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Aseptic non-touch technique and catheter-related bloodstream infection in children receiving parenteral nutrition at home

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Abstract

Objectives: Parenteral nutrition (PN) at home is an acceptable form of delivering long-term PN for children with intestinal failure. Catheter-related bloodstream infection (CRBSI) is one of the serious complications of long-term PN and can lead to increasing morbidity and mortality. Using aseptic non-touch technique (ANTT) was proven to decrease the incidence of CRBSI in hospital patients. In this study we aimed to review the incidence of CRBSI in children receiving PN at home in our institution using the ANTT and a simplified training programme for parents and carers.

Methods: We retrospectively collected clinical and microbiological data on all children with intestinal failure (IF) who were on treatment with PN at home under our specialist IF rehabilitation service between November 2012 and November 2013.

Results: Thirty-five children were included, 16 of whom did not have any infection recorded during the study period. The overall CRBSI rate was 1.3 infections per 1000 line-days, with *Staphylococcus* being the commonest organism. Twenty-one children did not require catheter change and the overall catheter changes were 1.8 per 1000 line-days.

Conclusion: In this article, we report a low incidence of CRBSI in a single institution by using the principle of ANTT for accessing central venous catheters combined with a simplified, nurse-led, two-week standardised training programme for parents of children going home on PN.

Keywords

Parenteral nutrition, PN, catheter-related bloodstream infection, CRBSI, paediatric, aseptic non-touch technique, ANTT

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Introduction

Intestinal failure (IF) in children can be defined as the reduction of functional gut mass below the minimal necessary for adequate digestion and absorption to satisfy the nutrient and fluid requirements for growth.[1] Children with IF depend on parenteral nutrition (PN) for their calories and nutritional needs. Home PN is usually initiated in children when the underlying disease leading to IF does not respond to treatment and it becomes apparent that PN is likely to be needed for at least three months.

Since its first introduction more than 30 years ago, PN at home has become an acceptable form of delivering long-term PN. It is considered cost effective when compared with prolonged hospital stay and it improves quality of life both for the affected children and their families.[2] However, PN at home is a high-risk treatment with short- and long-term complications. Adequate venous access via central venous catheters (CVCs) is essential for safe administration but complications such as catheter-related infection, thrombosis and mechanical malfunction are common.[3]

Catheter-related bloodstream infection (CRBSI) is one of the most serious complications of CVCs, with reported incidence of 2.7 to 9.1 per 1000 catheter-days in children.[4] The resulting sepsis can lead to increased morbidity, recurrent hospitalisation and even mortality.[5] Treatment of CRBSI is determined by the microorganism isolated and the clinical presentation of the child. Routine removal of long-term CVC is

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not necessary in uncomplicated CVC infection. However, complicated infections and the presence of tunnel infection or port abscess usually require removal of the CVC.[6] Repeated CVC change can lead to occlusion of access sites.[7,8] Hence, every effort should be directed to safeguard the longevity of CVCs as the risk of accumulated complications and the loss of vascular access can have direct life-threatening consequences.[5]

The principle of aseptic non-touch technique (ANTT) is based on the fact that if a key part is not touched, it cannot be contaminated. It involves effective hand washing, maintaining clean environment and equipment and the use of alcohol-based solutions for decontamination with adequate cleaning and natural evaporation of the alcohol.[9] Incorporating ANTT with a relatively simple education programme of health care workers was proven to decrease the risk of CRBSI in hospital patients.[6]

There is no consensus in literature regarding duration or training regimen best used for preparing parents and carers to carry out PN at home; however, recognising PN complications and CVC care with emphasis on hand hygiene and access site disinfection are essential to any training programme.

The aim of this study was to review the incidence of CRBSI over a 12-month period in children receiving PN at home following a simplified training programme for parents and carers and using the principle of ANTT, hand antisepsis and disposable gloves (non-sterile examination gloves) when accessing CVCs.

Patients and methods

We retrospectively collected clinical and microbiology data on all children with IF who were on treatment with PN at home under our specialist IF rehabilitation service between November 2012 and November 2013. Data collected included type of CVCs, duration of PN, aetiology of IF, comorbidities and presence of stomas as well as microbiological data regarding CRBSI. All infectious episodes were recorded and classified. We identified CRBSI by positive blood culture in a symptomatic child with fever and/or signs of sepsis.[7,10] Blood culture was taken when body temperature was recorded as more than 38.5°C on at least one occasion or the child had other symptoms such as temperature instability, unusual lethargy or any new, otherwise inexplicable symptom that in the individual patient had been associated with a previous episode of septicaemia. CRBSIs were treated with intravenous antibiotics according to our local microbiology protocol. Antimicrobial therapy was modified according to culture and sensitivity results. We also recorded the use of taurolidine line lock following PN disconnection.

All catheters were inserted under radiological control by an interventional radiologist under strict aseptic techniques. In keeping with the internationally recognised guidelines, the tip of the CVC was placed high in the right atrium.[11] Peripherally inserted central venous catheters (PICC) were inserted for short-term use, while tunnelled, cuffed, single-lumen catheters *Hickman* or *Broviac* were inserted for permanent access. Single-lumen catheters were routinely used unless multiple ports were required for clinical use. We used sterile, transparent, semi-permeable dressing to cover the exit site that was changed every seven days or more often if the exit site was visibly soiled.

Ethical approval

The study was approved by the local joint research and development office.

Training programme

All parents were trained in managing intravenous nutrition by a specialist clinical nurse in a standardised two-week formal training programme prior to discharge. The training included effective hand washing and the ANTT with disposable (non-sterile examination) gloves for CVC contact. Parents were taught how to administer specific intravenous medications when required by their child. They were also taught to check body temperature and other salient clinical signs when clinically appropriate. Competencies related to CVC care and knowledge of potential complications was assessed before they were considered fully trained. A family hand-held manual with the training information and contact details of the nutrition support team was provided before discharge.

When accessing CVCs or changing exit site dressing, we used wipes containing 2% chlorhexidine in 70% isopropyl alcohol[6,12] to clean the hubs of CVCs and the needle-free devices' connection port for 30 seconds with friction, allowing them to dry before connection.

All necessary equipment and PN for use at home was compounded and delivered by a home-care company. A single-bag system was used for administration of all intravenous nutrients. Lipids use was tailored to the clinical need of the individual child and usually limited to two or three nights per week. PN bags were delivered to the patients' homes every two weeks and stored in a specialised non-domestic PN-dedicated fridge to ensure tight temperature control.

Results

A total of 35 patients on PN at home were included. Nineteen (53%) were male and 17 (47%) were female. The mean duration of PN at home per child (±SD) was

Table 1. Background, demographic and patient characteristics.

Parameter	Value
Number of children	35
Males/females	19 (54%)/16 (46%)
Age in years	
(Mean ± SD)	7.4 (± 4.3)
Range	2.2–19.1
Number of years on PN per child	
Mean (± SD)	4.2 (±3.3)
Range	0.3–13
Number of years on PN during study period (± SD)	31.6 (± 0.18)
Aetiology of intestinal failure, number (percentage)	
Short bowel syndrome	9 (25.7%)
GI motility disorders	13 (37.1%)
Inflammatory disorders	8 (22.9%)
Small intestinal enteropathy	5 (14.3%)
Number of children with	
Gastrostomy (percentage)	27 (77%)
Jejunostomy (percentage)	6 (17%)
Ileostomy (percentage)	11 (31%)
Children without stoma	6 (17%)
Patients on taurolidine line lock (percentage)	16 (46%)

PN: parenteral nutrition; GI: gastrointestinal; SD: standard deviation.

Table 2. Aetiology of bloodstream infection.

Microorganisms	Number of episodes (percentage)
Gram positive	
Staphylococcus aureus	4 (13.8%)
Staphylococcus epidermidis	6 (20.7%)
Streptococcus species	2 (6.9%)
Kocunia rhizophilia	1 (3.4%)
Gram negative	
Kelbsiella	4 (13.8%)
Pseudomonas species	3 (10.3%)
E. coli	1 (3.4%)
Stenotrophomonas	5 (17.2%)
Candida	3 (10.3%)

4.2 years (±3.3) range of 0.3 to 13 years. Combined total duration of PN for all children was 31.6 years (±0.18). Background and demographic profiles for patients are listed in Table 1.

During the 12-month study period, there were 29 CRBSIs. Sixteen (46%) patients did not have any recorded infection episode. Fifteen of the 29 (52%) CRBSI episodes occurred in two patients with intestinal dysmotility, an underlying connective tissue disorder and immunodeficiency. Both patients continued to harbour infections in gastrointertinal tract with difficult to treat and multiple organisms. The remaining 14 CRBSIs occurred in 17 patients. Sixteen children were on taurolidine line lock.

The overall line infection rate was 2.5 infections per 1000 line-days. Sixteen (55%) CRBSIs occurred in boys while 13 (45%) in girls which did not carry statistical significance (p value 0.3). Adjusting the data by excluding the two immunocompromised patients, the rest of the cohort CVC infection rate dropped to 1.3 infections per 1000 line-days. Organisms responsible for the CRBSIs are listed in Table 2.

Although we were unable to build a statistically significant model of logistic regression due to small sample size of the studied parameters; children with jejunostomy appeared to develop higher rates of CRBSI (p value 0.02 95% – confidence interval (CI) 1.4–110.4), the wide range CI probably reflecting small number of children with jejunostomy in the study. The presence of ileostomy did not increase the risk of developing CRBSI (p value 0.6 95% CI 0.9–4.1).

Twenty-one children did not require CVC change during the study period. There were a total of 31 CVCs inserted in 14 children (±SD 1.5), translated to 2.6 line insertions per 1000 CVC days. Eleven CVC insertions were in the same two patients who were responsible for 52% of the CRBSIs. Excluding those two from the analysis, there were 20 CVC insertions in 12 children during the study period (±SD 0.5), meaning 1.8 line insertions per 1000 line-days.

Discussion

Children receiving long-term PN are at increased risk of developing bloodstream infection due to a variety of factors.[5,6] PN components are susceptible to infection. Lipids can support bacteria and fungi while amino acids and dextrose support fungal growth.[13] Other causes of infection are microbial contamination either from skin organisms, catheter hub contamination or improper CVS handling.[14] Also, catheters can become infected from haematological seeds from another infection focus.[15]

Universal guidelines of strict infection control measures combined with maintenance of tight temperature across storage and transport as well as infusing PN at home in less than 24 hours have significantly reduced the risks of contamination.

The reported incidence of CRBSIs in paediatric varies from 0.9 to 13.6 infections per 1000 catheter-days depending on underlying diagnosis and age of the child.[4,16–18] The number of children included in

those studies is small with a different follow-up period, which may explain the wide incidence range. Hojsak et al. described an incidence of 0.9 infections per 1000 catheter-days; however, they reported on nine children during a period of 21 years with variable standard of care.[17] Drews et al. reported seven infections per 1000 catheter-days in 45 children on PN at home over two years' follow-up.[19] In our cohort, the incidence of CRBSI was 1.3 infections per 1000 catheter-days in children receiving PN at home, at the lower end of the previously reported range.

Educating parents/carers on the safe administration of PN at home is essential to reduce the risk of complication. Different methods can be used to prepare families for PN at home. Gandullia et al. described an in-hospital, nurse-led, two- to three-week training programme for families focusing on signs of sepsis and mechanical problems.[20] There is no consensus in literature regarding the optimum duration for training required to prepare families for life on PN at home; however, training programmes of up to eight weeks in duration is in use in clinical practice across the United Kingdom (personal communication). European Society of Parenteral and Enteral Nutrition (ESPEN) guidelines for PN at home for adult patients emphasised the content of the teaching programme to include catheter care, prevention, recognising and managing complication and storage and handling of the bags. The duration and methods of training were not specified.[5]

In this study, the indication for using PN at home in our population is comparable to that of the published literature.[16,17,21] Thirty-seven per cent of patients suffered from gastrointestinal (GI) dysmotility, which reflects the referral pattern to our institution as a centre that caters to GI motility disorders.

Children with IF and ileostomy are at increased risk of developing small intestinal bacterial overgrowth (SIBO) due to increased intestinal permeability, lumen dilatation and stasis.[22,23] SIBO can act as a translocation focus for microorganisms increasing the risk of CRBSI.[24] In our series, ileostomy did not increase the risk of developing CRBSI. Children with jejunostomy appeared to develop higher rates of CRBSI. No solid conclusion can be drawn due to small sample size. Children with underlying gut motility disorders are more likely to be colonised with pathologic organisms in their small bowel[22] for which jejunostomy provides a direct access. Although we were unable to explain the association between jejunostomy and CRBSI, one theory is that parents may be less vigilant when handling a jejunosotmy tube compared with ileostomy bags. Also, the proximity of jejunostomy to the CVC exit site is another factor to consider.

Staphylococcus epidermidis was the commonest organism causing CRBSI in our series followed by *Staphylococcus aureus* and *Klebsiella*, not that different from what has been previously reported.[25,26] There were five episodes of infection with *Stenotrophomonas* in one patient with underlying immunodeficiency needing frequent line change and prolonged courses of antimicrobial therapy.

Early detection of line infection and prompt treatment with appropriate antibiotics can salvage the CVCs in the majority of patients. Certain organisms can produce exopolysaccharide to form a microbial biofilm layer that acts as a solid enclave where organisms can embed avoiding host defence mechanisms and making them less susceptible to antibiotics.[9,27] In such circumstances, antimicrobials alone are not sufficient to eradicate infection and the CVC should be replaced. Nevertheless, line change ought to be reserved as the last resort if the infection is not clearing despite aggressive antimicrobials, or the child becomes unwell as frequent change of CVCs can damage the veins and limit future access sites.[8] Total loss of central venous access site can lead to mortality in children who are PN dependent and will jeopardise any potential for intestinal transplantation.[28]

More than one-quarter (26%) of the CVC changes during the study period were elective, replacing PICC to tunnelled *Hickman*/*Broviac* line. Broken PICC lines which were repaired more than once were electively replaced. In our institution, to ensure an infection-free period between the removal and insertion of infected tunnelled CVCs, temporal PICC lines were inserted. Although there is no consensus in literature regarding CRBSI risk between PICC and CVCs, there is evidence to support that PICC lines are associated with lower incidence of CRBSIs than other devices.[29–31] However, the evidence in paediatric patients receiving PN at home is less clear.

In our series, there were 2.6 line insertions per 1000 line-days (average catheter indwelling time was 384.6 days). Twenty-one children did not require any CVC change during the study period. Of the total 31 CVC replacements, 11 (35.5%) occurred in two children, the same two children who harboured 52% of the infection episodes. Adjusting the calculations, in the remaining patients' group there were 1.8 line insertions per 1000 line-days (average catheter indwelling time was 555.6 days). The reported average indwelling time for CVC in children with PN at home was between 244 and 780 days.[17,19,32]

This study has a number of limitations: the sample size is small and we collected only one year of patients' data. We do not have a control group; to compare our findings we used the previously published incidence of CRBSI. We also note that there are many potential confounding factors including the effect of duration of PN and the comorbidities. However, our data

showed that the use of hand antisepsis, ANTT and clean gloves when accessing CVCs in paediatric patients on PN at home combined with a shorter training programme for parents and carers is as comparable as other methods described in literature with similar CRBSI rates and CVC life span.

In conclusion, we report a low incidence of CRBSI in a single institution by adopting a simplified, nurse-led, two-week standardised training programme for parents of children going home on PN. We use the principle of ANTT when handling CVCs and provide parents with a teaching package that contains detailed written instructions about line care and a troubleshooting guide for the commonly encountered problems. Our dedicated nutritional support team provides long-term support and follow-up. Although no firm conclusion can be made, we believe that this approach can provide an effective tool to reduce CRBSI and ensure longevity of CVCs in children receiving PN at home.

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Conflict of interest

None declared.

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