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The prevention, diagnosis and management of central venous line infections in children

Emily Chesshyre [a], Zoy Goff [b], Asha Bowen [b,c], Jonathan Carapetis [b,c,*]

[a] Bristol Royal Hospital for Children, Bristol, United Kingdom
[b] Princess Margaret Hospital for Children, Perth, Western Australia, Australia
[c] Telethon Kids Institute, University of Western Australia, Perth, Western Australia, Australia

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Summary With advancing paediatric healthcare, the use of central venous lines has become a fundamental part of management of neonates and children. Uses include haemodynamic monitoring and the delivery of lifesaving treatments such as intravenous fluids, blood products, antibiotics, chemotherapy, haemodialysis and total parenteral nutrition (TPN). Despite preventative measures, central venous catheter-related infections are common, with rates of 0.5—2.8/1000 catheter days in children and 0.6—2.5/1000 catheter days in neonates. Central line infections in children are associated with increased mortality, increased length of hospital and intensive care unit stay, treatment interruptions, and increased complications. Prevention is paramount, using a variety of measures including tunnelling of long-term devices, chlorhexidine antisepsis, maximum sterile barriers, aseptic non-touch technique, minimal line accessing, and evidence-based care bundles. Diagnosis of central line infections in children is challenging. Available samples are often limited to a single central line blood culture, as clinicians are reluctant to perform painful venepuncture on children with a central, pain-free, access device. With the advancing evidence basis for antibiotic lock therapy for treatment, paediatricians are pushing the boundaries of line retention if safe to do so, due to among other reasons, often limited venous access sites. This review evaluates the available paediatric studies on management of central venous line infections and refers to consensus guidelines such as those of the Infectious Diseases Society of America (IDSA).

* Corresponding author. Telethon Kids Institute, 100 Roberts Road, Subiaco, Western Australia 6008, Australia. Tel.: +61 8 9489 7967.
E-mail addresses: emilychesshyre@gmail.com (E. Chesshyre), Zoy.Goff@health.wa.gov.au (Z. Goff), Asha.Bowen@menzies.edu.au (A. Bowen), jonathan.carapetis@telethonkids.org.au (J. Carapetis).

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Background

Definitions

The Centers for Diseases Control and Prevention (CDC) definition of a central venous catheter (CVC) is an intravenous catheter where the tip terminates in one of the great vessels at or close to the heart.[1] CVCs may be short-term percutaneous catheters or long-term surgically implanted catheters. The different types are summarised in Table 1. Table 2 summarises the common definitions used in relation to CVC infection, although the definitions used in studies vary, and need to be understood for accurate interpretation of the study results.[2] For the purposes of this review we will use the term central line-associated bloodstream infection (CLABSI).

Epidemiology

CLABSI is the commonest cause of healthcare-associated infection in children[3] and the most common reason for requesting a paediatric infectious diseases consult.[4] Rates in paediatric patients vary depending on the underlying condition of the patient with the highest rates reported in children undergoing treatment for malignancy, bone marrow transplant recipients, and patients dependent on TPN due to gastrointestinal dysfunction.[5,6] Neonatal CLABSI rates are also high, with the highest rates found in infants with the lowest gestation and very low birth weights. This is due to a combination of loss of skin integrity, relative immune deficiency, underlying illnesses, and the widespread use of medical devices in neonates.[5,7] Rates have decreased mainly due to prevention measures. In addition, the definition for a BSI due to a skin colonising bacteria was made more stringent in 2008, with the requirement for two blood cultures taken prior to antibiotics to be positive with the same organism for the diagnosis of CLABSI, which has contributed to the observed decline in neonatal CLABSI rates.[5,8,9]

Mortality rates in children who develop a CVC infection in paediatric intensive care units are higher than in those who do not (15% versus 7%).[6] In addition, paediatric CLABSI is associated with longer total hospital stay (by 19 days on average) and longer intensive care unit stay.[10–12] The health economic burden is also large, with the average cost of a paediatric CLABSI estimated to be $US 55,646.[12] The same has been seen in neonates, where BSI in very

Key points.

Diagnosis

Ideally, central line and paired peripheral blood cultures or catheter tip for culture is collected before antibiotics are commenced to confirm the diagnosis of central line infection.

However, in practice most children are managed as a presumed central line infection when a single blood culture collected from the device is positive with a known pathogen. This is due to the absence of paired peripheral blood cultures and fervent attempts to salvage the line whenever possible making a catheter segment culture unavailable. In this situation close monitoring to exclude an alternative infection is critical.

Novel diagnostic methods such as 16s ribosomal polymerase chain reaction (PCR) have not yielded the hoped for advance in diagnostic techniques.

Prevention

The use of aseptic non-touch technique (ANTT) when inserting/accessing central venous catheters (CVCs), hand hygiene, maximal sterile barriers and skin disinfection techniques are strongly recommended.

Daily chlorhexidine bathing is recommended for patients in intensive care units (ICUs) over 2 months of age.

In places with high central line-associated blood stream infection (CLABSI) rates despite adherence to basic prevention measures 'special' measures should be carried out such as the use of chlorhexidine-impregnated dressings in infants over 2 months of age, antiseptic containing hubs and antimicrobial lock solutions.

For neonates under 30 weeks gestation born in units with high rates of CLABSI despite basic prevention measures the use of silver zeolite-impregnated umbilical catheters should be considered.

A hospital-wide CLABSI prevention team with leadership and educational responsibilities have demonstrated efficacy in reducing CLABSI rates.

National and regional quality improvement programme initiatives have driven a successful reduction in CLABSI rates.

Utilising 'bundles' to streamline key aspects of CVC care have been very successful in reducing rates of CLABSI.

CLABSI rates should be monitored and reacted to, with results and improvement plans fed back to staff.

Treatment

Recommendations for treatment of central line associated infections in children range between 5 and 14 days of antimicrobials if the catheter is removed, and 7–14 days if it is retained, depending on the causative organism (see Fig. 1).

Catheter salvage is recognised as an acceptable approach in children, provided none of the absolute criteria for removal are present (such as the CVC is no longer essential, presence of septic shock or other complications, and specific causative pathogens such as *Candida* species) and the child is closely monitored for clinical and microbiological response and the line removed if neither resolves promptly.

Adjunctive antibiotic line lock therapy may be considered in support of catheter salvage.

PCR — polymerase chain reaction, ANNT — aseptic non-touch technique, CVC — central venous catheter, ICU — intensive care unit CLABSI — central line-associated blood stream infection.