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Reduction of blood stream infections in children following a change to chlorhexidine disinfection of parenteral nutrition catheter connectors

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SUMMARY

Background & aims: Catheter-related-blood-stream-infection (CRBSI) might be prevented by optimal catheter connector antisepsis in children with intestinal failure on parenteral nutrition (PN). We changed the disinfectant used from isopropanol 70% to chlorhexidine 2% in 70% isopropanol, which leaves a residue of chlorhexidine on the connector.

Methods: We conducted this before/after study in children treated with PN for >28 days. Episodes of CRBSI were recorded for all 42 children treated for >28 days during May–November 2006 before introducing chlorhexidine and for all 50 children treated in May–November 2007 after chlorhexidine was introduced.

The number of hospital-acquired CRBSI and number of PN days was counted for each period. The rate of CRBSI/1000 catheter days and the proportion of patients that experienced at least one CRBSI during the two periods were compared.

Results: There were 3.1 CRBSI/1000 catheter days prior to using chlorhexidine and 0.4 CRBSI/1000 catheter days after it was introduced, $p = 0.03$.

Prior to chlorhexidine 10/42 (24%) patients experienced at least one episode of CRBSI, compared to 3/50, (6%) after introducing it ($p = 0.02$). The survival rate in both periods was similar, but after chlorhexidine significantly more children made a full recovery and a lower proportion of children had irreversible intestinal failure ($p = 0.01$).

Conclusions: Our results support the use of 2% chlorhexidine not only to reduce risk of sepsis for central venous catheter connector antisepsis in catheters used for intravenous nutrition, but also to improve the patients' chances of recovering intestinal function.

1. Introduction

Parenteral nutrition (PN) is a good medium for microbial and fungal growth due to constituents such as glucose, lipids and protein[1] and this may increase the risk of infection in such patients. Central venous catheters (CVC) used for PN might be more prone to infection and less responsive to an improvement in catheter disinfection than catheters used for clear fluids and medication. We are not aware of any previous studies reviewing sepsis rates solely in patients with catheters used for PN.

Children with severe intestinal failure (IF) require treatment with PN. PN should be infused through a central venous catheter in order safely to provide adequate amounts of calories and protein to meet the child's daily needs.[2] Catheter related blood stream infections (CRBSI) are a common cause of illness in such patients and can lead to death. Along with intestinal failure associated liver disease, sepsis is the most serious and life threatening complication.[3–5] In addition, the underlying gastrointestinal disease is frequently exacerbated by each septic episode.

In order to avoid life-threatening problems the catheter may need to be removed when sepsis occurs. Repeated replacement of catheters can damage the major blood vessels and lead to loss of venous access. This is a serious problem in a child with chronic severe intestinal failure who may need access for many months or even years. Unlike adults, young children commonly contaminate CVC with faeces[6] and attempt to touch and pick at their catheter and exit site predisposing them to sepsis.[6,7]

Abbreviations: IF, intestinal failure; PN, parenteral nutrition; CRBSI, catheter related bloodstream infection; CVC, central venous catheter.

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Since the catheter hub[8] and needle-less connectors (to attach the PN/other fluid infusions) are recognised sources of infection, disinfection of connectors has been recommended[9,10] for many years. Chlorhexidine in isopropanol has a broad-spectrum microbicidal activity that is thought to be mediated by the disruption of microbial cell membranes.[11] It was found to be more effective than isopropanol alone for the antisepsis of needle-less connectors in clinical use[12] and a change from isopropanol to 2% chlorhexidine in isopropanol was followed by a substantial fall in CRBSI.[13–15] Previous studies have looked at CVC in general; the sub-group of patients using the CVC for PN have not been investigated separately.

The aim of this study was to investigate the efficacy of chlorhexidine in reducing infections solely in the high-risk group of patients receiving parenteral nutrition infusions.

Secondary aims were to review length of hospitalisation, patient survival rate, proportion of children weaned from PN and the number who failed to wean and were discharged home on PN.

2. Methods

This observational single centre study was conducted retrospectively during a period of routine surveillance of catheter-related sepsis in a tertiary children's hospital. We investigated children receiving PN for more than 28 days. Taurolodine, prophylactic antibiotics or other indwelling 'line locks' other than heparin, were not used. Children treated with PN for over 27 days have been defined to have 'long-term' IF.[16] Positive blood cultures were documented during the study period, i.e. pre and post adding 2% chlorhexidine to 70% isopropanol for cleansing the catheter at the site of connections and disconnections.

From February–April 2007 the disinfectant used to clean the hubs of needle-less connectors and catheter hubs was changed from swabs containing 70% isopropanol (Iso-sachets from Griffiths & Nielsen Ltd., Billinghurst, UK) to 2% Chlorhexidine in 70% isopropanol (predominately Clinell® wipes from Gama Healthcare, London, UK). The recommended method of disinfection was to swab the catheter connector for 30 s, then to leave the connector port to dry completely before use. This method remained unchanged throughout the study.

From hospital pharmacy records we obtained the identities of patients with severe IF who received PN for a period of more than 27 days[16] as inpatients from May–November 2006 and May–November 2007 and the dates when they received it. This time interval was chosen not to interfere with an audit of hand hygiene within the institution that could have additionally contributed to a reduction in infection rate. PN constituents including fluid volume, calories, nitrogen and lipid prescribed/kg body weight were recorded. Energy and protein provision was concordant with the ESPGHAN/ESPEN guidelines of 2005.[2]

Demographic characteristics, gender, age, duration of hospitalisation and age of starting PN were obtained from the patients' medical records. In addition patient outcome was recorded with regard to survival, weaning off PN and regaining intestinal function or persistent intestinal failure with discharge home on PN treatment.

2.1. Definition of catheter related bloodstream infection

Patients with a positive blood culture were considered to have a new episode of hospital-acquired CRBSI if the following were the case:

1. The blood culture was taken from an in-patient with a CVC in place, more than 48 h after admission.
2. The patient was not known to have a clinical condition (other than the presence of the CVC) likely to have caused the bacteraemia.
3. The patient had developed at least one of the following signs within 24 h of the culture being taken: fever $>$ 38 °C, hypothermia $<$ 36 °C, chills, rigors, systolic blood pressure 20 mmHg below that expected, apnoea or bradycardia.
4. The bacterial strain grown was not similar to one grown from a blood culture taken before admission to the tertiary paediatric hospital or within 48 h of admission.
5. A second blood or CVC tip culture had been positive for a similar strain to that cultured from the blood or there was a resolution of signs of infection after appropriate antibiotic treatment or removal of the CVC.
6. In patients with a CRBSI who had a further positive blood culture, this was only counted as a new episode if the above criteria were met and a new bacterial strain was isolated from a new blood culture.
7. Hospital-acquired CRBSI were included in the analyses if they arose during the period of PN treatment.

New episodes of hospital-acquired CVC related bacteraemia were classed as polymicrobial bloodstream infection if two or more strains were isolated. Specific microorganisms causing infections were recorded.

2.2. Central venous catheters

Most of the catheters were Hickman lines that were inserted under radiological control and tunnelled under the skin into the jugular or another major vein. Peripherally inserted long lines were used in neonates. These were inserted on the ward through a peripheral vein and advanced so that the tip was centrally placed. In all cases the tip of the central catheter was placed in the superior vena cava or high in the right atrium. The nutrition was infused through the catheter on a daily basis for up to 24 h. Many patients also received other intravenous fluids, antibiotics and other medications as needed through the catheter.

The nurses caring for PN patients had all been specifically trained in handling CVCs.

2.3. Ethical approval

An outline of the study was sent to the Chair of the Local Research ethics committee who approved the retrospective study since he considered further formal ethical consideration was unnecessary.

2.4. Statistics

Statistical analyses were performed with SPSS Software (version 18.0 Mac; SPSS, Chicago, IL). The Fisher's exact test (2 tailed) was used for comparisons of proportions of infections between the two periods. The total number of days patients were treated with PN was also recorded. Hospital-acquired CRBSI/1000 CVC days for 2006 (before chlorhexidine) were compared with those for 2007 (after chlorhexidine) using the Mann–Whitney-*U* test (2 tailed).

3. Results

3.1. Patients demographic characteristics

Altogether, in the two periods May–November 2006 and 2007, 92 children fulfilled the inclusion criteria and received PN for more than 27 days. Demographics of patients during the study periods

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