systemic inflammatory symptoms with a positive blood culture from a CVC, peripheral venous catheter, or both, with no other apparent source of infection while receiving HPN.

## Statistical analysis

Patient characteristics and descriptive baseline data are expressed as number (percentages) for categorical variables, mean  $\pm$  SD or median (25th, 75th percentile) for continuous variables, depending on whether the data were normally distributed. Comparisons between groups were assessed by the independent samples *t* test or Mann–Whitney U test for continuous variables and using the  $\chi^2$  or Fisher's exact test for categorical variables, as appropriate. The incidence of CRBSIs was reported per 1000 catheter days. Models predicting the total number of CRBSIs per person by Poisson regression analysis were used to identify possible predictive factors of CRBSIs, incidence rate ratios (IRR), SE, and 95% confidence intervals. After univariate analysis of the factors associated with CRBSIs, only significant variables ( $P < 0.1$ ) were included in the multivariate analysis. All statistical analyses were performed using Stata version 14 (StataCorp LLC, College Station, TX, USA).  $P < 0.05$  was considered statistically significant.

## Results

### Patient characteristics

Seventy-two patients (45.8% male, mean age  $56.2 \pm 15.7$  y) with intestinal failure were discharged with HPN from Ramathibodi Home Parenteral and Enteral Nutrition Referral Center between October 2002 and April 2014. While treated at Ramathibodi Hospital, the patients had a total of 99 CVCs inserted (55.6% tunneled catheter and 44.4% implantable port).

Patient characteristics and various factors related to HPN infusion are presented in Table 1. The 72 patients in the present study consisted of 53 (73.6%) oncology and 19 (26.4%) non-oncology patients, with a total of 14 230 d of catheterization. Of the 53 oncology patients, 16 (30.2%) received chemotherapy and 4 (7.5%) received radiotherapy while they were on HPN. The median time (25th, 75th percentile) of HPN administration was 138.5 d (62.5, 258) and median time (25th, 75th percentile) to the first CRBSI was 168 d (74, 503.3).

In nearly all cases (94.4%), patient caregivers provided HPN administration and care. HPN frequency was 7 d/wk among 71 patients (98.6%) and 3 d/wk for only 1 patient (1.4%). Thirty patients (41.7%) received HPN infusion continuously (24 h/d) and 42 (58.3%) received cyclic HPN (16 h/night). Intravenous lipid emulsions (IVLEs) were administered for all HPN patients. Thirty-one patients (43.1%) received soybean oil (SO)-based IVLEs (100% SO) and 41 (56.9%) received new-generation IVLEs containing either medium-chain triacylglycerols (MCT)-based IVLEs (50% MCT, 50% SO) or olive oil (OO)-based IVLEs (80% OO, 20% SO) or fish oil (FO)-containing IVLEs (30% SO, 30% MCT, 25% OO, and 15% FO). The frequency of catheter exit site care was at least once per week in 42 patients (58.4%) and every 2 wk in 30 (41.7%). Fifty-nine patients (81.9%) used 2% chlorhexidine gluconate (CHG) in 70% isopropyl alcohol as a catheter hub disinfectant and 13 (18.9%) used alcohol-based povidone–iodine (PVP-I) solution. Approximately 55.6% of patients used sterile gauze as an exit site dressing and 44.4% used an antimicrobial transparent dressing containing CHG gel. The main reason for

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