CVAD Infection Literature

Intravascular catheters are used to give fluids and blood products, drugs and parenteral nutrition, and to facilitate haemodialysis and haemodynamic monitoring. Bloodstream infection is the commonest serious complication associated with their use, occurring in around 6,000 people each year in the UK. Catheter-related infection is now the most frequent cause of hospital-acquired bacteraemia in critically ill patients. Here, we review the prevention and management of such infections. We concentrate on adult patients, but many of the issues discussed will apply also to infants and children.


BACKGROUND: We compared the rates of infection in external catheters (ECs) and totally implantable devices (TIDs) and the effect of timing of insertion in children with acute lymphoblastic leukemia (ALL).

PROCEDURE: Central line data was collected on all children with ALL referred to the National Guard Hospital, Jeddah. Data was collected retrospectively from 1996 to September 1999 and prospectively thereafter. Only ECs were inserted prior to 1999 subsequently TIDs were preferred.

RESULTS: One hundred forty eight children with ALL, mean age 5.1 years had 129 ECs and 70 TIDs inserted for a total of 41,382 catheter days. The overall rate of infective episodes (infections/1,000 catheter days) was 3.43. Of the initial 148 lines 100 developed complications of which 76 (51%) were secondary to an infective episode. Only young age and treatment protocol were risk factors for first line infections (P < 0.05). There was weak evidence that ECs had an earlier time to infection compared to TIDs (P = 0.056).

CONCLUSIONS: In this study, population central lines were associated with a high rate of infection. Treatment protocol and age were the only significant risk factors when only first lines were considered. Delaying catheter insertion for more than 3 weeks from diagnosis did not reduce the risk of infection. Copyright 2003 Wiley-Liss, Inc.


Bloodstream infections related to the use of central venous catheters are an important cause of patient morbidity, mortality, and increased health care costs. Catheter-related infection may be due to fibrin deposition associated with catheters. Interventions designed to decrease fibrin deposition have the potential to reduce catheter-related infections. This study was a randomized, controlled trial in which 246 patients with nontunneled central venous catheters were randomly assigned to receive a heparin-coated catheter with 50 mL/d of normal saline solution as a continuous infusion (heparin-coated group) or a noncoated catheter with a continuous infusion of low-dose unfractionated heparin (control group: continuous infusion of 100 U/kg/d). Catheter-related bloodstream infection occurred in 2.5% (3/120 catheters) in the heparin-coated group (0.9 events per 1,000 days) and in 9.1% (11/120 catheters) in the control group (3.5 events per 1,000 days; P = 0.027). No other risk factors were found for the development of catheter-related bloodstream infection. Six and seven patients experienced severe bleeding in the heparin-coated and control groups, respectively (P = 1.00). We did not observe heparin-induced thrombocytopenia. The use of heparin-coated catheters can be a safe and effective approach to the prevention of catheter-related bloodstream infection in patients with hematoooncologic disease.

**BACKGROUND:** A long term venous access device is essential in children with malignancies for the safe administration of medication and to avoid repeated painful venipunctures. The advantage of peripherally inserted central venous catheters (PICC) over conventional central venous catheter (CVC) is easy bedside insertion without need for general anesthesia and theatre time. The purpose of this study was to evaluate our experience with PICCs particularly with regard to catheter life, reason for removal and complications in children suffering from various malignancies.

**PROCEDURE:** A retrospective analysis of all PICCs inserted in children with cancer was done with regard to the demographic data, catheter life, reason for removal, and complications. The latter two were evaluated in association with patient age, catheter days, and year of insertion.

**RESULTS:** Of 127 catheters inserted in 127 children, median catheter life was 161 days with a total of 18,955 catheter days (for 124 patients, 3 lost to follow-up). Elective removal occurred in 63/101 (62.4%) PICCs and removal due to complications resulted in a complication rate of 2.41 per 1,000 catheter days. The common reasons for catheter removal were suspected infection, breakage/leakage, dislodgement, phlebitis, and occlusion with rates of 1.27, 0.57, 0.31, 0.06, and 0.06 per 1,000 catheter days, respectively.

**CONCLUSION:** We found PICC to be a convenient, cheap, safe, and reliable device for long term intravenous access in children with malignancies. This was possible with the help of dedicated catheter care nurses.


**BACKGROUND:** Accurate diagnosis of catheter-related blood stream infection (CRBSI) is necessary to make a decision about removal of the catheter. Differential time to positivity (DTP) and the ratio of quantitative cultures (RQC) between central and peripheral blood cultures have not been evaluated against a strict standard in children, namely catheter tip culture.

**OBJECTIVE:** Our aim is to compare DTP and RQC in the diagnosis of catheter tip-confirmed catheter-related infection in children.

**METHOD:** Prospective study performed in 2 large hospitals in Santiago, Chile. Children with clinically suspected CRBSI had 2 peripheral and central vein blood samples obtained for automated culture in Bact/Alert and for quantitative cultures in 5% sheep blood agar plate. The catheter tip was cultured. Sensitivity, specificity, positive predictive value, negative predictive value, likelihood ratios (LR), and accuracy of DTP and RQC were compared against catheter tip-confirmed CRBSI.

**RESULTS:** During a 3-year period, 344 clinically suspected CRBSIs were diagnosed in children of which 124 episodes met study criteria. Catheter tip culture-confirmed CRBSI in 25 (20%) of 124 episodes. A total of 34 microorganisms were cultured from 25 CRBSI; 8 of 25 (32%) episodes were polymicrobial. Staphylococcus aureus followed by coagulase-negative Staphylococcus were the most common microorganisms. For CRBSI, DTP and RQC reached a sensitivity of 75% versus 24% (P < 0.001), specificity of 86 versus 94%, positive predictive value of 58% versus 50%, negative predictive value of 93% versus 82%, LR of 5.48 versus 4.50, and accuracy of 0.84 versus 0.79.
CONCLUSIONS: In children, DTP was better than RQC for diagnosis of catheter tip-confirmed CRBSI.


The placement of a central venous access device (CVAD) has revolutionized supportive care for pediatric cancer patients. The CVAD is used to administer chemotherapy/biotherapy, blood products, total parenteral nutrition, antibiotics, and many other supportive medications. CVADs also provide the ability to obtain blood samples without the trauma associated with venipuncture. Frequent blood sampling is often needed to monitor the side effects and response of the cancer treatment. Unfortunately, the most common method requires discarding blood (0.5-10 mL, depending on the institution's protocol) with each lab draws, for various reasons. For pediatric oncology patients, this can result in a large volume of blood being discarded and subsequently increase the need for blood transfusions. Repeated exposure to allogeneic (donor) blood products can put this patient population at additional risk for alloimmunization and febrile reactions. The purpose of this study is to test the limits of agreement between laboratory values (chemistry panel 18 and complete blood count) obtained using the push-pull and standard methods of blood sampling from CVADs in pediatric oncology patients.


The aims of this study were to analyze the factors associated with antibiotic failure leading to tunneled central venous catheter (CVC) removal during catheter-associated bloodstream infections (CABSIs) and with recurrence and reinfection in children with cancer. All cases of CABSIs in patients attending the Department of Pediatric Hematology-Oncology between November 2000 and November 2003 were reviewed. A total of 207 episodes of CABSIs, including multiple episodes involving the same catheter, were identified in 146 of 410 tunneled CVCs (167 Hickman, 243 implantable ports). The most common organism isolated was coagulase-negative Staphylococcus (CONS). The CVC was removed in 96 (46%) episodes. Hypotension, persistent bacteremia, previous stem cell transplantation, multiple CABSIs in the same CVC, exit-site infection, inappropriate empiric antibiotic therapy, and Candida infection were all significantly associated with increased risk of catheter removal (P < 0.05, odds ratios 7.81, 1.14, 2.22, 1.93, 3.04, 2.04 and 24.53, respectively). There were 12 episodes of recurrent infection, all except 1 caused by CONS (odds ratio 20.5, P = 0.006). Inappropriate empiric therapy, especially in implantable ports, was the only mutable risk factor for antibiotic failure. Because CONS was the predominant isolate in these devices, adding glycopeptides to the empiric therapy for suspected implantable-port CABSIs might decrease the removal rate. This issue should be explored in future controlled trials.


The aim of this study was to define and compare the infectious and non-infectious complications associated with Hickman catheters and implantable ports in children. The study was conducted over a three-year period in the Department of Haematology-Oncology at the Schneider Children's Medical Center of Israel. All patients who required a central venous catheter (CVC) were included in the study. For each episode of
catheter-associated bloodstream infection, demographic, clinical and microbiology data were recorded. During the study period, 419 tunnelled CVCs (246 implantable ports and 173 Hickman) were inserted in 281 patients. Compared with implantable ports, Hickman catheters were associated with a significantly higher rate of bloodstream infections (4.656 vs 1.451 episodes per 1000 catheter-days), shorter time to first infection (52.31 vs 108.82 days, P < 0.001), shorter duration of catheterization (140.75 vs 277.28 days, P < 0.001), and higher rate of removal because of mechanical complications (P < 0.005). Gram-positive bacterial infections were more prevalent in the implantable port group (63.6% vs 41.6%), whereas Gram-negative rods, polymicrobial infections and mycobacterial infections were more prevalent in the Hickman group (31.4% vs 50.9%, 17% vs 36% and 0% vs 4.4%, respectively; P < 0.05 for all). Haematopoietic stem cell transplantation was identified as an independent risk factor for infection [odds ratio (OR) -1.68, P = 0.005] and for catheter removal due to complications (OR -2.0, P < 0.001). Implantable ports may be considered the preferred device for most paediatric oncology and stem cell transplantation patients.


Long-term central venous access is an integral part of the management of many, but not all children with cancer. The proper selection of those children who require this access and which access device (external vs. totally implanted) is best suited to that child is important to minimize complications and obtain optimal results. Although most of these devices can be expected to last the duration of the treatment protocol or the patient’s life, complications (infection, occlusion, dislodgment) occur with higher than desired frequency, infection being the most common. No measures are clearly beneficial in preventing infection, but most infections can be treated successfully without device removal. Premature removal or dislodgement occurs more frequently with external catheters and may be minimized by techniques used at insertion. Occlusion, detected early, can be successfully managed by clot lysis in most children. [References: 68]


We have inserted 20 totally implantable central venous devices in 17 patients with severe metabolic disease over a 43-month span. Patient ages ranged from 2 months to 17 years (mean, 4.2 years). The underlying pathology was Gaucher’s disease in six patients, vitamin D-dependent rickets type II in five, propionic acidemia in two, and methylmalonic acidemia, 3-hydroxyl-3-methylglutaryl coenzyme A (CoA) lyase deficiency, fructose 1,6 diphosphatase deficiency, and urea cycle disorder in one child each. There were seven complications (six due to catheter-related infection and one due to occlusion of the system) during a total of 7,278 patient-catheter days. The infection rate was 0.8 per 1,000 days. Six catheters were removed due to complications and two due to completion of treatment. There were no operative complications or deaths. Our experience demonstrates that a totally implantable device may be useful in children with metabolic disease who need long-term venous access. Attention should be given to minimize the infection rate to reduce the rate of catheter removal.

BACKGROUND: Catheter-associated blood stream infections (CABSI) are frequent complications encountered with cancer treatment. In order to understand which factors might predispose to CABSIs in children and young adults, we evaluated risk for infection in association with tumor type, catheter type, and setting of occurrence.

METHODS: All pediatric oncology patients having a central venous catheter (CVC) with a tunneled external (TE) or totally implantable design (TID) were prospectively followed for the occurrence of a CABSI for 12 months. CABSIs were defined in accordance with the guidelines published by the Centers for Disease Control, and were quantified as the number of occurrences per 1,000 device days. Rates of CABSIs were stratified by tumor histology, type of catheter design, and setting of occurrence. Statistical comparisons were made using the Mantel-Haenzel statistic and the Cox proportional hazard model.

RESULTS: A total of 58 CABSIs were identified in 139 patients over a period of 35,935 CVC days. The overall CABSI rate was 1.6 infections per 1,000 CVC days (95% CI 1.2, 2.1). Stratified analysis demonstrated increased risk for CABSIs in hospitalized patients having TEs, and while patients with solid tumors were also at higher risk; this association was not supported by the Cox proportional hazard model.

CONCLUSION: While our baseline CABSI rate was comparatively lower than for other institutions, subset analyses identified that hospitalized cancer patients having TEs are at the highest risk for developing CABSIs. Our findings may help to guide improved methods of anticipating and controlling infections in immunocompromised patients. (c) 2008 Wiley-Liss, Inc.


The aim of this study was to determine the rate, risk factors and outcomes of catheter-related bloodstream infections (CRBSIs) in patients in a paediatric intensive care unit (PICU). A prospective cohort study was performed in King Abdulaziz Medical City, Riyadh, Saudi Arabia; a 650-bed academic/tertiary care centre with a combined 10-bed medical and surgical PICU. All patients admitted to the PICU from July 2000 to February 2003 who had a central line placed were monitored for the development of bloodstream infection (BSI) from insertion until 48 h after removal. Four hundred and forty-six patients with 2493 central-line-days were documented; 273 (55%) were male and the mean age was 2.6 years. Of the 446 patients, 278 (56%) had congenital heart disease, 108 (22%) had genetic disorders and/or congenital malformations, 55 (11%) had respiratory disease, and 42 (8%) had trauma. There were 50 episodes of CRBSI in 46 patients with a rate of 20.06 per 1,000 central-line-days and a device-utilization rate of 57%. Of these 50 episodes, 24 (48%) were polymicrobial, 16 (32%) were due to Gram-negative organisms, five (10%) were due to Gram-positive organisms, and five (10%) were fungal. The most common organisms isolated were Klebsiella pneumoniae (N=12, 16%), coagulase-negative staphylococci (N=10, 14%) and Pseudomonas aeruginosa (N=8, 11%). The mean duration of line insertion was 11.8 days for CRBSI patients and 4.22 days for non-BSI patients (P<0.0001). The mean PICU stay was 30.20 days for CRBSI patients and 6.35 days for non-BSI patients (P<0.0001). BSI occurred more often in catheters inserted in the PICU compared with the operating room, and in the femoral site compared with jugular or subclavian sites (P<0.001). In multiple logistic regression analysis of the risk factors, CRBSI patients were more likely to have multiple central lines [odds ratio (OR) 9.19; 95% confidence intervals (CI): 3.76-22.43], the line was more likely to be used for total parenteral nutrition (OR: 8.69; 95% CI: 3.5-21.4), and guidewire exchange was more likely to be performed on the line. CRBSI was not associated with a higher mortality rate. The CRBSI rate in our hospital is high compared with that reported by the National Nosocomial Infection Surveillance system. This study has established a
benchmark for future comparisons. Additional studies from Saudi Arabia are necessary for national comparison and development of preventive measures.


A case of catheter-associated fungemia due to Exophiala oligosperma in a 3-year-old leukemic child is presented. The etiologic agent was isolated from blood specimens and the catheter tip. The isolate was identified by its morphological characteristics and DNA sequencing of the internal transcribed spacer region of rDNA. Despite initial amphotericin B and itraconazole therapy, the child's fever subsided only after removal of the catheter. A review of the medical literature revealed 29 cases of infection due to Exophiala species. Twenty-three of these 29 patients had a CVC in place when they developed fever or other manifestations of fungemia. Withdrawal of the CVC together with amphotericin B and/or itraconazole therapy generally resulted in a good prognosis. [References: 12]


Agrobacterium radiobacter is an opportunistic pathogen often associated with indwelling catheters. We report five children with central venous catheter-associated A. radiobacter bacteremia and review the characteristics of pediatric Agrobacterium infections. Cure was achieved with appropriate antibiotics, often ticarcillin-clavulanate and gentamicin, and removal of the catheter. [References: 26]


PURPOSE: This study was undertaken to determine if central venous catheter (CVC)-related infection in children with cancer could be prevented by monthly flushing of the catheter with urokinase.

PATIENTS AND METHODS: Between August 1994 and July 1998, 103 patients with cancer were randomized at the time of subcutaneous CVC placement to receive monthly flushing of their catheters with either 5000 IU of urokinase-heparin or heparin alone. Patients subsequently had blood cultures taken from their CVCs during an episode of fever.

RESULTS: Seventy-four of the 103 patients (72%) enrolled in the study received at least 6 catheter flushes: 40 with urokinase-heparin and 34 with heparin. The median number of flushes was 9.5 in the urokinase-heparin group and 10.2 in the heparin-only group (P = 0.62). There were 5 positive blood cultures in the urokinase-heparin group and seven in patients receiving heparin alone (P = 0.27). Staphylococcus epidermidis was isolated from the blood of 3 patients receiving urokinase-heparin and 6 in those receiving heparin alone (P = 0.17).

CONCLUSION: Prophylactic monthly catheter flushes with 5000 IU urokinase did not significantly decrease the number of documented bacteremic events in children with cancer who have CVCs.

We reviewed our experience with paired quantitative and standard blood cultures in the evaluation of children with suspected central-line sepsis with the hypothesis that by employing both systems we would increase our yield of pathogenic isolates. A total of 913 paired cultures were reviewed, representing 267 pathogenic isolates and 58 individual episodes of sepsis. The isolates were analyzed for recovery rates for each system and by combining both systems. The Isolator system proved to be equal to the BACTEC system for the recovery of all groups of pathogenic isolates. The combined use of both the quantitative and the standard culture systems demonstrated a statistically significant advantage ($p$ less than 0.001) for the recovery of pathogens as compared with either system alone. The use of either system alone would have missed 15% of the total pathogenic isolates. Quantitative colony counts were helpful in identifying the line as the source of infection in 35 to 58 episodes of sepsis and were often beneficial in the clinical management central venous line infection. We recommend the use of the Isolator 1.5 ml combined with a conventional broth-bottle system in selected pediatric patients to enhance the recovery of pathogenic organisms.


Discussions on the complications of central venous catheterization in children typically focus on infectious and the more common mechanical complications of pneumothorax, hemothorax, or thrombosis. Rare complications are often more life-threatening, and inexperience may compound the problem. Central venous catheter complications can be broken down into early or late, depending on when they occur. The more serious complications are typically mechanical and occur early, but delayed presentations of pericardial effusions, cardiac tamponade, and pleural effusions may be of equal severity, and delay in diagnosis can be catastrophic. Careful insertion techniques, as well as continued vigilance in the correct position and function of central venous catheters, are imperative to help prevent serious complications. [References: 44]


Routine frequent central venous catheter (CVC) changes in burned patients (either change in insertion site or change over guidewires) has been advocated to decrease catheter-related sepsis. The need for this management has not been verified for children with burns. We reviewed our pediatric burn population with regard to CVC sepsis rate and individual CVC longevity to confirm this traditional policy. From 1978 to 1988, 70 children admitted to the Children’s Hospital of Oklahoma Burn Unit required central venous access. Patients in whom CVCs were changed frequently (FC), ($n = 10$; no. of CVC, 46) were compared with those in whom CVCs were changed only for mechanical complications or sepsis (NFC), ($n = 60$; no. of CVC, 74). There were 10 septic CVCs in each group. The difference in mean length of individual CVC use between FC and NFC was significant (4.6 v 17.7 days; $p$ less than .01). The difference in the number of septic CVCs per total number of catheter days in each group was highly significant (FC: 10 CVC/212 d. = 0.05; NFC: 10 CVC/1,112 d
This study demonstrates a significant decrease in catheter-related sepsis when CVCs are not changed on a routine frequent basis.


**BACKGROUND/PURPOSE:** Chronic vascular access catheters have become an important adjunct to the treatment of children with complex medical diseases, particularly malignancy. One of the major complications of chronic venous access devices is bacterial infection of the catheter site and bloodstream. Infusion of systemic antibiotics directly into the catheter has been the standard initial therapy with failure leading to catheter removal and replacement. It has been suggested by a number of investigators that the addition of urokinase as a thrombolytic agent to lyse any accumulated thrombus or fibrin would increase the successful catheter clearance by antibiotics. This study was designed as a prospective, randomized trial to compare treatment of children with positive catheter blood cultures with either antibiotics alone or in combination with urokinase 5,000 U boluses 12 and 24 hours after study entry.

**METHODS:** A total of 63 patients were entered in the study. Thirty-three received antibiotics and urokinase, and 30 received antibiotics alone.

**RESULTS:** A total of 45 catheters (71%) were cleared of infection and salvaged. Treatment failures leading to catheter removal occurred in 9 of 33 in the experimental group and 9 of 30 in the control population (no significant difference).

**CONCLUSIONS:** Urokinase could not be shown to act as an adjuvant in the clearance of infection from chronic central venous access catheters that had no evidence of clot or thrombus. This study required the performance of a dye study and excluded any patient with a known thrombus. This conclusion must therefore be limited to patients with no evidence of a clot or fibrin sheath.


**SUMMARY:** The approach to treating febrile non-neutropenic hematooncologic patients with central venous catheters varies. We recently introduced once-daily administration of cefonicid and gentamicin for such children who were in good clinical condition and without focal signs of infection. Our 2-year experience of 125 episodes in 54 children is hereby reported. Absolute neutrophil counts were 550 to 16,700/mm. Bacteremia occurred in 6.4% episodes: only in patients with Hickman/Broviac catheters and not in those with port-a-caths [8/37 (21.6%) vs. 0/17 patients, P=0.046; 8/86 (9.3%) vs. 0/39 episodes, P=0.056]. The pathogens were coagulase-negative staphylococci (3), Streptococcus pneumoniae (2), Pseudomonas aeruginosa and Klebsiella pneumoniae (1), methicillin-sensitive Staphylococcus aureus (1), and Streptococcus milleri (1). All patients remained in stable clinical condition and all, except for 2 who became neutropenic and 1 with S. aureus bacteremia who developed cellulitis, defervesced while on the empiric therapy. Three episodes could not be managed as outpatients. No adverse effects were observed. We conclude that our approach is efficacious and safe and, furthermore, that empiric antibiotic therapy
may not be indicated for selected patients with port-a-caths. Future study of children with Hickman/Broviac catheters will evaluate the use of cefonicid alone.


Implanted vascular access devices (ports) play a major role in the management of children with cystic fibrosis (CF) and many haematological conditions. With the expanding use of ports, new and more frequent complications are being encountered. To retrospectively review the complications associated with ports, the case notes of all patients who underwent insertion of a port between 1997 and 2000 were analysed. Details of the underlying disorder, type of vascular device, nature of use, and complications were recorded; 55 ports were inserted in 41 patients (a second port was required in 12, a third port in 2) during this period. Their underlying diagnoses were CF (11), haemophilia (4), haemolytic anaemias (2), immunological disorders (6), solid neoplasms (8), and leukaemia (10). Thirteen ports (24%) were removed and replaced for various complications: infection (2), blockage (4), leak (2), dislodgement (2), and malposition (3). Including four port-related problems managed conservatively (3 access problems managed by change in access technique; 1 blockage managed by urokinase), the overall complication rate was 31%. Ports thus have a high complication rate with long-term use. Selecting the right port system, proper installation of the port chamber, and efficient handling and maintenance by trained staff could prevent the vast majority of port-related complications.


Surgically placed central venous catheters (CVCs) facilitate the delivery of medication and nutrition support for patients with malignant disease. There is little information regarding allergic reactions to materials used for standard CVC care or about mechanical complications associated with CVC use. This study describes allergic and mechanical complications that occurred in a series of 288 CVCs implanted in 238 pediatric patients with malignant disease. There were 20 episodes of cutaneous reactions to standard central line dressing care (alcohol/povidone-iodine/Tegaderm), 13 incidents of catheter exit site infections, and 14 experiences of mechanical breakage in external CVCs. Complications were managed from algorithms that provided a systematic sequence of nursing interventions for alternative catheter dressing techniques and line repair. Only two CVCs were removed because of progressive infection, and one catheter was removed because of occlusion after repair.


OBJECTIVE: This study was conducted to investigate the microbial spectrum, outcome and catheter management in febrile neutropenic acute leukemia patients with long-term central venous access, at a single center in Kuwait.

METHODS: One hundred and thirty-three febrile neutropenic episodes in 64 adult acute leukemia patients with long-term central venous access encountered at the Kuwait Cancer Control Centre were studied. The
frequency of clinically documented infections, microbiologically documented infections, fevers of unknown origin and catheter-related infection was determined. Response to treatment and the need for catheter removal were studied.

RESULTS: In the 133 febrile neutropenic episodes, clinically documented infections, microbiologically documented infections and fever of unknown origin occurred in 12.8, 30.8 and 56.4%, respectively. Thirty-two episodes of catheter-related infections were encountered. Gram-positive and gram-negative infections occurred in equal frequency. Escherichia coli and methicillin-resistant Staphylococcus aureus were the most frequent organisms. Of all episodes, 87.2% responded to antibiotics and 11 episodes required removal of the catheter. Of the clinically documented infections, 76.5% of the episodes responded to treatment without catheter removal. Of the microbiologically documented infections, 68.3% were treated successfully without removal of the catheter. One hundred percent of the episodes of fever of unknown origin responded to a broad spectrum of antibiotics, without catheter removal.

CONCLUSION: Gram-negative and gram-positive infections occur in equal frequency in febrile neutropenic acute leukemia patients with long-term central venous catheters. E. coli and methicillin-resistant S. aureus are the most frequent organisms and the majority of the episodes are curable by antimicrobial therapy without the removal of the catheter. Copyright (C) 2000 S. Karger AG, Basel.


BACKGROUND: The use of central venous catheters (CVCs) in pediatric cancer patients is associated with substantial risk of producing sepsis. The treatment of catheter-related infections has generally consisted of antibiotic administration with or without catheter removal. The authors report the first published experience using intraluminal hydrochloric acid (HCl) instillation as an adjunct to systemic antimicrobials in the management of catheter-related infections in children with cancer.

METHODS: All episodes of intraluminal instillation of 2 M HCl in oncology patients at The Children's Hospital at Westmead between December 1994 and August 2000 were reviewed. Episodes of HCl use were identified from a prospectively maintained infection data base. Successful treatment was defined as no recurrence of infection and no need for CVC removal in the 100 days after HCl administration.

RESULTS: Forty-two episodes of HCl instillation were evaluated that occurred in children in whom blood cultures remained positive despite 48 hours of appropriate, systemic antibiotics and formed the basis of this review. All patients had in situ a surgically placed, subcutaneously tunneled CVC. The combination of systemic antibiotic therapy and HCl instillation was successful in eradicating infection in 67% of infection episodes in this patient cohort. The catheter salvage rate was 83% in patients with isolated Gram-negative infections, 75% in patients with isolated fungemia, and 50% in patients with isolated Gram-positive infections.

CONCLUSIONS: The results suggest that HCl instillation is a useful adjunct to systemic antibiotic therapy, enabling both catheter salvage and eradication of antibiotic-refractory catheter-related infection.

The purpose of this study was to test agreement in blood values obtained from a discard method and a push-pull method in samples from central venous catheters in pediatric patients. The discard method causes blood loss beyond what is necessary for blood testing and increases potential for infection each time the central venous catheter is entered. Twenty-eight children ranging in age from 6 months to 12 years were enrolled in the study. A research protocol was developed to pair the 2 methods of blood collection for each sample. The Bland-Altman method was used to test agreement on each blood value for each paired sample. Of the 438 pairs of measured blood values, 420 (95.9%) fell within the limits of agreement. Nurses reported no difficulty in using the push-pull technique to obtain any samples. The push-pull method of obtaining blood specimens from pediatric central venous catheters should be considered. It can eliminate blood loss through discard and can reduce infection because it reduces the number of times a catheter is entered.


In a 7-month period we studied 38 Hickman central venous catheters (CVCs) positioned in children with hematologic malignancies with the aim of evaluating the incidence and clinical impact of CVC clots. Clots were found in 74% of the CVCs. Three methods of catheter care were developed for flushing the clotted CVCs: (a) use of a heparinized solution (400 IU/mL) on alternate days, (b) use of a heparinized solution (400 IU/mL) and saline solution containing urokinase (10,000 IU/mL) on alternate days, and (c) use of a saline solution containing urokinase (10,000 IU/mL) daily. Only method b decreased clot formation (33% success rate). There were no major mechanical complications in any of the CVCs with clots. Eighteen percent of patients with clots in their CVCs presented with CVC-related infections while no infective complications were observed in the patients without clots in their CVCs. In conclusion, CVC clots may predispose the patient to infections, which must be correctly treated.


BACKGROUND: Bacillus organisms are common laboratory contaminants. The majority of Bacillus bacteraemias are transient and not clinically significant. Clinically significant infection due to Bacillus species is rare and mostly due to Bacillus cereus infections in immuno-compromised hosts.

CASE PRESENTATION: We report a case of central venous catheter infection with Bacillus pumilus in an immunocompetent child with tufting enteropathy on long-term parenteral nutrition (PN). There were three episodes of central venous catheter infection with Bacillus pumilus in three months. Despite adequate and appropriate use of intravenous antibiotics, the infection failed to clear resulting in the need for removal of the catheter for complete cure.

CONCLUSION: Bacillus species can cause clinically significant central venous catheter infection, even in an immunocompetent host. Despite adequate antibiotic treatment, the central venous catheter may need removal for complete cure.


Invasive Aspergillus infection is still a major problem in immunocompromised patients. A central venous catheter infection by Aspergillus fumigatus, however, has not yet been reported. We describe the case of a
10-year-old female patient with B-type non-Hodgkin lymphoma treated according to the German chemotherapy protocol NHL-BFM 90. Isolation of Aspergillus fumigatus from the blood was the first hint of invasive aspergillosis. A central venous catheter-associated infection was suggested, since Aspergillus was also isolated from the thrombotic tip of the removed catheter. Secondary pulmonary aspergillosis was documented radiologically. The patient was treated successfully by Amphoto-thericin B and Itraconozol and explantation of the central venous catheter under conditions of complete hematopoietic regeneration of the bone marrow with omission of the final chemotherapeutic cycle.


This prospective observational study was designed to assess the incidence of, risk factors for, and outcome of catheter-related bloodstream infection in children undergoing cardiac surgery. A staff specifically trained to handle the central venous catheters with proper aseptic techniques and an appropriate patient to medical staff ratio remain the most effective measures to prevent this infection.


PROBLEM: Bloodstream infections associated with catheters were the most common nosocomial infections in one paediatric intensive care unit in 1994-7, with rates well above the national average. DESIGN: Clinical data were collected prospectively to assess the rates of infection from 1994 onwards. The high rates in 1994-7 led to the stepwise introduction of interventions over a five year period. At quarterly intervals, prospective data continued to be collected during this period and an additional three year follow-up period.

SETTING: A 292 bed tertiary care children's hospital.

KEY MEASURES FOR IMPROVEMENT: We aimed to reduce our infection rates to below the national mean rates for similar units by 2000 (a 25% reduction).

STRATEGIES FOR CHANGE: A stepwise introduction of interventions designed to reduce infection rates, including maximal barrier precautions, transition to antibiotic impregnated central venous catheters, annual handwashing campaigns, and changing the skin disinfectant from povidone-iodine to chlorhexidine. Effects of change Significant decreases in rates of infection occurred over the intervention period. These were sustained over the three year follow-up. Annual rates decreased from 9.7/1000 days with a central venous catheter in 1997 to 3.0/1000 days in 2005, which translates to a relative risk reduction of 75% (95% confidence interval 35% to 126%), an absolute risk reduction of 6% (2% to 10%), and a number needed to treat of 16 (10 to 35).

LESSONS LEARNT: A stepwise introduction of interventions leading to a greater than threefold reduction in nosocomial infections can be implemented successfully. This requires a multidisciplinary team, support from hospital leadership, ongoing data collection, shared data interpretation, and introduction of evidence based interventions.

The aim of this study was to compare the Hickman and Groshong central venous catheters (CVCs) for incidence and severity of catheter-related complications in children. Seventy-three patients with hematological malignancies were observed, 42 with Groshong CVCs and 31 with Hickman CVCs. The number of infective episodes per 100 CVC-days was not significantly different (0.25 in the Hickman group versus 0.13 in the Groshong group; P = 0.24). The most frequent type of CVC-related infection in both groups was microbiologically documented sepsis; in most cases Gram-positive bacteria were isolated. Neutropenia (P < 0.001 for both CVCs) and hospital CVC management (P = 0.0047 for the Hickman group, P < 0.001 for the Groshong group) emerged as the major risk factors for the outbreak of infections. The rate of mechanical complication episodes per 100 CVC-days was similar in both groups (1.01 in the Hickman group versus 1.1 in the Groshong group: P = 0.58). Some complications (fissures, ruptures, total lumen obstruction by clots) occurred only in the Groshong group. Our study did not demonstrate any statistically significant difference in the incidence of mechanical and infective CVC-related complications between these two types of catheter.


The effect of a 1-hour nurse training program on the frequency of bacteremia in patients receiving parenteral nutrition was evaluated in a pediatric tertiary center. All of the nurses had previous instruction on aseptic techniques in nursing school. The current program focused on aseptic management of intravenous catheters and implanted subcutaneous ports in patients receiving parenteral nutrition (PN). One hundred eighty-four nurses had a 1-hour training session in groups of three to five. The frequency of bacteremia in children receiving PN was not reduced (9.2% versus 8.9%), and there was no significant difference in time from the start of PN to the diagnosis of bacteremia (P = 0.31). The authors conclude that a 1-hour training session for the nursing staff was not sufficient. It is suggested that staff training for prevention of bloodstream infections associated with intravascular devices should cover a wider range of topics and take place over a longer period of time.


Twenty-five central venous lines (two external 23 subcutaneous ports) were placed in 19 boys with haemophilia A (n = 17) or B (n = 2). The mean age of the boys was 4.9 years (range 0.2-15.3 years). The haemophilia was severe (factor level < 1%) in 18 boys and moderate (factor level 3%) in one. Three boys had circulating inhibitors and three were positive for human immunodeficiency virus (HIV)-1 antibody. Central venous lines were placed to facilitate intermittent factor replacement therapy (n = 6), long-term factor prophylaxis (n = 9), induction of an immune tolerance protocol (n = 2) or therapy for acquired immunodeficiency syndrome (AIDS)-related complications (n = 2). The ports remained in place for 15795 days (mean 687 days, range 11-2059 days). The frequency of port-related sepsis was 48% (11/23 ports in eight boys) or 0.7 port infections per 1000 patient days. Ports were removed from five boys with an unresolved infection (four with Staphylococcus aureus sepsis and one with Pseudomonas sp. sepsis). Other complications requiring port removal included a catheter tip placed too high in the venous system (n = 1),
severe persistent pain associated with needle access of the port (n = 1) and a subclavian vein thrombosis (n = 1). Both the benefits and risks of a subcutaneous port should be considered when deciding whether to place this device in a very young child with haemophilia.


The most frequent indication for placement of a central venous access device in hemophiliacs is in very young boys (ages 1-2 years) with severe hemophilia who are started on a program of long-term factor prophylaxis designed to eliminate target joint bleeding and the development of chronic musculoskeletal disease. Although expensive, this strategy is extremely successful. It involves intravenous infusion of 25-40 factor units per kg on alternate days (minimum 3 times a week) for boys with severe hemophilia A, and twice a week for boys with severe hemophilia B. To facilitate this prophylaxis regimen some hemophilia clinics routinely recommend placement of a central venous access device; others, more concerned about associated complications such as sepsis, stress the importance of using peripheral veins wherever possible, with central access devices reserved for occasional, selected cases only. A decision to use such a device should only be made after discussion of the risks/benefits with parents (or guardians) and with patients if of an appropriate age. If such a system is to be used, we recommend that a totally implantable device (Port-A-Cath) be placed because of the lower risk of infection, and because totally implantable devices allow children to take part in activities such as swimming. Important complications include catheter-related sepsis, which may occur in 25% or more of devices over time and, much less frequently, catheter-related deep vein thrombosis. [References: 10]


The experience with central venous implantable devices (portacaths) has been reviewed in children attending the Auckland Hospital Haemophilia Centre. Fourteen children had 23 portacaths inserted. Thirteen had severe Haemophilia A, of whom five had high responding inhibitors to factor VIII. All the children were HIV negative. Ages ranged from 4 months to 13 years at the time of initial placement and 12 were under 5 years. Indications for portacath placement included primary and secondary prophylaxis, induction of immune tolerance, prophylactic therapy post intracranial haemorrhage and poor venous access. Catheter-related infections occurred in 48% of cases. Staphylococcal species were the most common organisms isolated followed by gram-negative bacilli. 63% of the infections were successfully cleared with antibiotics. Haematoma formation occurred in 17% of catheters, primarily in patients who had high factor VIII inhibitor levels. Mechanical problems including blockage, leakage and extrusion of the portacath occurred less frequently (13%). The significant rate of infection in this immunocompetent population is consistent with other reports. Despite the obvious benefits of portacaths this complication is potentially serious and causes appreciable morbidity. In contrast, bleeding complication rates were relatively low.


This article aims to discuss problems with central venous catheters (CVCs) and offer strategies to assist in preventing their replacement. The article focuses on the most frequent complications of infection and
obstruction. Traditional treatment options are presented and endoluminal brushing is introduced as an innovative treatment for retaining CVCs. The expert opinion that follows focuses on CVCs that are used for parenteral nutrition in paediatrics, but the evidence described can also be applied to larger adult catheters.


Atlanto-axial subluxation with torticollis is an uncommon condition that occurs in children usually as a result of pharyngeal infection, minor trauma, or neck surgery. Passive motion of the head and neck during general anesthesia is probably another etiologic factor. Torticollis is the most common presenting physical finding. Pain may or may not be present, but is commonly present with passive neck motion. Neurologic sequelae are uncommon. Our case illustrates this condition as a complication of central venous catheter (CVC) insertion in a child under general anesthesia. The surgeon should suspect this pathology when a child presents with torticollis following CVC placement. Precautions should be taken in the operating room to avoid aggressive rotation and extension of the child's neck while under general anesthesia whether or not cervical inflammation is present. Special attention to head and neck positioning should be taken in patients with Down's syndrome since they are at increased risk for atlanto-axial subluxation. The prognosis is excellent when diagnosed early. A delay in diagnosis can result in the need for surgical intervention.


Kluyvera is an opportunistic pathogen that can occur in immunosuppressed as well as immunocompetent hosts. We report a case of Kluyvera species infection involving a central venous catheter, and we review the literature on Kluyvera infections in children. Our case demonstrates that removal of the central venous catheter was necessary to eradicate the infection and hasten the resolution of refractory neutropenia. The spectrum of disease due to Kluyvera infection in children includes central venous catheter infection and/or sepsis, urinary tract infection, enteritis, and, in one instance, fatal peritonitis. It is clear on the basis of our case report that uncommon, opportunistic organisms such as Kluyvera can be significant pathogens. [References: 11]


During past 10 years 234 central venous access ports (CVAP) were implanted in 225 patients at the Department of Pediatric Hematology and Oncology in Zabrze. Mean exposure time was 745 days and total implantation time reached 173,768 days. Complications were encountered in 17 patients (7.6%). This mainly concerned central venous line infection, which led to removal of 10 CVAP (4.4%). The remaining complications necessitating removal of the CVAP consisted mainly of mechanical problems (catheter fracture, occlusion, and erroneous implantation to artery). In the opinion of the authors, subcutaneously implanted CVAP are a safe and effective option for high-dose chemotherapy deliverance in childhood cancer patients.

The current standard of care for a fungal central venous catheter infection in a pediatric patient usually requires removal without any other feasible options. Although removal may reduce the rate of Candida-associated complications, literature reviews question whether the outcomes of removal substantiate this being the standard of care. We report 6 cases of central venous catheter fungal infections treated with liposomal amphotericin-B lock therapy. These cases consisted of 4 patients, 2 of whom received recurrent therapy. In 4 of these cases, there was successful eradication of the infectious fungal agent, allowing continued use of the catheter. A controlled study of antifungal lock therapy should be considered as a potential alternative to removal.


We conducted a retrospective cohort study of children with catheter-associated bloodstream infections (BSIs) due to Escherichia coli and/or Klebsiella. Risk factors for poor outcome (ie, death or recurrence of infection) were receipt of mechanical ventilation (adjusted odds ratio [aOR], 4.6 [95% confidence interval {CI}, 1.39-16.30]) and receipt of total parenteral nutrition (aOR, 3.5 [95% CI, 1.1-10.8]). A significant proportion of children with catheter-associated BSI were treated successfully without catheter removal.


BACKGROUND: We aimed to evaluate the use of central catheters introduced by a peripheral vein (PICC) in children with CF.

METHODS: A descriptive study in patients in whom a PICC (Beckton Dickinson) was inserted.

RESULTS: 24 children aged (median (range) 10.2 years (0.3-17.3) undergoing 44 procedures were included. PICC was successfully inserted in 93.2% (41/44) of cases. Total procedure duration was (median (range)) 32.5 (10-105) minutes. The operators encountered few difficulties, median (range) 2 (1-10) (1 (absence) to 10 (maximal)); median (range) 1 (1 to 5) attempt per child). No major side effects or infections were observed. PICC obstruction in 5 (12%) cases was successfully unblocked in 4 cases (urokinase). The catheter was functional throughout the antibiotic course in 40/41 cases. A final Doppler scan (30 cases) showed total permeability of the central veins in all cases. Satisfaction index of the operators and the patients were high: median (range) 9.5 (1-10) and 8.0 (6-10) (scale: 1 (worse) to 10 (best)), respectively.

CONCLUSION: PICCs are simple to use, and may be safely inserted in the ward. Such catheters are well tolerated, may increase the well-being of children with CF and prove an effective means by which to deliver IV therapy in this population. copyright 2009 European Cystic Fibrosis Society.


Since its inception in early 2000, Vanderbilt University’s Peripherally Inserted Central Catheter (PICC) Service has experienced a high level of success as measured by high proficiency rates and increasing patient
procedures each year, low complication rates during and after PICC placements, and an increasing scope of influence within the Vanderbilt University Medical Center and Children's Hospital, the surrounding community, and in the Southeastern United States. Primary drivers of the PICC Service's continuing success include consistent applications of technique and technology, a data-driven approach to assessing the program's progress, and appropriately managing customers' expectations and needs. Over the past five years, data were collected on more than 12,500 PICC placements performed in this specialized nursing program. Retrospective analyses of the data demonstrate an increasing rate of successful placements (from 87.2% to 92.4%) since the program's inception in 2000 to late 2004. Furthermore, the choice of PICC technology has had a significant impact on the odds for occlusion or infection. The Vanderbilt PICC Service provides a model by which other programs can be established, maintained, and expanded into advanced practice.


A case of catheter-related septicemia, due to Coryneform CDC group A-5, in an 11 yr old boy with acute myelomonocytic leukemia is discussed. The child failed to respond to initial antibiotic therapy, even following the addition of vancomycin. Laboratory studies later showed the organism to be vancomycin resistant but cefotaxime susceptible.


Central venous long-term catheters offer reliable, large-lumen vascular access with high flow rates for delivery of nutrition or for cell-containing infusions and perfusions. Catheter-associated infections (CAI) pose the greatest threat to such vascular access, despite existing preventive measures. In this article one prospective and one retrospective study of CAI in pediatric therapy are presented. Study I: A retrospective investigation from 1990 through 1995 of 60 conventional long-term catheters in 50 patients. The total number of days in which the catheters were in place was 11,818. The calculated CAI incidence was 1 per 1,000 days of catheter insertion. Bacteriologically demonstrated CAI (identical isolate on the catheter tip and in a blood culture) occurred in three instances (5%). Five cases (8.3%) were diagnosed with a therapy-resistant, septic clinical picture. Study II: A prospective, randomized comparison of long-term silver-impregnated (Erlanger silver catheters) and control catheters (Quinton Instrument Co.) was made with 41 patients (20 with a silver catheter, 21 with a Quinton catheter). To date, the silver catheters have been distinguished by sterile bacteriological findings, whereas three cases of CAI have been demonstrated with the comparative catheters. One patient recently underwent intensive care after becoming unstable with signs of septic shock and demonstrable Pseudomonas aeruginosa, and two other patients manifested coagulase-negative staphylococci on the catheter tips. In three of nine control catheters an incidence of 1.18 per 1,000 days of indwelling catheters was found, whereas no CAI has occurred with the eight microbiologically tested silver catheters.

BACKGROUND: Central venous lines are placed in children with acute lymphoblastic leukemia at diagnosis, despite significant cytopenias, to facilitate the administration of chemotherapy and blood sampling. The present study aimed to determine the safety of central line placement in these patients.

METHODS: We reviewed the charts of 115 consecutive patients treated during a 10-year period. Data abstracted comprised age, gender, presenting and preoperative blood counts, type of central line, blood products transfused preoperatively, duration of neutropenia (absolute neutrophil count [ANC], <500/microl), treatment, and central line-associated complications.

RESULTS: There were 66 male and 49 female patients with a median age of 4 years. Seventy-one patients were classified as standard-risk and 44 as high-risk. Respective median blood counts at diagnosis and prior to surgery were white cell count (microl), 4,200 and 5,550; hemoglobin (g/dl), 7.7 and 9.4; platelet count (microl), 63,000 and 72,000; and ANC (microl), 3,950 and 4,900. The median duration of neutropenia was 15 days in the standard-risk group and 18 days in the high-risk group. Thirty-eight patients were not transfused preoperatively. There were no episodes of bacteremia. Seven patients (7%) with life-ports experienced a complication: in four blood could not be aspirated, two ports needed realignment, and one a wound infection developed without dehiscence. Four patients (27%) with external lines had a complication: one each with line occlusion, accidental removal by patient, line rupture, and line leakage at insertion site. The complication rate between ports and external lines was different (P = 0.045).

CONCLUSIONS: Central line placement prior to anti-leukemia treatment is safe. Most complications are mechanical and not due to leukemia, chemotherapy, or cytopenias.


The number of children receiving central venous catheters (CVCs) for the administration of medications is at an all-time high. Unfortunately, placement of these CVCs is not without risks. Infection of CVC insertion sites is one of the most common, yet often preventable, causes of nosocomial bacteremia in both children and adults worldwide. Throughout the years, multiple practice recommendations have been made regarding the proper site care of CVCs. The most popular antimicrobial solution used for site care has traditionally been povidone-iodine. Chlorhexidine gluconate solution, however, has been shown to be more effective than povidone-iodine in preventing CVC-related infections in adults. There continues to be controversy regarding the efficacy and safety of antimicrobial solutions for pediatric CVC site care. An evidence-based approach was used to determine current recommendations for CVC site care in children. [References: 12]


Complications in 322 percutaneous subclavian vein catheters placed in 272 children by the infraclavicular approach were investigated prospectively. Ages ranged from 4 days to 15 years. Incidents during catheter introduction occurred in 13 cases, and were more common when insertion was on the right side (p less than 0.01). Nine (2.8%) required urgent treatment: (6 pneumothorax, 1 hydrothorax, and 2 hemothorax). Anomalous lodging of the catheter tip was more common when insertion was on the right side (p less than 0.05). Complications during catheter maintenance were 3 venous thromboses, 3 catheter obstructions, and 7 migrations out of position. There was no significant difference in complications related to age. Catheter
cultures were positive in 33 (17%) of 190 catheters cultured (27 through colonization and 6 through catheter-related sepsis). Staph. epidermidis was the organism most frequently isolated (19 cases; 58%). Catheterization time of more than 5 days and catheter-related sepsis were statistically associated (p less than 0.05). Staph. epidermidis isolation and duration of cannula use were statistically related (p less than 0.01). No catheter-related deaths occurred. We conclude that subclavian vein catheterization is a simple and useful procedure that entails relatively few serious complications when performed by experienced pediatricians.


Among 102 episodes of intravenous catheter related bacteraemias documented between January 1989 and July 1996 in children receiving antineoplastic chemotherapy or bone marrow transplantation at G. Gaslini Children's Hospital, Genoa, Italy, were identified seven episodes due to unusual pathogens: Bacillus circulans, Bacillus licheniformis, Brevibacterium casei, Flavimonas oryzihabitans, Porphyromonas asaccharolytica, Comamonas acidovorans and Agrobacterium radiobacter. Susceptibility to different antibiotics of all strains are reported. In all cases catheter removal was required for culture negativization. All episodes were diagnosed in absence of granulocytopenia. [References: 22]


AIM OF THE STUDY: To evaluate the possible link between malfunctioning events and catheter related infections in indwelling central venous devices in children with cancer.

PATIENTS AND METHODS: Prospective observation of 418 devices inserted in 2 Italian tertiary care pediatric cancer centers. The presence of a relationship was identified if a malfunctioning event was followed by a catheter related infection within 10 days, or vice versa.

RESULTS: The 418 catheters were followed for a period of 107,012 days. Among the malfunctioning events 2 out of 141 (1%) were followed by a catheter related infection while among infectious episodes 3 out of 93 (3%) were followed by a malfunctioning event.

CONCLUSIONS: Malfunctioning events followed by catheter related infections and catheter related infections followed by malfunctioning are both rare events in children with cancer.


The incidence of pathogens causing catheter-related bacteraemias in children undergoing antineoplastic chemotherapy with or without bone marrow transplantation at G. Gaslini Children's Hospital, Genoa, Italy, was analysed by comparing data from a retrospective study (1985-1988) with that obtained from a prospective one (1989-1992). In both periods catheter-related bacteraemias one (1989-1992). In both periods catheter-related bacteraemias were more frequent in non-neutropenic than in neutropenic patients. Among catheter-unrelated bacteraemias the pattern of infecting pathogens remained unchanged...
between the study periods, with Gram-positive bacteria remaining the predominant pathogens. Conversely, among catheter-related bacteraemias, the incidence of Gram-negative bacilli increased significantly from 3 to 38%, and that of Gram-positive bacteria fell from 63 to 32% (P = 0.001, chi 2 test for heterogeneity.


AIM: To evaluate the incidence of surgical site infections and bacteremias occurring within 30 days from insertion of partially implanted central venous catheters.

PATIENTS AND METHODS: Four hundred eighteen devices positioned in children with cancer or undergoing bone marrow transplant were followed prospectively.

RESULTS: During a follow-up of 12,394 catheter-days, a total of 13 infectious episodes were documented, with an overall incidence of 3.1% and 1.05 episodes/1,000 catheter-days. Coagulase-negative staphylococci represented the causative pathogens of all episodes. Overall, surgical wound infections occurred in 1.4% of all catheters, with a rate of 0.48/1,000 catheter-days, while isolated bacteremias were observed in 1.7% of all inserted devices, with a rate of 0.57/1,000 catheter-days.

CONCLUSIONS: Infections are rare events within 30 days from insertion of partially implanted central venous catheters and coagulase-negative staphylococci represent the most frequently isolated cause of these complications. (c) 2006 Wiley-Liss, Inc.


A prospective pediatric survey on the incidence of central venous catheter (CVC) complications was performed aimed at identifying risk factors of premature CVC removal. The study comprised 129 Broviac-Hickman CVCs inserted during a 13-month period in 112 children. The total number of CVC days was 19,328 (median: 122 days, range: 1-385). The overall rate of complications was 6.2/1000 CVC days, i.e., 4.5/1000 and 1.7/1000 CVC days for mechanical and infectious complications, respectively. Interestingly, only two CVC-related cases of septicemia and no thrombotic events were documented. At the end of the study period, 38 of 129 CVC (29.5%) had been removed: 20 due to CVC-related complications (dislocation18, rupture 2), 10 due to the patient's death, and 8 due to completion of therapy. Age at CVC insertion <4.9 years was a significant predictor of premature CVC removal ( p=0.01). Mechanical complications, especially in younger children, are the main cause of premature loss of CVC. These data underline the importance of more effectively securing the CVC to subcutaneous tissue in pediatric patients to reduce accidental dislocations.


PURPOSE: There are limited prospective data on whether the method of flushing affects the complication rate of tunneled central venous catheters (CVCs).
PATIENTS AND METHODS: During a 25-month period, 203 pediatric patients who had newly placed Broviac-Hickman CVCs were randomly assigned to standard flushing with heparin solution or to experimental flushing with normal saline via a positive-pressure cap.

RESULTS: Two hundred twenty-one complications were recorded among 75,249 CVC-days (2.94 per 1,000 CVC-days). A higher incidence of CVC occlusion (83 v 41 episodes; P = .0002) and bacteremia (24 v 9; P = .01) were found in the experimental arm. The cumulative probability of developing at least one CVC complication was higher in the experimental arm than in the standard arm (65.1% [95% CI, 55% to 75%] v 43.8% [95% CI, 34% to 54%], respectively; P = .01). No difference was found in either the cause or the frequency of premature removal of CVCs between the two study arms. After a median follow-up of 360 days (range, 4 to 1,073), CVC survival was similar: 77% (95% CI, 66% to 84%) for the experimental arm and 69% (95% CI, 53% to 80%) for the standard arm (P = .7). The factors associated with the occurrence of CVC complication were a diagnosis of leukemia/lymphoma, double-lumen CVC, and experimental flushing. The only factor significantly associated with premature removal of a CVC was a diagnosis of leukemia/lymphoma (hazard rate, 2.3; 95% CI, 1.1 to 4.7).

CONCLUSION: An increased complication rate was found with normal saline flushing, but additional investigation is warranted to clarify whether it is related to saline use or to once-a-week flushing.


PURPOSE: To assess the feasibility and complications of peripherally inserted central catheters (PICCs) in pediatric patients.

MATERIALS AND METHODS: The authors attempted to place PICCs in 122 patients aged 9 days to 19 years (mean, 6.82 years; median, 5 years). Catheters were placed to allow prolonged administration of antibiotics or chemotherapeutic agents (n = 50), provide total parenteral nutrition (n = 41), and establish prolonged intravenous access for blood draws and fluid administration (n = 31). Silicone catheters measuring 3, 4, and 5 F were inserted in either basilic or cephalic veins and positioned at the junction of the superior vena cava and right atrium under fluoroscopic guidance. Patients were monitored for complications until devices were removed.

RESULTS: Fluoroscopically guided PICC placement was successful in 137 of 148 attempts. Postinsertion complications included mechanical defects of the catheter, PICC-related infection, occlusion of the PICC, and venous stasis. Complications occurred at a rate comparable to those seen with blind insertion.

CONCLUSION: Fluoroscopically guided PICC placement is feasible and safe in pediatric patients.


This article provides an overview on the current management of catheter-related blood stream infection in neonates and children. New techniques, such as acridine orange stain and differential time to positivity, are useful in diagnosing catheter-related bacterial infections without catheter removal. Furthermore, they are feasible for those hospitals with limited manpower and budget in microbiology service. Management of catheter-related infections depends on bacterial, device (type of device, nature of the infusate) and host factors (age, birth weight, gestation and underlying diseases). Bacterial factor is probably the most
important consideration for the decision of catheter removal, choice of antibiotics and duration of therapy. Catheter-salvaging strategies including antibiotic-lock therapy and urokinase had been suggested but only the former is still useful in patients with uncomplicated infections involving implantable devices or tunneled catheters. In addition, changing of a catheter over a guidewire because of concern about losing venous access is not recommended.


BACKGROUND: Catheter-associated bloodstream infections (CABSI) are among the most common and serious adverse events experienced by critically ill children. Randomized trials have demonstrated that the use of central venous catheters (CVC) coated with antiseptic solutions reduces rates of CABSI in adult patients; however, their efficacy in children has not been evaluated.

OBJECTIVE: To compare the incidence of CABSI, rate of complications, and microbiology of infection in critically ill children treated with antibiotic-coated or noncoated CVC (NC-CVC).

METHODS: A prospective observational trial was conducted in the pediatric intensive care unit (PICU) during a 13-month period. A minocycline-rifampin-coated CVC (MR-CVC) or NC-CVC was placed by PICU physicians who nonpreferentially selected CVC type.

RESULTS: We studied the outcomes associated with the first CVC placed in 225 patients, including 69 MR-CVC and 156 NC-CVC. Patients who received MR-CVC, as compared with NC-CVC, were similar in gender, age, and severity of illness at time of PICU admission. The incidence density of CABSI did not vary by catheter type [MR-CVC: 7.53 per 1000 catheter-days (95% confidence interval 2.05-19.17); NC-CVC: 8.64 CABSI per 1000 catheter-days (95% confidence interval 3.74-16.96)]. However, the median time to infection in children with MR-CVC was 3-fold longer than in children with NC-CVC [18 versus 5 days (P = 0.053)]. No difference was seen in the incidence of complications, including thrombosis and catheter site reaction, between MR- and NC-CVC. No significant difference was observed in the types of organisms recovered from patients with MR- and NC-CVC.

CONCLUSIONS: The use of MR-CVC significantly delayed the onset of CABSI in PICU patients. Larger, randomized trials are needed to better define potential differences in the incidence of CABSI, rate of complications, and microbiology of infection among pediatric patients treated with antiseptic-coated CVC and NC-CVC.


BACKGROUND: Recent meta-analyses of published controlled studies concluded that adult patients with cancer randomly assigned to receive parenteral nutrition had higher rates of infectious complications than control subjects.

METHODS: The infection risk associated with parenteral nutrition was assessed in 310 pediatric patients with cancer. These patients had central venous access devices (CVAD), Hickman/Broviac (H/B) catheters, or implantable subcutaneous ports in place for the delivery of chemotherapy and supportive care.
RESULTS: The median duration of CVAD placement was 363 days; a total of 450 patient years (i.e., the sum of the total years of catheters experienced from all patients studied) were examined. Overall, the infection rate was 0.06 infections/100 days. During the period of parenteral nutrition administration, the rate increased to 0.5 infections/100 days. Among patients who received parenteral nutrition, there were no significant differences in any clinical parameter between the patients who developed an infection and those who did not. When evaluating the entire study population, infection was more likely to occur in patients who had acute nonlymphocytic leukemia (P < 0.01) or H/B catheters (P < 0.01), or who received parenteral nutrition (P < 0.02); there was no relationship between infection and catheter duration, days hospitalized, or days neutropenic (absolute neutrophil count < 0.5 x 10^9/l). Only CVAD type and parenteral nutrition retained significance in a multivariate Cox proportional hazards model. After adjustment for diagnosis and CVAD type, the risk of infection was 2.4-fold greater in patients given parenteral nutrition (95% confidence interval 1.5 to 3.9; P < 0.001).

CONCLUSION: These data confirm that administration of parenteral nutrition is associated with an increased risk of infection in children who have CVAD in place for cancer therapy.


Central venous catheters are widely used in the care of critically ill patients. This paper reviews our experience with central lines in paediatric patients requiring intensive care, between the period August 1994 and August 1995. A total of 57 insertions were performed in 40 patients, all less than 12 years of age. We found that the most common indication for catheter use was nutritional support (40%). The overall complication rate was 58%. Catheter-related infection was the most serious problem, occurring in 32% of all insertions. Coagulase-negative Staphylococcus aureus was the organism most frequently isolated. Maintenance problems affected 17 of our catheters in which 9 were blocked. Both infected and blocked catheters were promptly removed. We had 3 cases of perforation and 2 cases of thrombosis. There were no deaths directly attributed to catheter use. Recommendations made include: 1) staff education and new guidelines for catheter care, 2) use of bacteria filters, 3) careful prospective monitoring of catheter infection rate, 4) heparinisation when infusion rate less than 2 ml/h, 5) eliminate use of stiff polyethylene catheters and 6) routine confirmatory X-ray or waveform monitoring before catheter use, if possible. We concluded that central venous catheterisations greatly facilitated the management of our patients. However, one must bear in mind that the use of such catheters is associated with problems which must be recognised early and promptly treated and, if possible, prevented with safe practice.


Ochrobactrum anthropi, formerly known as CDC group Vd, is an oxidase-producing, gram-negative, non-lactose-fermenting bacillus that oxidizes glucose and grows readily on MacConkey agar. Only occasionally isolated from human clinical specimens, this organism has rarely been found to be pathogenic. We describe the first reported case of infection due to O. anthropi in a child, that of bacteremia in a 3-year-old girl undergoing chemotherapy for retinoblastoma. In addition, we review the literature concerning cases of infection due to this and closely related bacterial species, namely Alcaligenes xylosoxidans subspecies xylosoxidans, Agrobacterium radiobacter, and "Achromobacter" group B. Finally, we attempt to clarify the
confusing history and taxonomy of these organisms as well as make recommendations regarding antimicrobial therapy for infections caused by them. [References: 39]


A single center’s procedural and follow-up results of radiological chest port placement in pediatric oncology patients are presented. Between July 2002 and December 2003, 37 children (20 boys, 17 girls; age range, 4 months to 16 years; mean 6.7 years) underwent chest port placement. All patients received only one port through the internal jugular vein access, and all of the implantations were performed in the interventional radiology suite. Our database and electronic charts were retrospectively reviewed to obtain follow-up data. All chest ports were successfully implanted. The mean catheter life was 223 days (range: 15-450 days), with a total of 8,258 catheter days. Twenty-eight ports are still in use, four patient deceased, one port was prematurely removed because of a late infection, and four patients were lost to follow-up. Infection rate was 2.7% (0.12/1,000 catheter days). Malfunction due to partial catheter thrombosis and fibrin sheath formation was observed in three patients (8.1% or 0.36/1,000 catheter days), and all were relieved with rt-TPA dwell. None of the ports were revised or removed because of blockage, malposition or difficulty accessing the port. The peri-procedural complication rate was 0%. Chest ports in children can be inserted in interventional radiology suites under imaging guidance with high rates of technical success. The rates of infection and complications are comparable to that of surgically placed ports.


BACKGROUND: It is critical to establish a safe and functional i.v. access in severely sick patients. We evaluated the frequency of application and complications of central venous catheters in a pediatric intensive care unit.

METHODS: Pediatric patients in whom central venous catheters were inserted between March 1997 and May 1999 in the Pediatric Emergency Room and Intensive Care Unit were enrolled in this study. Patients were evaluated with respect to age, sex, weight, central venous catheter indication, site, duration of catheter stay and complications.

RESULTS: During the study period a total of 156 central venous catheters were successfully inserted into 146 patients. Of the 156 central venous catheter attempts, 148 (94.9%) were placed into the subclavian vein; six were inserted into the femoral vein, and two into the jugular vein. In 156 attempts, arterial injuries occurred in 20 cases (12.8%). Pneumothorax developed in two patients on mechanical ventilation. Three catheters had to be removed due to catheter related infections. The mortality rate was 0%.

CONCLUSIONS: We concluded that subclavian central venous catheterization is a safe procedure with minimal complications in pediatric patients. Arterial injury was the most frequent complication. In experienced hands, the success rate was 100%. Subclavian central venous catheter insertion may be considered as the first approach in critically ill patients.

The objective of this retrospective study was to evaluate the significance and complications of percutaneous central venous catheterization in pediatric patients affected by hematologic malignancies. One hundred and fifty-eight central venous catheters were inserted in 125 pediatric patients (male/female 67/58; median age: 4 years; range 10 m - 6 y.) affected by hematological malignancies. Venous access was obtained by means of a tunneled silicone rubber Groshong catheter inserted percutaneously in the subclavian vein (91.1%), the internal jugular vein or in the femoral vein. The medial duration of catheterization was 231.8 days (range 8-1014 days). The total number of catheter days was 33,792 (92.6 years). There were no complications related to catheter insertion. Only one patient developed significant post-operative bleeding. One hundred and nine catheters (68.9%) were removed when they were no longer needed and 49 (31.1%) were removed due to complications: 6 catheter occlusions (12.2%), 7 were accidentally withdrawn (14.3%), 3 for local infections (6.1%) and 33 for catheter-related infection (67.3%). A Groshong catheter seems to provide good access to the blood stream for a long period of time with a low incidence of complications in children with acute hematological malignancies.


The use of central venous catheters (CVC) in children with coagulation disorders allows home treatment, the use of prophylactic blood product replacement and induction of immune tolerance. Previous reports have suggested an almost complete lack of infective complications in this patient group. We reviewed 23 patients with bleeding disorders who have had 32 CVC inserted at this institution with a median follow-up of 27 months (range 1-92 months). There were 25 documented line-associated infections, including two subcutaneous infections at the port site, and 23 bacteraemias (one episode per 26 patient months at risk). There were 15 Gram-positive, nine Gram-negative and one mixed infection. Infections occurred in 48% of the patients. 15 CVCs were removed: one for erosion through the skin, two for line blockage and 12 for infection. Five patients with inhibitors to factor VIII suffered 14 infections in 12 lines (one per 8.3 months) whereas the 18 without inhibitors suffered 11 infections in 20 lines (one per 50 months) (P<0.03). The use of CVCs is favoured by families of children with bleeding disorders in spite of these complications, but close liaison between families and experienced staff at a Haemophilia Centre is essential to ensure that patients gain the benefits of a CVC as safely as possible.


BACKGROUND AND AIMS: This study aimed to assess the incidence and etiology of central venous catheter (CVC) infections in children on home parenteral nutrition (HPN).

METHODS: 207 CVC-years were studied retrospectively in 47 children on HPN, aged 8.1+/−5.0 years.

RESULTS: 125 CVC were used (means: 2.6 CVC/patient and 21 months utilization/CVC). Half of the hospitalizations (162) were due to proven CVC-related infections. The mean infection incidence was 2.1/1000 HPN days. The total population divided in two groups below and above this value: group one including 24 children, incidence < or = 2.1 per 1000 days (mean: 0.83) and group two including 23 children, incidence >2.1 per 1000 days (mean: 4.3). No differences were found between the two groups in terms of
underlying disease, presence of ostomies, age at the time of HPN onset, or micro-organisms responsible. The only differences (p<0.05) were the mean duration of HPN (longer in group one) and the delay between HPN onset and the first infection (longer in group one).

CONCLUSIONS: This study does not highlight any risk factors for CVC infection. However, early CVC infections after HPN onset appear to predict a bad prognosis. Copyright 2000 Harcourt Publishers Ltd.


Microbial colonization and the incidence of catheter-related bloodstream infections (CR-BSI) associated with Oligon Vantex silver central venous catheters (CVC) in critically ill patients were determined. A prospective, randomized, controlled 17-month trial was carried out in an intensive care unit (ICU). All patients requiring a triple-lumen CVC for four days or longer were enrolled. Patients were randomized to receive a standard polyurethane CVC or an Oligon Vantex silver CVC. Before removal of the catheter either due to discharge from the ICU or suspected infection, blood for cultures was taken via the CVC and a peripheral site. Skin and hub swabs and catheter-tips were also cultured. Two hundred and six catheters, 103 in both groups, were evaluated. In the control group (CG) 45/103 (44%) and in the silver group (SG) 30/103 (29%) were colonized or had a CR-BSI (P=0.04). The SG was less likely to be colonized than the CG when the catheter remained in situ for eight days or less (P=0.03) or over 15 days (P=0.01); a second or subsequent catheter was present in the same patient (P=0.002), or if the CVC was placed in the internal jugular vein (P=0.05). Multivariate logistic-regression showed predisposing factors for catheter colonization were jugular and femoral sites, second or subsequent catheter, and being a member of the CG. CR-BSI occurred in five cases (four in CG). Rates of CR-BSI per 1000 catheter-days in the CG were 2.8 and in the SG, 0.8 (P<0.001). The Oligon Vantex silver catheter reduced the incidence of catheter-colonization and may decrease the risk of CR-BSI.


OBJECTIVE: Our goal was to determine whether an intervention involving staff education, increased awareness, and practice changes would decrease central line-associated bloodstream infection rates in a pediatric cardiac ICU.

METHODS: A retrospective, interventional study using an interrupted time-series design was conducted to compare central line-associated bloodstream infection rates during 3 time periods for all patients admitted to our pediatric cardiac ICU between April 1, 2004, and December 31, 2006. During the preintervention period (April 2004 to December 2004), a committee was convened to track and prevent nosocomial infections. Pretesting demonstrated knowledge deficits regarding nosocomial infection prevention, and educational tools were developed. During the partial intervention period (January 2005 to March 2006), a comprehensive central line-associated bloodstream infection prevention initiative was implemented, including establishment of a unit-based infection control nurse position, education for physicians and nurses, real-time feedback on central line-associated bloodstream infection data, implementation of central venous line insertion, access, and maintenance bundles, and introduction of daily goal sheets on rounds that emphasized timely central venous line removal. Central line-associated bloodstream infection rates in the preintervention, partial intervention, and full intervention (April 2006 to December 2006) periods were compared.
RESULTS: The estimated mean preintervention central line-associated bloodstream infection rate was 7.8 infections per 1000 catheter-days, which decreased to 4.7 infections per 1000 catheter-days in the partial intervention period and 2.3 infections per 1000 catheter-days in the full intervention period. The preintervention central line-associated bloodstream infection rate was significantly higher than the median rate of 3.5 infections per 1000 catheter-days for multidisciplinary PICUs reporting to the National Healthcare Safety Network. During the full intervention period, our central line-associated bloodstream infection rate was lower than this pediatric benchmark, although statistical significance was not achieved.

CONCLUSIONS: A multidisciplinary, evidence-based initiative resulted in a significant reduction in central line-associated bloodstream infections in our pediatric cardiac ICU.


Central venous catheters (CVC) are frequently used in children with haemophilia to deliver factor infusions for the treatment or prophylaxis of bleeding. Complications of CVCs in patients with haemophilia include thrombosis and infection. We report a young boy with severe haemophilia A and an inhibitor who developed disseminated Staphylococcus aureus infection most likely related to a CVC. To our knowledge, this is the first reported case of fatal sepsis secondary to a CVC in a patient with haemophilia.


PURPOSE: To evaluate prospectively the use of peripherally inserted central catheters in a large pediatric population.

MATERIALS AND METHODS: During a 3-year period, data were collected prospectively on 523 consecutive attempts to place peripherally inserted central catheters in children. Patients underwent radiologically guided placement because attempts were unsuccessful on the inpatient units or a patient request was made. Fluoroscopy with use of contrast material and venography were used to place catheters and document the position of the catheter tip. Follow-up data were collected until treatment cessation or catheter removal.

RESULTS: Among 523 attempts, 486 (92.9%) catheters were successfully placed. In the 37 (7.1%) unsuccessful cases, more than half of these children were younger than 24 months of age or weighed less than 5 kg. Ages of patients in whom 523 placement attempts were made ranged from 3 weeks to 18 years (mean, 6.9 years). Catheters were in place from 1 to 390 days (mean, 20 days). Frequency of infection was 1.9% (nine cases); incidence of infection was 0.93 per 1,000 catheter-placement days. There were two cases (0.4%) of central venous thrombosis. Most patients were discharged within 2 days of catheter placement.

CONCLUSION: Fluoroscopically guided placement of peripherally inserted central catheters is a safe and effective method for establishing intermediate- and long-term central venous access in the pediatric population.

Central venous access is frequently used in infants and children with a wide variety of conditions. This report evaluates our experience and the complications from central venous catheters (CVC) placed percutaneously in children at a public hospital of a developing country—Brazil. To identify associated complications, data were collected prospectively and 155 consecutive catheterizations in children at a public hospital over a nearly 8-month period were analyzed. Data collected included sex, age, weight, primary diagnosis, indication for placement, presence of blood coagulation disturbance, hospital department for procedure, type of anesthesia, type of catheter (diameter, lumen number, material), site of catheterization, number of attempts, number of puncture sites, complications during puncture, the time catheter remained in place, later complications (mechanical, infectious) and reason for catheter removal. A total of 155 catheters were placed in 127 patients. There were 130 neck lines and 25 groin lines. The success rate was 81.9% at the initially chosen puncture site and rose to 100% with the inclusion of the second site. Perioperative complications occurred in nine (5.8%) cases, including six (3.9%) hematomas and three (1.9%) arterial puncture. There was no pneumothorax, hemothorax or hydrothorax. During the time the catheter remained in place, there were 51 (32.9%) complications, of which 33 (21.3%) were mechanical and 18 (11.6%) suspected catheter-related infection. These complications were responsible for the removal of the catheter. Despite the relatively high complication rate there were no catheter-related deaths. Body weight was significantly lower for children who underwent more than one puncture site (P=0.01). Age, sex, type of catheter and primary diagnosis were not associated with complications. Knowledge of anatomy and familiarity with the Seldinger technique highly increase the catheterization success rate, with few surgical complications. A better nursing care of CVC is emphasized. The available modern venous catheters at a public hospital in Brazil have contributed to improve the quality of pediatric medical care. Nowadays, the percutaneous CVC is the preferred method in pediatric patients.


BACKGROUND: Central venous catheter-related (CVC) infections represent the most common complication of parenteral nutrition. These infections are usually treated by means of long-term systemic antibiotic treatment. The objective of this study was to determine the efficacy of combining a local antibiotic lock with a short systemic double antibiotic to treat CVC-related staphylococci infections.

METHODS: Any child with coagulase-negative staphylococci or Staphylococcus aureus septicemia, confirmed by a positive blood culture, was included in the study. A double antibiotic systemic treatment composed of amikacin and teicoplanin was started and continued for 5 days. The antibiotic treatment was combined from the first day (D0) with a local teicoplanin lock, which was left for 12 hours a day in the catheter for 15 days. Parenteral nutrition was continued on a nocturnal cyclic mode during antibiotic treatment. The efficacy of the treatment was evaluated by clinical (body temperature), biologic [C-reactive protein levels (CRP)], and bacteriologic (blood culture) measures.

RESULTS: Twenty CVC-related infection episodes in 13 patients were analyzed for the study. In the initial biologic test, CRP varied from 2 to 130 mg/L (mean 43 mg/L). After 3 days of treatment, CRP varied from 2 to 61 mg/L (mean 12 mg/L). The median time until normalization of temperature and CRP levels after the beginning of antibiotic treatment was 3.2 days (range 1 to 14 days) and 6.2 days (range 2 to 19 days), respectively. All blood cultures were negative for infection 48 hours after stopping the treatment. Only 1 therapeutic failure was observed during the treatment. The patient had persistent signs of clinical septicemia that required removal of the CVC. Two catheter-related infection recurrences were observed in
the month after termination of the local antibiotic lock, which also required removal of the CVC. The central venous catheter was maintained in the other cases.

**CONCLUSIONS:** Teicoplanin antibiotic locks, combined with a short conventional systemic antibiotic treatment and continuation of cyclic parenteral nutrition, seem effective and well-tolerated treatments for CVC infections.


In an attempt to decrease the incidence of central venous catheter sepsis in children with cancer, we conducted a study to evaluate the benefit of adding broad-spectrum antibiotics to the catheter "flush solution." In a prospective, placebo-controlled, double-blinded, randomized trial, 69 children with different types of malignancies were studied. The central venous catheters in these children were flushed with either the standard solution (normal saline + 100 U/ml of heparin) or the study solution (25 microgram/ml of both amikacin and vancomycin added to the standard solution). At the conclusion of the study, 64 children with a total of 67 indwelling central venous lines were assessable. The total catheter days on study were 20,700 days, with a median of 323 catheter days per patient. We documented 10 events of catheter-related infections (0.49 events/1,000 catheter days at risk). Five of these events were catheter-related sepsis (0.24 sepses/1,000 catheter days): two were fungal and three were bacterial. Due to the low incidence of catheter-related sepsis in this study, no statement regarding the prophylactic use of antibiotics could be made. The extremely low rate of catheter-related sepsis reported herein may be retrospectively attributed to continuous staff education regarding aseptic techniques in handling these catheters. Staff education is essential, and probably the most effective factor in preventing catheter-related sepsis.


Central venous catheter sepsis is the most common complication encountered when children are maintained on total parenteral nutritional therapy. In this article, the author describes children with gastrointestinal diseases who require total parenteral nutritional therapy. The organisms involved in causing central line sepsis and clinical presentation of the infection are covered. Pharmacological interventions aimed at treating the infection as well as infection control measures are described. Implications for infection control for nurses and others caring for these children are offered.


**PURPOSE:** To assess the ethanol-lock technique as a means of treating central venous line infections. Bloodstream infections in patients with tunneled central venous catheters can lead to removal of the lines.
METHODS: Twenty-eight children and adolescents aged 2 to 18 years, with different types of cancer, had Broviac catheters and presented with positive blood culture and clinical signs of infection between January 2000 and December 2001. The ethanol-lock technique was performed 24 times in 18 patients in addition to empiric (initially) and specific (after antibiogram) intravenous antibiotic treatment. In another 15 cases, 13 children were treated with systemic antibiotics alone.

RESULTS: Sixty-seven percent of the patients treated with ethanol locks had no infectious relapse of any kind within 4 weeks of treatment or during subsequent aplasia, compared with 47% treated with systemic antibiotics alone. In one boy the catheter infection could not be cleared with systemic antibiotics alone, but after one course of ethanol locks no more blood culture-positive infectious episodes were observed. No severe clinical side effects of ethanol flush were observed. Mild symptoms that occurred were tiredness, headaches, dizziness, nausea, and light-headedness.

CONCLUSIONS: The ethanol-lock technique appears to be a safe, well tolerated, and effective way to treat central venous line infections, even in small children. A prospective randomized study should be designed to compare antibiotic-lock, ethanol-lock technique, and systemic antibiotics alone in the treatment of device-associated bloodstream infection.


A prospective study of septicaemia, with special reference to central venous catheter (CVC)-related septicaemia, was performed over a nine-month period in paediatric cancer patients undergoing anti-neoplastic therapy. A total of 142 patients with 153 CVCs were included in the study. Seventy-two episodes of septicaemia were detected in 66 patients; overall, 46% of patients developed one or more episodes of septicaemia. Thirty-nine (54%) of these episodes occurring in 34 patients were CVC-related. Twenty-one (29%) of the episodes occurring in twenty patients were probably unrelated to CVCs and 12 (17%) episodes in 12 patients were of uncertain source. A total of 22932 CVC days were studied. The rate of CVC-related septicaemia was 1.7 episodes/1000 catheter days. Gram-positive organisms were commonest, causing 34 (87%) episodes of CVC-related septicaemia. Twenty-five (71%) of 35 evaluable episodes were successfully treated with antibiotics without CVC removal. Two patients died, CVC related sepsis probably contributing to death, and one patient suffered prolonged morbidity associated with CVC sepsis. Gram-negative organisms were the commonest cause of CVC-unrelated septicaemia, being implicated in 13 (62%) episodes.


We reviewed retrospectively 31 cases of candidemia in children with central venous catheters. Infection rate was significantly higher in 1- to 4-year-old children with central venous catheters. Infection rate was significantly higher in 1- to 4-year-old children than in other age groups (8.4% vs. 2.2%; P less than 0.05). Serious sequelae occurred in 11 (35%) cases and included fatal outcome (5 instances), Candida endocarditis (2), renal abscesses, meningitis, arthritis and osteomyelitis (1 each). Complications were significantly more common in infants than in older children (P less than 0.05) and appeared 3 to 52 days after the first positive blood culture (mean, 16 days). In fatal cases catheters were left in place a significantly greater number of
days than in nonfatal cases (P less than 0.05). A literature review identified 43 additional cases of catheter-related candidemia described in 11 series. The rate of Candida infection in the group as a whole was 2.7%. Patients treated with catheter removal plus amphotericin B had a significantly higher cure rate than patients treated with catheter retention plus amphotericin B (P = 0.009). Prompt catheter removal remains crucial in the treatment of catheter-related candidemia.


The use of central venous lines has come to be widely accepted by children with cancer and their families. However, attendant infection is a cause of considerable morbidity. Coagulase-negative staphylococci, the predominant aerobic species on the skin, are now the commonest cause of catheter-related bacteremia. We introduced a protocol to reduce the colonization of the skin at the catheter insertion site. Antiseptic skin scrubs, with 4% chlorhexidine gluconate, were performed on the neck and anterior chest the night before and again on the morning of the surgical procedure. A single dose of cephalothin (or vancomycin for penicillin-allergic patients) was administered IV immediately before the operation. Compared to the 12 month period prior to initiation of this protocol, the rate of infections (occurring within 30 days of catheter placement) in the 3.5 year period of intervention dropped from 8 to 4.9 per 1,000 catheter days. The proportion of infections that were staphylococcal was reduced from 93 to 63% and the proportion of non-ports removed within 30 days of placement fell from 45 to 0%. Despite these changes, the major contribution to improved infection control appeared to be the use of an increased proportion of ports (a rise from <10 to almost 60%).


In the period 1980-1988, data were collected (prospectively from 1985) on the clinical utilization of exteriorized, tunneled, right atrial catheters in children with cancer undergoing treatment at a single institution. A total of 231 devices were placed in 180 patients. Individual catheters were in place for a median of 314 days, with a total experience of more than 83,000 days. This form of long-term venous access was used for the administration of antineoplastic agents and other drugs, blood products (especially platelet concentrates and packed red blood cells), parenteral nutrition and infusion of other fluids, obtaining samples of venous blood, and giving intravenous contrast media and radiolabeled substances for radiological investigations. Almost 80% of catheters were removed electively (on completion of scheduled therapy or at death), with the remainder requiring removal in the management of infection or device displacement. Infections were manifest in two-thirds of the children, most commonly (60%) at the catheter exit site on the anterior chest wall. "Clinically significant" infection occurred with a frequency of 2.1 episodes per 1,000 patient days, with Staphylococcal species predominating except for the circumstances of catheter colonization in which Gram-negative, waterborne organisms were most in evidence. Empirical, intravenous, combined antibiotic therapy was effective in approximately 90% of "clinically significant" episodes. Mechanical complications (traveling, leakage, or catheter occlusion) occurred less frequently and were managed by repairing or replacing the device, or clearing the block. Indwelling catheters, of the Broviac or Hickman types, offer major advantages with acceptable morbidity in the management of children with malignant diseases.

OBJECTIVE: The objective of this study was to investigate the rates of success and of complications of percutaneous subclavian central venous catheterization in children and adolescents and to identify factors associated with them.

METHODS: This was a study of a series of 204 percutaneous subclavian central venous catheterizations of children and adolescents, using polyvinyl chloride catheters (Intracath), at the Instituto Materno-Infantil Professor Fernando Figueira between December 1, 2003 and April 30, 2004. An analysis was performed of variables related to the patient, such as age, and of variables related to the procedure such as success/failure, type of anesthesia, complications, who performed the procedure and the number of attempts needed.

RESULTS: Overall, 89.2% of catheterizations were successful. Percentage success rates were significantly greater when percutaneous subclavian central venous catheterization was performed with the child sedated (94%). Around 43.2% of subclavian catheterizations progressed with complications related to insertion of the catheter; however, complications of greater severity were observed in just 3.5% of cases. There were a greater number of complications related to percutaneous subclavian central venous catheterizations performed by a first-year resident (58.8%), who performed a significantly greater percentage of procedures on children younger than 1 year and who also made a greater number of attempts per patient.

CONCLUSIONS: The chance of success was greater when patients were sedated for catheterization. There was a greater chance of complications related to insertion of the catheter when percutaneous subclavian central venous catheterization was performed by less experienced physicians, and it would be prudent to designate those central venous catheterizations that present greater risk to surgeons with greater experience in the experience. Copyright copyright 2007 by Sociedade Brasileira de Pediatria.


Between 1986 and 1990, 50 venous access devices have been implanted in 45 children with various types of cancer and in one patient with Langerhans cell histiocytosis. Twenty-five devices were of the so-called "pediatric" type (Port-A-Cath: 24, Vascuport: 1) and 25 were "adult" ports (Port-A-Cath: 8, Vascuport: 6, Infuse-A-Port: 6, Theraport: 5). The catheters (in silicone elastomer or polyurethane) were inserted percutaneously or surgically. Cumulative total venous access was 15024 patient-days (mean: 290 days per patient, range 2-900 days). Occlusion of the system, the most frequent complication, was encountered in 5 patients (11%). Rarer complications were catheter-related infection (2 pts), pneumothorax (1 pt), skin necrosis (1 pt), catheter leakage (1 pt) and port-catheter disconnection (1 pt). No serious complication ever occurred in 35 patients (76%). Seven of the 11 complications, including all 3 port occlusions, were encountered with "pediatric" systems. All the adult access devices tested were safe and allowed long-standing access to the central venous system in this series of pediatric cancer patients. With proper placement technique and adequate nursing care, they represent a definite improvement in child cancer therapy.
OBJECTIVE: Following the introduction and widespread use of central venous catheters (CVCs) in adults, these devices are being used with increasing frequency in the pediatric population. This review will focus on differences between adults and children regarding CVC use and its potential complications. Both mechanical and infectious complications will be discussed.

DATA SOURCES: Systematic review of the literature.

CONCLUSIONS: CVC-related complications in pediatric patients are closely linked to age, body size, and age-related immune status. In older children, many complications are similar to those encountered in adult patients. Because of ongoing growth and body changes, a cutoff point beyond which children can be regarded as "young adults" is difficult to define; many of our recommendations are therefore age-related. More frequently than in adults, an implanted port may be the first choice in pediatric patients when long indwelling times are expected. The optimal site of insertion also depends on factors such as the patients’ age as well as the need for sedation and analgesia during the insertion procedure. In contrast to guidelines in adult patients, we recommend that a radiograph always be made following CVC insertion to check the position of the catheter. Regarding prevention of infectious complications, we recommend full sterile barrier precautions during CVC insertion and strict protocols for catheter care. CVCs should be removed as soon as possible when they are no longer needed, but there is no place for elective CVC replacement on a routine basis. New developments such as the use of impregnated catheters might help reduce infection rates; however, additional research will be required to provide more evidence of benefit in the pediatric population. [References: 179]


BACKGROUND: Totally implantable vascular access devices (TIVADs) are accepted as a safe and effective method of facilitating long term intravenous therapy. We report our experience of the use of these devices in children with cystic fibrosis with a particular focus on the incidence and type of complications.

METHODS: The medical records of patients with cystic fibrosis who underwent placement of a TIVAD at the Royal Children's Hospital, Melbourne, Australia from January 1987 to October 1996 were reviewed. Venous ultrasonography with Doppler was performed in surviving patients with a TIVAD in situ from November 1996 to April 1997 to detect occult thrombotic complications.

RESULTS: A total of 57 TIVADs were implanted in 44 children with a median functional duration of 700 days (range 27-3347 days). Twenty one children had devices inserted without complications. Forty eight complications (30 mechanical, 18 infectious) occurred in 36 devices in 23 children during a total functional duration of 53,057 catheter days. Mechanical complications occurred in 53% of devices (one per 1712 catheter days). Symptomatic venous thrombosis occurred five times in four patients (9%). Infectious complications occurred in 32% (one per 2948 catheter days) while sepsis occurred in five devices (9%). Doppler ultrasonography detected unsuspected thrombosis in two of 10 patients examined.

CONCLUSIONS: While TIVADs provided effective long term intravenous access, septic and thrombotic complications caused significant morbidity in this population. Careful patient selection, adherence to aseptic technique for access and blood sampling, and periodic ultrasonography with Doppler to detect early thrombosis may help reduce these risks.

We aimed to retrospectively evaluate the skin and soft tissue complications secondary to procedures in acute leukemia patients with and without catheters. Eighty-seven acute leukemia patients (75 acute lymphoblastic leukemia, 12 acute myeloid leukemia ) were included. There were 30 patients with 37 catheter use (6 port, 31 Hickman catheter) and 57 patients without catheter. In patients with catheters, skin and soft tissue complications were seen in 20 (66%) children. The most frequent complication was cellulitis (55%). In the patients without catheter, skin and soft tissue complications were seen in 37 (65%) patients. Cellulitis (37.8%) and extravasation (37.8%) were the most frequent causes. When the frequency of skin and soft tissue complications in patients with and without catheters were compared with each other, there was statistically no significant difference (P=0.792). The duration of chemotherapy was significantly longer in patients who developed skin and soft tissue complications with or without catheters when compared with the duration of the therapy in patients without any skin and soft tissue complications (259.2+/−36.3 and 218.3+/−58.3 d, respectively; P<0.0001). In pediatric leukemia patients, with or without catheters, skin and soft tissue complications are common and these complications may prolong the duration of chemotherapy.


PURPOSE: Infection and thrombosis are serious complications of long-term vascular access devices in children undergoing chemotherapy. Since routine fibrinolytic therapy may decrease these complications, the purpose of this study was to compare the efficacy of an every-2-week administration of urokinase with standard heparin flushes in reducing the incidence of device-related infections and occlusions.

MATERIALS AND METHODS: This study was a prospective, randomized phase III multicenter trial conducted by the Children's Cancer Group, in which patients with implantable ports or tunneled catheters received either urokinase or heparin every 2 weeks for 12 months. Study end points were time to first occlusion or time to first device-related infection.

RESULTS: Five hundred seventy-seven patients from 29 institutions were enrolled, of whom 51% had external catheters and 49% had ports. Urokinase administration resulted in fewer occlusive events than heparin (23% v 31%; P =.02), a longer time to first occlusive event (log-rank analysis, P =.006), and a 1.6-fold difference in the rate of occlusive events (Poisson regression, P =.003). Similar results were noted when comparing ports and tunneled catheters. The urokinase group also had a 1.4-fold difference in the rate of infection (Poisson regression, P =.05) and longer time to first infection (log-rank, P =.07), but the difference was significant only in tunneled catheters.

CONCLUSION: Urokinase administration every 2 weeks significantly affects the rate of occlusive events in ports and tunneled catheters and of infectious events in external catheters compared with heparin administration.


Central vascular access devices are widely used in the neonatal and paediatric intensive care unit, however, the risk of nosocomial infection is exacerbated with their usage. Catheter-related bloodstream infections continue to contribute to the causes of morbidity and mortality amongst vulnerable populations. National
and local infection control policies should be implemented in order to minimise the risk of infections and reduce their potentially devastating effects.


We conducted a retrospective survey of our experience with central venous access devices (CVADs) implanted in children with haemophilia seen at the Vanderbilt Hemostasis-Thrombosis Clinic from 1986 to 2000. Following discussion with parents on the merits and risks associated with the use of CVADs for immune tolerance induction or factor prophylaxis, catheters were inserted under sterile technique in the operating room. One nurse provided demonstration and teaching about catheter care and access. Thirty central venous catheters were inserted in 22 children. Our survey revealed that the two most common complications associated with central venous catheters were bacteraemia and thrombosis. We found a sepsis rate of 0.30/1000 catheter-days or one episode of bacteraemia for every 3346 days of catheter use. The thrombosis rate of our cohort was 0.13/1000 catheter-days or one episode of thrombosis for every 7529 days of catheter use. Uncomplicated venous access is essential in children with severe haemophilia who require prophylaxis or immune tolerance induction. While infection was the most common complication observed in our series, we experienced a lower overall infection rate than several reported series. Catheter thrombosis and subsequent obstruction may occur as a result of intraluminal fibrin deposits. We conclude that the use of implantable central venous catheters is an effective method for accessing children with haemophilia. We accept that the benefits of CVADs in the treatment of paediatric haemophilia patients outweigh the previously documented risks. Future prospective studies should be designed to define all associated risks and to determine effective strategies to reduce them.


BACKGROUND: Bloodstream infections (BSIs) are an ever-present concern for clinicians evaluating ill-appearing pediatric patients with central venous catheters (CVCs) in the ambulatory care setting.

METHODS: We performed a case-control study of a cohort of 200 pediatric patients who were evaluated in the ambulatory care setting and who were found to have laboratory-confirmed BSI in the context of a CVC. This study sought to compare patients with polymicrobial versus monomicrobial BSIs to identify potential risk factors for polymicrobial BSI.

RESULTS: Of the 200 patients enrolled in the study, 73 (37%) had a polymicrobial BSI. Patients with polymicrobial BSI were more likely than those with monomicrobial BSI to be younger (P=.002) and less likely to have been recently discharged from the hospital (P=.01). The odds of a polymicrobial BSI were >4 times greater for patients aged <3 years than for those aged >or=3 years (odds ratio, 4.54; 95% confidence interval, 1.68-12.29), and the odds were 50% lower for those discharged from the hospital in the prior 7 days than for those without recent hospitalization (odds ratio, 0.46; 95% confidence interval, 0.22-0.95) after controlling for an underlying cancer diagnosis and the time of year during which a patient presented. Recent antibiotic use, recent BSI, duration that the CVC had been in place, and underlying gastrointestinal dysfunction were not associated with a risk of polymicrobial BSI.
CONCLUSIONS: Younger children and those who had not recently been discharged from the hospital had an increased risk of developing catheter-related polymicrobial BSI. Special consideration should be given to the increased likelihood of polymicrobial BSIs in these pediatric patients when initiating empirical antimicrobial therapy.


PURPOSE: To determine prospectively the feasibility, complications, and mid- and long-term advantages of peripheral insertion of central catheters in infants and children.

MATERIALS AND METHODS: During a 15-month period between March 1995 and June 1996, a total of 285 catheter placement attempts were made to peripherally insert central catheters in 183 pediatric patients (89 boys, 94 girls). Phlebographic guidance was used, and the catheters were inserted below the elbow in 99% of cases. Catheter insertion was indicated for prolonged antibiotic therapy in 108 patients (158 catheter placement attempts), hematologic or oncologic care in 24 patients (40 attempts), total parenteral nutrition in 16 patients (46 attempts), and venous access for fluid or blood in 35 patients (41 attempts). The success rate and complications were recorded along with the indication, patient age, and duration of catheter placement.

RESULTS: One hundred fifty-two of 158 (96%) catheter placement attempts were successful in outpatients (n = 108), 124 of 127 (98%) in hospitalized patients (n = 75), and 70 of 73 (96%) in patients aged less than 1 year. Infection and pericatheter venous thrombosis were the main complications and were seen in 17 of 276 (6%) and one of 276 (0.3%) catheter placement attempts, respectively. Catheter occlusion occurred in 23 of 276 (8%) catheter placement attempts.

CONCLUSION: Peripheral insertion of central catheters was highly feasible in infants and children with this protocol. Such catheters were well tolerated in the pediatric population with a low frequency of complications.


Although neutropenia is recognized as a risk factor for infection and compromised wound healing, there are little data regarding the specific impact of neutropenia on morbidity and mortality after placement of implanted central venous catheters (CVC). We conducted a retrospective review of children with a diagnosis of acute lymphocytic leukemia or aplastic anemia who received a CVC over a 5-year period. The absolute neutrophil count immediately before catheter placement was recorded. Three hundred eight catheters were placed in 195 patients with acute lymphocytic leukemia and 15 with aplastic anemia. Absolute neutrophil count was less than 0.5 x 10(9)/L in 105 cases (Group 1). The incidence of CVC removal for all causes and for infection within 100 days in Group 1 was 17.1 per cent and 11.4 per cent, respectively, compared with 7.9 per cent (P = 0.01) and 1.5 per cent (P < 0.0001) with absolute neutrophil count 0.5 x 10(9)/L or greater (Group 2). Infections included two cases of mucormycosis with one death. Ports were more likely than Hickman catheters (C. R. Bard Inc., Murray Hill, NJ) to be removed for all causes (P = 0.01) and for infection (P = 0.04). The placement of implanted central venous catheters in neutropenic children was associated with substantial infectious morbidity and one death. When possible, CVC, particularly ports, should be avoided in the presence of neutropenia.

OBJECTIVE: To report a case in which ampicillin was used successfully as lock therapy for a central venous intravascular catheter and to discuss the implications of ampicillin used in this modality.

CASE SUMMARY: A 14-month-old girl with a long-term central venous catheter acquired a polymicrobial (Escherichia coli and Enterococcus durans) bloodstream infection. The central venous catheter was suspected as the source for the bacteremia based on the timing and number of positive blood cultures in relation to therapy with antibiotics. Antibiotic sensitivity testing revealed ampicillin monotherapy to be an ideal choice to treat both organisms. A combination of systemic therapy via a temporary catheter and antibiotic lock therapy of the central venous catheter was then instituted using ampicillin without anticoagulants. The patient tolerated this therapy without complications, and follow-up cultures demonstrated effective clearance of the bacteria.

DISCUSSION: Antibiotic lock therapy has been shown to be useful in the treatment of catheter-related bloodstream infections. However, many antibiotics have yet to be tested with this modality. Ampicillin, which is frequently used in the treatment of Enterococcus and E. coli infections, has not previously been reported as a single agent for lock therapy.

CONCLUSIONS: Ampicillin may be a useful agent with the relatively new modality of lock therapy for central venous catheters. Further studies are needed to demonstrate possible compatibility of this agent with anticoagulants, such as heparin, as well as its efficacy in treating catheter-related bloodstream infections.


Thirty-two consecutive patients with haematological disorders, in need of a permanent central venous catheter (CVC) were randomly allocated to have their CVC bandages (Tegaderm) changed once (OAW, n = 20) or twice (TAW, n = 19) a week. The two randomization arms were balanced in respect of age, sex, and underlying disease. The exit site of the CVC was inspected daily through the transparent bandage and erythema was noted. If severe erythema occurred, daily wet gauze dressings were applied. Samples for bacterial cultures were taken from the exit site of the CVC at every change of bandages. There was no difference in complications leading to removal of the CVC between the two groups (7/20 OAW vs. 7/19 TAW) or in CVC survival-time (P = 0.4). However, the OAW group had more positive CVC tip cultures (OAW 11/14 vs. TAW 2/9; P < 0.05) and a tendency to: (i) more extra dressings (P = 0.08); (ii) more cultures from the exit skin site showing high numbers of colony forming units (P = 0.07); (iii) shorter time to first exit site infection (P = 0.09); and (iv) more Gram-positive septicaemias (P = 0.08). Both clinical and bacteriological data in this study indicate that changing transparent polyurethane CVC bandages twice a week is superior to once a week.


The complications of right atrial catheters (RACs) in pediatric oncology patients are unknown for centers in developing countries. This study examined the complications of RACs at Ankara University Medical School, Turkey. A total of 90 RACs were placed in 61 children for long-term chemotherapy with a total experience of
15,536 catheter days. The rate of catheter-related sepsis was 4.9 episodes per 1000 catheter days. Coagulase-negative staphylococci and Candida species were the most common organisms, accounting for 25.0 and 13.1% of all organisms, respectively. The most common reasons for the removal of the RACs were infection (42.4%) and dislodgement (32.2%). The rates of complications were significantly higher in this study than in western studies. This increase could be explained by the differences in catheter care practices in the Turkish center. In conclusion, the use of RACs in a developing country necessitates an appraisal of the benefits and risks for each patient and improvement of catheter care procedures.


This is the final article in a series of three concerned with the delivery of effective intravenous (IV) therapy to neonates and children. There are many clinical issues that influence the administration of IV therapy and this article will focus upon those most likely to be encountered by practitioners. The common complications that can occur and the strategies that can be employed to minimise them will be identified.


BACKGROUND: The use of hemodialysis catheters is an essential component of dialysis practice. Children are particularly likely to require multiple courses of dialysis over their lifetime, hence the repeated need for vascular access. These catheters remain a significant source of morbidity and mortality.

METHODS: All catheters inserted for hemodialysis at the Center of Pediatric Nephrology and Transplantation, Cairo University over a period of 40 months were studied. Patient data as well as data of catheter insertion, dwell, cause of removal and complications were reported.

RESULTS: A total of 195 uncuffed central venous catheters were used for temporary access in 131 patients for a mean duration of 35.7 days. Of attempted insertions, 87.4% achieved successful access, of which 56% remained for the required period, 8.9% were accidentally dislodged, and 35.1% were removed due to complications--mostly infection. The overall rate of possible catheter-related bacteremia was 9.6 episodes/1,000 catheter days. Infection increased with longer catheter dwell. Nineteen cuffed tunneled catheters were surgically inserted and used for up to 11 months (mean 117 days). Loss of these catheters was attributed mainly to infection (ten episodes) and catheter thrombosis (six episodes). During the study, 317 femoral catheters were inserted.

CONCLUSION: Uncuffed central venous catheters are both needed and useful for short-term hemodialysis. Vascular access for extended durations may be provided by cuffed tunneled catheters. Infection is the major serious concern with both uncuffed and cuffed catheters.


The aim of this study was to evaluate the acridine orange leukocyte cytospin (AOLC) test for the rapid diagnosis of septicemia caused by central venous catheters (CVCs), without removing the catheter, in a pediatric intensive care unit population. Twenty-six patients admitted in the pediatric intensive care unit of
Azienda Ospedaliera "Ospedali Riuniti di Bergamo", Italy, were prospectively evaluated for CVC-related infection. Blood for culture was taken from all patients. Quantitative endoluminal cultures of the removed catheter tip by Cleri’s technique and semiquantitative superficial cultures of the hub were performed. Gram staining and an AQLC smear were done according to Kite’s technique. Four Staphylococcus CVC-related bloodstream infections were identified. CVC colonization was detected in 8 patients. Four had septicemia (Enterococcus faecalis, Escherichia coli, Klebsiella oxytoca, Candida glabrata) without CVC involvement. However, Gram staining and the AQLC test were negative in all cases. We conclude that cytocentrifugation and acridine orange staining of blood withdrawn by Kite’s method from an in situ catheter, although simple, quick, and inexpensive, did not aid diagnosis in this pediatric population.


The aim of this study was to analyse the diagnostic, empirical and therapeutic strategies adopted when a blood culture from a hospitalized child with a central venous catheter is 'positive', and to assess whether practices complied with the consensus adopted in our hospital, inspired by published recommendations. One hundred and ten cases of bacteraemia were studied prospectively. Investigations to determine whether the catheter was the cause of infection were carried out in 45% of cases, and the catheter was removed as recommended in 39% of cases. Of the patients that received empirical treatment, 56% received broad-spectrum antibiotics with no apparent clinical justification. Following susceptibility testing on the isolated strain, the antibiotic treatment was considered to be appropriate in 58% of cases. Overall, compliance with the consensus recommendations was poor. This was partly due to the high turnover rate of antibiotic prescribers.


Mycobacterium mucogenicum is an unusual cause of central venous catheter and wound infections in immunocompromised persons. The organism is often found in drinking water and is resistant to many disinfectants. We report a cord blood transplant recipient who developed a central venous catheter infection after the patient herself had flushed her catheter with tap water. The infection was successfully treated by removal of the central venous catheter and administration of antimicrobial therapy.


PURPOSE: Multiple studies have demonstrated that catheter-related bloodstream infections (CRBI) can be successfully treated without catheter removal (in situ therapy), but there is insufficient information available to determine if catheter design can influence the eradication of bacteremia or recurrence.

PATIENTS AND METHODS: Bacteremic episodes in patients at St Jude Children's Research Hospital between January 1996 and May 2001 were identified and patient records were reviewed.

RESULTS: A total of 172 unique episodes of CRBI were identified. In situ therapy resulted in successful eradication of bacteremia in 87% of the episodes. Bacteremia recurred in 10% of the episodes. Although
catheter design (Hickman and Broviac versus totally implantable central venous catheter) did not influence short-term eradication of bacteremia, totally implantable central venous catheters were significantly associated with recurrence of bacteremia (odds ratio, 10; 95% confidence interval, 3.1 to 33.3). In a multivariable analysis, this association between catheter design and recurrence remained statistically significant after adjustment for other factors that influenced recurrence in this study (isolation of coagulase-negative staphylococci and inadequate duration of initial antibiotic therapy).

CONCLUSION: This study demonstrates that patients with CRBI with a totally implantable central venous catheter in place are more likely to develop recurrent bacteremia. Management strategies to prevent recurrence in this setting should be explored.


BACKGROUND: Catheter-related bloodstream infections (CRBIs) are frequent complications of the use of long term central venous catheters (CVCs). Comparative quantitative culture of blood obtained via the CVC and a peripheral vein (PV) is a well-accepted method of diagnosing CRBI; however, an alternative definition for use when a PV culture is not available is desirable.

METHODS: A computerized search of patient records identified all positive blood culture results from the St. Jude Children’s Research Hospital Microbiology Laboratory between January 1996 and May 2001. Demographic data, catheter information and culture results were abstracted. Sensitivity, specificity, positive predictive value (PPV), and likelihood ratio were calculated for 2 alternative definitions of CRBI.

RESULTS: Review of the medical records revealed 136 episodes of bacteremia that were evaluable for alternative definition 1 and 241 episodes that were evaluable for alternative definition 2. In patients with a double lumen CVC, CRBI can be diagnosed by a > or = 5-fold difference in colony-forming units/mL between the 2 lumens (alternative definition 1) with sensitivity, specificity, PPV and likelihood ratio of 61.8, 93.3, 92.2 and 9.22, respectively. In patients with a single or double lumen CVC, CRBI can be diagnosed when the CVC culture yields > or = 100 colony-forming units/mL (alternative definition 2) with sensitivity, specificity, PPV and likelihood ratio of 75.5, 69.1, 79.3, and 2.44, respectively.

CONCLUSIONS: Our study suggests that comparison of colony counts from 2 lumens of a double lumen catheter is acceptable for diagnosis of CRBI when a PV culture is not available. Further validation is needed before discontinuing the recommendation to obtain a PV culture.


PURPOSE: Mechanical complications in tunneled indwelling central venous catheters (CVCs) often involve a risk of displacement. Fixation procedures are, therefore, of primary importance. We prospectively evaluated the incidence of CVC-related mechanical and infectious complications observed in devices fixated with the Sri Paran technique.

METHODS: All CVCs inserted in children with cancer at our Institution from October 2005 to January 2007 were prospectively monitored for device-related mechanical and infectious complications. The Sri Paran
A fixation technique was used in all cases. The complication rate per 1,000 days was calculated as 1,000 times the number of complications divided by the total number of catheter days.

**RESULTS:** Ninety-five CVCs were positioned in 84 children. The overall length of observation ranged between 41 and 482 days for a total of 18,618 catheter days. Mechanical complications occurred in 5% of the devices (specific rate 0.27); infections were observed in 6% of the devices (specific rate 0.32). No complications were observed during the first 30 days after CVC insertion.

**CONCLUSIONS:** The results, we obtained with the Sri Paran technique are extremely encouraging. Yet, randomized studies are required to prove these preliminary data.

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**PURPOSE:** To compare two types of central venous catheters (Broviac and valved clampless) for the incidence and severity of catheter-related complications in children.

**PATIENTS AND METHODS:** The authors report data on the mechanical and infectious complications collected in a prospective analysis of 92 catheters inserted in 82 children from January 2000 to March 2001.

**RESULTS:** Two different devices were inserted: 51 Broviac and 41 clampless valved catheters. During the follow-up of 17,803 catheter-days 52 complications were observed: 40 mechanical episodes and 12 infectious events. In the Broviac group the median follow-up was 179 days and the total number of catheter-days was 10,911. A total of 29 complications were observed, occurring in 22 catheters (43%), with an overall incidence of 0.27/100 catheter-days. In the clampless group the median follow-up was 134 days and the total number of catheter days was 6893. A total of 23 complications were observed, occurring in 19 devices (46%), with an incidence of 0.32/100 catheter days.

**CONCLUSIONS:** There were no major differences in the incidence of mechanical or infectious complications between the two devices. Malfunction was more frequent in Broviac catheters, whereas catheter displacement occurred more frequently in clampless valved catheters. These results show the importance of central venous catheter-related mechanical complications in the management of children with hematologic or oncologic malignancies.

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**BACKGROUND:** The use of indwelling central venous catheters (CVCs) has become commonplace in the management of children undergoing anticancer treatment. Several types of CVC are available, while information on complications observed in children is scarce. We describe the experience of two tertiary care centers in Italy that prospectively followed up three types of CVC used at both institutions over a 30-month period.
**PATIENTS AND METHODS:** Between January 2000 and May 2002, double-lumen (DL) or single-lumen (SL) Hickman-Broviac (HB) catheters, and single-lumen pressure-activated safety valve (PASV) catheters were used and prospectively evaluated. Four types of possible complication were defined a priori: mechanical, thrombotic, malfunctioning and infectious.

**RESULTS:** Four hundred and eighteen CVCs (180 SL-HB, 162 DL-HB and 76 PASV) were inserted in 368 children, for a total of 107 012 catheter days at risk of complication. At least one complication occurred while using 169 of the devices (40%): 46% of the DL-HB, 46% of the PASV and 33% of the SL-HB (P=0.02) catheters. Subjects with hematological malignancies or non-malignant diseases had significantly more complications than those with solid tumors (P <0.0001). Overall, 234 complications were documented: 93 infectious [complication rate per 1000 catheter days at risk (CR)=0.87], 84 malfunctioning (CR=0.78), 48 mechanical (CR=0.45) and nine thrombotic (CR=0.08). SL-HB had statistically fewer infectious complications, while PASV had more mechanical complications. In a multivariate regression model, the most significant risk factors for having a CVC complication were hematological disease [relative risk (RR)=3.0; 95% confidence interval (CI) 1.8-4.8] and age <6 years at CVC insertion (RR=2.5; 95% CI 1.5-4.1). As for the type of CVC, compared with SL-HB, the DL-HB catheter had a statistically significant two-fold increased risk of any complication (RR=2.1; 95% CI 1.2-3.6), while the PASV catheter had a borderline RR of 1.8 (95% CI 1.0-3.6). Analysis by tumor type showed a higher risk of any kind of complication in patients with solid malignancies who had received a DL-HB catheter as compared with an SL-HB catheter (RR=7.2; 95% CI 2.8-18.7).

**CONCLUSIONS:** CVCs may cause complications in up to 40% of patients, with type of CVC, underlying disease and patient age being the three main factors that affect the incidence of CVC-related complications. SL-HB catheters have the best performance.


Data were collected on all peripherally inserted central catheters (PICCs) inserted by one i.v. nurse clinician from July, 1989 to June, 1992 in an urban pediatric teaching hospital of more than 100 beds. Growth of this PICC program, as well as outcome of patients with PICCs, was recorded and compared to published reports. During the surveillance period, 269 PICCs were successfully inserted in 226 patients out of 330 patients referred for PICC placement. This article contains the outcome of that program. Catheter duration and rate of PICC complication at St. Christopher's Hospital for Children (Philadelphia, Pennsylvania) was comparable to eight other published reports. PICCs are an efficacious and safe method of i.v. access for intermediate to long-term use in children. [References: 13]


**PURPOSE OF REVIEW:** Thrombosis is one of the most frequent complications of indwelling central venous catheters. During the past year, new information has emerged regarding the incidence and predisposing factors of thromboembolic complications of indwelling central venous catheters. Because indwelling central venous catheters are widely used, it is important to be aware of new information regarding thromboembolic complications of these devices.

**RECENT FINDINGS:** Recent studies have better defined the risks of thromboembolic complications in patients with cancer with indwelling central venous catheters. Acquired hypercoagulable disorders such as
heparin-induced thrombocytopenia, antiphospholipid syndrome, and therapy with asparaginase are associated with thromboembolic disorders in patients with indwelling central venous catheters. Studies analyzing the association between inherited hypercoagulable disorders and thrombosis have shown conflicting results. Preliminary studies suggest that low molecular weight heparins could have a role in the prevention of catheter-related thromboembolic disorders. Nevertheless, larger prospective studies will be necessary to determine the role of anticoagulants in the prevention of thromboembolic disorders in patients with cancer with indwelling central venous catheters.

SUMMARY: Recent reports will facilitate the evaluation and risk assessment of children with cancer who have indwelling central venous catheters. Despite these advances, large, controlled studies focusing on specific populations of patients, such as children, should be undertaken to determine the true performance and optimal use of indwelling central venous catheters. Future studies should also address better ways to prevent catheter-related thrombosis and infection. [References: 14]


BACKGROUND: Concerns regarding the safety and success of peripherally inserted central catheters (PICCs) placed at the bedside in the pediatric population initially precluded the development of a nurse-inserted PICC program at our pediatric center. Previously, all PICCs were inserted by interventional radiologists (IRs) with fluoroscopic guidance. A new nurse-inserted PICC program was initiated with collaboration between PICC nurses and IRs.

METHODS: Three nurses participated in the project. Patients who met preestablished selection criteria were approached. All insertions were performed with sterile technique on the fluoroscopy table, with IRs available to support the PICC nurse. Veins were accessed visually or through palpation. Final tip position was confirmed in all cases with contrast material administration and fluoroscopy. Additional fluoroscopy was performed only if placement difficulties were encountered. All patients were monitored prospectively.

RESULTS: Ninety-nine patients (age: 3-18 years; average age: 13.6 years) met the selection criteria. Two patients underwent primary insertion by an IR. The remaining 97 patients underwent an insertion attempt by a nurse. Sixty-nine PICCs (71.1%) were placed successfully by a nurse, 15 (15.5%) required minor assistance from an IR, and 13 (13.4%) were inserted by an IR after an unsuccessful nurse attempt. No insertion complications were noted. Insertion difficulties included difficulty advancing the catheter (19.6%), difficulty cannulating the vein (6.2%), and tip malposition (2.1%). Postinsertion complications occurred for 27.8% of PICCs, and 13.4% required removal before the end of therapy.

CONCLUSION: This novel, pediatric nurse-inserted PICC program has a good safety profile, high success rate, and low postprocedural complication rate.


Septic deep venous thrombosis is a major complication associated with central venous catheterization in intensive care units. The most common causative organisms are Staphylococcus aureus, gram-negative bacilli and Candida species. The incidence of Candida infections is increasing, especially in intensive care patients receiving total parenteral nutrition and long-term broad-spectrum antibiotics. Although intravascular catheter-induced septic thrombophlebitis is quite common, superior vena cava obstruction is a
rare complication. However, few data exist concerning the best strategy for managing septic thrombophlebitis, especially when medical therapy fails. We report successful surgical management of Candida albicans suppurative thrombosis of the superior vena cava in a young patient.


PATIENTS: Eight hundred thirty-two children aged 0-14 years. INTERVENTION: None. MEASUREMENTS AND MAIN RESULTS: One thousand ninety-two catheters were analyzed. Seventy-four (6.81%) catheter-related bloodstream infections (CRBSI) were found. The CRBSI rate was 6.4 per 1,000 CVC days (95% CI 5.0-8.0). Risk factors for CRBSI were weight under 8 kg (p < 0.001), cardiac failure (RR 2.69; 95% CI 1.95-4.38; p < 0.001), cancer (RR 1.66; 95% CI 0.97-2.78; p=0.05), silicone catheters (RR 2.82; 95% CI 1.49-5.35; p = 0.006), guidewire exchange catheterization (p=0.002), obstructed catheters (RR 2.67; 95% CI 1.63-4.39; p<0.001), and more than 12 days' indwelling time (RR 5.9; 95% CI 3.63-9.41; p<0.001). Multivariate Cox regression identified lower patient weight (HR 2.4; 95% CI 1.11-5.19; p=0.002), guidewire exchange catheterization (HR 2.2; 95% CI 1.07-4.54; p=0.049) and more than 12 days' indwelling time (HR 1.97; 95% CI 0.89-4.36; p=0.089) as significant independent predictors of CRBSI. Factors which protected against infection were the use of povidone-iodine on hubs (HR 0.42; 95% CI 0.19-0.96; p=0.025) and porous versus impermeable dressing (HR 0.41; 95% CI 0.23-0.74; p=0.004). Two children (0.24%) died from endocarditis following catheter-related sepsis due to Stenotrophomonas maltophilia in one case and P. aeruginosa in the other.

CONCLUSIONS: Catheter-related sepsis is associated with lower patient weight and more than 12 days' indwelling time, but not with the insertion site. Cleaning hubs with povidone-iodine protects from infection.


Current methods for diagnosis of catheter-related infection (CRI) are cumbersome and may require removal of the central venous catheter (CVC). A prospective study was conducted to validate the difference in time to detection (DTD) of cultures of blood samples obtained simultaneously from a peripheral vein (PV) and from the CVC for differentiation of CRI and non-CRI. During a 15-month period, 9 episodes were categorized as CRI and 24 as non-CRI. The median DTD for patients with CRI was significantly higher than that for patients with non-CRI (457 vs. -4 min; P<.001). The optimum cutoff point for diagnosis of CRI was a DTD of > or =120 min (sensitivity, 88.9%; specificity, 100%). With pretest probability of CRI ranging from 28% to 54%, the positive predictive value of a DTD of > or =120 min for the diagnosis of CRI was 100%; the negative predictive value was 89%-96%. On the basis of findings from this study, which is the largest, to date, to involve pediatric patients with tunneled CVCs and the first to use paired quantitative blood cultures as a "criterion standard," DTD was found to be a simple, reliable tool for diagnosis of CRI in hospitals that use continuously read blood culture systems.

BACKGROUND: Current methods for in situ diagnosis of catheter-related bloodstream infections require concurrent collection of central venous catheter (CVC) and peripheral vein (PV) blood cultures. Both the pain and inconvenience of PV cultures are undesirable.

METHODS: A prospective study was conducted (August 2002 to March 2004) to assess the accuracy of diagnosing catheter-related bloodstream infections based on the difference in time to detection of blood cultures drawn concurrently from 2 lumens of a multilumen CVC. This difference in time to detection between 2 lumens was compared with results of the standard criterion with paired CVC and PV blood cultures.

RESULTS: Twenty-one infectious episodes were categorized as catheter-related bloodstream infections and 38 as non-catheter-related bloodstream infections. With a cutoff in difference in time to detection between 2 lumens of > or =180 minutes, the sensitivity of this test to diagnose a catheter-related bloodstream infection was 61% (95% confidence interval, 39-80%) and the specificity was 94% (95% confidence interval, 82-99%). In 4 of 7 episodes with false-negative results, the colony counts in cultures from both lumens were >400 colony-forming units/mL (maximal value reported), indicating the limitation of this method when both lumens of the catheter are colonized. With the pretest probability of catheter-related bloodstream infections ranging from 28% to 54%, the positive predictive value of a difference in time to detection between 2 lumens of > or =180 minutes for diagnosis of catheter-related bloodstream infections ranged from 81% to 93% and the negative predictive value ranged from 67% to 86%.

CONCLUSION: Within the context of its limitations, this novel method provides an alternative for diagnosing catheter-related bloodstream infections among patients with a CVC, without PV cultures.


Patients with chronic gastrointestinal diseases may require long-term parenteral nutrition. The authors describe a case in which a subendocardial abscess developed in the right atrium in association with staphylococcal septicemia. The patient, a 15-year-old boy, had a malpositioned Silastic catheter, the tip of which was in his right atrium. Staphylococcal abscess of the heart has been described previously after cardiac surgery, but the authors believe this is the first reported case related to a central venous catheter.


BACKGROUND: Paired quantitative and qualitative blood cultures have been introduced for the diagnosis of catheter-related bloodstream infections (CRBI) with the catheter in situ. The aim of the study was to compare the diagnostic performance and the prognostic value of the two methods in the evaluation of febrile episodes without an apparent source in children with cancer.
PROCEDURE: During a 4-year period, in every febrile episode without an apparent focus, blood was drawn simultaneously from the catheter lumen and a peripheral vein in order to perform paired quantitative (Isolator) as well as qualitative (BacT/Alert) blood cultures. The diagnosis of a CRBI was defined as either a case of greater (at least 10 fold) or earlier (differential time to positivity >2 h) bacterial growth from the catheter compared to the peripheral blood sample, respectively.

RESULTS: Nineteen febrile episodes manifested in 16 children (total period of observation 11,150 catheter-days) were evaluated with both methods. A concordant diagnosis of CRBI was stated with both methods in six episodes; one episode was diagnosed as CRBI only with qualitative culture criteria. Treatment failure resulted in catheter removal in five out of the seven episodes defined as CRBI with either method. Episodes where a CRBI was ruled out with both methods had a favorable outcome.

CONCLUSIONS: In this study the two methods showed comparable results in the diagnosis of CRBI and both were of prognostic significance, regarding the outcome of the treatment. However, large scale studies are required in order to evaluate the clinical relevance and the cost effectiveness of performing routinely paired blood cultures with either method. 2005 Wiley-Liss, Inc.


Quantitative blood cultures have been used in order to define catheter-related bloodstream infection (CRBI) in pediatric patients with malignancy and central venous catheters (CVCs). We prospectively followed 32 patients with a total of 38 CVCs for a period of 4 y (14,068 catheter-days). Of a total of 35 cases of bacteremia, 9 were considered to be CRBI (25%). The incidence of bacteremia in our study was 2.48 episodes/1,000 catheter-days and 20/38 CVCs (52%) were affected by bacteremia. The incidence of CRBI was 0.63 episodes/1,000 catheter-days and it was detected in 9/38 CVCs (23%). The catheter salvage rate in cases of bacteremia, irrespective of etiology, was 30/35 (85%). The catheter salvage rate in cases of CRBI was only 4/9 (44%), whereas all the catheters (26/26) in non-catheter-related cases of bacteremia were salvaged. We suggest that the use of quantitative blood cultures is a useful tool for the evaluation of bacteremia in patients with CVCs and is of prognostic value.


Tunnel infection is an uncommon but serious complication observed in patients with partially implanted central venous catheters. International guidelines suggest that should include antibiotics and catheter removal. A success rate of only 5-20% was reported without catheter removal. We treated 13 episodes of tunnel Gram-positive bacterial infection occurring in pediatric patients with cancer or serious blood disorders with 24-hr intra-catheter antibiotic continuous infusion. This approach led to a 69% success rate. Continuous infusion might be an attractive option to treat tunnel Gram-positive bacterial infections when catheter removal might not be feasible or advisable. 2007 Wiley-Liss, Inc

PURPOSE OF REVIEW: Clinicians need information on the relative effectiveness of different types of impregnated central venous catheter for serious infection and their relative costs and adverse effects in order to decide which type, if any, to use.

RECENT FINDINGS: We systematically reviewed 37 randomized controlled trials involving 11 586 patients. Only seven studies were classified as good on all measures of study quality. Compared with standard catheters, significant and substantial reductions in catheter-related blood stream infection were found for heparin-coated and antibiotic-impregnated central venous catheters. We found no statistically significant benefits of antiseptic central venous catheters, coated with chlorhexidine and silver sulphadiazine, or silver-impregnated central venous catheters, compared with standard catheters. The few 'head-to-head' comparisons confirmed the benefits of antibiotic impregnation compared with chlorhexidine and silver sulphadiazine or silver impregnation, but no significant difference was found for heparin-coated compared with silver-impregnated central venous catheters. No studies reported serious adverse events, but there is some evidence of antibiotic resistance from in-vitro studies. No impregnated central venous catheter exists for neonates weighing less than 3 kg, and few studies have been undertaken in larger children.

SUMMARY: The most promising options for reducing catheter-related blood stream infection are heparin-coated or antibiotic-impregnated central venous catheters. Large, high-quality randomized controlled trials are needed to evaluate which of these methods is most effective for reducing clinically important consequences of catheter-associated infection. [References: 84]


BACKGROUND: Central venous catheters facilitate venous access, allowing the intravenous administration of complex drug treatments, blood products and nutritional support, without the trauma associated with repeated venepuncture. However, central venous catheters are associated with a risk of infection. Some studies have indicated that the type of dressing used for central venous catheters may affect the risk of infection. Gauze and tape or transparent polyurethane film dressings such as Tegaderm, Opsite or Opsite IV3000 are the most common types of dressing used to secure central venous catheters. Currently, it is not clear which type of dressing is the most appropriate.

OBJECTIVES: To compare gauze and tape and transparent polyurethane central venous catheter dressings in terms of catheter related infection, catheter security, tolerance to dressing material and dressing condition in hospitalised adults and children.

SEARCH STRATEGY: The Cochrane Wounds Group Specialised Trials Register (October 2002), the Cochrane Controlled Trials Register (4th Quarter 2002) and the databases; MEDLINE (1966-December 2002, CINAHL (1982-October 2002) and EMBASE (1980-December 2002) were searched to identify any randomised controlled trials comparing the effects of gauze and tape and/or transparent polyurethane dressings for central venous catheter sites. Additional references were identified from bibliographies of published literature and were also sought from other sources.

SELECTION CRITERIA: All randomised controlled trials evaluating the effects of dressing type (i.e. gauze and tape and/or transparent polyurethane dressings) on central venous catheter related infection, catheter security, tolerance to dressing material and dressing condition in hospitalised patients.

DATA COLLECTION AND ANALYSIS: Twenty-three studies were reviewed. Data was extracted from each paper by two members of the review team independently and results then compared. Differences were
resolved either by consensus or by referral to a third member of the review team. Authors were contacted for missing information.

**MAIN RESULTS:** Of the 23 studies reviewed, 14 were excluded. Nine studies were included. Data was only available for meta-analysis from six of the nine included studies. Of the six included studies with available data, two compared gauze and tape with Opsite IV3000, two compared Opsite with Opsite IV3000, one compared gauze and tape with Tegaderm, and one compared Tegaderm with Opsite. There was no evidence of any difference in the incidence of infectious complications between any of the dressing types compared in this review. Each of these comparisons was based on no more than two studies and all of these studies reported data from a small patient sample. Therefore it is probable that the finding of no difference between dressing types is due to the lack of adequate data.

**REVIEWER’S CONCLUSIONS:** There is a high level of uncertainty regarding the risk of infection with the central venous catheter dressings identified in this review. Therefore, at this stage it appears that the choice of dressing for central venous catheters can be based on patient preference. To identify the most appropriate central venous catheter dressings, further research is necessary. It is paramount that any future studies investigating this issue must be rigorously performed randomised controlled trials. [References: 34]


**BACKGROUND:** Administration of intravenous therapy is a common occurrence within the hospital setting. Routine replacement of administration sets has been advocated to reduce intravenous infusion contamination. If decreasing the frequency of changing intravenous administration sets does not increase infection rates, a change in practice could result in considerable cost savings.

**OBJECTIVES:** The objective of this review was to identify the optimal interval for the routine replacement of intravenous administration sets when infusate or parenteral nutrition (lipid and non-lipid) solutions are administered to people in hospital via central or peripheral venous catheters.

**SEARCH STRATEGY:** We searched The Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, CINAHL, EMBASE: all from inception to February 2004; reference lists of identified trials, and bibliographies of published reviews. We also contacted researchers in the field. We did not have a language restriction.

**SELECTION CRITERIA:** We included all randomized or quasi-randomized controlled trials addressing the frequency of replacing intravenous administration sets when parenteral nutrition (lipid and non-lipid containing solutions) or infusions (excluding blood) were administered to people in hospital via a central or peripheral venous catheter.

**DATA COLLECTION AND ANALYSIS:** Two authors assessed all potentially relevant studies. We resolved disagreements between the two authors by discussion with a third author. We collected data for the outcomes; infusate contamination; infusate-related bloodstream infection; catheter contamination; catheter-related bloodstream infection; all-cause bloodstream infection and all-cause mortality. MAIN

**RESULTS:** We identified 23 references for review. We excluded eight of these studies; five because they did not fit the inclusion criteria and three because of inadequate data. We extracted data from the remaining 15 references (13 studies) with 4783 participants. We conclude that there is no evidence that changing intravenous administration sets more often than every 96 hours reduces the incidence of bloodstream infection. We do not know whether changing administration sets less often than every 96 hours affects the incidence of infection. In addition, we found that there were no differences between participants with
central versus peripheral catheters; nor between participants who did and did not receive parenteral nutrition, or between children and adults.

AUTHORS' CONCLUSIONS: It appears that administration sets that do not contain lipids, blood or blood products may be left in place for intervals of up to 96 hours without increasing the incidence of infection. There was no evidence to suggest that administration sets which contain lipids should not be changed every 24 hours as currently recommended. [References: 36]


OBJECTIVE: To determine the optimal time interval for the routine replacement of intravenous administration sets when crystalloids or parenteral nutrition are administered via a central or peripheral catheter in an acute care setting.

DESIGN: Systematic review of all randomized or systematically allocated controlled trials addressing the frequency of replacing intravenous administration sets.

METHODS: The Cochrane Controlled Trials Register (June 2001) and the Ovid databases (Medline, CINAHL, and CancerLit-July 2001) were searched. Bibliographies, relevant conference proceedings, and any product information were also checked for references.

RESULTS: Eighteen studies were selected for review. The 12 included studies were separated into 3 intravenous administration set change comparisons: 24 hours versus 48 hours or more; 48 hours versus 72 hours or more; and 72 hours versus 96 hours or more. There was good evidence that changing intravenous administration sets every 72 hours or more does not increase the risk of infusate-related bloodstream infection (BSI) in patients with central or peripheral catheters and a fair level of evidence that it does not increase the risk of catheter-related BSI. There were insufficient data regarding the incidence of BSI among patients receiving parenteral nutrition, particularly lipid-containing parenteral nutrition.

CONCLUSIONS: It appears that intravenous administration sets containing crystalloids can be changed in patients with central or peripheral catheters every 72 hours or more without increasing the risk of BSI. However, it is not possible to conclude that intravenous administration sets containing parenteral nutrition, particularly lipid-containing parenteral nutrition, can be changed at this interval.


Children have limited venous access possibilities; therefore, when long-term therapy is necessary, it is better to place a catheter in a central vein. The Port catheter, totally implanted, is less exposed to the risk of infection and permits a normal life. However, there is the possibility of the displacement or fragmentation of the catheter that can be diagnosed initially only by clinical symptoms and later by a chest X-ray. We report a case of disconnection between the Port catheter and the reservoir resulting in catheter migration to the left pulmonary artery.
Central venous access devices have become important tools in the management of pediatric patients with malnutrition, malignancy, and infections requiring long-term antibiotic treatment. Hemophilia presents a lifetime challenge for venous access and at times can be an urgent or life-threatening situation. Since 1986, the authors have implanted 11 subcutaneous infusion ports in nine patients with hemophilia. The systems have remained in place for up to 7 years, without major complications or problems. Two catheters were replaced, after 4 and 6 years, because of skin erosion and blockage, respectively. One catheter was removed after 7 years because of blockage following local trauma and was not replaced. A recent survey through the Canadian Hemophilia Centre Directors Group obtained a further 45 subcutaneous infusion ports in other centers across Canada. The benefits of this system are overwhelming enthusiasm by the parents and children and no major complications. Some of the patients are now HIV-positive and are able to use their system for ongoing drug therapy.


OBJECTIVE: The prevalence of asymptomatic catheter-related thrombosis of the upper venous system in children with cancer has not been determined. We evaluated patients with cancer and implantable central venous catheters (ports) for this complication.

STUDY DESIGN: Children with cancer undergoing port removal were eligible for this study. Vessel patency was evaluated by contrast venography. We examined each child for physical stigmata of thrombosis and retrospectively assessed catheter-related mechanical difficulties and infections.

RESULTS: Thirty-one ports had been placed in 24 children (aged 20 months to 18 years; median age, 9 years) with diagnoses of leukemia/lymphoma (n = 10), solid tumor (n = 12), and histiocytosis (n = 2). Venography showed abnormalities in 12 of the 24 patients. Physical examination revealed dilated superficial veins on the chest in 3 patients. Venograms showed abnormalities in all 3 children with prominent superficial thoracic veins. Nine of the 21 other patients had clinically occult central venous occlusion.

CONCLUSION: Fifty percent (95% CI, 30% to 70%) of children who had implantable ports removed during or after treatment of cancer exhibited deep venous thrombosis at the site of catheter placement. Future studies should determine the contribution of inherited and other acquired risk factors for thrombosis and assess measures to prevent and/or treat catheter-related thrombosis in this population.


Medical records of 18 pediatric acquired immunodeficiency syndrome patients with 24 central venous catheters (CVCs) were reviewed to determine the rates and types of CVC complications and to evaluate the influence of selected social factors, absolute granulocyte counts and CD4+ T cell counts on the rate of CVC infections. CVCs were in place for a total of 4233 days. CVCs were used for blood sampling, administration of blood products and infusions of intravenous immune globulin, parenteral nutrition and medications. Complications included catheter-related infections (8 episodes; with a rate of 1.9/1000 CVC days), occlusions (15 episodes) and unplanned catheter removals (9 episodes). Reduced CD4+ T cell counts were not predictive of CVC infection. The CVC infection rate in our pediatric acquired immunodeficiency syndrome
patients was similar to rates reported in children with cancer and adults with cancer and acquired immunodeficiency syndrome.


An 18-month analysis of 52 percutaneously placed central venous catheters in 48 critically ill children was done. Success rate were 91.7% (33/36) and 93.8% (15/16) for femoral and non-femoral catheters respectively. Presence of hypotension (48.1%) and significant coagulopathy (26.9%) did not affect the success rate significantly. Minor bleeding and venous congestion was seen in 5.5% (2/36) of patients with femoral catheters. Infections were found in 2.7% (1/36) of femoral and 6.6% (1/15) of non-femoral catheters. The low incidence of complications and the relative ease of insertion makes the femoral route the preferred site for trainee medical officers in critically ill children when central access is indicated.


To assess the incidence of bacteremia in pediatric cancer patients with indwelling central venous catheters with fever, we reviewed the records of all 67 such patients sequentially admitted during a 10-month period at our institution. There were a total of 140 episodes of fever in these 67 patients. In 55 of the episodes (39%) patients were nonneutropenic (absolute neutrophil count, greater than 500/mm3); 85 episodes (61%) were associated with neutropenia. Twenty-four percent of all episodes of fever in nonneutropenic patients were related to bacteremia vs. 9.5% of episodes of fever in the presence of neutropenia (P less than 0.05). When clinical evidence of an exit site infection was absent, the incidence of bacteremia in the neutropenic and nonneutropenic groups was similar (11% in the neutropenic group; 10% in the nonneutropenic group). We conclude that bacteremia is frequently observed in febrile pediatric cancer patients with indwelling venous catheters who are not neutropenic, particularly if there is clinical evidence of an exit site infection. Thus empiric antibiotic therapy is warranted in all pediatric oncology patients with indwelling catheters who develop fever.


BACKGROUND: Pediatric peripherally inserted central catheters (PICCs) can be secured with tape, sutures, or sutureless securement devices. Despite widespread catheter use, no standardized method of securement has been proven superior.

METHODS: A prospective randomized trial of catheter securement with either tape or suture was undertaken in pediatric patients hospitalized at a tertiary children's hospital. Patient demographics, catheter dwell time, and all catheter complications were collected. All patients were followed for the entire dwell time of the catheter, including those discharged with lines still in place.

RESULTS: Sixty-six patients completed the study, with 34 children in the suture group and 32 children in the tape group. Patients’ ages ranged from 9 months to 19 years. Overall complication rate in our sutured group was 5.8%, and 32.4% in the tape group.
CONCLUSIONS: In this study of children of varying ages, sutured PICCs were associated with significantly fewer complications than those catheters secured with tape (p=.005). The 3 most common complications included migration, occlusion, and leaking catheters.


BACKGROUND/PURPOSE: Pediatric oncology patients who have undergone placement of multiple central venous catheters may have thrombosis or stenosis in the upper venous system. The purpose of this study was to identify factors that predict venous thrombosis or stenosis and to evaluate the role of Doppler ultrasonography in assessing the upper venous system of pediatric patients requiring multiple central vascular catheters.

METHODS: The medical records of eligible patients were reviewed with regard to demographics, primary disease, type of catheter, duration of previous central venous access, association with infection, operative notes, and Doppler ultrasonographic findings.

RESULTS: Our evaluation criteria were met in 50 cases (47 patients). In 10 cases, Doppler ultrasonography revealed abnormality in the upper venous system. Patient demographics, primary disease, type of catheter, duration of previous central venous access, or association with infection were not found to significantly predict the abnormality in the upper venous system. Placement of central venous access device was performed without difficulty when the site of placement was chosen on the basis of ultrasonographic findings.

CONCLUSION: Doppler ultrasonography is useful in diagnosing thrombosis or stenosis in asymptomatic pediatric patients requiring placement of multiple central venous catheters.


PURPOSE OF REVIEW: The placement of central venous catheters is often necessary to facilitate optimal anaesthetic and perioperative management or for the long-term management of chronic underlying diseases. Insertion may be a challenge in selected patients, and the risk of infection, thrombosis, and other complications may result in significant risk factors.

RECENT FINDINGS: Ultrasound visualization of the cervical veins with Valsalva manoeuvres significantly increases the rate and safety of central venous cannulation, and decreases needle passes in paediatric patients even with experienced operators. Pericardial effusion with tamponade is a more frequent phenomenon than generally realized, and accurate location of the catheter-tip position is essential. The femoral venous approach has proved to be safe even in premature babies. Clear guidelines for infection control and the prevention of intravascular catheter-related infections in children have been established; however, the high incidence of nosocomial catheter-related infections requires effective prevention strategies. The impact of antimicrobial-impregnated central venous catheters on the prevention of bloodstream infections in children is not yet clear. Routine use of prophylactic antibiotic (i.e. vancomycin) to prevent catheter-related infection cannot be recommended. Thrombolytic therapy with recombinant tissue plasminogen activator is safe, efficient, well tolerated and effective for lysis of catheter-induced
intravascular and intracardiac thrombi even in neonates. Embolized catheter fragments can be retrieved in neonates and children by non-surgical interventions using standard procedures applied by paediatric cardiologists.

**SUMMARY:** Despite a variety of new techniques, the major problem of central venous catheterization in neonates and children remains the prevention of catheter-related infection and infection control.


Prophylaxis was recommended as the optimal treatment regimen for severe hemophilia by several expert committees. This led to increased utilization of prophylaxis and, subsequently, central venous access devices (CVADs). Although prophylaxis is the preferred treatment, episodic therapy is used by many. CVADs are employed to facilitate administration of prophylactic and episodic infusions; however, there are no data on the risk of CVAD-related infections for prophylaxis compared with episodic therapy. Data from the Study for the Prevention of Joint Disease in Preschool Children with Severe Hemophilia, a randomized clinical trial of prophylaxis versus episodic therapy, were used to evaluate the association between CVAD-related infection and treatment. The crude and adjusted rate ratios for first CVAD-related infection per 1000 CVAD days associated with episodic therapy versus prophylaxis were 1.42 (95% confidence interval: 0.46-4.40) and 1.23 (95% confidence interval: 0.33-4.56), respectively. Although we cannot make a definitive statement about treatment and CVAD-related infection risk, this study suggests that prophylaxis likely does not put children at higher risk of CVAD-related infection than episodic therapy. Given the need for CVADs in some children and the benefits of prophylaxis, we conclude there is no reason to recommend against prophylaxis on the basis of existing knowledge of CVAD-related infection risk.


Static electricity within sterile packaging may result in bacterial contamination of central venous catheters (CVCs) prior to insertion. To prevent this, some surgeons inject saline into the pack before opening it. This trial was designed to determine the effect of this procedure. A double blind randomised controlled trial of 47 CVCs comparing injection of 2 ml of sterile saline into the pack prior to opening with no injection was performed. Five centimetre lengths cut from the tip of the catheter before and after subcutaneous tunnelling were sent for microbiological culture. Eight catheters (17%) showed evidence of bacterial contamination prior to insertion into the vein. Two (4.2%) were contaminated prior to tunnelling and seven (14.9%) afterwards. One catheter was contaminated before and after tunnelling. All but one of the contaminating bacteria were coagulase negative staphylococci. There was no significant difference in the contamination rate between catheters from packs that had been injected (5/25) and those that had not (3/22), P = 0.56. Just under one-fifth of the catheters were contaminated with bacteria prior to insertion into the vein but this was not influenced by prior injection of saline into the pack. We conclude that there is no evidence to support the practice of injecting the catheter pack prior to opening.

**PURPOSE:** In many institutions protocols have not been developed as to when implantable venous access devices are accessed in children with cancer. The differences in complication rates (infection, hematoma, mechanical failure, and extravasation) between immediate versus delayed access remain unknown.

**PATIENTS AND METHODS:** This retrospective study looks at the incidence of complications in two groups of pediatric patients who had an implantable venous access device inserted between 1998 and 2001 at McMaster Children's Hospital. Group 1 (immediate access group) had 23 patients and group 2 (delayed access) had 74 patients.

**RESULTS:** The incidence of infection was 22% in group 1 and 14% in group 2. The difference between these infection rates was not statistically significant. All infections occurred in patients with a diagnosis of acute lymphoblastic leukemia. Of the patients in this study with acute lymphoblastic leukemia, 33% in group 1 and 36% in group 2 developed infections.

**CONCLUSIONS:** These results suggest that implantable venous access devices can be accessed at the time of device insertion to decrease painful needle punctures in children with cancer and to provide secure immediate central venous access.


In the present study the complication rate of Broviac catheters in the therapy of children with cancer was determined. Of special interest was the question of to what extent the incidence of bacteremias is increased by the implant. For this reason the method of matched pairs analysis was chosen comparing 55 patients with 61 catheters to 1 child each who received the therapy via peripheral veins. Apart from having the same disease, the same therapy protocol and the same age group the partners had a similar number of leukocytopenic days (leukocyte counts, < 1000/microliters) in the study period. The observation time was 9671 days in the catheter group and 9666 days in the control group. During this time 167 fever episodes (17.7 episodes/1000 days) were recorded in the patients with implant but only 133 episodes (14.0/1000 days) in the control patients. Study and control groups had similar frequencies of fever of unknown origin with leukocyte counts > or = 1000/microliters and fever with a known focus. However, 29 bacteremias (2.9 episodes/1000 days) represented a 4 times higher complication rate with the use of Broviac catheters than in the control group (7 bacteremias, 0.7 episode/1000 days). Episodes of fever of unknown origin with leukocytopenia were 1.5 times more common in the catheter group than in the control group. Although it is not possible to prove that the catheter played a role as focus of bacterial infection, an increased risk of infection must be supposed. The Broviac catheter meets with broad approval by the patients, parents and medical staff.(ABSTRACT TRUNCATED AT 250 WORDS)


We report data from an observational benchmarking study of adherence to recommended practices for insertion and maintenance of central venous catheters at a heterogeneous group of academic medical
centers. These centers demonstrated a need for significant improvement in implementation and documentation of quality performance measures for the prevention of catheter-related bloodstream infections. copyright 2008 by The Society for Healthcare Epidemiology of America. All rights reserved.


This videocassette, part of a two-part series, is intended for parents and caregivers of children with central lines. It demonstrates heparinization and emergency care of a central line. This video discusses infections resulting from the central line, catheter damage and leaks, occlusion of the central line, and air in the bloodstream.


We report 2 life-threatening cases of Burkholderia cepacia sepsis caused by infusate contamination during compounding. Bacterial isolates from the patients' blood cultures and the infusate were indistinguishable by pulsed-field gel electrophoresis. Proper quality controls at a local and national level are important for ensuring safe delivery of compounded medications to patients in all settings, including those outside health care facilities.

Hemsworth, S., K. Selwood, et al. (2007). "Does the number of exogenous infections increase in paediatric oncology patients when sterile surgical gloves are not worn for accessing central venous access devices?" European Journal of Oncology Nursing 11(5): 442-447.

The aim of this study was to determine whether the routine use of sterile gloves when accessing central venous catheters (CVCs) affects the incidence of exogenous septicaemia in paediatric oncology patients. The 36-month study period ran prospectively from September 2000 to August 2003. During this time the routine use of sterile gloves for accessing CVCs was suspended. Sterile gloves were only used when obtaining blood samples from the line or injecting substances that required direct entry into the lumen with removal of line cap. Surveillance cultures of throat and rectum were obtained to detect carriage of potential pathogens. Exogenous septicaemia was defined as a blood stream infection due to microorganisms not carried by the patient in throat and/or rectum. The incidence of exogenous septicaemia following a change of practice of not routinely using sterile gloves for accessing lines was compared to the incidence of exogenous septicaemia in a historical control group. The number of exogenous septicaemia episodes per inpatient days with gloves and without gloves was calculated for the total number of episodes and for the first episode for each child. The relative incidence and 95% confidence intervals was also calculated for first and total episodes. For both, all episodes and first episodes there was no statistically significant difference in the incidence of exogenous septicaemia comparing the control and study patients. In summary, this study does not support or approve the use of sterile gloves when accessing CVCs in respect of exogenous septicaemia.
Implanted subcutaneous (s.c.) central venous port accesses including Port-A-Cath (PAC) facilitate the administration of chemotherapy or blood products and are frequently used in children with cancer. The incidence of PAC-related infections was determined in 155 consecutive paediatric cancer patients with PAC followed for a total of 134,773 days (median, 738; range, 25-2080). Overall, 48 bloodstream infections occurred in 26 patients. 12 (25%) of these infections and 3 local infections at the insertion site were treatment-resistant and demanded removal of the PAC. Coagulase-negative staphylococci were involved in 12 of these 15 episodes. The rate of clearly PAC-related infections in this so far largest reported series was 0.11 episodes per 1000 PAC days, one of the lowest in the literature. Although catheter-related infections demanded PAC removal in 8% of our patients, the long periods PAC were in use and their benefits argue for continued PAC use in the paediatric cancer population. [References: 42]

In a prospective randomized study the durability of tunnelled and non-tunnelled central venous catheters was investigated in children with malignant diseases. Twenty children were included in the study but four (two in each group) had to be excluded; three because the entry criteria turned out not to be fulfilled and one because of lack of data. The median duration of the tunnelled catheters was 224 days with a range of 25-846 days which was significantly longer than that of conventional catheters (39.5 days, range 9-228 days). In addition six of eight conventional catheters were accidentally removed whereas all catheters in the tunnelled group had to be removed via a small incision. Three cases of catheter related sepsis, two in the tunnelled group and one in the conventional group, were registered. The corresponding number of infections per catheter days were 1 in 1189 days and 1 in 522 days, respectively. In conclusion cuffed, tunnelled central venous catheters are less prone to displacement than traditional percutaneous central venous catheters when used in children with malignant diseases.

PURPOSE: To determine whether an antibiotic flush solution containing vancomycin, heparin, and ciprofloxacin (VHC) can prevent the majority of line infections. PATIENTS AND METHODS: A prospective double-blind study was performed comparing VHC to vancomycin and heparin (VH) to heparin alone in 126 pediatric oncology patients. RESULTS: The 153 assessable lines resulted in 36,944 line days studied. There were 58 blood stream infections (43 gram-positive, 14 gram-negative, and one fungal). Forty were defined as line infections (31 heparin, three VH, six VHC). The time to develop a line infection was significantly increased using either antibiotic flush (VH, P =.011; VHC, P =.036). The rate of total line infections (VH, P =.004; VHC, P =.005), gram-positive line infections (VH, P = .028; VHC, P =.022), and gram-negative line infections (VH, P =.006; VHC, P =.003) was significantly reduced by either VH or VHC. Sixty-two (41%) of the lines developed 119 occlusion episodes (heparin, 3.99 per 1,000 line days; VHC, 1.75 per 1,000 line days; P =.0005). Neither antibiotic could be detected after flushing, and no adverse events were detected, including increased incidence of vancomycin-resistant Enterococcus colonization or disease. CONCLUSION: The use of either VH or VHC flush solution significantly decreased the complications associated with the use of
tunneled central venous lines in immunocompromised children and would save significant health care resources.


BACKGROUND: Bacterial infections in infants constitute a risk factor for parenteral nutrition (PN)-related cholestasis. The possible role of infections in the development of liver fibrosis, the most severe long-term complication, has yet to be documented. This study retrospectively compares the incidence of sepsis in children with and without severe liver fibrosis.

PATIENTS AND METHODS: Medical reports of 30 children in prolonged PN programs between March 1985 and March 2000 were reviewed. Starting at birth, the mean PN duration was 65 months (range, 8-150 months). According to the results of liver biopsy (LB), patients were split into 2 groups: group A (n = 16) with severe liver fibrosis (ie, septal fibrosis involving >50% of portal fields or cirrhosis) and group B (n = 14) with normal hepatic architecture or mild fibrosis (<50% of portal fields).

RESULTS: Duration of PN at the time of LB was shorter in group A (30.5 months; range, 8-96 months) than in group B (105 months; range, 37-150 months; P < 0.001). In group A the incidence of sepsis was significantly higher than in group B (3.2 +/- 0.3 /year vs 1.5 +/- 0.2 /year) and the first infection occurred earlier (group A, 1 month [range, 1-2 months]; group B, 4 months [range, 1-19 months]). By contrast, both groups were similar in terms of pregnancy duration, birth weight, age of PN onset, underlying diseases, mode of PN delivery, and number of cholestasis episodes.

CONCLUSIONS: Incidence and early onset of infections may contribute to the development of liver fibrosis in cases of long-term PN. New strategies are required in prevention and treatment of infections in children receiving PN.


Central venous catheter related bloodstream infection is an important cause of morbidity and mortality.


A rapidly growing mycobacterium similar to strains in the present Mycobacterium fortuitum complex (M. fortuitum, M. peregrinum, and M. fortuitum third biovariant complex [sorbitol positive and sorbitol negative]) was isolated from a surgically placed central venous catheter tip and three cultures of blood from a 2-year-old child diagnosed with metastatic hepatoblastoma. The organism's unique phenotypic profile and ribotype patterns differed from those of the type and reference strains of the M. fortuitum complex and indicate that this organism may represent a new pathogenic taxon.

BACKGROUND: Surgical central venous access in children usually requires open exposure of the internal jugular vein or one of its tributaries. The percutaneous route has the potential advantages of a reduced rate of wound infection, superior cosmesis and reduced operating time. We report our modifications to the percutaneous approach that facilitate the application of this technique to children over the age of 12 months.

METHODS: The dilator and peel-away sheath of the introducer set should be inserted into the subclavian vein under fluoroscopic control. Elevation of the ipsilateral shoulder assists passage of the peel-away sheath and subsequently the catheter from the subclavian vein into the superior vena cava. RESULTS: This technique has been used successfully to establish surgical central venous access in the majority of children at the Women's and Children's Hospital, Adelaide, South Australia, over a 3-year period.

CONCLUSIONS: With the modifications described this technique may be safely applied to the paediatric age group.


Central venous catheters (CVC) have become an important adjunct to the overall management of paediatric patients, but their use is associated with frequent complications resulting in premature removal. This report evaluates the insertion techniques and complications of 295 consecutive surgically inserted CVC from 1987 to 1991 in a paediatric hospital. Fully implanted catheters had significantly less incidence of catheter-related problems necessitating removal (infection, dislodgment, leaking, blockage, or migration - 31%) compared to exteriorised catheters (58%). One-third of catheters were removed because of infection, one-third as they were no longer needed, and the remaining for multiple reasons. Infected (110+/−18 days), dislodged (18+/−4 days), or migrated (44+/−6 days) catheters were removed significantly earlier than those removed because they were no longer needed (195+/−24 days). Catheters became dislodged more frequently in the younger patients. Catheters with the tip in the subclavian vein (29%) migrated more frequently than those in the right atrium. There was a significantly increased incidence of infection in catheters inserted into the saphenous vein (43%) compared to those in the internal jugular vein (11%). Some episodes of catheter infection were managed with antibiotics, with short-term resolution of symptoms and signs. However, all 71 infected catheters ultimately required removal for further sepsis. Fully implanted catheters had 1.1 episodes of catheter-related sepsis per 1,000 catheter days compared to 3.7 for exteriorised catheters. The position of the catheter tip, vein used for insertion, training of young surgeons, and location of the subcutaneous tunnel need particular attention in order to reduce catheter complications.


Phlebitis and cellulitis are commonly encountered problems in oncology patients receiving chemotherapy through peripherally inserted intravenous catheters. Use of central venous access devices (CVAD) is
desirable. We have seen a steady increase in the use of CVADs in our oncology service with frequent use of indwelling ports, particularly during the last 2 years. In this study we have attempted to elucidate advantages of CVAD and compared them to peripheral catheters. This is a retrospective study with chart review of all oncology patients admitted in our oncology service at the Aga Khan University Hospital from March 2003 to March 2005. A survey was also conducted from a randomly selected sample of parents of children with cancer to elicit parental views regarding their choice of a particular catheter. Catheter-related infections were quite common (over 50%) in patients with peripheral lines, resulting in increased costs and prolonged hospitalization. Externalized CVADs were found difficult to care for, carried a risk of being accidentally pulled out or punctured, and were deemed undesirable for older female patients for cosmetic reasons. We found that the internalized CVADs (portacath) were superior to the externalized or peripheral lines and resulted in better patient and family satisfaction. Use of peripheral lines must be gradually phased out of pediatric oncology practice in Pakistan. Indwelling CVADs have become the standard of care internationally and should be considered for most patients in developing countries whenever resources are available.


PURPOSE/OBJECTIVES: To determine whether a comprehensive educational program influenced the incidence of hub colonization of central venous catheters (CVCs) and bloodstream infection rates in children with cancer, to identify risk factors related to infection rates, and to determine the impact of an educational program on nurses' knowledge of CVC care for children with cancer.

DESIGN: Prospective, longitudinal.

SETTING: Pediatric cancer center in a large children's hospital in the southwestern United States.

SAMPLE: 51 catheter hub cultures were obtained from 27 children with cancer, and 121 nurses participated in the educational intervention.

METHODS: CVC hub cultures were obtained prior to and three months after an educational intervention. A written pre- and posteducation assessment was used to evaluate the nurses' learning.

MAIN RESEARCH VARIABLES: Hub colonization and bloodstream infection rates. FINDINGS: Post-test mean score of 87% was significantly higher than the pretest mean score of 72%. Prior to the education program, 57% of the hubs were culture positive, and after the educational program, the proportion of culture-positive hubs was reduced to 36%.

CONCLUSIONS: A comprehensive educational program increases nurses' knowledge of CVC care and reduces CVC hub colonization and catheter-related bloodstream infections in children with cancer.

IMPLICATIONS FOR NURSING: Patient and family participation in practice changes is very important because they have the most to gain. Additional research evaluating the relationship between hub colonization and subsequent bloodstream infection in a larger sample is warranted.

The use of central venous catheters may be complicated by thrombosis and infection. We report a case of a needle-phobic 5-year-old boy with factor IX deficiency, in whom a portacath was inserted owing to poor compliance with prophylactic treatment. Within a week, he developed a Staphylococcus aureus line infection that was treated with a 2-week course of intravenous antibiotics. One month later he presented with nonspecific symptoms and blood cultures again grew S. aureus. An echocardiogram revealed a large vegetation adherent to the tricuspid valve, confirming the diagnosis of bacterial endocarditis. His clinical course was further complicated by the development of pulmonary emboli. Medical treatment with intravenous antibiotics led to a successful resolution of the endocarditis and pulmonary emboli with a favourable long-term outcome.


BACKGROUND AND PURPOSE: Subcutaneously implanted central venous access devices (SICVADs) are a common route of intravascular access for pediatric patients with cancer. This study was performed to evaluate the risk for SICVAD-related infection in a large consecutive series of unselected children with cancer in a single medical center.

METHODS: The medical charts of 209 pediatric patients with cancer who received a SICVAD from January 1, 2001 to December 31, 2005 were retrospectively reviewed, and the patients were followed-up until June 30, 2006. The demographics, clinicopathologic features, and infectious complications were collected for analysis.

RESULTS: There were 137,924 SICVAD days (median, 660 days; range, 16-1962 days). The rate of SICVAD-related infections was 0.15 episodes/1000 SICVAD days. There were 21 episodes of SICVAD-related infection among 17 patients, 18 were bloodstream infection among 14 patients and the other 3 were local infection among 3 patients. Sixteen SICVADs were removed, 13 were associated with bloodstream infection and 3 with local infection. Young age (<2 years) was associated with a high risk for SICVAD-related infection. Staphylococcal spp. and fungi were the most common pathogens associated with SICVADs.

CONCLUSIONS: The rate of SICVAD-related infection in children with cancer was low. Children younger than 2 years had a higher risk for SICVAD-related infection than older children. Fungi play an important role in SICVAD-related infection.


Since 1984, 316 subcutaneous ports (SP) and 339 external venous catheters (EC) [Roko Catheter, The Hospital for Sick Children (HSC)] have been inserted in hematology/oncology patients at HSC. During a 22-month period (July 1987 to April 1989), a committed central line nurse (J.I.) prospectively collected clinical and microbiologic data on 144 consecutive SPs and 130 consecutive ECs. Children with the SP had 0.6 infected lines and 0.7 infectious episodes per 1,000 patient days compared to 2.9 infected lines and 4.3 infectious episodes per 1,000 patient days with the EC (p less than 0.001). This lower infectious
complication rate with SP was demonstrated in the entire group of unselected patients and in a cohort of children with acute lymphoblastic leukemia (ALL) receiving intensive chemotherapy, and it was evident in all age groups. In view of the other advantages of SP—normal activity, absence of the need for home maintenance, improved body image, less expense—these data suggest that SPs are the preferred device in pediatric patients and provide effective venous access with acceptable complication rates.


PURPOSE: The aim of this study was to characterize the perioperative complications of central venous catheter placement in children infected with human immunodeficiency virus (HIV)

METHODS: A retrospective chart review was conducted of all central venous catheters placed by the surgical service into HIV-infected children from 1988 to 1998 at a large urban children's hospital. Complications occurring within 1 month of catheter placement were analyzed for several host and environmental factors.

RESULTS: Forty HIV-positive patients underwent 60 central venous access procedures. Thirty-two of the patients were severely immunosuppressed. Eight catheter placements (13%) resulted in perioperative complications, including hemorrhage (n = 2), site infection (n = 2), catheter sepsis (n = 2), thrombotic occlusion (n = 1), and a pleural effusion secondary to catheter malposition (n = 1). Only 3 patients required catheter removal. There was no significant relationship between either hemophilia or thrombocytopenia and perioperative hemorrhage. No significant relationship was found between infectious complications and preoperative white blood cell count, absolute neutrophil count, CD4% and CD4#, suggesting that a patient's compromised immune status should not be considered a contraindication to central venous catheter placement.

CONCLUSION: The complication rate of central venous catheter placement into HIV-infected children is low (<15%), but is still higher than that of the general pediatric population. With careful preoperative preparation this procedure can be performed safely, even in patients with advanced HIV disease. J Pediatr Surg 36:1777-1780. Copyright 2001 by W.B. Saunders Company.


BACKGROUND: It is critical to establish a safe and functional i.v. access in severely sick patients. We evaluated the frequency of application and complications of central venous catheters in a pediatric intensive care unit.

METHODS: Pediatric patients in whom central venous catheters were inserted between March 1997 and May 1999 in the Pediatric Emergency Room and Intensive Care Unit were enrolled in this study. Patients were evaluated with respect to age, sex, weight, central venous catheter indication, site, duration of catheter stay and complications.

RESULTS: During the study period a total of 156 central venous catheters were successfully inserted into 146 patients. Of the 156 central venous catheter attempts, 148 (94.9%) were placed into the subclavian vein, six were inserted into the femoral vein, and two into the jugular vein. In 156 attempts, arterial injuries occurred
in 20 cases (12.8%). Pneumothorax developed in two patients on mechanical ventilation. Three catheters had to be removed due to catheter related infections. The mortality rate was 0%.

CONCLUSIONS: We concluded that subclavian central venous catheterization is a safe procedure with minimal complications in pediatric patients. Arterial injury was the most frequent complication. In experienced hands, the success rate was 100%. Subclavian central venous catheter insertion may be considered as the first approach in critically ill patients.


OBJECTIVE: Catheter-related thrombosis is a common problem in the pediatric intensive care unit. Strategies that reduce the incidence of thrombosis may have significant clinical advantage. Nitroglycerin (NTG) infusions release nitric oxide (NO). NO is responsible for much of the vasodilating and antithrombotic properties of the vasculature. We hypothesized that an intracatheter NTG infusion would reduce the incidence of catheter-related thrombosis.

DESIGN: Prospective, randomized, controlled trial.

SETTING: Pediatric intensive care unit.

PATIENTS AND PARTICIPANTS: Children of 6 years or less with femoral venous catheters who were not on antithrombotic therapy.

INTERVENTIONS: Subjects were randomly assigned to NTG or control groups. NTG group patients received NTG at 0.1 mcg x kg x min in 5 % dextrose; control group patients received only 5 % dextrose. Infusions were delivered continuously through the catheter until the catheter was removed. Demographic data, physical and laboratory findings, catheter insertion attempts and infusate composition were recorded. Clinical evidence of vascular thrombosis or catheter malfunction was noted. Ultrasound examinations were performed within 2 days of catheter insertion and within 2 days after removal.

MEASUREMENTS AND RESULTS: Forty-four patients (age 12.0 +/- 2.6 months) completed the study, 21 in the NTG group and 23 in the control group. Duration of catheter placement was 7.5 +/- 0.7 days. Twelve of 44 patients (27 %) had thrombi: 7/21 in the NTG group; 5/23 in the control group (p = NS). There were no significant differences between children with and without thrombi in age, gender, number of insertion attempts, duration of catheter placement, clinical signs of thrombosis or catheter malfunction was noted. Ultrasound examinations were performed within 2 days of catheter insertion and within 2 days after removal.

CONCLUSIONS: Catheter-related thrombosis is common after placement of femoral venous catheters in children. Low dose intracatheter NTG infusion does not protect against catheter-related venous thrombosis in children.


BACKGROUND: Central venous catheter (CVC) occlusion occurs frequently in children. This problem is often associated with disruption of intravascular therapy and monitoring. Multiple factors may predispose to
catheter occlusion, but reflux of blood into the catheter lumen is a common factor. We hypothesized that use of a positive pressure valve device would reduce the incidence of catheter occlusion.

METHODS: In phase I of this sequential study design, newly placed CVCs were capped with a standard device. In Phase II, CVCs were capped with a positive-pressure valve device. Data collected included patient demographics, type of catheter, infusate, catheter duration, and complications. Partial and complete catheter occlusions were delineated. A user satisfaction survey was conducted.

RESULTS: There were 153 children (mean age 48.0 +/- 7.7 months) with 312 CVC lumens enrolled in the study. Mean catheter duration was 9.4 +/- 0.9 days. There were fewer complete occlusions in CVCs capped with the positive pressure valve device than with the standard device [6/161 (3.7%) vs 18/151 (11.9%) occlusions, respectively; p = .012]. There were no significant differences in partial occlusions, phlebitis, or catheter-related bloodstream infection between the 2 groups.

CONCLUSIONS: CVCs with a positive-pressure valve cap device have a lower incidence of complete catheter occlusion than those with a standard cap device.


BACKGROUND: The use of central venous catheters is recognised as a risk factor for nosocomial infection. Prophylactic antibiotics may be effective in preventing catheter-related blood stream infection in newborns but may also have the undesirable effect of promoting the emergence of resistant strains of microorganisms.

OBJECTIVES: To determine the effect of prophylactic antibiotics on mortality and morbidity in neonates with central venous catheters.

SEARCH STRATEGY: Searches were done of the Cochrane Neonatal Review Group Specialised Register, MEDLINE from 1950 to April 2007, CINAHL from 1982 to April 2007, and the Cochrane Central Register of Controlled Trials (CENTRAL, The Cochrane Library, Issue 2 2007). Previous reviews (including cross references) were also searched.

SELECTION CRITERIA: Randomised controlled trials or quasi-randomised controlled trials of adequate quality in which either individual newborn infants or clusters of infants were randomised to receive prophylactic antibiotics (not including antifungals) versus placebo or no treatment. Infants must have had central venous catheters, been full term infants less than 28 days old or preterm infants up to 44 weeks (postmenstrual) corrected age.

DATA COLLECTION AND ANALYSIS: Criteria and methods used to assess the methodological quality of the trials: standard methods of the Cochrane Collaboration and its Neonatal Review Group were used. The review authors extracted data independently. Attempts were made to contact study investigators for additional information as required.

MAIN RESULTS: Three small studies have been included in this review. Prophylactic antibiotics in neonates with central venous catheters had no effect on overall mortality (typical RR 0.68, 95% confidence interval 0.31, 1.51). Prophylactic antibiotics in neonates with central venous catheters decreased the rate of proven bacterial sepsis (typical RR 0.38, 95% confidence interval 0.18, 0.82). Prophylactic antibiotics in neonates with central venous catheters decreased the rate of suspected or proven bacterial septicaemia (typical RR...
AUTHORS' CONCLUSIONS: Prophylactic systemic antibiotics in neonates with a central venous catheter reduces the rate of proven or suspected septicaemia. However, this may not be clinically important in the face of no significant difference in overall mortality and the lack of data on long-term neurodevelopmental outcome. Furthermore, there is a lack of data pertaining to the potentially significant disadvantages of this approach such as the selection of resistant organisms. The routine use of prophylactic antibiotics in infants with central venous catheters in neonatal units cannot currently be recommended. [References: 33]


OBJECTIVE: The goal of this effort was to reduce central venous catheter (CVC)-associated bloodstream infections (BSIs) in pediatric intensive care unit (ICU) patients by means of a multicenter evidence-based intervention.

METHODS: An observational study was conducted in 26 freestanding children's hospitals with pediatric or cardiac ICUs that joined a Child Health Corporation of America collaborative. CVC-associated BSI protocols were implemented using a collaborative process that included catheter insertion and maintenance bundles, daily review of CVC necessity, and daily goals. The primary goal was either a 50% reduction in the CVC-associated BSI rate or a rate of 1.5 CVC-associated BSIs per 1,000 CVC-days in each ICU at the end of a 9-month improvement period. A 12-month sustain period followed the initial improvement period, with the primary goal of maintaining the improvements achieved.

RESULTS: The collaborative median CVC-associated BSI rate decreased from 6.3 CVC-associated BSIs per 1,000 CVC-days at the start of the collaborative to 4.3 CVC-associated BSIs per 1,000 CVC-days at the end of the collaborative. Sixty-five percent of all participants documented a decrease in their CVC-associated BSI rate. Sixty-nine CVC-associated BSIs were prevented across all teams, with an estimated cost avoidance of $2.9 million. Hospitals were able to sustain their improvements during a 12-month sustain period and prevent another 198 infections.

CONCLUSIONS: We conclude that our collaborative quality improvement project demonstrated that significant reduction in CVC-associated BSI rates and related costs can be realized by means of evidence-based prevention interventions, enhanced communication among caregivers, standardization of CVC insertion and maintenance processes, enhanced measurement, and empowerment of team members to enforce adherence to best practices.


Use of right atrial catheters (RACs) in children with cancer improves the comfort and efficacy of therapy. However, catheter-related infections are responsible for significant morbidity leading to the removal of approximately 20% of implanted RACs. Sepsis has been linked to thrombus and fibrin sheath formation within the RAC. Gram-negative and fungal infections appear to be particularly resistant to antibiotic therapy
alone and most of these infections have required catheter removal. Urokinase has been effectively used for reopening thrombus occluded RACs. Theoretically, thrombolytic agents could improve the treatment of catheter-related infections by removing luminal sites of bacterial/fungal colonization. We prospectively monitored the use of urokinase and antibiotics for catheter-related sepsis in our pediatric hematology/oncology population from 1985 to 1991. Sepsis episodes were treated with 2 doses of urokinase and antibiotics (10 to 42 days) infused through the RAC. One to 2 mL of urokinase (5,000 U/mL) was instilled in the RAC for 1 hour, then removed and repeated 24 hours later. During the study, 224 RACs were placed in 177 children. RACs were in place for a total of 71,134 days (median, 274 days). There were 67 blood culture-positive sepsis episodes occurring in 50 RACs. Fifty-nine sepsis episodes were treated with urokinase and antibiotics and all responded by clearance of organisms from the blood. Three patients (5.1% of urokinase treated) had recurrent sepsis with the same organism within 2 months, were considered treatment failures and had RACs removed. Only 1 of 16 episodes of multiple organism/Candida sepsis led to RAC removal due to inability to cure the infection.(ABSTRACT TRUNCATED AT 250 WORDS)


BACKGROUND: There are many reports on the complications that occur at the time of insertion and during the life of central venous indwelling catheters. However, there is no literature that describes the complications that occur at the time of removal of these lines.

METHODS: A retrospective review of 136 central line (Broviacs [B], Port-A- Caths [PC] and Hickmans [HC]) removals during the last 5 years was undertaken.

RESULTS: A total of 97% were removed after completion of chemotherapy, and 3% because of sepsis or malfunction. Three PC lines broke at the time of removal resulting in a length of line remaining in the central venous system (the superior vena cava, innominate vein, and brachio-cephalic subclavian junction). Two lines were inserted by a cut-down technique into the external jugular and one line by the percutaneous technique into the subclavian vein. At follow-up, none of the residual lines were associated with thrombus formation, and none showed any evidence of migration.

CONCLUSIONS: This review identifies a specific problem that can occur with central line removal. Both the long-term affects of residual catheter within the central venous system and the need to remove the foreign body have yet to be addressed. Copyright 2003, Elsevier Science (USA). All rights reserved. [References: 14]


PURPOSE: Asymptomatic deep vein thrombosis (DVT) is a complication of central venous catheter (CVC) use in children with cancer, but its clinical significance is not well defined. Children with CVCs commonly experience two other CVC-related complications: occlusion and infection. The aim of this study was to determine the frequency of these two complications and their association with DVT.

PATIENTS AND METHODS: We conducted a retrospective cohort study of patients who were diagnosed with cancer. Data collected included number and type of catheter insertions, duration of use, reason for removal, associated catheter complications, and demographic information.
RESULTS: Catheters were placed in 287 patients for a total of 128,403 days (mean, 290 +/- 269 days/catheter). Of 21 patients (7%) diagnosed with CVC-related DVT, only five had specific signs or symptoms. Nineteen (90%) of these 21 children had prior history of catheter occlusion, and 10 of the 19 also experienced infection. Ten children (48%) were not identified as having DVT until they had had multiple catheters with recurrent complications. Odds of having DVT were higher in patients who had a single catheter complicated by repeated occlusions (odds ratio [OR], 3.7; P = .001) or infection (OR, 2.2; P = .016). Patients experiencing both infection and occlusion were at 6.4 times (P < .0001) higher risk of developing DVT.

CONCLUSION: Children with CVC-related DVT frequently have recurrent catheter complications. Unrecognized thrombosis may therefore be clinically important. Prospective studies are needed to determine if identification and treatment of occult DVT will prevent additional CVC-related complications and prolong the duration of catheter use.


PURPOSE/OBJECTIVES: To describe methods of drawing blood samples from central venous catheters (CVCs) currently in use in pediatric bone marrow transplant (BMT) units, the rationale for method selection, and concerns of clinicians related to those methods.

DESIGN: Descriptive survey.

SETTING: National. SAMPLE: 34 pediatric BMT units (median = 8 beds) in hospitals ranging in size from 48 to 1,100 beds (median = 530).

METHODS: A mailed questionnaire was completed by a designated member of the BMT nursing staff. MAIN RESEARCH VARIABLES: Type of blood drawing method, volume of blood drawn, rationale for using a specific method and volume, and clinician concerns regarding drawing procedure. FINDINGS: The majority of the BMT units use the discard method of blood drawing (i.e., prior to drawing the required volume of blood for testing, a sample of blood is withdrawn and discarded). Discard volumes ranged from 0.5 ml-10 ml. The most frequently cited concerns were risk of infection, blood loss, and accuracy of laboratory values.

CONCLUSIONS: The concerns of the respondents and the lack of empiric studies mandate that research determine the safest method of drawing blood samples through CVCs in a pediatric BMT population. IMPLICATIONS FOR NURSING PRACTICE: Concern regarding current practice exists, but minimal data are available to assist nurses in determining safe and appropriate methods for withdrawing blood through CVCs. A prospective, randomized study of the three methods currently being used with a large sample can provide the information necessary to establish quality practice guidelines.


PURPOSE: This study was conducted to determine urokinase use practices in pediatric hematology/oncology centers.
METHODS: Pediatric hematology/oncology centers were surveyed by telephone regarding urokinase use in children with central venous catheters (CVCs).

RESULTS: A total of 92 centers participated in the study. Urokinase is the primary thrombolytic agent used in pediatric hematology/oncology centers; 67 of 92 (73%) centers had a written protocol for its use. Multiple boluses of urokinase were used in most centers; only 16 of 92 (17%) centers limited urokinase use to 1 bolus per episode of CVC occlusion. At 10 of 92 (11%) centers, adverse events (e.g., fever, chills, or bleeding) after urokinase administration were reported. At 83 of 91 (91%) centers, urokinase was routinely used to clear thrombi in children with central nervous system tumors despite contraindications. At 80 of 92 (87%) centers, occluded CVCs were replaced after unsuccessful thrombolytic therapy, but only 21% of the centers altered the CVC maintenance protocol after replacement. Written protocols, the use of multiple boluses, and urokinase infusions were more likely at larger centers (i.e., > 200 patients) than in medium (100-200 patients) or small (< 100 patients) centers.

CONCLUSIONS: Urokinase is a widely used alternative to replacement of occluded CVCs, but protocols vary widely. Indiscriminate urokinase use can be expensive and potentially hazardous. Centers that use urokinase should have standardized protocols, monitor use and adverse effects, and periodically review efficacy data.


Catheter-related central venous thrombosis is a serious and common problem among children. The traditional management has been anticoagulation and early catheter removal. Unfortunately, many patients require a new catheter, which is associated with complications that include possible further thrombosis. Although others have used thrombolytic agents in attempts to avoid catheter removal, the authors of the present study believe that the associated complications occur too frequently and are too serious. They have had success with standard anticoagulation in a limited number of patients. Between February 1991 and April 1994, 17 patients (6 weeks to 19 years of age) were treated for catheter-related deep venous thrombosis. Eight patients underwent early catheter removal accompanied by anticoagulation; two of them had intrinsic catheter problems that necessitated removal, and one had hemophilia. Nine others received anticoagulation without catheter removal. Of these, one required catheter removal after 10 days heparin administration failed to diminish the thrombosis. Another patient responded well to anticoagulation but required catheter removal several weeks later because of catheter-site infection. The other seven patients responded well to anticoagulation, and their catheters were retained. For patients with a functional catheter essential to their care, anticoagulation may safely prevent catheter removal.


BACKGROUND: Intravascular devices (IVDs) carry significant risk of device-associated bloodstream infection (BSI). Catheter thrombosis increases the likelihood of microbial colonization of the catheter and BSI. Urokinase has been studied for the prevention of BSI associated with IVDs. We undertook a systematic review to determine the efficacy of urokinase-heparin lock or flush solution compared with heparin alone in preventing IVD-associated BSI.
METHODS: Computerized databases were searched for relevant publications in English from January 1966 to 1 January 2007. We identified randomized controlled trials comparing a urokinase-heparin lock or flush solution with heparin alone for prevention of BSI associated with long-term IVDs. Summary effect sizes were calculated with assessment of heterogeneity.

RESULTS: Five randomized, controlled trials involving a total of 991 patients being treated with IVDs met the inclusion criteria; all five studies were conducted among patients with cancer; three of these studies were undertaken in children and two in adults. The summary risk ratio with a urokinase-heparin lock solution for IVD-associated BSI was 0.77 (95% confidence interval [CI], 0.60-0.98; p=0.01). Results of the test for heterogeneity were not statistically significant (p=0.53).

CONCLUSIONS: Use of a urokinase lock solution in high-risk patient populations being treated with long-term central IVDs may reduce the risk of BSI. However, there are few randomized trials and methodologic limitations of these preclude more robust recommendations regarding the use of urokinase to prevent BSI. Further adequately powered studies should seek to evaluate the efficacy of urokinase and optimize dosage and instillation regimen. [References: 45]


Indwelling intravenous catheters are an invaluable part of the curative therapy or terminal care of children with haematological malignancies. The increase in their use has been paralleled by an increase in Gram-positive infections, however. This article provides an overview of non-inpatient treatment of central line infections using teicoplanin. The main drivers for considering non-inpatient therapy were to increase the quality of the patient's life by reducing the amount of time spent in hospital, and to prolong the life of the catheter. A large proportion (95%) of the children in the unit described have indwelling catheters in situ, including Port-a-caths, Hickman catheters and Vascaths. The indications suitable for non-inpatient antibiotic therapy of line infections were those patients near the end of their chemotherapy courses, during terminal care, in non-neutropenic patients to complete an antibiotic course, and in patients with chronically neutropenic aplastic anaemia. Persistent line infections are not always eradicated but usually controlled. Care can take place in the home, in the general practitioner (GP) surgery or in the outpatient clinic. Care can be undertaken by nurses, older patients and parents. Follow-up procedures are in place to ensure safe, effective therapy.


This is the first report of infection caused by "Mycobacterium lacticola," a rapidly growing, scotochromogenic mycobacterium that was isolated from the blood of an immunosuppressed child. The organism was identified by sequence analysis of >1,400 bp of the 16S rRNA gene. The clinical relevance of this isolate, coupled with its unique 16S rRNA gene sequence, should prompt further investigation to establish this organism as a valid mycobacterial species.

Central venous catheters are often mandatory devices when caring for critically ill children. They are required to deliver medications, nutrition, and blood products, as well as for monitoring hemodynamic status and drawing laboratory samples. Any foreign object that is introduced to the body is at risk for infection. Central venous catheters carry a particularly high risk of infection and these infections can be life threatening. Advanced practice nurses possess the power to influence catheter-related line infections in their critical care units. Understanding current recommendations for catheter material selection, site selection, site preparation, and site care can affect rates of catheter-related bloodstream infections. This article discusses risk factors for developing catheter-related bloodstream infections in critically ill children, as well as measures to decrease incidence of catheter-related bloodstream infections, including a review of recommendations from the Centers for Disease Control and Prevention. [References: 67]


To evaluate the role of inherited thrombophilia in the development of central venous line (CVL)-related thrombosis, the following parameters were determined in 77 pediatric-oncologic patients with CVL: activated protein C (APC)-ratio, factor V (FV) G1691A and prothrombin G20210A mutation, protein C, protein S, antithrombin, coagulation factor XII, lipoprotein (a) and homocysteine. An inherited prothrombotic risk factor was found in 17 patients (23%). Four out of 14 patients with a single defect (hyperlipoproteinemia, heterozygous FV G1691A and prothrombin G20210A mutation, protein C deficiency type I) and all three patients with combined defects (heterozygous FV G1691A mutation combined with heterozygous prothrombin G20210A variant, protein S deficiency or hyperlipoproteinemia) suffered from CVL-related thrombosis. In 11 out of 77 patients (14%) a CVL-related thrombosis was detected. In 2 children thrombosis occurred a few days after asparaginase therapy and in another three thrombosis was associated with CVL-related septicemia caused by Staphylococcus epidermidis. After removal of CVL, thrombosis was detected in 5 children, in 2 without clinical symptoms but in the presence of inherited prothrombotic risk factors. Conclusion. The present study demonstrates the clinical importance of CVL in combination with inherited thrombophilia in the development of thrombosis in pediatric-oncologic patients. Before or shortly after insertion of CVL, patients should be tested for the presence of factor V G1691A mutation, prothrombin G20210A variant and increased lipoprotein (a) values.


BACKGROUND: The peripherally inserted central catheter (PICC) is commonly used in children for medication and fluid administration. In addition, PICCs are used occasionally for blood sampling as an alternative to venipuncture. Blood sampling from these catheters carries the hypothetical risk of catheter occlusion caused by blood remaining in the catheter, and this practice is not supported by PICC manufacturers. Children often undergo multiple needle punctures, which are associated with pain, anxiety, and dissatisfaction with care. The authors hypothesized that blood sampling through 3-Fr PICC devices is effective and safe for children.

METHODS: After placement of a 3-Fr PICC, all the children were sequentially enrolled in one of two groups. The control group included patients that had 3-Fr PICC devices without blood sampling. The blood sampling group included patients with 3-Fr PICC devices through which blood samples were obtained. Demographic data, PICC placement and sampling data, infusate composition, catheter occlusion, mechanical
complications, and blood stream infections were recorded. The primary outcome variable was the difference in occlusion rates between the two groups.

**RESULTS**: The analysis included 204 children with 3-Fr PICCs (120 in the blood sampling group and 84 in the control group) who had a mean age, 117.7 +/- 4.9 months. The mean PICC duration was 15.6 +/- 1.0 days. Blood sampling was successful more than 98% of the time from all blood sampling group catheters, with a mean of 4.4 +/- 0.5 samples removed from each catheter. There was a higher occlusion rate in the blood sampling group. However, this result did not reach statistical significance. There were no significant differences between the groups in terms of infection or mechanical complication rates.

**CONCLUSIONS**: Blood sampling is feasible and effective through 3-Fr PICC devices in children. This practice is not associated with a significant increase in occlusion, infection, or mechanical complication rates.


A 14-y-old girl with osteosarcoma developed 3 episodes of catheter-related bacteraemia by Bacillus cereus. After removal of the first and insertion of a second Hickman catheter, further episodes of B. cereus bacteremia occurred. PFGE analysis revealed that bacteraemic episodes related to each catheter were caused by a distinct B. cereus strain.


A retrospective analysis was carried out to compare the performance and complications of central catheters inserted into either the saphenous (27) or jugular (52) veins. The saphenous route may be preferred in certain circumstances including extensive mediastinal pathology, prior neck surgery, previous catheter(s), and cosmetic reasons. There was no difference in complications (local or systemic catheter-related infections, catheter occlusions, or venous thrombosis). The incidence of catheter removal due to complications was also not different between sites. Hence, the saphenous route can provide an additional portal of vascular access in selected patients.


Frequent infusion of factor concentrates may be challenging in young boys with haemophilia, especially if their disease is complicated by inhibitors. A central venous access device (CVAD) is often placed in young patients in need of repeated infusions for prophylaxis or immune tolerance induction. Although user friendly and capable of providing reliable venous access, these devices are associated with a high complication rate over time. In the haemophilia population, major complications include CVAD-associated infections and deep venous thrombosis, which is most often silent. Established risk factors for catheter-related infection include age less than 6 years at the time of CVAD placement and use of an external CVAD when compared with a totally implantable device such as a port. Avoidance of CVAD-related infections is facilitated by strict adherence to aseptic technique. The risk of deep venous thrombosis appears related to the duration for which the catheter is in place, with the risk increasing beyond 4 years. The promotion of a strict clinic policy in which CVADs are left in place for as short a time as possible should decrease the risk of
complications. In rare cases where a totally implantable CVAD cannot be placed for technical reasons, an arteriovenous fistula may provide reliable venous access. In all cases, however, venous access via peripheral veins is preferred over CVADs. [References: 19]


Mycobacterium aurum was cultured from the Broviac catheter of a 5-year-old child with metastatic Wilms tumor. Removal of the catheter resulted in prompt resolution of the fever and sterilization of the blood culture. This rapidly growing mycobacterium, previously believed to be a commensal, can cause disease in the immunocompromised host.


Catheter sepsis with catheter removal is an important problem in patients with short-bowel syndrome. We determined the incidence of catheter sepsis and the catheter salvage rate in 20 pediatric patients with short-bowel syndrome. To evaluate the intestine as a source and translocation as the pathophysiologic mechanism for catheter sepsis, we identified the sepsis organisms, compared them with the fecal flora, and used mesenteric lymph node cultures to document translocation. The incidence of catheter sepsis was significantly higher in patients with short-bowel syndrome than in patients without short-bowel syndrome (7.8 vs 1.3 per 1000 catheter days). Overall catheter salvage was 42% and was highest in gram-negative sepsis (71%). Enteric organisms were responsible for 62% of cases of catheter sepsis in patients with short-bowel syndrome vs 12% in patients without short-bowel syndrome. Anaerobes were strikingly absent in 25 of 28 stool cultures. The sepsis organism was identified in the fecal flora in 19 of 28 cases. The dominant fecal organism or yeast was the septic organism in 12 of these 19 cases and was isolated in three of four mesenteric lymph node cultures. Our findings support translocation as a mechanism in catheter sepsis in patients with short-bowel syndrome.


BACKGROUND: The incidence of Hickman catheter sepsis is 10% to 40%, with resultant catheter loss in one third of infections. Urokinase causes dissolution of colonized intracatheter fibrin thrombi and may improve salvage.

STUDY AIMS: To evaluate the efficacy of 12-hour-interval slow-push urokinase infusion in addition to standard antibiotic therapy in the treatment of catheter sepsis in a pediatric oncology population.

METHODS: A two-arm randomized double-blind trial was undertaken, with catheter salvage rate as the end point. Patients with Hickman catheter sepsis were randomized after culture data confirmed the diagnosis. The study drug was administered by a slow intravenous push and given at 12-hour intervals for a total of four doses. The catheters were aspirated after 1 hour.
RESULTS AND CONCLUSIONS: The trial was stopped after 41 patients were entered into the study; 18 patients received a placebo, and 23 received the urokinase. In the placebo group, six catheters were lost; in the urokinase group, eight were lost. The rate of bacterial clearance was equivalent for both. After administration of the study drug, each group had three episodes of fever and chills; two of these resulted in hypotension (one in each group). The authors conclude that slow-push urokinase infusion during established Hickman catheter sepsis does not result in improved catheter salvage or bacterial clearance. Slow intravenous push infusions in this setting may provoke hemodynamic instability even after initiation of antibiotics.


A yellow-pigmented coryneform rod was isolated from the blood of a child with acute lymphoblastic leukemia who was perfused with a central venous catheter. The culture bottles were positive twice, at a 2-month interval. The isolate was identified as a Microbacterium sp. and studied along with five other similar strains. Phenotypic, chemotaxonomic, and genetic characteristics indicated that they are closely related to Microbacterium oxydans but that they belong to a distinct species, for which the name Microbacterium paraoxydans sp. nov. is proposed. The type strain of M. paraoxydans is CF36(T) = DSM 15019(T). The G+C content of its DNA is 69.9 mol%.


OBJECTIVES: To characterize and enumerate central venous catheter (CVC)-related complications among children with chronic illnesses, and to reduce the complication rate through changes in CVC management and education.

DESIGN: A prospective observational study followed by an educational program and a nonrandomized interventional trial.

SETTING: The Children’s Hospital of Philadelphia, a tertiary, pediatric facility.

PATIENTS: 268 children with Broviac, Hickman, or Infusaport catheters in place during 58,290 catheter days.

INTERVENTIONS: Development and implementation of protocols for cleaning insertion site and hub, use of nonocclusive dressings, and manipulation of access; formal staff and parental education about protocols.

RESULTS: CVC-related infections fell from 4.58/1,000 catheter-days preintervention to 3.83 postintervention (risk ratio [RR], 0.20; 95% confidence interval [CI95], 0.89-1.62; P = .25); exit-site infections fell from 0.58 to 0.11 (CI95, 1.22-45.64; P = .02); rates among infants on the surgical service fell from 15.46 to 6.67 (RR, 2.31; CI95, 1.10-4.30; P = .02).

CONCLUSIONS: Education and changes in management protocols reduced the incidence of exit-site infections among all patients and reduced the overall infectious complication rate among the infants receiving parenteral nutrition on the surgical service. Other interventions are needed to decrease further the infectious complications in these children.

The most common complication of central venous access device (CVAD) use is infection, which occurs in 3 to 48% of hospitalized patients. It is recommended that regular surveillance of adverse events with CVADS be conducted, expressed as a proportion of 1000 device days and reviewed and acted upon by the institution's infection control committee. In the process of developing a CVAD program the authors attempted to determine the standard of practice at other Canadian pediatric hospitals. A telephone survey of infection control practitioners (ICPs) or CVAD nurses in 15 university-affiliated Canadian pediatric hospitals was conducted using a standard questionnaire. Fourteen hospitals (93%) conduct surveillance for infections associated with CVADS. One program, a pilot project, follows mechanical complications of CVAD use. Eleven centres conduct comprehensive surveillance; in three, selected patients are followed. Only three programs have sufficient staff to follow out-patients. Definitions for CVAD infections varied widely. A positive blood culture from the catheter is sufficient for diagnosis in eight of the 14 centres (57%); the rest use Centers for Disease Control and Prevention (CDC) or modified CDC criteria. In the four centres where CVAD line days are collected on most or all patients, multiple personnel other than the ICP assist in data collection. Four hospitals report number of infections per 100 discharges, four report absolute number of infections and two use more than one denominator. Surveillance methods rely largely on paper-based chart and microbiology record review; no hospital had access to computerized patient data for direct data retrieval. Eight centres have CVAD committees for policy development, and all 15 have or are developing hospital-wide protocols for CVAD use. Canadian pediatric hospitals recognize the importance of CVAD infections, but it appears that insufficient resources are available to meet recommended data collection methods. Interhospital comparison of rates is not possible at present because of variation in definitions and denominators and in types of patients surveyed.


BACKGROUND: Central venous catheters (CVCs) have provided many benefits in modern-day medical practice; however, they also put patients at risk of catheter-related complications. Numerous studies have been carried out in relation to the management of central venous catheters with conflicting results. While there were several systematic reviews of central venous catheter-related issues, it is clear that there was no systematic review of CVC-related studies specific to the paediatric population in the acute care setting.

OBJECTIVE: To present the best available evidence for effective management of central venous catheters and catheter sites in the prevention and/or reduction of catheter-related complications in hospitalised paediatric patients.

METHODS: A systematic review was undertaken according to the approach of the Centre for Reviews and Dissemination (CRD; http://www.york.ac.uk/inst/crd).

DATA SOURCE: Literature was identified by electronic searching of Cochrane Library, MEDLINE, CINAHL, HealthSTAR, and CancerLit; checking references of all review articles; hand searching of key relevant journals and conference proceedings; and contact with expert informants, medical suppliers, and pharmaceutical companies.
INCLUSION/EXCLUSION CRITERIA: The review included randomised and non-randomised controlled trials conducted with hospitalised paediatric patients. Studies that included mixed adult and paediatric populations and mixed hospitalised and home care settings were excluded.

DATA EXTRACTION: Two independent reviewers extracted data onto a standard data extraction form, with differences resolved by discussion.

QUALITY ASSESSMENT: The quality assessment of retrieved studies included: study design, the degree to which systematic bias was avoided or minimised, the degree to which the assessment was "blind," the degree to which follow up was completed.

DATA SYNTHESIS: Quantitative pooling of studies was not feasible due to the diversity of interventions and outcome measures between similar studies. A narrative account of the study characteristics and results was therefore undertaken.

RESULTS: Thirty-eight randomised and quasi-randomised controlled trials were retrieved for critical appraisal. Of these, 32 were excluded from the review because the studies did not meet the inclusion criteria and some lacked reporting of appropriate data. Six studies met the criteria with interventions such as antibiotic flushes, antiseptic skin preparations, and dressing materials.

CONCLUSION: Quality of reporting was generally lacking. Statistical pooling of results was not possible due to diversity in the reporting of outcomes. There was no evidence to make recommendations on the degree of barrier precautions and the type of aseptic technique to be used at the time of catheter insertion in the paediatric population to prevent catheter-related infection. There was insufficient evidence to support the routine use of an antibiotic flushing solution. There was a lack of randomised controlled trial (RCT) evidence on the benefit of heparin flushes, the use of in-line filters, the frequency of fluid administration set changes, or the type of dressing to use and the frequency of dressing changes. There was some evidence to suggest that chlorhexidine lotion is superior to povidone iodine as a cutaneous antiseptic at the catheter insertion site. However, no recommendation can be made for the use of chlorhexidine in neonates less than 2 weeks old or in premature infants. This systematic review concluded that there is an urgent need for well-designed randomised controlled trials with sufficient power to determine the effectiveness of various interventions in relation to management of CVCs. [References: 29]

Leibundgut, K., C. Muller, et al. (1996). "Tunneled, double lumen Broviac catheters are useful, efficient and safe in children undergoing peripheral blood progenitor cell harvesting and transplantation." Bone Marrow Transplantation 17(4): 663-667.

We prospectively evaluated performance, efficiency, safety and compliance of large-bore central venous catheters (Cook TPN; Cook (Switzerland) AG) introduced via saphenous veins in 32 children and infants elected to undergo peripheral blood progenitor cell (PBPC) harvesting and transplantation (PBPCT). With these catheters a flow rate (25-65 ml/min) adequate for leukapheresis was achieved in all patients. There were no important catheter-related complications during harvest. The total duration of catheter placement was 4569 days (median, 139 days; range, 8-268 days). During this period which included conditioning and PBPCT, we observed five mechanical complications and 12 septic episodes not necessarily catheter-related (0.11 and 0.26 events per 100 catheter days, respectively). All infections resolved after systemic antibiotic treatment. There was no exit or tunnel area infection, and no catheter had to be removed due to infection. Two catheters were replaced because of displacement. Tunneled double lumen Broviac catheters
introduced via saphenous veins were not only efficient and safe, they were also well accepted by children
and young adults undergoing PBPC harvesting and transplantation.

central venous catheters in infants and children: a randomized controlled study." Pediatric Infectious

BACKGROUND: Infections of short term, nontunneled, intravascular catheters are often caused by migration
of organisms from the insertion site. The aim of this study was to evaluate the effectiveness and safety of a
chlorhexidine gluconate-impregnated dressing for the reduction of central venous catheter (CVC)
colonization and CVC-associated bloodstream infections in infants and children after cardiac surgery.

METHODS: This prospective, randomized, controlled study was conducted in the pediatric cardiac intensive
care unit of a tertiary care pediatric medical center. Patients 0-18 years of age who were admitted to the
pediatric cardiac intensive care unit during a 14-month period and required a CVC for >48 hours were
randomized to receive a transparent polyurethane insertion site dressing (control group) or a chlorhexidine
gluconate-impregnated sponge (Biopatch) dressing covered by a transparent polyurethane dressing (study
group). The main outcome measures were rates of bacterial colonization, rates of CVC-associated
bloodstream infections and adverse events.

RESULTS: Seventy-one patients were randomized to the control group and 74 to the study group. There
were no significant between group differences in age, sex, Pediatric Risk of Mortality score or cardiac
severity score. CVC colonization occurred in 21 control patients (29%) and 11 (14.8%) study patients (P =
0.0446; relative risk, 0.6166; 95% confidence interval, 0.3716-1.023). Bloodstream infection occurred in 3
patients (4.2%) in the control group and 4 patients (5.4%) in the study group. Local redness was noted in 1
control patient and 4 study group patients.

CONCLUSIONS: The chlorhexidine gluconate-impregnated sponge is safe and significantly reduces the rates
of CVC colonization in infants and children after cardiac surgery.


A case is reported of septic arthritis in a child with human immunodeficiency virus-negative hemophilia A
associated with a Staphylococcus aureus catheter-associated septicemia. The infection occurred in relation
to the use of a totally implantable central venous catheter. The organism was eventually eradicated with
antibiotics injected via the catheter. With increasing use of such catheters in the hemophilic population,
clinicians should be alerted to the possibility of septic arthritis for prompt diagnosis and treatment.


From two U.K. centres 23 children with severe congenital coagulopathy had a total of 27 port-a-cath devices
inserted to facilitate factor VIII or IX prophylaxis (eight patients), domiciliary therapy (seven patients),
immunotolerance (four patients), or a combination thereof (four patients). Six children had a factor VIII
inhibitor at the time of insertion. The mean age at operation was 30 months, with a range of 9-76 months. The cumulative length of follow-up is 639 months with a mean of 27.8 months and a range of 5-79 months. Haemostasis was achieved peri- and post-operatively with high-purity concentrate in the majority of patients without an inhibitor. All those with an inhibitor had porcine factor VIII, except one who had recombinant factor VIIa. The post-operative complication rate was 27% (6/23): three had a port-site haematoma (one required removal and replacement), two had post-operative infection, and one had swelling caused by extravasation. To date there have been 13 documented infections in 10/23 patients (five with inhibitor): a rate of 0.24 per follow-up year or 0.67 per 1000 patient-days. Six were caused by Gram-positive and seven by Gram-negative organisms. Six infections could not be eradicated by antibiotics and the port-a-cath system had to be removed; in three it was replaced by a second port-a-cath. Although there are risks involved in the use of port-a-caths in this population, both clinicians and parents involved in the care of these children believe that the benefits are considerable and the potential hazards are acceptable.


Pseudozyma aphidis is a heterobasidiomycetous yeast related to the smut fungi in the genus Ustilago. Pseudozyma species are usually isolated from plants and rarely from clinical specimens. We report what is believed to be the first paediatric case of central venous catheter (CVC)-related fungaemia associated with P. aphidis. Prompt removal of the CVC in conjunction with anti-fungal therapy resulted in a successful outcome.


Complications resulting from the use of implantable central venous devices (subcutaneous ports) were studied in 68 pediatric oncologic patients. These included six infections, three skin necroses, four dislodgements, and two occlusions. The complication rate was 21.4% (15/70). Devices were necessarily removed in four patients, and revised in three. Risk factors for infectious complications were analyzed. The average time-interval between the last preimplant chemotherapy and the implantation was 10 days for the infection cases vs 35 days for noninfections (p<0.01). It is suggested that a time interval of more than 15 days (mean+2 S.D.) should minimize infection complication.


Infections, thrombosis and technical problems are the most frequent complications when using implantable central venous access devices in patients with haemophilia. There seem to be two major experiences concerning infections in non-inhibitor patients, one is approx. 0.2 infections per 1000 days and the other approx. 1.0(0.7-1.6)/1000 days. Infections are more frequent in inhibitor patients and one can expect approx. one infection per 6-12 months of use. The figures are low for clinically apparent thrombosis in the larger series on record, but routine venograms were not done in most of these series. In studies where this has been done, a high frequency of abnormalities on venograms have been seen in some but not in others. The final decision to use a central line has to be a compromise between the medical goal, the patient's
bleeding tendency, the social situation and the expected risk of complications at the particular haemophilia center. Some of the complications may be reduced by adequate aseptic measures both during implantation and in the subsequent use and clear basic routines for surveillance of the systems and repeated education of the users. [References: 28]


Infections are the most frequent complications associated with the use of central venous lines (CVLs) in children with haemophilia. Several retrospective studies that include data from a substantial number of patients have reported approximately 0.2-0.3 infections per 1000 catheter-days (mainly Port-A-Cath). Some studies have shown a much higher frequency of infections, 1-2/1000 catheter-days. The most plausible explanations, for the difference seen in frequency of infections with Port-A-Caths, are probably related to the protocol used for the device care and the quality of education and the compliance of the users, whether these are parents or health-care professionals. The figures are low for clinically apparent thrombosis in the larger series on record, but routine venograms were not performed in most of these series. In studies, where this has been performed, a high frequency of abnormalities (>50%) on venograms have been seen in some series but not in others. Despite obvious potential risks with CVLs, they are useful in many cases and facilitate the treatment of a serious disorder. With careful guidelines and surveillance protocols, the risk of complications should be reduced in the future. [References: 58]


Twelve children with a severe form of haemophilia A received a totally implantable venous access system (Port-A-Cath) to facilitate regular prophylactic treatment with factor VIII. The indication for implantation was difficulty in obtaining regular access to a peripheral vein. Postoperative bleeding around the portal site occurred in two of 12 cases. After a median duration of follow-up of 26 months (range 5-79 months), none of the systems had needed replacement due to bleeding, septicaemia or thrombosis. One child, with an inhibitor against factor VIII, had an infection at the portal site and this system was removed. None of the other children had any serious side effects. Nine of the 12 children’s parents learned how to use the Port-A-Cath system, thus enabling optimal prophylactic home treatment with factor VIII to be begun early in life.


Experience of the Port-A-Cath implantable venous access system in 53 children with severe or moderate haemophilia A or B from seven centres in five countries is reviewed. The cumulative duration of follow-up was 1578 months (median 30 months, range 1-114). Of the devices implanted, 70% (37/53) were used without complications (median follow-up 32 months; range 1-114) and the remaining 30% (16/53) were associated with various types of complication: infection, bacteraemia or septicaemia in 56% (9/16) of cases, i.e. a rate of 0.07 per follow-up year or 0.19 per 1000 patient days, or various technical complications occurring after a median of 32 months (range 4-75) of uncomplicated use in the remaining 44% (7/16). Of the patients with inhibitors, 64% (7/11) manifested complications. Both doctors and parents considered that the Port-A-Cath device can be used with an acceptable frequency and severity of complications, and that it
enables regular prophylactic or on-demand home treatment of children with haemophilia to be begun at an early age.


OBJECTIVE: This retrospective case series sought to determine the incidence and profile of catheter-related complications associated with Port-A-Cath insertions in paediatric cancer patients, as well as predictive factors for infection-related port removals.

METHODS: Between January 2002 and December 2004, 175 consecutive Port-A-Cath insertions were followed for a total of 75,000 days (median, 407; range, 6-1,074). Incidence of catheter-related bloodstream infections (CRBSIs), other complications and CRBSI-related port removals were analysed for cases with acute leukaemia versus other malignancies.

RESULTS: A total of 33 CRBSIs were encountered in 26 cases (18.9%), an infection rate of 0.44 episodes per 1,000 catheter days. While mean preoperative platelet count was 125.34 x 10(9)/L in children with acute leukaemia and 392.11 x 10(9)/L in those with other malignancies (p < 0.01), the incidence of all complications were similar between both subgroups. Staphylococcus epidermidis (23.1%) and Klebsiella spp. (19.2%) were most commonly isolated from infected ports. Median patient age and duration of implantation in CRBSI-related port removals was 1.5 years and 111 days respectively, and 10.0 years and 414 days respectively in CRBSIs without port removal.

CONCLUSION: Minimal complications are associated with Port-A-Cath insertions, even in thrombocytopaenic leukaemic patients. The dominance of Gram-negative organisms in CRBSIs parallels the changing trend of nosocomial infectious agents involved in catheter-related infections.


BACKGROUND: Unnecessary delay of insertion of Port-A-Cath indwelling venous catheters in thrombocytopenic patients may result from fear of potential morbidity. This study sought to compare the morbidity of Port-A-Cath insertions in acute leukemic patients with platelet counts below and above 50 x 10(9)/L.

METHOD: Incidence and profile of catheter-related bloodstream infections (CRBSIs) and other complications were determined in 80 consecutive Port-A-Cath insertions in pediatric patients with acute leukemia from January 2002 to December 2004. Subgroup analysis was performed for patients with platelet levels below and above the recommended safe level of 50 x 10(9)/L.

RESULTS: Twenty-two (27.5%) patients had insertions performed at platelet levels below the recommended level (median, 35.3; range, 10-49 x 10(9)/L); postoperative counts were correspondingly higher (median, 66.0; range, 20-207 x 10(9)/L) with perioperative platelet transfusion. Catheter-related bloodstream infection incidence was similar in patients with platelets less than and greater than the recommended threshold (18.2% vs 17.2%, respectively), and likewise for CRBSIs encountered in the immediate 30 postoperative days (4.6% and 5.2%, respectively). Only 2 episodes of postoperative bleeding occurred, both in the group with platelet counts greater than 50 x 10(9)/L, with an equally low incidence of other local and
mechanical complications in both subgroups. Patient demographics and other preoperative blood parameters did not differ significantly.

CONCLUSION: Preoperative thrombocytopenia was not associated with increased incidence of postoperative complications for Port-A-Cath insertions in acute leukemic children.


PURPOSE: To define the per-day risk of central line associated bacteremia in an infant-toddler population and to describe risk factors associated with the development of central line bacteremia.

METHOD: The Central Line Data Tool collected information on 102 central venous catheters from 73 patients ranging in age from 1 day to 29 months. Each line was in place for 3 days or longer. FINDINGS: There were 17 documented catheter-related infections during the 1-year study period (7.7 infections per 1,000 catheter days). Factors significantly associated with central line bacteremia included: PAS infusion, catheter type and site, medication administration, blood withdrawal, and accidental line disruption.

CONCLUSIONS: Use of central lines for multiple purposes should be minimized.


The use of central venous catheters, while advantageous, is associated with a range of complications including thrombosis and infection. These complications can pose significant physical and financial costs to the patient and health care system. A critical appraisal of the two randomized controlled trials examining this topic in critically ill patients has shown that heparin-bonded central venous catheters significantly reduced the incidence of catheter-related thrombosis and infection in children and adults. These findings suggest that heparin-bonded central venous catheters should be considered for routine use in critically ill patients.


OBJECTIVE: We evaluated the technical success and complications associated with radiologic placement of implantable chest ports in children for long-term central venous access.

MATERIALS AND METHODS: Between May 1, 1996 and January 11, 2000, 29 chest ports were placed in 28 children (15 girls, 13 boys; age range, 2-17 years; mean, 11.7 years). The patient's right internal jugular vein was used for access in 93% (27/29) of the procedures, and a collateral neck vein was used as a conduit to recanalize the central veins in two procedures because of bilateral jugular and subclavian vein occlusion. All procedures were performed in interventional radiology suites. Both real-time sonography and fluoroscopy were used to guide venipuncture and port insertion. Follow-up data were obtained through the clinical examination and electronic review of charts.

RESULTS: Technical success was 100%. Fourteen percent of the catheters were removed prematurely, including one catheter removed 17 days after placement because the patient's blood cultures were positive for Candida albicans. No patients experienced hematoma, symptomatic air embolism, symptomatic central
venous thrombosis, catheter malposition, or pneumothorax. The median number of days for catheter use by patients was 280 days (total, 9043 days; range, 17-869 days). The rate of confirmed catheter-related infection was 14% or 0.04 per 100 venous access days. One catheter occluded after 132 days.

**CONCLUSION:** In pediatric patients, radiologists can insert implantable chest ports using real-time sonographic and fluoroscopic guidance with high rates of technical success and low rates of complication.


Helen Lucas and Simon Attard-Montalto evaluate the effectiveness of dressing in reducing exit site infection following central venous catheterisation.


An audit of 151 central venous catheters (CVCs) in 118 children with malignant disease was carried out over 20 months. The types included 31 valved silastic (Groshong), 58 non-valved silastic (Hickman), and 62 non-valved polyurethane (Cuff Cath) CVCs. There was no difference between the three groups with regard to the clinical diagnosis. The mean patient age at catheter insertion was 5.5 years and the mean weight 21.6 kg. None of the catheter types were associated with an increased risk of problems at insertion, migration, mechanical damage, blockage, sampling, or catheter infection. The incidence of catheter infection was 1.4 /1,000 catheter days. Exit-site infection was less frequent with Groshong CVCs (P < 0.05), which were in situ for the shortest period. The risk of problems with blood sampling was significantly increased in those catheters whose tip was sited outside the right atrium (P < 0.005). For the 60 CVCs removed electively, the mean duration in situ was similar for all catheter types; 43 were removed following a problem. Of these, Groshong catheters were in situ for the shortest period (P = 0.05), probably as a result of delayed anchoring of the cuff. The tip position was the single most important determinant in the correct functioning of CVCs, irrespective of the type of catheter. Intraoperative screening of the tip position at catheter insertion is therefore mandatory for optimal catheter functioning.


Intensive care patients with central catheters were included in a month-long study to describe the usage of central catheters and determine factors associated with nosocomial infections. Eighty-seven patients had 130 catheters of five different types used for multiple purposes. All study variables were higher for the infected group. Significant differences were found between noninfected and infected groups in regard to number of single-lumen catheters, laboratory blood draws, intermittent infusions, heparin-locked ports, types of infused solutions, dressing changes, and hospitalized days. Total hospitalization days and total number of intermittent infusions were the best predictors of infection (P < .05).

BACKGROUND: Recommendations for subclavian vein catheter placement in children are extrapolated from adult experience. The purpose of this study was to determine the ideal body position to optimize the size of the subclavian vein in children for percutaneous catheter placement.

METHODS: Children underwent ultrasound imaging of the subclavian vein in four supine body positions: head in a neutral position with the chin midline (NL) and no shoulder roll (SR); head turned 90 degrees away (TA) and no SR; head NL with an SR; and head TA with an SR. The cross-sectional area (CSA) of the subclavian vein was calculated and statistical significance was determined using the Student’s t test and the Wilcoxon signed rank test.

RESULTS: Nine children participated in the study, with a mean age of 5.3 years. The CSA of the subclavian vein was 0.39 +/- 0.24 cm² with the head NL and no SR, compared with 0.31 +/- 0.20 cm² with the head TA or 0.32 +/- 0.23 cm² with the head TA and SR. This represented a significant reduction in the CSA of the subclavian vein by 22% and 18%, respectively (p < 0.05).

CONCLUSION: In children, the recommended maneuvers of turning the head or turning the head and placing a posterior shoulder roll significantly reduce the cross-sectional area of the subclavian vein. Maintaining the head in a normal position with the chin midline without a shoulder roll optimizes subclavian vein size. Positioning children in this manner may serve to reduce the morbidity associated with percutaneous subclavian vein cannulation.


OBJECTIVE: To evaluate, in critically ill children, the safety and effectiveness of routine central venous catheterisations (CVCs) performed by residents from all disciplines.

DESIGN: Prospective audit of all CVCs over a 24-month period.

SETTING: Multidisciplinary intensive care unit at Baragwanath Hospital, Soweto.

PATIENTS: All critically ill patients 12 years of age or younger requiring CVC. All percutaneous sites (subclavian, internal jugular and femoral) were used; these were selected by the attending doctor and not influenced by the audit.

RESULTS: There were 272 catheterisation attempts, of which 241 (88.6%) were successful. Patient age and size but not disease severity influenced incidences of both catheterisation failure and minor bleeding. The latter was the commonest early complication, occurring in 63 (23.2%) successful catheterisations. There were 7 major complications-3 pneumothoraces, 2 tachyarrhythmias and 2 major bleeds, all with subclavian vein catheterisation. Catheter-related infections (CRIs) occurred in 85 (51.2%) of 166 lines and catheter-related septicemia (CRS) in 10 (5.7%) of 175 lines where there were sufficient data for evaluation. No patient or line factor, including duration of insertion, influenced CRI or CRS. In CRI, Staphylococcus epidermidis was the commonest organism. Other common CRI isolates were Enterococcus faecalis, Klebsiella spp. and Candida albicans. Six different organisms were implicated in CRS.
CONCLUSIONS: CVC is a safe procedure with a high success rate. The femoral vein is the recommended percutaneous site of choice as it carries no great risk of sepsis and does not expose the patient to the hazard of intrathoracic complications.


Appropriate use of central venous catheters (CVCs) to administer parenteral nutrition (PN) to pediatric patients requires a working knowledge of catheter types, inpatient care, out-patient management, complications, and troubleshooting. Because of the expanded role of the dietetics professional who works with PN-dependent children, he or she may be the clinician who is informed of a complication in a home patient that requires appropriate referral for further evaluation. He or she also may identify a psychosocial situation that puts the child who has a CVC at risk for harm related to caregiver-inflicted CVC damage or infection. Understanding the typical approach to CVC care, usual treatment of a complication, and how to direct the parent for further help is part of the scope of practice for a dietetics professional who is part of a nutrition support team. This article discusses types of CVCs used for PN in pediatrics, how skin care is guided by an understanding of neonatal and pediatric development, complications of CVC use, and current therapies used to treat or prevent complications.


The purpose of this trial was to prepare for a large randomized trial comparing Arglaes film dressing, a recent innovation containing silver ions, against Tegaderm, a transparent polyurethane dressing. Thirty-one patients admitted to the intensive care unit and requiring the insertion of an arterial line or central venous catheter were recruited into the study. Skin swabs were taken from the insertion sites prior to catheterization and on removal of the intravascular device to measure skin colonization rate between the two dressings. The catheter tips were also cultured on removal to establish if there was a difference between the two groups. No statistical differences were found in bacterial growth between the two dressings.


We analyzed the use of non-tunneled (polyurethane, double lumen) central venous catheters (CVCs) for the collection, conditioning, transplantation and immediate post-transplantation periods in 56 children with various malignant diseases. A total of 71 leukaphereses were performed, with a mean of 1.2 apheresis per patient, following administration of granulocyte colony-stimulating factor (G-CSF) using a continuous flow blood cell separator (Cobe Spectra). The mean TBV (total blood volume) processed was 4.5 +/- 1.2 s.d. (range 2.4-7). The mean flow rate was 30.6 ml/min and the duration of a single apheresis was 327 +/- 84 s.d. (range 175-511 min). The mean purities and efficacies of collections were 77.38 +/- s.d. (range 42-100) and 42.78 +/- s.d. (range 24-80), respectively. The mean numbers of mononuclear cells (MNC) and CD34+ cells collected were 9.3 +/- 6.9 s.d. x 10(8)/kg (range 2-49) and 6.2 +/- 7.2 s.d. x 10(6)/kg (range 1-42), respectively. We observed the following complications during catheter insertion for collection:
pneumothorax (1.7%), mechanical dysfunction (3.5%) that resolved with thrombolytic therapy. Complications during conditioning, transplantation and immediate post-transplantation periods were entry site infection in five patients (8.92%), catheter-related infection in two (3.57%) and catheter-related sepsis in three (5.35%). Our results indicate that the collection of PBSC with non-tunneled catheters is safe, effective and dis associated with a low incidence of complications.


We analyzed the use of non-tunneled (polyurethane double lumen) central venous catheters (CVCs) in 62 children undergoing bone marrow transplantation. The catheters were inserted in the Critical Care Unit without surgery or general anesthesia. The complications were pneumothorax in two patients and hemopneumothorax in two other patients (6.06%), entry site infection in six patients (9.6%), catheter-related infection in eight patients (12.9%) and catheter-related sepsis in nine patients (14.5%). The catheters were removed upon completion of therapy in 46 patients (74.1%), death in seven patients (11.3%) and in nine cases (14.5%) for infection. Despite the complications specific to non-tunneled catheter insertion, we believe this is indicated for patients during conditioning, transplantation and immediate post-transplantation periods.


We examined long-term central venous line catheter complications in 78 immuno-compromised children who underwent 81 porta-cath insertions. The rate of infection was 15% (12/81). Conservative treatment failed to clear the infection in all these cases (12/12) leading to the removal of the porta-cath. One catheter slipped in the right atrium of the patient and was retrieved by the interventional radiologist under general anesthesia. Another catheter was removed due to complete blockage by thrombosis. Our experience shows that complications following central venous line insertion can be markedly reduced by collaboration and regular communication between the surgical and nursing team.


More than 90% of all intravascular device-related septicaemias are due to central venous or arterial catheters. To assess the efficacy of cutaneous antisepsis to prevent catheter-associated infection, we prospectively studied three antiseptics for disinfection of patients' central venous and arterial catheter insertion sites in a surgical intensive care unit. 668 catheters were randomised to 10% povidone-iodine, 70% alcohol, or 2% aqueous chlorhexidine disinfection of the site before insertion and for site care every other day thereafter. Chlorhexidine was associated with the lowest incidence of local catheter-related infection (2.3 per 100 catheters vs 7.1 and 9.3 for alcohol and povidone-iodine, respectively, p = 0.02) and catheter-related bacteraemia (0.5 vs 2.3 and 2.6). Of the 14 infusion-related bacteraemias (4 due to contaminated infusate or catheter hub, 10 due to infected catheters), 1 was in the chlorhexidine group and 13 were in the other two groups (odds ratio 0.16, p = 0.04). We conclude that use of 2% chlorhexidine, rather than 10%
povidone-iodine or 70% alcohol, for cutaneous disinfection before insertion of an intravascular device and for post-insertion site care can substantially reduce the incidence of device-related infection.


Venous access represents the major barrier to the feasibility of prophylaxis and immune tolerance induction (ITI) in haemophilic children. Ports improve treatment feasibility, but their duration is limited by infectious complications. This study aimed at evaluating whether or not ports allow haemophilic children to maintain the treatment regimen in the long term. Children were prospectively followed-up and underwent port removal either for complications or transition to peripheral veins. Of 27 ports (17 used for prophylaxis and 10 for ITI), 25 were removed after a median of 3.3 years. Inhibitor children showed a younger age at port insertion (P = 0.02), an earlier occurrence of infections (P = 0.006) at a higher rate (P = 0.00001) and an earlier removal for infection (P = 0.05) than non-inhibitor patients. Daily port use was associated with earlier infections at a higher rate compared to less frequent use (P = 0.02). Port removal after a median of 0.8 years prevented ITI completion in 50% of children, while it hampered the maintenance of prophylaxis in 27% of patients. This study showed that ports improved the feasibility of prophylaxis in the majority of non-inhibitor children, while they were not suitable for inhibitor children who require a prolonged ITI regimen with daily infusions.


BACKGROUND: Peripherally inserted central venous catheters (PICCs) have been increasingly used in pediatric patients. However, little is known about the incidence and risk of complications when using this device in children with cancer. The purposes of this study are to assess the feasibility of PICCs and to determine the risk factors for PICC-related complications in pediatric patients with various types of malignancies.

PATIENTS AND METHODS: We attempted to place PICCs in 53 patients with a median age of 5 years ranging from 2 months to 20 years. PICCs were used to administer fluid, parenteral nutrition, anticancer agents, antibiotics, and blood products and also for the through-line blood sampling. The duration of catheterization and the incidence of PICC-related complications requiring removal were retrospectively evaluated in association with the diagnosis, sex, age and body weight of the patients, size, insertion site and tip location of the catheters, type of treatment, and duration of leukopenia.

RESULTS: PICCs were successfully placed in 109 of 112 attempts (97.3%) in 53 patients, and they were followed for a total of 11,797 catheter days (median placement, 87 days; range, 3 to 512 days). Fifty five PICCs (50.5%) were removed as a result of PICC-related complications with a rate of 4.66 per 1,000 catheter days. The most common reasons for catheter removal were occlusion (n=18), breakage/leakage (15), and infection (10). More than 70% of such complications occurred more than 30 days after placement. The catheter tip location in the superior vena cava or the right atrium might decrease the risk of complications. Other parameters did not influence the incidence of complications.

CONCLUSIONS: PICCs were found to provide a reliable access for prolonged intravenous administration and blood sampling in children intensively treated for hematologic and solid malignancies, thus leading to a
reduction of physical pain and psychological stress in such patients. However, the long-term placement of PICCs may also be related to an increased risk of complications.


A novel way of using teicoplanin in situ to treat central venous catheters is described. Profound immunosuppression and the fact that the lines remain indwelling for long periods are two of the main reasons for these infections. In children it is also difficult to prevent these lines being played with, which increases the likelihood of infection. The different types of infection that can occur in a central venous catheter are described and the clinical definition of a catheter infection is provided. In an initial study, infective episodes in a small group of 11 children were treated successfully with in situ amikacin. Most pathogens were Gram-negative cocci. None of the catheters had to be removed, and catheter life was prolonged by a mean of 118 d. Due to the high incidence of Staphylococcus epidermidis in the initial study, in situ teicoplanin was assessed in a subsequent study. Over the course of 1 yr, 20 line infections occurred in 12 children. Empirical amikacin therapy was instituted and switched to teicoplanin once the pathogen was confirmed as Gram-positive. An antibiotic-heparin mixture was introduced into the line and left in place for 24 h, after which time it was replaced with fresh mixture until cultures were sterile. All pathogens were sensitive to teicoplanin, all infections were treated successfully and no catheters had to be removed. Overall, catheter life was prolonged by a mean of 136 d. It was concluded that in situ teicoplanin was effective and well tolerated for line infections (no side-effects were reported during the study). A minimum of 6 d therapy was recommended. The patients with less severe infections would have been suitable for treatment at home by their parents, district nurse or general practitioner (GP).


Nan McIntosh reports on a five-year audit of CVC use in children in a cancer treatment centre.


OBJECTIVE: Few data exist on successes at reducing pediatric catheter-associated bloodstream infections (CA-BSI). The objective was to eradicate CA-BSI with a multifaceted pediatric-relevant intervention proven effective in adult patients.

DESIGN: Prospective cohort of pediatric intensive care (PICU) patients with historical controls.

SETTING: Multidisciplinary PICU. PATIENTS/PARTICIPANTS: PICU patients with intervention targeting PICU providers.

INTERVENTIONS: Multifaceted intervention involving preintervention staff surveys, provider educational program, creation of central catheter procedure cart, guideline-supported central catheter insertion checklist, nursing staff empowerment to stop procedures that breached guidelines, and real-time data feedback to PICU leadership.
MEASUREMENTS AND MAIN RESULTS: We measured rate of CA-BSI per 1000 catheter days from August 2001 through September 2006. Reliable use of evidence-based best practices for insertion of central catheters in our PICU was associated with a statistically and clinically significant decrease in our CA-BSI rate for 24 months postintervention (p < .05). During a portion of this postintervention period, we experienced a dramatic increase in our CA-BSI rate that was ultimately found to be due to the introduction of a new positive displacement mechanical valve intravenous port in April 2004. After removal of this positive displacement mechanical valve, our CA-BSI rate dropped from 5.2 +/- 4.5 CA-BSI per 1000 central catheter days to a rate of 3.0 +/- 1.9 CA-BSI per 1000 central catheter days. Chart review of postintervention CA-BSI cases revealed that these patients acquired CA-BSI weeks after both PICU admission and after insertion of the most recent central catheter.

CONCLUSIONS: Our data show that improving practices for insertion of central catheters leads to a reduction of CA-BSI among pediatric patients but not elimination of CA-BSI. More research is needed to identify best practices for maintenance of central catheters for children. In addition, our experience shows that even despite good interventions to control CA-BSI, institutions must remain vigilant to factors such as new technology with apparent advantages but short track records of use.


PURPOSE: In pediatric patients with acute lymphoblastic leukemia (ALL), the optimal time for central venous line (CVL) insertion and the optimal type of CVL (internal v external) is unclear. This study was undertaken to compare complication rates between early versus late line insertion, and between internal versus external lines in children with lesser risk ALL.

PATIENTS AND METHODS: We performed a retrospective analysis of patients enrolled onto Pediatric Oncology Group (POG) protocol 9201. Data regarding demographics, CVL types and insertion dates, blood counts, and complications were reviewed through week 25 of therapy.

RESULTS: Of 697 patients enrolled onto POG protocol 9201, 362 patients had sufficient data for analysis. When compared to late line placement (> day 15 of induction), early CVL placement (</= day 15 of induction) was associated with an increased risk of having a positive blood culture (odds ratio, 2.2; 95% CI, 1.0 to 5.0; P = .05). When compared with internal CVLs ("ports"), external CVLs were associated with a positive blood culture (odds ratio, 3.1; 95% CI, 1.3 to 7.5; P = .01), thrombosis (odds ratio, 3.9; 95% CI, 1.5 to 10.3; P = .006), and CVL removal (odds ratio, 5.6; 95% CI, 2.7 to 11.6; P < .001).

CONCLUSION: In pediatric patients with lesser risk ALL, internal lines (ports) should be the preferred CVL type due to a lower risk of infectious and thrombotic complications. In addition, CVLs placed early in induction are associated with a higher risk of positive blood culture than those placed later in induction.


Roseomonas is a newly described genus of pink-pigmented, gram-negative bacteria. Human infections caused by Roseomonas species are very rare. We report two cases of central venous catheter-related bacteremia associated with Roseomonas species (one case with R. gilardii and one with R. fauriae), and
review the clinical spectrum of previously reported cases in the literature. Clinicals should be aware that Roseomonas species may cause serious infections in children.


Reliable venous access is essential to facilitate the administration of prophylactic factor concentrate or blood products in children with congenital coagulation disorders and immune tolerance therapy (ITT) regimens in those who develop high responding inhibitors. Poor venous access is even more problematic in very young children, the vast majority of whom will require the insertion of central venous access devices (CVADs). Previous studies have suggested that infection rates are low and that there are few long-term complications associated with CVAD usage. We have reviewed 86 CVADs that have been inserted, since 1988, in 58 children with congenital bleeding disorders, aged 6 d to 16.5 years, attending Great Ormond Street Hospital, London, and the National Children's Hospital, Dublin. The devices have remained in situ for 2 weeks to 92 months (median 22.5 months). Early (0-2 weeks) complications of CVAD insertion included nine bleeding episodes, one extravasation of factor concentrate, three allergic reactions to factor concentrate and five catheter infections. Overall, CVAD infection was the commonest problem encountered, with 52 devices (60%) becoming infected. Twenty-seven CVADs (31%) required removal. Infection rates in children without inhibitors (29/68) were 1/20 patient-months or 1.6 infections/1000 patient-days, but infection rates for those with inhibitors were 1/8.5 patient-months or 4.3/1000 patient-days. Staphylococcus epidermidis was the predominant organism (25/52) isolated. Blockage of CVAD (four) and catheter disconnection (four) were the most frequently occurring non-infectious long-term complications. Skin erosion of the port was also seen in three children, in one child at 20 months, in one at 29 months and in one at 34 months after insertion. This study demonstrates a high CVAD infection rate and highlights the long-term complications of CVAD usage.


To assess the risk of deep vein thrombosis in haemophiliacs with long-term central venous catheters, we studied haemophiliacs followed at our centre with implantable venous access devices (ports) in place for > 6 months. Medical records were reviewed for a history of catheter-related complications. Each patient was examined for physical stigmata of thrombosis. Patency of the vessels was evaluated by contrast venography. Of 21 males with ports, 19 had factor VIII deficiency and two factor IX deficiency. Nineteen ports were evaluable (i.e. were in place for > 6 months). Seventeen patients have their original ports in place; two ports were replaced for mechanical dysfunction (1) and recurrent infection (1). Difficulty withdrawing or infusing occurred with three ports, two of which were cleared with urokinase. Physical examination was normal on all 19 patients. Venograms were performed in 13 of 19 patients. Parents of the remaining six patients refused venography because of the need for peripheral venipuncture. One patient had a small nonocclusive thrombus on the same side as his functioning catheter, and another had minimal narrowing of the subclavian vein at the site of a prior catheter. The overall prevalence of clinically relevant upper venous system thrombosis identifiable by contrast venography was zero (95% CI, 0-23%). We conclude that haemophiliacs do not have as high a risk of thrombosis as other populations of patients with central venous catheters. The theoretical risk of thrombosis should not preclude use of central venous catheters in patients with haemophilia.

We compared catheter survival and sepsis rates in a tertiary paediatric gastroenterology centre with those at home in the same patients. We examined whether there were differences in the safety in the two locations, and estimated the financial and opportunity cost implications of any difference. We used survival analysis to analyse differences. Surgical records were audited to determine venous access workload, and to estimate cost implications. Twenty patients with chronic intestinal failure but stable parenteral nutrition requirements, ranging from 0.04-15.83 years of age were studied. The duration of line survival and sepsis-free intervals and rates of re-operation for venous access were determined to estimate morbidity and costs. The study encompassed 28 patient-years in hospital and 48 patient-years at home. There was a significant reduction in the rate of sepsis at home compared with hospital (Z = 4.30, P < 0.00001), and a similar improvement in line survival (Z = 4.36, P < 0.00001). Line insertions accounted for 21% of minor surgery in our hospital, one third being reinsertions. We conclude that central venous catheter sepsis rates are greatly improved at home. If home results could be achieved in the hospital setting, considerable cost savings would be made.


BACKGROUND: There have been many reports of complications of central venous lines in children but limited discussion of the specific problem of retained intravascular fragments after attempted removal. We report on a series of 6 patients from 2 tertiary pediatric hospitals that had intravascular segments of long-term central venous lines that could not be removed and so were left in situ.

METHODS: We conducted a retrospective multiinstitutional review of long-term central venous lines (Broviacs, Port-A-Caths, and Hickmans) removed in the operating room with a focused chart review and prospective follow-up of those patients that had a failed attempt at removal.

RESULTS: A total of 299 central venous lines were removed with 6 patients identified as having fragments of lines left behind (2%). The lines had been in place for an average of 37 +/- 12 months. The average follow-up period is now 5.4 +/- 3.9 years; none of the patients have developed any symptoms, evidence of thrombus, infection, or catheter migration.

CONCLUSION: Given the 2% incidence rate, the issue of managing a stuck long-term central venous line will face most individuals who place these lines. We have demonstrated that simply ligating the catheter and leaving the fragment in place appears to be a safe option with minimal risk to the patient. [References: 16]


Blood samples were collected for quantitative 16S rDNA analysis from the vascular access device (VAD) of patients presenting with fever at participating centres of the UK Children’s Cancer and Leukaemia Group. In total, 260 of 301 episodes of fever were evaluable and were classified as probable, possible, unlikely or unclassifiable VAD-associated infection. The sensitivity of the 16S rDNA assay declined concomitantly with delays from time of presentation to sampling. The sensitivity with >0.125 pg of bacterial DNA/microL of
whole blood was 80% for the 20 probable VAD-associated infections diagnosed with samples collected on the day of or day following presentation. The specificity rose with increasing amounts of bacterial DNA, from 93% with >0.125 pg, to 98% with 0.25-0.5 pg, and to 100% with >0.5 pg/microL blood. The positive predictive value (for probable or possible) was 88% (95% CI 70-98%) with 0.25 pg/microL, and 100% (95% CI 83-100%) with >0.5 pg/microL. All 18 (6.8%) episodes with >0.5 pg of bacterial DNA/microL blood were associated with positive blood cultures. Identifications derived from the DNA sequence were consistent with the blood culture identifications for 15 of the 17 episodes with a DNA sequence identification. The VAD was removed because of suspected infection in six (2.8%) of 216 episodes with <0.125 pg of bacterial DNA/microL, in one (5%) of 20 episodes with 0.125-0.25 pg/microL, in one (16.7%) of six episodes with 0.25-0.5 pg/microL, and in nine (50%) of 18 episodes with >0.5 pg/microL. A bacterial DNA concentration of >0.5 pg/microL in blood drawn through a central venous catheter at the time of fever presentation had a high positive predictive value for VAD-associated infection and predicted an increased risk of VAD removal because of suspected infection.


OBJECTIVE: The objective of this study was to define the efficacy and complications of implantable venous access devices (IVADs) in children with hemophilia.

STUDY DESIGN: Records were reviewed on all patients with congenital blood coagulation disorders monitored at two children's hospitals in whom one or more central venous catheters had been placed.

RESULTS: Since 1989 external and implantable central venous catheters have been inserted to enhance venous access for regular factor concentrate infusion in 45 patients with hemophilia ranging in age from 8 months to 19.5 years (median 7.4 years); 37 patients had factor VIII deficiency and 8 factor IX deficiency. Hemorrhagic complications of catheter placement were infrequent and minor. In the 41 patients having one or more IVADs in place for a median of 31 months, only six episodes of bacteremia occurred in 5 patients during 44,070 days of follow-up. The overall rate of bacteremia complicating IVADs in these patients was 0.14 episodes per 1000 catheter days. Other catheter-related complications were uncommon. Catheters are still in place in 33 patients for a median of 32 months.

CONCLUSION: The low risk of infection and other complications associated with the use of IVADs makes the use of these devices attractive in the treatment of patients with hemophilia who require frequent venous access for factor concentrate infusions.


Central venous catheters are integral to the care of acutely ill children, providing reliable vascular access for infusions, hemodynamic monitoring, and blood sampling. However, there are risks associated with their use, the most common of which is central line-associated blood stream infections. These infections result in increased lengths of stay, increased costs, and high mortality rates. A thorough review of research evidence has been completed to fully appreciate the state of the evidence regarding the effects of bundling together the care for central venous catheters, and practice recommendations have been provided. Published studies have been appraised and evaluated for clinical and statistical significance. This appraisal has resulted in clear
and specific recommendations for evidence-based practice applications, and potential policy implications are outlined in this article. [References: 18]


The complications associated with the placement and use of Hickman catheters (n = 120), Broviac catheters (n = 146), and implantable ports (n = 93) in children with cancer were analyzed. Percutaneously placed central venous access devices (CVADs) tended to fail less often (P = .86) and to develop infections less often (P = .056) than surgically placed CVADs. The difference in complications with percutaneous versus surgically placed CVADs requires confirmation in a randomized trial to assure they are not a result of differences in patient characteristics. When all catheter failures (removal due to infection, obstruction, or dislodgement) were considered, ports had a significantly longer failure-free duration of use than externalized Hickman and Broviac catheters (P = .0009). Ports also remained infection-free longer than externalized catheters (P = .0014). The greatest risk of infection occurs in the first 100 days of use, particularly for ports. This study demonstrates that for long-term use (greater than 100 days) ports are superior to externalized catheters in children with cancer.


With the widespread use of central venous catheters in children, the incidence of catheter-related bloodstream infections (CR-BSIs) is increasing. Current evidence-based practice strategies to decrease CR-BSIs include using maximum barrier techniques during insertion, practicing good hand hygiene, performing skin antisepsis with 2% chlorhexidine, using a chlorhexidine-impregnated patch (CIP) covered by a semipermeable polyurethane dressing, and promptly removing catheters when no longer needed. Implementation of evidence-based practice bundles, along with monthly monitoring of infection surveillance, has resulted in significant decreases in the average rates of CR-BSIs per 1,000 catheter days in many pediatric intensive care units.


It has been estimated that there may be as many as 150,000 healthcare associated infections (HCAI) in Australia each year, contributing to 7,000 deaths, many of which could be prevented through the implementation of appropriate infection control practices. Contact with contaminated hands is a primary source of HCAI. Intensive care staff have been identified as one of the least adherent groups of health care professionals with handwashing; they are less likely to practise hand antisepsis before invasive procedures than staff working in other patient care specialties. The study examined the self-reported clean and aseptic handwashing practices of nurses working in paediatric intensive care units (PICUs) across Australia and New Zealand, the patterns in variation between nurses’ reported handwashing practices and the local policies,
and patterns in the duration of procedural handwashing for specific procedures. A survey was undertaken in 2001 in which participating tertiary paediatric hospitals provided copies of their infection control policies pertaining to central venous catheter (CVC) management; five nurses on each unit were asked to provide information in relation to their handwashing practices. Seven hospitals agreed to participate and 30 nurses completed the survey. The study found an enormous level of variation among and between nurses' reported practices and local policies. This variation extended across all aspects of handwashing practices - duration and extent of handwash, type of solution and drying method used. The rigour of handwashing varied according to the procedure undertaken, with some evidence that nurses made their own risk assessments based on the proximity of the procedure to the patient. In conclusion, this study's findings substantiate the need for standardisation of practice in line with the current Centers for Disease Control and Prevention Guidelines, including the introduction of alcohol handrub.


The records of 27 pediatric patients who required parenteral nutrition (PN) for 5 to 14.5 years (mean +/- SD, 8.5 +/- 3.8) were analyzed to determine the frequency of complications with their central venous catheters (CVC). This represents a 230 patient-year experience. Patients with short bowel syndrome and chronic intestinal pseudoobstruction syndrome (CIPS) accounted for all but two of the patients. Unsuccessful medical management of the exit site or CVC infection was responsible for removal of 62% of the 123 CVCs. Ninety-five episodes of line infection occurred in 24 patients. Fifty (52%) were successfully treated without catheter removal. The organisms responsible for catheter removal were fungal (14), mycobacterium species (5), gram-positive cocci (22), or gram-negative bacilli (19). The CVCs were infected an average of once every 884 days. The life of the second CVC (23.5 +/- 17.9 months) was significantly longer than that of the first (P < .05). Clotting of the CVC with unsuccessful lysis of the clot was responsible for removal of 24%, and breakage or unsuccessful repair was responsible for 14%. In no patient were all possible venous sites for CVC placement exhausted. Patients with CIPS had substantially fewer catheter complications (P < .05) than did those with short bowel syndrome. In conclusion, CVCs can "survive" without major complications for more than a decade. Numerous factors contribute to the increased rate of CVC survival over time, including improvement in PN self-care with greater experience, improvement in teaching, regular follow-up of patients, better management of infection, and better ability to treat CVC thrombosis or breakage. [References: 32]


BACKGROUND: Children with short bowel syndrome (SBS) requiring central venous catheters (CVCs) may experience frequent catheter-related infections (CRIs). Treatment strategies include antibiotic- and ethanol-containing locks, with CVC removal if the CRI cannot be cleared. Ethanol lock therapy has been reported for CRI treatment in children but not for CRI prevention.

METHODS: Medical records of children with SBS receiving cycled home parenteral nutrition via a silicone CVC and who received a daily 70% ethanol lock at some time during their therapy were reviewed retrospectively.
MAIN RESULTS: Ten patients had 26 CVCs for a total of 3556 catheter-days and received a daily ethanol lock for 4 to 14 hours during a total of 3018 catheter-days. Before ethanol lock therapy (n = 5), there were 6 CRIs in 538 catheter-days (rate, 11.15 per 1000 catheter-days). During ethanol lock therapy in the same 5 patients, the CRI rate decreased to 2.06 per 1000 catheter-days (4 CRIs in 1936 catheter-days). In the 5 patients with no ethanol lock-free period, the CRI rate was 1.85 per 1000 catheter-days. Overall, CRI rate with ethanol lock therapy was 1.99 per 1000 catheter-days (2 CRIs in 1081 catheter-days). Four patients developed 6 CRIs during ethanol lock therapy. Four of these CRIs were cleared with systemic anti-infective and ethanol lock therapy; 2 CVCs were removed owing to infection. No adverse reactions were reported during ethanol instillation.

CONCLUSION: A daily 70% ethanol lock for CRI prevention was safe and effective in a series of 10 patients with SBS.


All tunnelled central venous catheters (TCVC) placed at the Alberta Children's Hospital in Calgary, Alberta, between November 1984 and July 1987, were retrospectively reviewed to study the association of catheter infection with a number of factors including age, diagnosis, catheter use, and areas caring for children. One hundred children received 130 silastic catheters placed for a total of 17,861 days. Each catheter survived a median of 100 days. Thirty-one episodes of catheter sepsis were identified (one episode for each 576 days of catheter use). Children under 2 years of age had more than two times the risk of catheter infection (p less than 0.01). Children with malabsorption had a greater risk (45.7%) than did those with infection (25.0%) or cancer (15.5%). The use of catheters for total parenteral nutrition (TPN) or for multiple purposes markedly increased the risk of catheter infection. The risk of infection of TCVC appears to be great in the young child, in particular, in those requiring TPN or multiple intravenous infusions. Use of TCVC in these children should be avoided if possible.


BACKGROUND: Totally implantable central venous access devices (ports) have been available for over 10 years but have not achieved widespread use in paediatric oncology patients. We reviewed our experience with these devices over 9 years to assess their safety and acceptability.

PROCEDURE: We conducted a retrospective review of insertion technique and reasons for removal of all ports placed in paediatric oncology patients in this hospital between 1989 and 1996, with follow-up until 1998. Acceptability of both ports and external catheters was assessed by a questionnaire in a subgroup of families attending the oncology clinic.

RESULTS: One hundred forty-nine ports were inserted during the study period. The median catheter life was 399 days (4-1,406), with a total of 69,342 catheter days. Sixty-nine percent of ports were removed electively at the end of treatment; 8% required removal because of infection and 5% because of blockage. No ports were accidentally dislodged or damaged. Children experienced significantly less restriction of activity with a port compared to an external catheter and greatly preferred the cosmetic appearance. The need for needle insertion to access the port was not seen as a disadvantage by most families.
CONCLUSIONS: Ports can provide satisfactory central venous access for the majority of paediatric oncology patients, with a low risk of line-related complications and a high degree of acceptability to children and their parents. Copyright 1999 Wiley-Liss, Inc.


We describe a case of catheter-associated Wangiella (Exophiala) dermatitidis fungemia in a human immunodeficiency virus-infected child who was successfully treated with antifungal therapy and catheter removal. Catheter-associated W. dermatitidis fungemia appears to be distinct from previously described cases of disseminated infection with organ involvement. [References: 10]


BACKGROUND: Blood stream infections are a common and serious complication of central venous catheters (CVCs). To decrease catheter colonization, some authors advocate tunneling the catheter in the subcutaneous tissue during insertion. This technique has proved effective in adults, but there are no data on its safety and efficacy in critically ill children. Our objective was to evaluate the efficacy and safety of subcutaneous tunneling of short term, noncuffed CVCs for the prevention of CVC-related infections in critically ill children.

METHODS: A prospective randomized controlled trial was performed at a tertiary children's medical center in Israel and included children ages 0 to 18 years admitted to the pediatric intensive care unit or the pediatric cardiac intensive care unit from September 2000 to April 2001 who required placement of a femoral central venous catheter for >48 h. The children were randomized for tunneled or nontunneled insertion. The main outcome measures were bacterial colonization of proximal and distal catheter segments tested by semiquantitative technique and infectious or noninfectious complications of the CVC.

RESULTS: Of 98 eligible children, 49 received tunneled catheters and 49 received nontunneled catheters. Patients' age ranged from 1 month to 16.5 years (mean, 3.07 +/- 2.48 years). There were no significant differences between the groups in age, sex, disease severity [Pediatric Risk of Mortality III (PRISM) score], duration of catheterization and underlying diseases. Bacterial colonization was found in 11 (22.4%) catheters in the nontunneled group compared with 3 (6.1%) in the tunneled group (P = 0.004). Proximal segment colonization occurred in 7 (14.2%) nontunneled catheters and 2 (4.8%) tunneled catheters (P = 0.07), and distal segment colonization occurred in 3 (6.1%) and 9(18.3%) tunneled and nontunneled catheters, respectively (P = 0.053). The main pathogens were coagulase-negative staphylococci, Pseudomonas spp. and Klebsiella spp. There was no statistically significant difference between the groups in the rate of bloodstream infection (2 in the tunneled group, 3 in the nontunneled). Except for 1 case of subcutaneous hematoma, which resolved, there were no immediate or late complications of the tunneling procedure.

CONCLUSION: Subcutaneous tunneling of CVCs in the femoral site is a safe procedure and decreases significantly the rate of CVC colonization in critically ill children.

Elective surgical procedures involving central venous access devices (CVADs) in patients with haemophilia are often necessary for adequate factor delivery but there are few data regarding haemostatic coverage and acute complication rates accompanying these procedures. To describe experience with CVAD insertion, revision and removal in young haemophilia patients at our institution and in the literature and to assess acute complications following CVAD procedures. PubMed, Medline and Cochrane databases were searched for articles, which included a description of factor coverage during CVAD procedures. A retrospective review of our comprehensive haemophilia database identified patients undergoing CVAD placement, revision and removal between January 1993 and August 2005. Manual and electronic searches of the published literature yielded 14 articles, which met inclusion criteria. Peri-operative factor administration varied greatly among the reports. Mean acute infection and haematoma rates were 8% and 12.5% respectively. A retrospective review identified 49 CVAD placements, revisions, or removals meeting inclusion criteria. Most patients received outpatient bolus factor replacement to achieve a level of 100% preoperatively, immediately postoperatively and on postoperative days 1, 2, 3, 5 and 7. Thirty-six procedures were performed without hospitalization. Ten patients developed 11 (22%) minor haematomas postoperatively. Major haemorrhage, acute infection, or pneumothorax was not encountered. Few published data exist regarding haemostatic coverage and complications following CVAD procedures. Our institutional experience using a consistent management approach was favourable. Further studies are required to define optimal haemostatic coverage during minor surgical procedures in haemophilia. [References: 157]


This study arose from a need to justify the extensive use of in-line intravenous filters in an Australian pediatric teaching hospital. The incidence of septicemia was observed for two 12-month periods before and after the withdrawal of in-line i.v. filters from patients with central venous access devices. A total of 19,221 i.v. days were monitored in 88 children in two 1-year periods. No significant differences were found in the incidence of septicemia between the children who had filters fitted and those who did not. As a result, the routine fitting of filters to i.v. lines infusing fluids filtered during manufacture under a laminar flow has been discontinued with significant cost savings.


Catheter-related bloodstream infections (CRBSIs) are a significant complication for children treated in the pediatric intensive care unit (PICU). This review seeks to identify the epidemiology, risk factors, treatment, and prevention strategies for CRBSIs in the PICU. Factors such as catheter type, insertion site, number of lumens, indwelling time, and medications delivered all can influence the rate of CRBSIs. Prevention strategies include use of full-barrier techniques during insertion, use of chlorhexidine cleaning solutions during insertion and dressing change, strict adherence to catheter-care protocols, and removal of catheters as soon as possible after conclusion of therapy. [References: 21]

**BACKGROUND:** This study was undertaken to determine the frequency of skin colonization, hub colonization, and central venous catheter colonization in transparent hydrocolloid versus standard polyurethane dressings.

**METHODS:** Adult patients requiring the insertion of a multilumen central venous catheter in an intensive care unit were randomized to receive either a standard polyurethane dressing or a transparent hydrocolloid dressing. Cultures were obtained from 125 skin insertion sites, 141 catheter hubs, 128 catheter tips, and blood samples from 132 patients. Extensive data on patient and catheter characteristics were collected.

**RESULTS:** Skin and hub cultures revealed no significant difference in degree of colonization. However, the hydrocolloid group had a significantly higher level of catheter colonization than the polyurethane group ($P = .048$). Conversely, there was a significantly higher frequency of positive blood cultures in the polyurethane group ($P = .03$), although the majority were considered to be potential contaminants. There were only 6 cases in which the same species was simultaneously isolated from a positive blood culture and a colonized catheter, 5 from the hydrocolloid group and 1 from the polyurethane group.

**CONCLUSIONS:** The results of this study suggest that an increased risk of catheter colonization is associated with the use of hydrocolloid dressings, despite previous research suggesting that they significantly reduce microbial growth compared with standard polyurethane. The clinical significance of increased numbers of positive blood cultures in the polyurethane group requires further examination, although distinguishing between contamination and true infection in intensive care settings continues to be methodologically challenging. Further studies are required to determine whether these findings are generalizable across different study settings and whether similar outcomes are obtained when different brands of hydrocolloid dressing are used.


**PURPOSE:** To evaluate the feasibility and complications of placement of a low-profile venous access port in the chest in children requiring long-term venous access.

**METHOD:** A low-profile peripheral arm port (PAS port; Sims Deltec, St. Paul, MN, USA) was implanted in the chest in 22 children over a 4-year period. The mean age of the study group was 6 years (range: 9 months to 20 years). Ports were placed for the administration of chemotherapy, hyperalimentation and frequent blood sampling. Sonographic guidance was used to access the internal jugular or subclavian vein in each case. A review of all inpatient and outpatient charts was undertaken to assess catheter performance and complications.

**RESULTS:** Access to the central venous circulation was successfully achieved in each case without complication. Ports remained implanted for 6579 catheter-days (mean: 299 days). Ten ports have been removed. Of three patients (13%) experiencing device-related infections (0.45 infections/1000 catheter days), two (9.1%) were unresponsive to antibiotics and removed (0.3 infections/1000 catheter days). One port was removed because of pain in the shoulder adjacent to the port implantation site. One port was removed because of difficult access. The final port was removed in order to place a dual-lumen catheter
prior to bone marrow transplant. Twelve ports remain implanted. Aspiration occlusion occurred in four patients (18%). Deep venous thrombosis did not occur in any patient.

**CONCLUSION:** Low-profile chest ports placed by interventional radiologists in the interventional radiology suite can be placed in children as safely as traditional chest ports placed in the operating room. The incidence of infection, venous thrombosis and aspiration occlusion is comparable to that of ports placed operatively.


**PURPOSE:** To compare the success and infection rates of radiologic placement with those of surgical placement of tunneled central venous access catheters (TCVACs) in infants and small children.

**MATERIALS AND METHODS:** In 17 pediatric patients, TCVACs were placed with vascular access under ultrasound or fluoroscopic guidance in the radiology department. In 29 other patients, TCVACs were placed with percutaneous puncture or surgical cutdown in the surgery department. **RESULTS:** Two (11%) of 18 attempts at radiologic placement were unsuccessful; six (38%) of the 16 radiologically placed catheters necessitated removal because of dislodgment, malfunction, or infection; six (38%) were electively removed; and four (25%) still function. Eight (23%) of 35 attempts at surgical placement were unsuccessful; 17 (63%) of the 27 surgically placed catheters required removal because of dislodgment, malfunction, or infection; nine (33%) were electively removed; and one (4%) still functions.

**CONCLUSION:** The success and infection rates of radiologic placement of TCVACs were similar to those of surgical placement. Radiologic placement required fewer attempts and was slightly less expensive.


**OBJECTIVE:** Over 250,000 cases of central venous catheter-associated bloodstream infections (CVC-BSI) occur annually in the US leading to increased morbidity, costs, and mortality. While found to decrease the incidence of CVC-BSI in adult patients, no recommendations exist on the use of antimicrobial-impregnated catheters (AIC) in pediatric patients. This study was conducted to assess the effectiveness of AIC in reducing the incidence rates of CVC-BSI in a pediatric intensive care unit (PICU).

**DESIGN:** Retrospective cohort study. Setting, A 16-bed PICU in a tertiary children's hospital. Interventions and measurements. All PICU admissions requiring placement of a central venous catheter (CVC) from January 1999 through June 2003 were assessed for CVC-BSI, 21 months before, and 30 months after, introduction of AICs.

**RESULTS:** Of 5005 admissions during the 51-month study period, 1656 (33%) required CVC placement. Of these, 1441 (87%) admissions were initially assessed. Of these, 612 admissions (3057 CVC days) required CVC placement during the initial 21-month period while 829 admissions (4220 CVC days) required CVC placement during the subsequent 30-month period. The nosocomial CVC-BSI rates before and after the introduction of AICs were 7.85 CVC-BSI/1000 CVC days and 5.21 CVC-BSI/1000 CVC days, respectively (p=0.17). A sub-cohort of 647 (39%) admissions that required placement of a single CVC was subsequently analyzed. In the sub-cohort, 284 admissions (1269 CVC days) required CVC placement during the 21-month
pre-AIC period, while 363 admissions (1458 CVC days) required CVC placement during the 30 months after introduction of AICs. The nosocomial CVC-BSI rates before and after the introduction of AICs were 3.15 CVC-BSI/1000 CVC days and 2.06 CVC-BSI/1000 CVC days, respectively (p=0.48). In multivariate regression analyses controlling for multiple risk factors for CVC-BSI, the use of AIC was not associated with statistically significant reduction in the rates of CVC-BSI among the entire cohort with multiple catheters (Incidence rate ratio = 1.04, 95% Confidence Interval: 0.93-1.15), or in the sub-cohort with single catheters (Incidence rate ratio = 0.91, 95% Confidence Interval: 0.78-1.06).

CONCLUSIONS: Introduction of antimicrobial-impregnated catheters was associated with no significant reduction in nosocomial CVC-BSI rates in a cohort of critically ill children. Further adequately-powered prospective studies to address the effectiveness of AICs in reducing nosocomial CVC-BSI rates among cohorts of critically ill children are required.


OBJECTIVE: Nosocomial bloodstream infections are associated with increased patient morbidity, mortality, and hospital costs. More than 90% of these infections are related to the use of intravascular catheter devices. This study was done to assess the risk and rates of catheter related-bloodstream infections (CR-BSI) associated with different intravascular technologies in a pediatric intensive care unit population. DESIGN: Retrospective cohort study.

SETTING: A 16-bed pediatric intensive care unit in a tertiary children's hospital.

STUDY POPULATION: All admissions between July 1997 and December 1999 requiring placement of an intravascular access device for care were examined. Patients with CR-BSI were identified through ongoing surveillance using Centers for Disease Control/National Nosocomial Infections Surveillance System definitions for bloodstream infection.

INTERVENTIONS: None.

MEASUREMENTS AND MAIN RESULTS: Of the 2,728 admissions during the review period, 1,043 (38.3%) required placement of an intravascular access device. Bivariate analysis revealed that patients who required intravenous cannulae for extracorporeal life support had a 10-fold increased risk of developing a CR-BSI, and patients requiring vascular access for renal replacement therapy demonstrated a 4-fold increase in the risk of developing CR-BSI compared with the referent group. There was a significant increase in the CR-BSI rate associated with the use of more intravascular access devices per patient admission. Multivariate logistic regression identified the use of extracorporeal life support therapy and the total duration of use of intravascular access devices as significant independent predictors of CR-BSI when controlling for other predictors.

CONCLUSION: The use of extracorporeal life support therapy, the presence of multiple intravascular access devices, and the total duration of intravascular access device use were associated with an increase in the rate and risk of developing CR-BSI in our pediatric intensive care unit population. Larger, prospective studies may help elucidate additional factors responsible for these observations.

BACKGROUND: Although many catheter-related bloodstream infections (CR-BSIs) are preventable, measures to reduce these infections are not uniformly implemented. OBJECTIVE: To update an existing evidenced-based guideline that promotes strategies to prevent CR-BSIs. DATA SOURCES: The MEDLINE database, conference proceedings, and bibliographies of review articles and book chapters were searched for relevant articles. STUDIES INCLUDED: Laboratory-based studies, controlled clinical trials, prospective interventional trials, and epidemiological investigations. OUTCOME MEASURES: Reduction in CR-BSI, catheter colonization, or catheter-related infection.

SYNTHESIS: The recommended preventive strategies with the strongest supportive evidence are education and training of healthcare providers who insert and maintain catheters; maximal sterile barrier precautions during central venous catheter insertion; use of a 2% chlorhexidine preparation for skin antisepsis; no routine replacement of central venous catheters for prevention of infection; and use of antiseptic/antibiotic impregnated short-term central venous catheters if the rate of infection is high despite adherence to other strategies (i.e., education and training, maximal sterile barrier precautions and 2% chlorhexidine for skin antisepsis).

CONCLUSION: Successful implementation of these evidence-based interventions can reduce the risk for serious catheter-related infection. [References: 183]


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CONCLUSION: Successful implementation of these evidence-based interventions can reduce the risk for serious catheter-related infection.


These guidelines have been developed for practitioners who insert catheters and for persons responsible for surveillance and control of infections in hospital, outpatient, and home health-care settings. This report was
prepared by a working group comprising members from professional organizations representing the disciplines of critical care medicine, infectious diseases, health-care infection control, surgery, anesthesiology, interventional radiology, pulmonary medicine, pediatric medicine, and nursing. The working group was led by the Society of Critical Care Medicine (SCCM), in collaboration with the Infectious Disease Society of America (IDSA), Society for Healthcare Epidemiology of America (SHEA), Surgical Infection Society (SIS), American College of Chest Physicians (ACCP), American Thoracic Society (ATS), American Society of Critical Care Anesthesiologists (ASCCA), Association for Professionals in Infection Control and Epidemiology (APIC), Infusion Nurses Society (INS), Oncology Nursing Society (ONS), Society of Cardiovascular and Interventional Radiology (SCVIR), American Academy of Pediatrics (AAP), and the Healthcare Infection Control Practices Advisory Committee (HICPAC) of the Centers for Disease Control and Prevention (CDC) and is intended to replace the Guideline for Prevention of Intravascular Device-Related Infections published in 1996. These guidelines are intended to provide evidence-based recommendations for preventing catheter-related infections. Major areas of emphasis include 1) educating and training health-care providers who insert and maintain catheters; 2) using maximal sterile barrier precautions during central venous catheter insertion; 3) using a 2% chlorhexidine preparation for skin antisepsis; 4) avoiding routine replacement of central venous catheters as a strategy to prevent infection; and 5) using antiseptic/antibiotic impregnated short-term central venous catheters if the rate of infection is high despite adherence to other strategies (i.e., education and training, maximal sterile barrier precautions, and 2% chlorhexidine for skin antisepsis). These guidelines also identify performance indicators that can be used locally by health-care institutions or organizations to monitor their success in implementing these evidence-based recommendations.


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There have been few reports on immune complex-mediated glomerulonephritis associated with chronic infection from long-term central venous catheterization in adulthood. We report here on a 13-year-old boy with nephritis who exhibited glomerulonephritis that had been induced by the long-term use of central venous catheters, and its resolution after extraction of the central venous catheter. A diagnosis of glomerulonephritis associated with chronic infection caused by long-term central venous catheterization was made, based on the absence of clinical findings after removal of the catheter, hypocomplementemia, pathology findings resembling membranoproliferative glomerulonephritis, and detection of Staphylococcus epidermidis from culture of the removed catheter culture. For clinicians using long-term central venous access for parenteral feeding, rapid catheter exchange is necessary for patients with fever of unknown origin.


BACKGROUND: An accepted pathogenesis of catheter-related bacteraemia (CRB) is the seeding of microorganisms from the intraluminal biofilm of central venous catheters. Antibiotic locks (ABL) are solutions containing high concentrations of antimicrobials with or without anticoagulants that aim to destroy the biofilm.

METHODS: In this study, two different ABL solutions, tissue plasminogen activator (TPA)-based and heparin-based ABL, used in conjunction with systemic antibiotics, were prospectively compared in the treatment of CRB.

RESULTS: A total of 42 children on chronic haemodialysis with 11,016 catheter-days were observed for signs and symptoms of CRB over a period of 10 months. Twenty-four CRBs were diagnosed in 18 children (2.2 CRB/1000 catheter-days) and were treated with the protocol. Symptoms of CRB resolved in 83% within 48 h of treatment. None of the infected catheters required early emergent exchange or removal for poorly controlled CRB. Six children had recurrence of CRB within 6 weeks, of which four required catheter exchange. There was no specific microorganism or type of CRB that predisposed to higher recurrence rates. The mean infection-free survival of the catheters following TPA-ABL treatment was shorter than that following heparin-ABL treatment, but was not statistically significant by the log-rank test (126.8 +/- 81.6 days versus 154.5 +/- 70.4 days).

CONCLUSION: Both TPA-ABL and heparin-ABL used in conjunction with systemic antibiotics can effectively clear CRB without significant late recurrence at 6 weeks. Early use of ABL for management of CRB can potentially decrease the need for catheter removal, thus salvaging vascular access sites.

OBJECTIVES: To use the ethanol-lock technique (in conjunction with systemic antibiotics) to salvage central lines from removal and to prevent persistence of catheter-related infections among pediatric patients with long-term intravascular devices.

DESIGN: Medical records of patients treated with ethanol locks were retrospectively reviewed from June 1, 2004, through June 22, 2005.

SETTING: Childrens Hospital Los Angeles, Los Angeles, Calif, a tertiary care pediatric hospital. Patients Forty children with diverse underlying disorders were treated for 51 catheter-related infections using the Childrens Hospital Los Angeles ethanol-lock technique.

INTERVENTIONS: Eligible infected central lines were instilled with a dose volume of 0.8 to 1.4 mL of 70% ethanol into the catheter lumen during 12 to 24 hours and then withdrawn. The volume of ethanol used was based on the type of intravascular device. MAIN OUTCOME MEASURES: Clearance of infection and incidence of recurrence.

RESULTS: Of the 51 ethanol-lock treatments in 40 children, no catheters were removed because of persistent infection. Eighty-eight percent (45/51) of the treated episodes cleared without recurrence (defined as a relapse within 30 days with the same pathogen). Twelve (75%) of 16 polymicrobial isolates and 33 (94%) of 35 monomicrobial isolates were successfully treated. There were no adverse reactions or adverse effects reported.

CONCLUSION: This retrospective study supports the use of the ethanol-lock technique in conjunction with systemic antibiotics as an effective and safe method to retain the use of a previously infected central venous catheter, decrease the need for line removal, and eradicate persistent pathogens in catheter-related infections.


Young infants, particularly following gastrointestinal surgery, are at high risk of septicaemia during parenteral nutrition. Febrile illness in the absence of focal infection inevitably raises suspicion of central venous catheter sepsis and poses the following dilemma: remove the catheter (which may then prove uninfected) and lose venous access, or leave the catheter and risk clinical deterioration? We examined retrospectively the isolates from blood culture during febrile episodes in 13 children who received long-term (> 2 months) parenteral nutrition via a central venous catheter, and assessed the effectiveness of through-catheter antibiotic treatment during 76 episodes of blood culture positive sepsis. Coagulase-negative Staphylococci accounted for only 16% of positive isolates, with yeasts accounting for 5%, and Gram-negative organisms accounting for 46%, suggesting that infection was often associated with bacterial translocation from the gastrointestinal tract. Treatment with the central venous catheter left in situ was successful in resolving infection in 53 (70%) of septic episodes. These findings indicate that, in this specific group of patients, through-catheter antibiotic treatment is often effective in treating septicaemia. When long-term venous access is essential, this approach should be tried before recourse to central venous catheter removal.

Infectious complications of the central venous catheter (CVC) are a major source of morbidity among children treated with hemodialysis (HD), with catheter-related bloodstream infections (CRBSI) being the most important clinical manifestations. As only a few studies of children on HD have been published, the management of CVC-related infections in this population is mainly based on data derived from adults or occasionally from children not affected by end-stage renal disease (ESRD). The aim of this review is to discuss current knowledge concerning the epidemiology, prevention, and treatment of catheter-related infections in children on HD. Catheters impregnated with antibiotics/antiseptics, lock antibiotic prophylaxis, nasal mupirocin, and the application of ointments at the exit-site have all been proposed as means of reducing the risk of CVC infections, but their real efficacy in the pediatric population has not yet been demonstrated. Furthermore, it is not clear how long antibiotic therapy should be continued, and there is still debate as to whether the catheter has to be removed. We propose some practical guidelines for the management of CRBSI in children with percutaneously inserted and surgically implanted HD catheters, but a number of unresolved clinical issues still remain, which will require prospective clinical trials specifically performed in pediatric patients with ESRD. [References: 81]


***OBJECTIVE***: To use multivariate analysis to determine risk factors for death among pediatric patients with candidemia and a central venous catheter in place.

***DESIGN***: Retrospective cohort study conducted at Santa Casa Complexo Hospitalar, a 1,200-bed teaching hospital in southern Brazil.

***METHODS***: All cases of candidemia in pediatric patients (age, \(<\)or=13 years) at our medical center over a 9-year period were reviewed. A diagnosis of sepsis was required for inclusion in the study. Severity of illness was confirmed by the presence of hypotension requiring inotropes and according to the following scores: the Pediatric Risk of Mortality (PRISM) II score, the PRISM III score, and the Pediatric Logistic Organic Dysfunction score. The following 2 outcomes were evaluated: early death, defined as death occurring within 7 days after candidemia was diagnosed, and late death, defined as death 8-30 days after candidemia was diagnosed.

***RESULTS***: A total of 61 patients were included in the study, including 14 neonates. Most (63.9%) of these patients were girls, and the median age was 0.3 years. A total of 80.3% of candidemia cases were due to species other than Candida albicans, primarily Candida parapsilosis (32.8% of cases) and Candida tropicalis (24.6% of cases). Using multivariate analysis, we demonstrated that failure to remove the central venous catheter was an independent risk factor for early death among pediatric patients with candidemia. However, patients whose catheters were retained were sicker than patients whose catheters were removed, and catheter removal had no impact on late death. Instead, severity of illness determined using the PRISM III score was also an independent predictor of late death.

***CONCLUSIONS***: Results from this study suggest that systematic removal of catheters from pediatric patients with candidemia does not reduce the occurrence of late death.

A 9-year-old boy was admitted to our pediatric intensive care unit after multiple trauma. On the 17th day post trauma, he developed catheter-related sepsis with candidemia. After removal of the catheter and 6 days of unsuccessful intravenous antifungal therapy, conventional and transesophageal two-dimensional echocardiography was performed revealing a large right atrial thrombus. Surgical thrombectomy under cardiopulmonary bypass was performed and the patient recovered within a few days. Fungal right atrial thrombus is a rare, life-threatening complication of central venous catheterization. Two-dimensional echocardiography is a simple and effective diagnostic technique that should be performed when candidemia is detected. The proper therapeutic response depends on the findings of this examination. For a symptomatic patient with a large, mobile thrombus, we strongly recommend thrombectomy. Surgery not only allows removal of the mass and thus elimination of the mechanical complication but is also a key to management of infection. [References: 10]


The aim of this study was to explore the complications related to Hickman-Broviac central venous catheters (Hickman-Broviac CVCs) in children with cancer, their incidence, and possible associations of complications and premature removal of CVCs with a number of risk factors. During the study period (1 Jan 2000-31 Dec 2003), 223 CVCs were inserted in 198 children (117 boys, 81 girls) at a mean age of 5.73 years (95% CI 5.19-6.27, SE 0.275). In total, 76 (38.4%) children suffered from solid tumors and 122 (61.6%) from leukemia. The mean follow-up after CVC insertion was 232.5 days (95% CI 214.9-250.2, SE 8.94) for a total of 51,839 catheter-days. A complication occurred in 20.8% of them and in 9.6% the complication led to the removal of the catheter. The most frequent complications were infection (63.9%), obstruction (26.2%), accidental failure (8.2%), and rupture (1.6%). An overall incidence of 1.17 (0.38 and 0.79 for mechanical complication and infection, respectively) per 1000 catheter days for the development of a complication was recorded. Additionally, the study revealed more nonelective removals in cases of leukemia compared to those of solid tumors. Systemic use of CVC does not appear to increase significantly the number of complications, and thus CVC remains an effective and safe tool for the management of childhood malignancies.


PURPOSE: Implantable venous access devices (IVADs), either centrally or peripherally implanted, have become increasingly popular in children with hemophilia to assist in the early treatment of bleeding episodes and in the prevention of arthropathy. Their use has been associated with complications including thrombosis, thrombophlebitis, and infection. We attempted to better define whether the benefits associated with IVADs in this population outweigh the associated risks.

PATIENTS AND METHODS: We studied the medical records of 35 children from the University of Minnesota's Comprehensive Hemophilia Center who received IVADs between 1992 and 1996.

RESULTS: There was no bleeding or thrombophlebitis associated with IVADs in our population. One patient required removal of a central IVAD due to thrombosis. The central IVADs were associated with local infection and bacteremia rates of 3% and 33%, respectively. The rates of local infection and bacteremia associated with peripheral IVADs were both 25%. The majority of infections were cleared with antibiotics, and ports remained intact. Both types of IVADs were associated with a high patient/parent satisfaction.
CONCLUSION: Despite being associated with a significant incidence of infection, we believe the benefits of IVADs for children with hemophilia and their families outweigh the risks. Possible explanations for the observed infection rates are discussed.


PURPOSE: To evaluate the procedural and follow-up results of radiologic central venous port placement in pediatric patients.

MATERIALS AND METHODS: Between July 2002 and July 2006, 127 chest ports were placed in 122 pediatric patients (80 boys, 42 girls). Five patients underwent port implantation twice. The mean age of the patients was 8.5 years (range, 4 months to 18 years). The most common underlying disease was leukemia (66%). Internal jugular vein access was used in all patients. All types of anesthesia or sedation for the procedures were applied by anesthetists in the angiography suite. Retrospective evaluation of an electronic database and hospital charts was performed for the detailed follow-up.

RESULTS: Technical success rate was 100%. The mean catheter life was 459 days (total, 51,373 d; range, 16-1,297 catheter-days). Overall, 82 ports are still in use, 10 patients are deceased, and eight (7.1%) and 12 (10.7%) ports were removed at the end of treatment or as a result of complications, respectively. One patient (0.9%) died 167 days after port implantation as a result of unconfirmed port-related sepsis. Eight ports (7.1%) were explanted as a result of infectious complications, three (2.7%) required removal for skin erosion, and one (0.9%) was explanted as a result of a broken catheter. The rate of confirmed overall port-related infection was 14.3%, or 0.31 infections per 1,000 catheter days. Fifteen patients were lost to follow-up.

CONCLUSIONS: Chest port placement by interventional radiologists in pediatric patients is safe, with a high rate of technical success and low rate of complications.


PURPOSE: To evaluate the long-term outcomes of radiologically inserted dual-lumen hemodialysis and infusion catheters in pediatric patients.

MATERIALS AND METHODS: The authors retrospectively reviewed the outcomes of 114 tunneled internal jugular catheters in 71 consecutive pediatric patients between March 2003 and May 2006. Forty hemodialysis catheters were placed in 23 patients (11 girls, 12 boys), and 74 infusion catheters were placed in 48 patients (14 girls, 34 boys). The mean patient age was 11.2 years (range, 1-16 years) in the hemodialysis group and 7.86 years (range, 4 months to 16 years) in the infusion group.

RESULTS: The technical success rate was 100%. The mean duration of catheter use was 84 days (range, 5-730 days) in the hemodialysis group and 58 days (range, 3-206 days) in the infusion group. Nine hemodialysis (22%) and 29 infusion (39%) catheters were electively removed. The most common reasons for catheter removal were malfunction (22%) in the hemodialysis group and completion of therapy (39%) in the infusion group. Revisions were performed at a rate of 0.6 and 0.4 per 100 catheters days in the hemodialysis and infusion groups, respectively. Total infection rates were 0.15 and 0.38 episodes per 100
catheter days in hemodialysis and infusion catheters, respectively. Mean primary device service intervals were 86 and 60 days for hemodialysis and infusion catheters, respectively, with total access site service intervals of 140 and 71 days.

CONCLUSION: Radiologically placed tunneled internal jugular catheters appear to be safe and effective, with very low complication rates for both hemodialysis and long-term infusion therapies. Higher infection rates were seen in patients with cancer.


OBJECTIVE: To determine whether heparin bonding reduces the incidence of catheter-related thrombosis and infection in critically ill children.

DESIGN: A prospective double-blind randomized controlled study.

SETTING: A tertiary paediatric intensive care unit.

PATIENTS: Two hundred and nine patients, 123 males and 86 females, aged 0-16 years, admitted to the intensive care unit and needing a central venous line (CVL), were randomized to receive either a heparin-bonded (HB, n = 102) or a non-heparin-bonded line (NHB, n = 107). Nine patients were excluded owing to incomplete data.

INTERVENTION: HB or NHB CVL.

MEASUREMENTS: Blood cultures were carried out on insertion of the line and every 3 days thereafter. Ultrasound was performed within the first 3 days and every 3 days thereafter. On removal the line was sent for culture. Results: The two groups were comparable for age, sex, severity of illness and length of time that the catheter was in situ. Proportional hazards modelling showed that heparin bonding was associated with a significant reduction in infections (hazard ratio 0.11, P < 0.00005). The incidence of infection was 4% and 33% in HB and NHB CVLs, respectively (4/97 vs. 34/103, P < 0.0005). The incidence of thrombosis was 0% and 8% in HB and NHB CVLs, respectively (0/97 vs. 8/103, P = 0.006). The number of HB CVLs which would need to be used to avoid one episode of infection or thrombosis was 3 and 13, respectively.

CONCLUSION: Our study shows a significant reduction in the incidence of infection and thrombosis associated with the use of HB CVLs.


BACKGROUND: Central venous catheters (CVCs) are often inserted into boys with hemophilia to secure venous access for factor prophylaxis and immune tolerance induction therapy. Complications associated with CVCs include catheter-related infections, local hemorrhage, and mechanical failure. Less frequently reported is CVC-related deep venous thrombosis (DVT). We conducted a prospective study to determine the frequency and outcome of this complication.

METHODS: All boys (n = 16) with congenital hemophilia A or B with a CVC in place who were registered in the pediatric comprehensive care program at the Hospital for Sick Children, Toronto, were included in the
study. They were prospectively assessed by imaging studies and clinical examinations for CVC-related DVT at two time-points, 2 years apart. Each boy was evaluated for inherited hypercoagulability.

RESULTS: Eleven (69%) of the 16 boys had radiological evidence of DVT at the first evaluation and 13/16 (81%) at the second evaluation. In two boys there was improvement in the venogram findings at the second evaluation. None of the CVC-related DVTs completely resolved. Median age at the time of initial insertion of a CVC was 1.0 years (range 0.02-6.7 years). Median duration of CVC placement was 6.4 years (range 3.3-15.5 years). Only 4/13 boys with DVTs had clinical evidence of upper venous system obstruction. Only one boy, who did not develop a DVT, had a low protein C level.

CONCLUSIONS: CVC-related DVTs occur in the majority of boys with hemophilia who have CVCs inserted for a prolonged period of time. Annual screening with imaging is recommended for boys with CVCs in place for \( \geq 3 \) years. Consideration should be given to removing CVCs as soon as peripheral venous access is feasible.


A children's hospital nutritional care team prospectively monitored the frequency of sepsis in central venous catheters used for administering parenteral nutrition. During an initial study period of 12 months, 2658 (45%) of catheters were removed because of proved sepsis. The possible causes of this alarmingly high rate were examined, with catheter care techniques on the wards coming under particular scrutiny. As a result protocols were modified and an intensive staff training programme implemented throughout the hospital, led by the nutritional care sister. Subsequently, the catheter sepsis rate was significantly reduced with only 9/107 (8%) of consecutive catheters becoming infected. These findings emphasise the key role that education of staff plays in controlling central venous catheter sepsis and the importance and cost effectiveness of special nursing staff in implementing such measures.


PURPOSE: To describe patterns of central venous catheter (CVC) use and determine the risk of infection associated with a catheter in children with acute lymphoblastic leukemia (ALL).

PATIENTS AND METHODS: Children with ALL (n = 1934), participating in Children's Cancer Group studies for good-prognosis ALL (CCG-1881) and intermediate-risk ALL (CCG-1891) were evaluated in a retrospective case-control study. The presence of a catheter and the occurrence of infectious complications were recorded after each treatment phase.

RESULTS: Young age and enrollment in the intermediate-risk study were associated with higher rates of catheter use. During each of the first four phases of therapy, the adjusted risk of infection was two- to fourfold higher when a catheter was in place. The proportion of patients with infection during the first four phases of therapy was 2.6 times higher with a CVC (14.4% versus 5.7%). Catheter use was associated with significantly increased hospitalization rates during induction, consolidation, and interim maintenance, but not during delayed intensification. A catheter did not significantly increase the risk of fever during neutropenia.
CONCLUSION: The presence of a CVC increases the risk of infection during the early phases of low-intensity therapy for ALL.


OBJECTIVE: To determine whether adding vancomycin to central venous catheter (CVC) flush solution would significantly reduce the incidence of bacteremia attributable to luminal colonization with vancomycin-susceptible organisms.

STUDY DESIGN: Fifty-five children with cancer and eight children given total parenteral nutrition by the surgery or nutrition support services were randomly assigned to receive a heparin CVC flush solution (n = 31) or a heparin-vancomycin CVC flush solution (n = 32).

RESULTS: During 9158 catheter days, 6.5% of the patients in the heparin group and 15.6% of the patients in the heparin-vancomycin group had bacteremia attributable to luminal colonization with vancomycin-susceptible organisms (p = 0.43). The mean rates of bacteremia attributable to luminal colonization with vancomycin-susceptible organisms were 0.6/1000 catheter days in the heparin group and 1.4/1000 catheter days in the heparin-vancomycin group (p = 0.25). There was no significant difference between the groups when the time to the first episode of bacteremia attributable to luminal colonization with a vancomycin-susceptible organism was compared by means of Kaplan-Meier survival estimates. Streptococcus viridans infection was not attributable to luminal colonization.

CONCLUSION: The addition of vancomycin to heparin CVC flush solution did not reduce bacteremia with vancomycin-susceptible organisms. Bacteremia with Streptococcus viridans was not related to the use of a CVC.


The risk of infection in individuals with haemophilia using central vascular access devices for administration of clotting factor concentrates for prophylaxis or immune tolerance is unknown. We conducted a survey of US haemophilia treatment centres to determine the incidence and clinical characteristics of infection associated with use of central venous catheters. Seventy (38.3%) of 183 patients using central lines developed device-associated infection, including 30 (28.0%) on prophylaxis and 40 (52.6%) on immune tolerance, P < 0.005. Over half (54.8%) the infections occurred in those [less-than or equal to] 3 years of age. Implanted/tunnelled devices (port catheters) were more likely to become infected in the first 30 days after insertion, 11 of 41 (26.8%), than external catheters (broviac/hickman), none of 29 (0%), P = 0.00003. The median time to infection from initial device placement, 124 days, varied with age, 57 days in those [less-than or equal to] 2 years of age vs. 161 days in those > 2 years of age, P = 0.0008, but not with type of device or treatment. Staphylococcal infections were more common with implanted devices (ports), 30 (73.2%), than external catheters, 12 (41.4%), P < 0.01, and Gram-negative infections were more common with external catheters, 17 (58.6%), than tunnelled devices, 7 (17.1%), P < 0.005. In summary, the rate of infection with central venous access devices in haemophiliacs is high, and alternative approaches to venous access should be explored.

The recent unequivocal demonstration that prophylaxis, three to four weekly factor infusions, is effective in preventing joint disease in children with haemophilia, has provided impetus to initiate prophylaxis early in such children. Yet, nearly a quarter (22%) of the 83% who required central venous access devices for factor infusion developed central venous access catheter (CVAD)-related infection. This limitation of CVAD use prevents many families from initiating prophylaxis. The frequent occurrence of local thrombosis accompanying CVAD-related infection in surgical patients and autopsy cases, the thrombogenic plastic CVAD surfaces, and local clot formation at the insertion site, suggest the potential role of thrombolytic agents in preventing these infections. Yet, correlation between CVAD-related infection and local thrombosis in children with haemophilia are lacking, and thromboprophylaxis to prevent CVAD-related infection is controversial. Tissue plasminogen activator (t-PA), a recombinant serine protease glycoprotein that lyses plasmin-bound fibrin and is safe and effective in the treatment of occluded catheters, has not been evaluated in the prevention of these infections. We performed a literature review of CVAD-related infection, CVAD-related thrombosis, and thromboprophylaxis studies to evaluate the role of t-PA in the prevention of these infections in children with haemophilia. Metanalysis of published thromboprophylaxis trials demonstrate current prophylaxis regimens do not prevent CVAD infection, and further, that thrombosis and infection do not necessarily occur simultaneously. Pilot data demonstrate CVAD infection reduction in haemophilic children by monthly t-PA in 18 haemophilic children, suggesting the potential role of t-PA in CVAD infection prevention. Clinical trials to evaluate t-PA in CVAD infection prevention are justified. [References: 66]


OBJECTIVE: To define central venous catheter-related infections in infants and children for the purpose of enrolling children in sepsis studies, for epidemiology and surveillance studies, and for clinical management.

METHODS: Review of the literature and consensus of experts.

RESULTS: No changes were made to the current Centers for Disease Control and Prevention criteria for defining local catheter infection. Because catheter tips are not available as often in children as in adults, smaller blood volumes are drawn per culture decreasing sensitivity, and antibiotics are rarely withheld, slight modifications to the existing adult Centers for Disease Control and Prevention criteria were made to increase practical use. Catheter-related bloodstream infection was categorized as definite, probable, and possible based on culture results and clinical symptoms.

CONCLUSIONS: For the purposes of enrolling patients with sepsis in clinical trials, only patients who meet criteria for definite catheter-related bloodstream infection should be categorized as having the catheter as the infection source. Because many patients suspected of having catheter-related bloodstream infection do not have positive blood culture results, which makes the confirmation of infection difficult, we recommend that these patients not be enrolled in sepsis trials. Because catheter tips are often not obtained for culture in children, the epidemiology of catheter-associated bloodstream infection (bloodstream infection in a patient who has a central venous catheter and no other obvious source of infection) is better understood than the epidemiology of confirmed catheter-related bloodstream infection in infants and children. Definitions for catheter-related bloodstream infection that compare the through-catheter and peripheral
culture for time to positivity or for quantitative growth are unlikely to be falsely positive, but sensitivity requires further validation. [References: 33]


Infection continues to be a major complication of the use of indwelling venous catheters. In an attempt to avoid removal of the catheter and to minimize the systemic side-effects of antibiotics, the potential value of in-situ treatment of confirmed Broviac catheter infection was assessed in carefully selected patients attending an oncology unit. Fourteen episodes from 11 children were included in the study. A variety of organisms were encountered. Infective episodes were divided into two categories: (a) those occurring in patients with negative peripheral blood cultures and neutrophil count greater than 1.5 x 10(9) l-1 which were treated only by local instillation of heparinized antibiotic 8-hourly for 7-14 days (N = 8); (b) those occurring simultaneously with positive peripheral blood culture (or peripheral blood culture not performed) regardless of neutrophil count, or infection restricted to Broviac catheter but with a neutrophil count of less than 1.5 x 10(9) l-1; these were treated, with one exception, as above with the addition of systemic antibiotics (N = 6). Treatment was successful in 100% of infective episodes with negative cultures achieved between 5 and 12 days. Catheters remained in use a mean of 118 days following treatment of infection. This approach has obvious advantages but requires careful patient selection and monitoring. It prolongs the catheter life, obviates the need for systemic antibiotics for a local infection, and with appropriate instruction to parents and family practitioner, treatment may be administered on an outpatient basis.


From September 2000 to August 2001, 104 central venous access devices (CVAD) were inserted in 91 children, governed by a uniform protocol. Thirty catheters were inserted in neonates, 29 in infants, 37 in children and 8 in adolescents. Fifty-one were planned insertions in the operating suite and 53 were emergencies - often by the bedside. There were 12 insertion related complications-all of which were minor. Neonatal age and bedside introduction had a higher risk of insertion related problems. The incidence of non-infectious complications was 20% (rate of 13.7/1000 line days) and was influenced by the child's age and insertion site. Femoral route was the safest. Incidence of catheter associated infections (CAI) was 15.4% (rate of 11/1000 line days). Only 2 children had catheter associated bloodstream infection. Neonates were at higher risk of catheter related infections. Age, insertion site and occurrence of insertion complications influenced duration of catheterization (median 7.5 days, range 2-243 days) There was no major complication, though more than 50% insertions were in neonates and infants. In our practice, use of CVAD is feasible and safe, especially in neonates and infants.


Atypical mycobacteria are seen more frequently as a cause of serious infection in children with cancer. Thirteen pediatric cancer patients with blood or tissue cultures positive for atypical mycobacteria were identified by review of records over a 5-year period at one center. All had central venous catheters and were lymphopenic at the time of infection. Eleven children had rapidly growing mycobacteria and two children
had M. avium-intracellulare. Nine patients had positive blood cultures. Three were treated with catheter removal as sole therapy, five had catheter removal plus antibiotics, and one had antibiotics alone. Two patients with pulmonary M. avium-intracellulare infection received antibiotic therapy alone. It is concluded that infection with rapidly growing mycobacteria in children with cancer is associated with presence of a central venous catheter and lymphopenia. Some children with uncomplicated catheter-associated infection with rapidly growing mycobacteria may be sufficiently treated with removal of the catheter alone. (c) 2004 Wiley-Liss, Inc.


A 2-year-old girl admitted with third degree burns (35% TBSA) received 7 weeks poly-antibiotic therapy combined with heparin for a severe Methicillin-resistant Staphylococcus aureus sepsis with multiple metastatic abscesses (lung, skin, brain), from a suppurative thrombophlebitis of the right jugularis interna, extended to the axillary and cava superior veins. Surgical treatment was contraindicated by the local extension. The child was discharged without major neurological sequelae 3 months after admission.


CONTEXT AND OBJECTIVE: Long-term totally implantable catheters (e.g. Port-a-Cath) are frequently used for long-term venous access in children with cancer. The use of this type of catheter is associated with complications such as infection, extrusion, extravasation and thrombosis. Embolism of catheter fragments is a rare complication, but has potential for morbidity. The aim here was to report on two cases in which embolism of fragments of a long-term totally implantable catheter occurred.

DESIGN AND SETTING: Case series study at Hospital do Servidor Publico Estadual, Sao Paulo. METHODS: Retrospective review of catheter embolism in oncological pediatric patients with long-term totally implantable catheters.

RESULTS: The first patient was a 3-year-old girl diagnosed with stage IV Wilms' tumor. Treatment was started with the introduction of a totally implantable catheter through the subclavian vein. At the time of removal, it was realized that the catheter had fractured inside the heart. An endovascular procedure was necessary to remove the fragment. The second case was a boy diagnosed with stage II Wilms' tumor at the age of two years. At the time of removal, it was noticed that the catheter had disconnected from the reservoir and an endovascular procedure was also necessary to remove the embolized catheter.

CONCLUSION: Embolism of fragments of totally implantable catheters is a rare complication that needs to be recognized even in asymptomatic patients.


BACKGROUND: The objective of this study was to determine whether vomiting at presentation of a febrile illness in immunocompromised children with central venous catheters (CVCs) predicts bacteremia.
METHODS: A chart review was conducted of children who were admitted to the hospital with a diagnosis of cancer or aplastic anemia, fever, and a CVC. Data were collected on the presence or absence of vomiting, catheter type, presence or absence of severe neutropenia, C-reactive protein (Crp) value, and culture results.

RESULTS: There were 143 admissions for fever among 48 children. Among 35 admissions with emesis, 19 included bacteremia; whereas, among 107 admissions without emesis, 19 included bacteremia (P < .001). There was a 5-fold greater risk of bacteremia in children with children without vomiting (odds ratio, 5.50; 95% confidence interval, 2.20-13.67). Gram-negative organisms were more likely to be associated with vomiting than Gram-positive organisms (P = .008). Children with severe neutropenia did not have a significantly higher rate of bacteremia than children who had neutrophil counts >500 cells/mm(3). Other factors that were associated with higher rates of bacteremia were underlying diagnosis and catheter type.

CONCLUSIONS: Immunocompromised children with a CVC and a fever who presented with vomiting were more likely to have bacteremia than similar children who presented without vomiting. Gram-negative organisms were more likely to be associated with emesis than Gram-positive organisms. The absence of severe neutropenia was not associated with a decreased likelihood of bacteremia. These findings may be useful in identifying children who are at high risk for bacteremia and in determining initial, empiric therapy.


This prospective study comprises 97 episodes of fever and neutropenia in children with cancer and central venous access. In 76% of episodes, patients had a Broviac-Hickman-like catheter, and in 24% a totally implanted venous access chamber system. The need for catheter removal during a febrile infection was 0.32/1000 catheter days, and the documented sepsis rate was 0.59/1000 catheter days. Our data indicate that 94% of episodes of fever and neutropenia in total, 78% of documented septicemias, and 97% of fevers of unknown origin were curable with broad-coverage antimicrobial therapy without removing the central venous line. Totally implanted chambers had a lower infection rate than catheters of Broviac-Hickman type.


In a 61-month period, 135 single-lumen central venous catheters (CVCs) were positioned in 125 children with mainly hematological malignancies. We retrospectively investigated the different role of home and hospital CVC management in development of CVC-related infections (CI) during different hematological conditions (presence or absence of neutropenia). Forty-nine percent of the children presented at least one CI, for a total of 109 episodes, during the 20,558 days a CVC remained in situ. CVC hospital management was safer and more reliable than CVC home management in both neutropenic and nonneutropenic patients. None of the CI was life threatening and only in 11% of the cases was it necessary to remove the catheter. Analysis of the microorganisms involved showed that they were mainly gram-positive with CVC home management and gram-negative with CVC hospital management. Careful evaluation of our retrospective survey study suggests that a better training of parents in the care of the CVC and more careful measures of asepsis in hospital could further decrease the incidence of CI, thus improving patients' quality of life.

Although there have been many studies evaluating risk factors for catheter-related infections in children with cancer, none have examined whether swimming presents such a risk. Families of children with cancer were asked about specific swimming practices and central line care to determine whether there is an association between swimming and infection. Parents completed a self-report questionnaire and medical records were reviewed to document catheter-related intraluminal, tunnel, and exit-site infections. Ninety-one children with a total of 101 tunneled catheters participated in the study. Forty-nine children with a total of 50 catheters were swimmers; 46 children with 51 catheters were nonswimmers (four children had two catheters and swam with one catheter but not the other, therefore, these children were counted twice). There were no statistically significant differences in rates of catheter-related infections between the two groups (0.04/catheter-month in swimmers versus 0.25/catheter-month in non-swimmers, relative risk; RR = 1.6, p = .16). When the analysis was confined to summertime infections per summertime catheter month, there were no significant differences in the rates of infections per summer month (0.06 for swimmers vs. 0.05 for non-swimmers, RR = 1.4; p = .50). When the analyses were performed to compare frequent swimmers with infrequent/non-swimmers, once again there were no differences found in rates of catheter-related infections between the two groups. These results suggest that swimming does not increase the risk of catheter-related infections in children with tunneled catheters.


The introduction of totally implantable venous access devices (TIVAD) has provided a solution to difficult venous access in patients with cystic fibrosis. Early reports have, however, recognized a number of complications with their use. We report our experience with five devices used over 8 yrs with regard to complications and patient attitudes. Patients' notes were reviewed to record the details of TIVAD insertion, duration of function, and complications. In January 1996 the surviving 30 patients were surveyed on their attitudes to TIVAD and complications by written questionnaire. Sixty one ports were implanted in 42 patients (aged 16-47 yrs) between June 1988 and January 1996, giving a total of 1,510 patient-months' experience. The duration of function ranged from 2 weeks to 6 yrs. Survival analysis showed that the median survival of ports was 53 months, 42 out of 61 (69%) had not failed in service at the end of follow-up or patient death. Twenty-three complications occurred in 19 patients. These included: line occlusion (10 patients), venous thrombosis (4), difficult access (3), infection (2), cellulitis (1), inversion of port chamber (2) and pneumothorax (1). The questionnaire showed that patients had strong views on the positioning of their port. Lifestyle issues included interference with seatbelts (8 patients), sport (4), clothing (2), sexual relations (2) and cosmetic appearance (15). Complication rates were similar to those in other studies, although infection rates and salvage of an occluded port were lower. The survey highlighted a number of lifestyle issues, with cosmetic appearance deemed unsatisfactory by half of the patients. However, the majority (28 out of 30) believed their totally implantable venous access devices to be a better alternative to cannulae or long lines.

Cellulosimicrobium cellulans (formerly known as Oerskovia xanthineolytica) rarely causes human infection. Infections have been reported in immunocompromised hosts or in patients with foreign bodies, such as catheters, where treatment has generally involved removal of the foreign body. We report on a case in which the organism was isolated in multiple blood cultures from a 13-year-old male. After initial therapy failed, treatment with vancomycin and rifampin resulted in infection clearance without removal of the central venous catheter.


An evaluation of totally implanted venous access systems inserted in 163 consecutive children with cancer is reported. From 1988 to 1994, 180 subcutaneous ports were inserted in children more than 1 year old. Initial diagnosis was acute leukaemia (n=79), non-Hodgkin's lymphoma (n=33), and solid tumour (n=51). Median age was 85 months. All venous procedures were performed through the device. Chemotherapy was either moderate (n=13) or intensive (n=119) or very intensive (n=48), including 16 patients undergoing marrow transplantation. Cumulative venous access totalled 55 770 patient days with a mean of 305 days/subcutaneous port. The cause of device removal was, end of treatment (n=111), death due to malignancy (n=20), catheter related infection (n= 7), and occlusion of the system (n=4). Mechanical complications occurred in 19 ports; 16 were due to clots, of which 14 were cleared with instillation of urokinase. Documented infectious episodes occurred in 47 ports, recurred once in 14, and twice in five cases. Among these infections, 47 were septicaemic; 31 due to Staphylococcus epidermidis. Twenty seven of initial septic episodes were considered to be catheter related; the rate was 15%/subcutaneous port or 0.05/100 catheter days. Risk factors for the development of a first infection were age below 4 years and the time of use. Since February 1993, vancomycin (50 mug/ml) has been given and this has reduced the rate of S epidermidis infection from 26 /83 subcutaneous port to 4/97. Life table analysis showed that the infection free interval for staphylococcus was significantly better after this technique was initiated (log rank test=0.02). Time saved was approximately 30minutes/patient/ week compared with external catheters, or 45 hours/month for the cohort of children treated. Subcutaneous ports in paediatric cancer patients are reliable, safe, and durable and may offer an attractive alternative to external catheters for prolonged venous access and intensive treatment.


Infection of a central venous thrombus is a serious but rarely recognized complication of the use of central venous catheters in children. We report the cases of seven children with persistent bacteremia or fungemia in which central venous thrombosis was demonstrated by ultrasonography after removal of the catheter. All patients had signs and symptoms of infection, but only one had clinical evidence of central venous stasis. Bacteremia persisted from 6 to 35 days. Infection did not resolve in any patient prior to catheter removal, and five patients had positive blood cultures for 5 or more days after removal of the catheter. Six patients, including all who survived, were treated parenterally with antibiotics for more than 28 days. Two patients died; neither death was directly attributable to infection. Central venous thrombosis should be suspected in patients with persistent catheter-related bacteremia. Optimal treatment of this problem is not yet known.

The objective of the study was to evaluate the effectiveness of chlorhexidine-impregnated sponges for reducing catheter-related infections of central venous catheters inserted for cancer chemotherapy. The method used was a randomized, prospective, open, controlled clinical study (three-step group sequential analysis protocol). The patients were from two high dependency units at a university hospital undergoing chemotherapy for haematological or oncological malignancies requiring central venous catheters (CVCs) expected to remain in place for at least 5 days. Six hundred and one patients with 9,731 catheterization days were studied between January 2004 and January 2006. Patients admitted for chemotherapy received chlorhexidine and silver sulfadiazine-impregnated triple-lumen CVCs under standardized conditions and were randomized to the groups receiving a chlorhexidine gluconate-impregnated wound dressing or a standard sterile dressing. Daily routine included clinical assessment of the insertion site (swelling, pain, redness), temperature, white blood count and C-reactive protein. Catheters remained in place until they were no longer needed or when a CVC-related infection was suspected. Infection was confirmed with blood cultures via the catheter lumina and peripheral blood cultures according to the time-to-positivity method. Six hundred and one patients were included. The groups were comparable with respect to demographic and clinical data. The incidence of CVC-related infections were 11.3% (34 of 301) and 6.3% (19 of 300) in the control and chlorhexidine-impregnated wound dressing groups, respectively (p=0.016, relative risk 0.54; confidence interval 0.31-0.94). Especially, catheter-related infections at internal jugular vein insertions could be reduced (p=0.018). No adverse effects related to the intervention were observed. The use of chlorhexidine-impregnated wound dressings significantly reduced the incidence of CVC-related infections in patients receiving chemotherapy.


Signs of infection with a central venous access device in situ raise the possibility of catheter sepsis. We evaluated three tests for diagnosis of infection in infants with suspected catheter sepsis. The acridine orange leucocyte cytospin (AOLC) test was 87% sensitive and 94% specific in the diagnosis of catheter-related sepsis defined by quantitative blood culture. The C-reactive protein and nitroblue tetrazolium tests were not as useful. Using the AOLC results, available in an hour, we now remove fewer catheters on suspicion of sepsis alone.


The use of indwelling central venous catheters has become widespread since their introduction by Broviac et al in 1973 and Hickman et al in 1974. They are of particular value in paediatric oncology where young children require intensive chemotherapy over a long period of time and where peripheral venous access may become a problem.
Background: Central venous lines (CVLs) are essential in the care of children with malignancies, but are associated with venous thromboembolism (VTE) and infections. Effective and safe prophylactic approaches are deficient. Aim: To perform a study of adjusted low-dose warfarin for the prevention of CVL-related VTE in children with malignancies.

Methods: Children with newly diagnosed cancer, a CVL in a jugular vein and an expected treatment period of over 6 mo were eligible for the study. Participants were randomized to low-dose warfarin, with intended international normalized ratio (INR) 1.3-1.9, or to a control group. Primary outcome was VTE in a jugular vein diagnosed by ultrasonography at 1, 3 and 6 mo after inclusion. Secondary outcome was CVL-related infections, mainly measured as days on antibiotics or positive blood cultures.

Results: The study enrolled 73 children, and 62 completed it fully. Asymptomatic CVL-related VTE was frequent (42%), but often transient. Regardless of severity, timing and duration, CVL-related VTE was equally frequent among children on warfarin as compared to controls (p=0.44). Low-dose warfarin (p=0.59) or jugular CVL-related VTE (p=0.91) did not have any impact on days on antibiotics, but we observed a tendency towards an association between CVL-related VTE and positive blood cultures (p=0.15).

Conclusion: Our randomized study of low-dose oral anticoagulation for the prevention of CVL-related asymptomatic VTE in children with cancer did not show any benefit of warfarin adjusted to maintain INR between 1.3 and 1.9.

Background: The frequency of asymptomatic central line-associated thromboses is high and well recognized among children with cancer, while the long-term consequences are mainly unknown.

Aim: In a cross-sectional study, we evaluated clinical and radiological venous outcome in children with previous long-standing intravascular catheters.

Methods: The study enrolled 71 children previously treated for malignant or haematological diseases, 4-180 (median 37) mo after removal of their central lines. Inclusion criteria were a prior central line in a jugular vein for a minimum of 6 mo and no previous history of thrombosis. The children had clinical examination for post-thrombotic syndrome (PTS) and Doppler ultrasonography of the central neck veins. Twelve children had additional venous magnetic resonance imaging (MRI). But no kind of venography was performed in the remaining.

Results: We observed mild PTS with increased superficial collaterals in four children (6%), but no cases of more severe PTS. None complained of symptoms related to venous late effects. By ultrasonography, post-thrombotic venous alterations were detected in 17 children (24%), and five of these had complete occlusion of the veins. The sensitivity for pathologically increased collaterals to identify occlusive thrombosis was 0.6, while the specificity was 0.98. Occulsive venous thromboembolism was associated with the total number of central venous lines (CVLs; p=0.002), previous severe CVL-associated infections (p=0.001) and duration of central line in place (p=0.042).
CONCLUSION: In spite of no prior history of thrombosis, children with previous long-term jugular lines frequently had local thrombotic sequelae, while clinical symptoms of PTS were rare.


BACKGROUND: Some children requiring chemotherapy, total parenteral nutrition, or repeated blood sampling for long periods have no more axillary, internal jugular, external jugular, saphenous, or femoral veins available for cannulation. In such patients, the central venous system can still be accessed via alternate routes e.g. the azygos vein, the gonadal vein or the inferior epigastric vein.

PATIENTS AND METHODS: We report the use of: 1) The inferior epigastric vein for placement of the catheter into the IVC in 20 patients. 2) The right gonadal vein for placement of the catheter using a retroperitoneal approach in five pediatric patients. 3) The second and third right intercostal veins for placement of the catheter by right intrapleural thoracotomy in five pediatric patients. Pre-procedural assessment of the patency of these veins was done using colour Doppler ultrasonography and confirmation of occlusion of common sites used for central venous access.

RESULTS: A total of 38 implantable venous access devices (IVAD) were inserted in 30 patients. The average age at operation was 1.4 years (range 1 month to 12 years). Infection was seen in two patients, venous thrombosis in two. The average longevity of IVAD is 6.5 months. Recovery from the procedure was uncomplicated and the patients were able to receive complete intravenous medication or nutritive mixtures after the insertion of the catheter.

CONCLUSION: The knowledge of alternate routes to obtain central venous access for children requiring chemotherapy, total parenteral nutrition, or repeated blood sampling for long periods is critically important, and the azygos system, right gonadal vein or the inferior epigastric vein can be used when standard accessible veins are unavailable.


Vascular catheter-related infection is an important cause of mortality and morbidity in hospitalized patients. The mean incidence of catheter-related bloodstream infection in hospitalized pediatric patients is 2.4 episodes per 1,000 days. Totally implantable central venous catheters may be associated with a lower risk of infection. Coagulase-negative staphylococci are the predominant cause and account for about one third of episodes of catheter-related bloodstream infection. The diagnosis of catheter-related bloodstream infection is often difficult because there are frequently no signs of inflammation around the catheter. Diagnosis depends on either a positive quantitative catheter culture yielding the same microorganism recovered from the bloodstream or differential quantitative blood cultures with significantly greater colony counts from blood drawn through the catheter than from blood drawn through a peripheral vein. Alternatively, probably catheter-related sepsis can be diagnosed when clinical sepsis is refractory to antimicrobial therapy but responds to catheter removal. Often these criteria are not met but catheter-related bloodstream infection is presumed because a common skin microorganism is isolated from the blood when clinical manifestations of bloodstream infection are present and there is no other apparent source of infection. Microorganisms causing catheter-related bloodstream infection gain access to the bloodstream predominantly from either the catheter insertion site or the catheter hub. Most catheter-related infections occurring shortly after
catheter insertion probably gain access to the bloodstream by extraluminal migration along the catheter from the skin at the catheter insertion site. When catheters are in place for extended periods, especially greater than 30 days, the catheter hub probably plays a major role in microorganisms gaining access and then migrating endoluminally until reaching the bloodstream. Recently employed strategies for the prevention of catheter-related infections include topical antibiotics or antiseptics at the catheter insertion site, flush solutions containing vancomycin, and bonding antimicrobial agents to the catheter. Infection of peripheral and central venous catheters generally resolves after catheter removal. For tunneled silicone catheters, most episodes of catheter-related infection can be initially managed with antimicrobial therapy infused through the catheter without catheter removal. Staphylococcus aureus is generally more aggressive and associated with more complications than coagulase-negative staphylococci. Microorganisms that usually require catheter removal include Candida and Bacillus species. Adjunctive treatments of catheter infections include the use of urokinase. Catheter-related infection remains an important complication of vascular access. Novel prevention and treatment strategies are currently being investigated. In the near future bonding of antibiotics or other agents to catheters may become routine. \( \text{ABSTRACT TRUNCATED AT 400 WORDS} \) [References: 161]


To assess the risks associated with the use of central venous ports in children with haemophilia, 15 HIV-negative patients were prospectively evaluated. Port insertion was required for immune tolerance in two inhibitor patients and continuous prophylaxis in 13 patients with severe factor VIII deficiency, for whom surgery was covered with recombinant factor VIII (rFVIII), then given daily at home until day 6. One inhibitor patient (titre 7BU/ml) received high-dose rFVIII by continuous infusion until day 3, followed by an immune tolerance treatment scheme; the other (titre 12 BU/ml) was given recombinant activated factor VII by continuous infusion until day 7. After training on the use of the port, all patients continued their infusion programme at home. All ports remained in place for a median period of 413d (range 125-509). The median number of entries into the port was 184 (range 53-567). Port-site haematoma and infection occurred in one patient on day 7 when an inhibitor became detectable (titre 12 BU/ml). An infectious complication occurred in another patient after 310d. The port infection rate was 0.42 per 1000 patient-days (0.33 per 1000 entries into the port). This protocol for port placement with short hospitalization appears feasible and safe.


The incidence of mechanical and infectious complications of totally implantable central venous access devices (TIDs) must be related to underlying disease, intensity of the chemotherapy, and frequency of manipulations. Records of the patients hospitalized from January 2002 to May 2005 were evaluated. Patients with TIDs were matched with patients without TIDs having the same malignancy and the same anti-neoplastic chemotherapy. Catheter-related complications were documented and corresponding phases of the chemotherapy in matched pairs were compared with regard to infections. TIDs were inserted in 31 patients with a median age of 4.3 years (22 acute leukemia, 1 NHL, and 8 solid tumors). Total number of catheter days was 5268, with a median catheter life of 174 days (range 9-493 days). Nine catheters (29%) were removed due to mechanical and infectious complications. There was 13 catheter-related infections
with a rate of 2.46/1000 catheter days. Total number of mechanical complications was 5 and overall rate of complications was 3.41/1000 catheter days. The rate of febrile episodes was 54 and 41 in the TID and no TID group, respectively (p: .11). Duration of neutropenia was 9.6 and 7.4 days and duration of fever per febrile attack was 5.6 and 4.4 days in the TID and no TID group, respectively (p: .047 and .56). Although most of the patients in this study had hematological malignancy and required frequent manipulation, the results were similar to those in developed countries. TIDs are essential for management of chemotherapy in pediatric malignancies with acceptable complications.


**BACKGROUND:** Intraluminal occlusion is common in children with central venous catheters (CVCs). Although multiple factors predispose CVCs to occlusion, reflux of blood is frequently implicated. We hypothesized that use of either a single-valve or positive-pressure-valve needleless connector device would reduce CVC occlusion rates in comparison to a standard device. We further hypothesized that saline would be as effective as heparinized saline flush in preventing occlusion and infection.

**METHODS:** CVC lumens were prospectively capped with 1 of 3 needleless connector devices in a 4-group design. Group 1 lumens were capped with a standard device, group 2 with a single-valve device, group 3 with a positive-pressure-valve device flushed with heparinized saline, and group 4 with a positive-pressure-valve device flushed with saline. Data were obtained regarding occlusion and infection rates and user satisfaction.

**RESULTS:** Three hundred sixty children with 599 CVC lumens completed the study. Complete occlusion occurred in 19/150 (12.7%) lumens in group 1 in comparison to 2/150 (1.3%) in group 2, 5/149 (3.4%) in group 3, and 6/150 (4%) in group 4 (p < .05). There was a trend toward a 2-fold greater infection rate in group 4. User satisfaction was higher in groups 2, 3, and 4 than group 1 (p < .05).

**CONCLUSIONS:** CVCs capped with a single-valve or positive-pressure-valve needleless connector device have lower complete catheter occlusion rates than those capped with a standard device. Heparinized saline flush affords no advantages over saline in reducing occlusion rate; however, there was a trend toward lower infection rate with the use of heparinized saline.


In a prospective study, cultures were obtained of all intravascular catheters removed from children in an intensive care unit. Of 366 catheters removed from 217 children, 110 (30%) were found to be colonized, most commonly with coagulase-negative staphylococci. Despite the high rate of colonization, there were only nine instances (2%) of catheter-related bacteremia.

A 7-year experience with home parenteral nutrition (HPN) in 35 children and adolescents suffering from severe gastrointestinal diseases is reported. The average duration of HPN was 577 days with a mean of 2.9 catheters per patient. There was a total of 82 episodes of proven catheter-related sepsis, an average of 1.5 septic episodes per patient year. In about half of these instances, the catheter had to be removed. Coagulase-negative and -positive staphylococci were the most common organisms isolated. All four Candida infections led to removal of the catheter. Children requiring HPN from early infancy had a higher frequency of catheter-related infections than those started on HPN after the first year of life. In four cases, clinically significant thrombotic complications occurred. The results suggest that even under optimal conditions of catheter placement and with extensive education in aseptic catheter handling, infection is still relatively common in children receiving HPN. However, there was no mortality related to this complication.


Forty-five children with oncologic or hematologic disorders requiring tunneled central venous catheters (TCVC) for the administration of immunosuppressive therapy were randomized to receive either 10 U/mL heparin (H) (24 patients) or a solution of 10 U/mL H and 25 micrograms/mL vancomycin (H-V) (21 patients) for all catheter flushes. Episodes of fever or suspected sepsis were evaluated to determine whether the addition of vancomycin to the flush solution would alter the incidence of symptomatic bacteremia attributed to luminal colonization of TCVC with vancomycin-susceptible bacteria. Patients were enrolled for 247 +/- 150 days, accounting for a total of 11,095 days of catheter use. Bacteremia attributed to luminal colonization with vancomycin-susceptible organisms occurred in five patients (six infections) receiving H alone compared with zero patients receiving H-V (P = .035). The time to the first episode of bacteremia with vancomycin-susceptible organisms, analyzed by Kaplan-Meier survival curves, was significantly longer in patients receiving H-V (P = .04). There were no differences in the incidence of other infections including bacteremia attributed to luminal colonization with vancomycin-resistant organisms, other bacteremias (including those arising from the catheter exit site), exit-site cellulitis, or fungal infections. No organisms resistant to vancomycin were identified. Vancomycin could not be detected in the peripheral blood of patients receiving vancomycin in the flush solution. No vancomycin-related toxicities were noted. We conclude that the use of an H-V flush solution in immunocompromised patients with TCVC can decrease the frequency of bacteremia attributed to luminal colonization with vancomycin-susceptible bacteria.


During a 26-month period, 158 central venous catheters were inserted in 114 children (median age: 4.5 years) with malignant diseases. Polyurethane catheters were used, inserted either using a cut-down procedure or percutaneously in the external or internal jugular vein. All catheters were tunnelled from the point of insertion to the midpoint of the manubrium or upper sternum. The catheter tip reached the superior caval vein or the right atrium in 94% of the cases. The catheters were used for all infusions, including total parenteral nutrition, and for blood sampling. The median catheter duration was 104 days (range 5-835 days). Sixty-eight (43%) of the catheters were removed as they were no longer needed, and 31 (20%) were removed due to local infection or sepsis. During a total of 23,486 catheter days (64.4 years), 110 episodes of septicaemia occurred. This represents one episode per 214 catheter days. In 43 of the 110 episodes of septicaemia, blood cultures showed growth of bacteria of the kind usually found in the
gastrointestinal and respiratory tracts. All septicaemias were treated with intravenous broad-spectrum antibiotics and in 21 cases the catheters were removed due to septicaemia. Thirty-four (22%) catheters were removed accidentally. There were two cases of subclavian vein thrombosis.


BACKGROUND: Complications associated with peripherally placed percutaneous central venous catheters (PCVC) in neonates include mechanical complications (catheter thrombosis, occlusion or dislodgement) and infection. Strategies to prevent catheter thrombosis and occlusion include the use of heparin. However, heparin is known to be associated with complications such as bleeding and thrombocytopenia.

OBJECTIVES: Primary objective: To assess the effectiveness of heparin for prevention of catheter related thrombosis.

SECONDARY OBJECTIVES: To assess the effectiveness of heparin on catheter occlusion, duration of catheter patency, catheter related sepsis and complications associated with the use of heparin.

SEARCH STRATEGY: A literature search of MEDLINE, EMBASE, CINAHL from their inception to December 2007, The Cochrane Library (Issue 4, 2007) and abstracts from the annual meetings of the Pediatric Academic Societies was performed without language restrictions.

SELECTION CRITERIA: Randomized or quasi-randomized clinical trials of neonates where heparin infusion was compared to placebo or no treatment for prevention of any of the complications related to peripherally placed PCVC were included.

DATA COLLECTION AND ANALYSIS: The methodological quality of included trials was assessed using criteria for masking of randomization, masking of intervention, completeness of follow-up and masking of outcome measurement. Data on relevant outcomes were extracted and the effect size was estimated by calculating relative risk (RR), risk difference (RD) and associated 95% confidence intervals (CI).

MAIN RESULTS: Three randomized trials were identified. Two trials of adequate methodology met the eligibility criteria. These studies included 267 neonates. There was reduced risk of catheter occlusion (typical RR 0.28, 95% CI 0.15, 0.53, NNT 5, 95% CI 3, 8). There was no statistically significant difference in the duration of catheter patency when analyzed as continuous data; however, in one study survival analyses identified benefit with heparin (adjusted hazard ratio 0.55, 95% CI 0.36, 0.83); (Shah 2007). This could be due to higher incidence of elective removal of catheters in neonates at the completion of therapy in the heparin group (63% vs. 42%; p = 0.002) (Shah 2007). There was no statistically significant differences in the risk of thrombosis (typical RR 0.93, 95% CI 0.58, 1.51), catheter related sepsis (typical RR 1.96, 95% CI 0.50, 7.60), or extension of intraventricular hemorrhage (typical RR 0.87, 95% CI 0.25, 3.03) between the two groups.

AUTHORS’ CONCLUSIONS: Implications for practice: Prophylactic use of heparin for peripherally placed PCVC allows a greater number of infants to complete their intended use (complete therapy) by reducing occlusion. Evidence from this systematic review support the prophylactic use of heparin for PCVC in neonates at a dose of 0.5 IU/kg/hr.

IMPLICATIONS FOR RESEARCH: None of these studies was powered to evaluate a lower incidence rate of adverse events. If this therapy is adopted in routine practice, monitoring of side effects is indicated.

[CINAHL Note: The Cochrane Collaboration systematic reviews contain interactive software that allows various calculations in the MetaView.]

BACKGROUND: Mechanical and infectious complications shorten the effective duration of peripherally inserted central venous catheters. Heparin use to prevent such complications and prolong the usability of peripherally inserted central venous catheters is inconclusive.

OBJECTIVE: Our goal was to evaluate the effectiveness of heparin in prolonging the usability of peripherally inserted central venous catheters in neonates.

DESIGN/METHODS: We performed a multicenter, randomized, controlled trial of heparin infusion (0.5 U/kg per hour) versus placebo for peripherally inserted central venous catheters in neonates. The primary outcome was duration of catheter use. Secondary outcomes were occlusion, catheter-related sepsis, thrombosis, and adverse effects of heparin. To detect a 168-hour (1-week) difference in the duration of catheter use, 192 patients were needed. Kaplan-Meier and Cox regression analyses were performed.

RESULTS: A total of 201 neonates were enrolled (heparin group: n = 100; control group: n = 101). Baseline demographics were similar between the groups. Duration of catheter use was longer in the infants in the heparin versus the placebo group. Study center, gender, birth weight, and type and position of the catheter were not predictors of duration of catheter use. For those in the heparin versus the placebo group, the incidence of elective catheter removal (therapy completed) was 63% vs 42%, of occlusion was 6% vs 31%, of thrombosis was 20% vs 21%, and of catheter-related sepsis was 10% vs 6%, respectively. No adverse events were noted.

CONCLUSIONS: Heparin infusion prolonged the duration of peripherally inserted central venous catheter usability, which permitted a higher percentage of neonates to complete therapy without increasing adverse effects.


BACKGROUND: Central venous catheters (CVCs) are a mainstay in the management of critically ill children. However, these catheters are associated with mechanical and infectious complications which reduce their life span. Heparin bonding of catheters has shown promise in animal studies and in adults.

OBJECTIVES: The primary objective was to determine the effect of heparin-bonded CVCs on the duration of catheter patency in children. Secondary objectives were to determine the effect of heparin-bonded catheters on catheter related thrombosis, occlusion, sepsis and side effects. SEARCH STRATEGY: We searched the Cochrane Peripheral Vascular Diseases (PVD) Group Trials Register (inception to August 2007) which contains trials identified through searches of MEDLINE (1966 to August 2007), EMBASE (1980 to August 2007), CINAHL (1982 to August 2007), and hand searches along with the Cochrane Central Register of Controlled Trials (CENTRAL) in The Cochrane Library 2007, Issue 3.

SELECTION CRITERIA: We included randomised and quasi-randomised controlled trials of heparin-bonded catheters versus non-heparin bonded catheters or antibiotic-impregnated catheters that reported on any of the prespecified outcomes, without language restriction.
DATA COLLECTION AND ANALYSIS: Methodological quality of the trials was assessed using the information provided in the studies and by contacting authors. Data were extracted and the effect size was estimated and reported as relative risk (RR), risk difference (RD) or number needed to treat (NNT), as appropriate.

MAIN RESULTS: Two eligible studies reflecting 287 patients were included; both had good methodological quality. There was no difference in the duration of catheter patency between heparin bonded and non-heparin bonded catheters (median duration 7 days vs 6 days) reported in one study. There was no difference in the risk of catheter related thrombosis (RR 0.71, 95% CI 0.44 to 1.15; RD -0.05, 95% CI 0.13 to 0.02; I(2) = 79%). Data from one study revealed a statistically significant reduction in the risk of catheter occlusion (RR 0.06, 95% CI 0.00 to 1.07; RD -0.08, 95% CI -0.13 to -0.02; NNT 13, 95% CI 8 to 50), catheter-related infections (RR 0.06, 95% CI 0.01 to 0.41; RD -0.17, 95% CI -0.25 to -0.10; NNT 6, 95% CI 4 to 10) and catheter colonization (RR 0.21, 95% CI 0.06 to 0.71; RD -0.11, 95% CI -0.19 to -0.02; NNT 9, 95% CI 5 to 25) in the heparin-bonded catheter group.

AUTHORS’ CONCLUSIONS: Two eligible studies on the use of heparin-bonded catheters versus placebo in children were identified. The use of heparin-bonded catheters is a promising therapy but warrants further studies. [References: 28]


BACKGROUND: Children with central venous catheters and suspected bloodstream infection are often hospitalized for 48 hours to receive empiric antibiotic therapy pending blood-culture results. Continuous monitoring blood-culture systems allow for more rapid detection of bloodstream infection than previous blood-culture systems, a feature that may facilitate earlier determination of the true presence or absence of bloodstream infection and shorten empiric antibiotic therapy and duration of hospitalization.

METHODS: This retrospective cohort study included children with central venous catheters who were diagnosed with laboratory-confirmed bloodstream infection after evaluation in the ambulatory care setting.

RESULTS: Two-hundred episodes of bloodstream infection were included. The median patient age was 5.5 years. Central venous catheters were in place for a median of 80.5 days. Gram-negative bacteria accounted for 51% of infections as part of either a monomicrobial (25%) or polymicrobial (26%) infection. The overall median time to blood-culture positivity was 14 hours. The predicted probability for a culture being positive at 36 hours was 99.2% for infections caused by gram-negative bacteria and 96.6% for any infection after adjusting for age, catheter type, and recent antibiotic use. In a multivariate Cox proportional-hazards regression model, polymicrobial infections with > or = 1 gram-negative bacteria and monomicrobial infections caused by gram-negative bacteria were independently associated with an earlier time to blood-culture positivity after adjusting for age, catheter type, and recent antibiotic use.

CONCLUSIONS: The time to blood-culture positivity depends on bacterial category. Bloodstream infections caused by gram-negative bacteria are detected most quickly. Our data suggest that discontinuation of empiric antibiotic coverage may be warranted in clinically stable children with central venous catheters if the blood-culture results remain negative 24 to 36 hours after collection.

Fifty-two pediatric oncology patients with central venous catheters (CVCs) who received home care services were studied. Gram-negative organisms were responsible for a greater proportion of CVC-associated bloodstream infections in pediatric oncology patients receiving home care than in hospitalized pediatric oncology patients.


Management of device-related infections includes device removal for some catheter-related bloodstream infections and all ventriculoperitoneal shunt-related infections. The isolation of certain organisms (eg, Staphylococcus aureus, Candida spp) in children with central catheters should prompt consideration of disseminated infection. Future research may determine the impact of increasing catheter use in non-intensive care hospital settings and in home care. New technologies, such as antimicrobial-impregnated central venous catheters and ventricular shunts, show promise in reducing the infection rates of these devices. [References: 72]


OBJECTIVE: The objectives of our study were to determine the incidence of catheter-associated bloodstream infection (CA-BSI) pre- and postintroduction of our CA-BSI bundle.

DESIGN: Retrospective chart review for 2004 and prospective descriptive study for 2005. Setting: A tertiary referral, university affiliated, medical-surgical pediatric intensive care unit with 22 beds and approximately 1100 admissions per year. Patients: All patients who were admitted to our unit who had any documented CA-BSI according to the Centre for Disease Control criteria between January 2004 and December 2005.

INTERVENTIONS: Education and institution of a bundle for decreasing CA-BSI. The CA-BSI bundle was adapted for pediatrics and included components for catheter insertion and ongoing catheter maintenance.

MEASUREMENTS AND MAIN RESULTS: Cases of CA-BSI were collected and rates per 1000 line days and per 1000 admissions were calculated pre institution of bundle (January to September 2004), during institution (October 2004 to May 2005) and postinstitution (June 2005 to December 2005). Infection rates per 1000 line days decreased from pre 8.8 (17/1934; 95% confidence interval [CI], 5.2-14) to during 1.8 (3/1665; 95% CI, 0.4-5.3) and post 2.2 (3/1367; 55% CI, 0.4-6.4). Decreases per 1000 admissions were also seen: pre 18.3 (17/928; 95% CI, 10.7-29), during 4.3 (3/691; 95% CI, 0.9-12.3) and post 5.1 (3/583; 95% CI, 1-15).

CONCLUSION: Strategies aimed at reducing CA-BSI appear to be effective.


Central venous catheters are being increasingly used as hemodialysis vascular access. We evaluated catheter survival, outcome predictors, and complications in a total of 36 catheters used in 13 children and young adults undergoing chronic maintenance hemodialysis through catheter for a duration of 10.4+/−5.6 months.
Reasons for catheter failure were: thrombosis 12 of 36 (33%), infection 6 of 36 (17%), and extrusion 2 of 36 (5.4%). Catheters were lost to infection and thrombosis at 1.1 and 2.2 episodes per 1,000 catheter days, respectively. Symptomatic infections, Gram-negative and polymicrobial sepsis increased the risk of catheter failure. Most of the thrombotic episodes occurred in patients with inherent thrombotic tendency. The survival of the 36 catheters was 62% at 1 year. The survival of 13 randomly chosen catheters, 1 from each patient, was 85% at 1 year. The time from insertion to first complication correlated significantly with the outcome (P<0.03). We conclude that central venous catheters are still associated with a high rate of failure and may be a regular access choice only in a selected patient population with no inherent thrombotic tendency and no other option available for long-term hemodialysis.


BACKGROUND: In an effort to avoid infections that can lead to the premature removal of indwelling central venous catheters (CVCs), the surgical technique and host factors present in pediatric recipients of permanent CVCs were reviewed.

STUDY DESIGN: All patients receiving CVCs over a 17-month period were identified. Those patients with fever and positive blood cultures drawn through the CVC within 45 days of line placement were labeled as having early infection. A case-control design was used to select two control patients for each infected patient. Charts from both the infection and control groups were reviewed for several factors present at the time of CVC placement, including fever, neutropenia (absolute neutrophil count [ANC] < 500 and ANC < 1,000), use of perioperative antibiotics, diagnosis, CVC site, and type of CVC. Chi-square test with Yates correction was used to compare the groups. Odds ratios (ORs) and 95% confidence intervals were derived.

RESULTS: Among the 473 CVCs placed, early infections developed in 53 patients (12%). The control group consisted of 106 patients. Neutropenia was present in 16 of 53 infected patients versus 8 of 106 controls (p = 0.004, OR = 5.30). Perioperative antibiotics were given to 25 of 53 infected patients versus 72 of 106 controls (p = 0.02, OR = 0.42). Fever was present in 12 of 53 infected patients versus 14 of 106 controls (p = 0.19, OR = 1.92). Factors that were equally prevalent between the groups and that did not appear to influence the CVC infection rate included a diagnosis of malignancy, CVC type, and site of placement. Of the 53 infected catheters, 16 (30%) could not be cleared of infection and were removed.

CONCLUSIONS: This study documents that neutropenia and failure to administer prophylactic antibiotics are risk factors for the development of early CVC infection in pediatric patients. To avoid early infection and possible premature CVC removal, we recommend that placement of permanent CVCs be postponed until the ANC is > 1,000. Perioperative antibiotics should be given. A trend toward higher infection rates was seen in patients with preoperative fever.


Peripherally inserted central catheters (PICCs) have been used for many years in developed countries, but few studies have been focused on children with cancer in developing countries. In this study, we assessed the feasibility of PICCs and determined the rate of PICC-related complications in children with cancer. We prospectively followed all children with cancer over 3 years of age who received chemotherapy and PICC
placement in our cancer center between June 2003 and May 2007. The date of last follow-up was January 31, 2008. A total of 119 PICCs were inserted into 116 patients during the 48-month period. PICCs were placed in 113 of 119 attempts, yielding an insertion rate of 95.0%. The 113 PICCs were in place for a total 26,721 catheter days (median time, 246 d; range, 8 to 455 d). The 113 PICCs had 53 overall complications, for a rate of 1.98/1000 catheter days. Twenty-one (18.6%) PICCs were removed because of complication with a rate of 0.79/1000 catheter days. The most common reason for PICC removal was breakage/leakage. An infection requiring PICC removal occurred in 4 patients. This study demonstrated relatively low complication rate and long duration for PICCs in children with cancer over 3 years of age in our hospital.


To document the risk of catheter sepsis associated with central venous catheter changes every 7 days in paediatric burn patients, and analysis of data collected prospectively on 234 such catheters was performed. During an 18-month period there were 301 acutely burned children admitted to a regional paediatric burn facility of whom 53, with an average burn size of 42 per cent TBSA, required 234 central venous catheters. A central venous catheter management protocol was followed which included catheter changes every 7 days. If insertion sites were clean and uninflamed, catheters were replaced by guidewire and the original catheter tip was semiquantitatively cultured. Catheters were replaced to a new site if insertion sites appeared inflamed or catheter tips grew 15 or more colony forming units. Overall, 3.2 per cent (10.9 per cent by Centers for Disease Control definition) of central venous catheters were associated with sepsis. When catheters were replaced by guidewire from one to three times, catheter sites were used for a mean of 15.6 days without an increased rate of line sepsis. There was no difference in sepsis rates between catheters placed at a new site or replaced by guidewire. There were no deaths attributed to catheter-related sepsis. We conclude that a protocol allowing for catheter change to a new site, or replacement by guidewire, every 7 days was associated with a low risk of catheter sepsis in paediatric burn patients.


We sought to better describe the expected incidence of mechanical and infectious complications associated with central venous cannulation of critically ill children. We undertook a retrospective analysis of a prospective data collection of 1056 consecutive percutaneous central venous catheters inserted under the supervision of an experienced surgeon. There were 245 (23%) subclavian (SC), 118 (11%) internal jugular (IJ), and 693 (66%) femoral (F) catheters placed in 289 children with an average age of 6.4 +/- 5.1 years (range, 4 weeks to 18 years) admitted to a burn intensive care unit. Catheter sepsis occurred in 7.4% of SC, 7.6% of IJ, and 4.9% of F catheters (NS, P = .25), for an overall sepsis rate of 5.8%. The number of catheter lumens did not impact infection rate. Infection rates increased in catheters left in situ more than 10 days, increasing to 37.5% at 14 days. Acute mechanical complications occurred in three insertions (0.3%), including two (0.8%) SC, zero (0%) IJ, and one (0.1%) F catheters (NS, P = .20). All three were arterial cannulations that were recognized and treated successfully without surgery. There were no pneumothoraces, vascular lacerations, acute thromboses, or catheter emboli. There were six (0.6%) cases of deep venous thrombosis that occurred in cannulated sites: one (0.4%) SC, two (1.6%) IJ, and three (0.4%) F sites (NS, P = .23). Patient age did not influence complication rates. A total of 239 (23%) of the CVCs were placed in infants less than 24 months; 273 (26%) 2 to 5 years, 259 (25%) 6 to 10 years, and 285 (27%) >10 to

Patients undergoing bone marrow transplant (BMT) are at great risk of infection and sepsis. Long-term central catheters (LTCCs), required for IV therapy, can be a portal of entry for infectious agents. This randomized, prospective study compared two types of catheter dressings in 98 patients undergoing BMT: a dry sterile gauze dressing (DSGD) changed daily and a transparent adherent dressing (TAD) changed every four days. Study outcomes included incidence and severity of local and systemic complications, patient assessment of comfort, and calculation of nursing time. One case of catheter-related infection occurred during the study. No significant differences existed between the two dressings in the incidence of positive skin cultures or local complications with the exception of skin irritation. The TAD caused less skin irritation, was preferred by patients, cost less, and required less nursing time. The findings indicate that TADs provide a safe, comfortable, and cost-effective alternative to DSGDs for patients undergoing BMT and receiving antibiotic support during aplasia.


**BACKGROUND:** Taurolidin/Citrate (TauroLock), a lock solution with broad spectrum antimicrobial activity, may prevent bloodstream infection (BSI) due to coagulase-negative staphylococci (CoNS or 'MRSE' in case of methicillin-resistant isolates) in pediatric cancer patients with a long term central venous access device (CVAD, Port- or/Broviac-/Hickman-catheter type).

**METHODS:** In a single center prospective 48-months cohort study we compared all patients receiving anticancer chemotherapy from April 2003 to March 2005 (group 1, heparin lock with 200 IU/ml sterile normal saline 0.9%; Canusal Wockhardt UK Ltd, Wrexham, Wales) and all patients from April 2005 to March 2007 (group 2; taurolidine 1.35%/Sodium Citrate 4%; TauroLock, Tauropharm, Waldbuttelbrunn, Germany).

**RESULTS:** In group 1 (heparin), 90 patients had 98 CVAD in use during the surveillance period. 14 of 30 (47%) BSI were 'primary Gram positive BSI due to CoNS (n = 4) or MRSE (n = 10)' [incidence density (ID); 2.30 per 1000 inpatient CVAD-utilization days]. In group 2 (TauroLock), 89 patients had 95 CVAD in use during the surveillance period. 3 of 25 (12%) BSI were caused by CoNS. (ID, 0.45). The difference in the ID between the two groups was statistically significant (P = 0.004).

**CONCLUSION:** The use of Taurolidin/Citrate (TauroLock) significantly reduced the number and incidence density of primary catheter-associated BSI due to CoNS and MRSE in pediatric cancer patients.


Otherwise unexplained clinical signs of infection in patients with long-term tunnelled or totally implanted central venous access devices (CVADs) are suspected to be CVAD-associated. Diagnostic methods include...
catheter swabs, blood cultures and cultures of the catheter tip or port reservoir. In the case of a suspected CVAD-related bloodstream infection in paediatric oncology patients, in-situ treatment without prompt removal of the device can be attempted. Removal of the CVAD should be considered if bacteraemia persists or relapses \( \geq 72 \) h after the initiation of (in-vitro effective) antibacterial therapy administered through the line. Timely removal of the device is also recommended if the patient suffers from a complicated infection, or if Staphylococcus aureus, Pseudomonas aeruginosa, multiresistant Acinetobacter baumannii or Candida spp. are isolated from blood cultures. Duration of therapy depends on the immunological recovery of the patient, the pathogen isolated and the presence of related complications, such as thrombosis, pneumonia, endocarditis and osteomyelitis. Antibiotic lock techniques in addition to systemic treatment are beneficial for Gram-positive infections. Although prospectively controlled studies are lacking, the concomitant use of urokinase locks and taurolidine secondary prophylaxis seem to favour catheter salvage. [References: 183]


Pediatric oncologists from Germany systematically reviewed the literature, considering the use of urokinase in pediatric oncology patients published since 1998 and came to the following conclusions. The use of urokinase to prevent central venous access device (CVAD)-related infections in pediatric cancer patients represents an evidence-based approach, at least in external, tunneled catheters (eg, Hickman, Broviac). The effectiveness of urokinase prophylaxis in decreasing infections and thrombotic events is probably related not only to the concentration and timing of the urokinase intervention but also to the type of CVAD, and perhaps to the intensity of the concomitant chemotherapy program. Urokinase can safely and effectively be used on CVADs with malfunctioning or intraluminal occlusion in a dose of 5000 IU/mL or as salvage 3-hour infusion with 1000 IU/kg/hour. Hitherto, adjuvant treatment with urokinase in the management of CVADs with intraluminal infection still relies on case reports and small case series. In this field, a randomized controlled study is necessary. [References: 23]


OBJECTIVE: To determine the incidence of all nosocomial infections (NIs) in pediatric hematology-oncology patients, as well as central venous access device (CVAD)-associated infections acquired during home care.

DESIGN: Prospective surveillance study.

SETTING: The Pediatric Hematology and Oncology Department at the University Hospital Bonn.

PATIENTS: All patients admitted from January through October 1998 (surveillance period).

METHODS: Standardized surveillance system based on the Centers for Disease Control and Prevention’s National Nosocomial Infections Surveillance System.
RESULTS: A total of 143 patients were hospitalized for 3,701 days (776 admissions) during the surveillance period. Of the 40 NIs detected, 26 were CVAD-related, with 21 bloodstream infections (BSIs) and 5 local infections. Four were Clostridium difficile-associated diarrheal illnesses, 3 were pneumonias, and 7 were other infections. The incidence of NIs was 10.8 per 1,000 patient-days (5.2 NIs/100 admissions). The overall CVAD-related BSI rate was 7.4 per 1,000 utilization days, without a significant difference between implanted infusion ports and tunneled catheters. In addition, 7 CVAD-related infections occurred during home care. All 8 BSIs associated with tunneled catheters and 13 (76%) of the 17 BSIs associated with ports were acquired nosocomially. For inpatients and outpatients combined, the exit sites of tunneled catheters were more likely to become locally infected than were the needle entry sites of ports (relative risk, 8.0; P=.007). In 30 (75%) of the 40 NIs, the affected patients had severe neutropenia (<500/mm³) at the time of infection.

CONCLUSIONS: Most NIs in the pediatric hematology-oncology patients were associated with CVAD devices. Although many infections in this high-risk population may not be preventable through infection control measures, the careful evaluation of specific infection rates permits the identification of risk factors that may be targeted by infection control programs. Prospective surveillance for NIs on pediatric oncology units is an indispensable tool for this internal quality control.


BACKGROUND: To assess the effects of extending the routine intravenous administration set (IVAS) change-interval from 72 h (group 1) to 7 days (group 2) on the incidence density for central venous access device (CVAD)-related bloodstream infections (BSIs) and on resource expenditures in a singlecentre pilot study.

PROCEDURE: Prospective pre-/post-intervention comparison of two consecutive 12-month surveillance periods (2001-2003) in a 17-bed paediatric oncology tertiary care unit. IVAS changes and nosocomial infections (NIs) were prospectively analysed using a standardized unit-based surveillance system (Oncopaed NI).

RESULTS: All 175 eligible patients were enrolled, 96 in group 1 and 79 in group 2. Both groups had similar distributions of primary diagnoses and risk factors. The proportion of IVAS changes performed after 3 days increased from 5.6% to 22.5%, but only 8% of IVASs in group 2 were changed after 7 days. Most IVAS changes (64.8% in group 1 and 92.9% in group 2) were done because of therapeutic interventions (blood products, parenteral nutrition [TNP]) before the scheduled endpoint. Overall, the rates and incidence densities of NIs were significantly lower during the second period. The corresponding results for CVAD-related BSIs did not show significant differences. No death attributable to a NI occurred. The ‘7-day’ strategy resulted in cost savings for devices (3,300 dollars/year) and of nursing time (23 working days/year).

CONCLUSIONS: Extending the routine IVAS change-interval from 3 days to 7 days appears to be safe and cost-effective in a paediatric oncology unit with high infection control standards and continuous surveillance for NIs. These results do not prove that 7-day intervals prevent infections, but they do suggest that this policy probably is not harmful and that a prospectively randomized study with sufficient power is needed.

Central venous catheters (CVCs) are an essential tool in paediatric intensive care, providing a means to monitor patient haemodynamics and to administer fluids, nutrition, blood products and medications. Because multiple factors contribute to the high risk of catheter related infection, a multi-strategy approach is required to prevent such infections. Using contemporary literature and clinical audit findings a 'care bundle' was created for use within the PICU at Birmingham Children's Hospital. This care bundle groups together best practices in order to prevent catheter related bloodstream infection.


**EPIDEMOLOGY:** Patient characteristics and system-level factors place children at increased risk for catheter-related bloodstream infection (CR-BSI). National Healthcare Safety Network data from 36 pediatric intensive care units (PICUs) demonstrate a pooled mean of 5.3 CR-BSIs per 1000 catheter-days and a median of 3.5 CR-BSIs per 1000 catheter-days. Almost 60% of CR-BSIs in children are caused by gram-positive bacteria. In the PICU setting, arterial catheterization, increased duration of catheterization, use of extracorporeal life support, and presence of a genetic abnormality are independent risk factors for CR-BSIs.

**ECONOMICS:** In children, cost estimates range from $36,000 to $50,000 per CR-BSI.

**TREATMENT:** Empiric therapy should target gram-positive and gram-negative bacteria, with the choice of drug treatment based on local antimicrobial susceptibility patterns. Results from pediatric studies shows that catheter removal is indicated for all cases of candidemia and persistent bacteremia.

**PREVENTION:** Based on limited data, antimicrobial lock therapy may be appropriate in certain clinical situations, and multifaceted interventions are effective in reducing CR-BSIs in children. In one center, maximum barrier precautions during insertion, antimicrobial-impregnated catheters, annual hospital-wide handwashing campaigns, physical barriers between beds, and use of 2% chlorhexidine skin disinfectant decreased CR-BSIs. copyright 2008 Association for Professionals in Infection Control and Epidemiology, Inc.


The use of indwelling central venous catheters for the ambulatory management of children with cancer has been well described. There remains uncertainty as to the best method for maintaining the patency of these catheters. The standard approach at our institution is to flush the catheter twice daily with a solution containing heparin. This is both costly and inconvenient for most families. We describe a randomized cross-over study designed to compare the standard approach to a less intense program using an isotonic saline flush once a week. Evaluation continued for approximately 1,515 days in each study arm. The catheters were monitored for blockage, clot formation, and infection. One catheter blocked in a patient receiving the experimental method of care. Two episodes of thrombus formation were demonstrated at the end of the study (one in each of the study arms). The incidence of infection, while in keeping with our overall experience, was higher in the experimental arm. This led to a subsequent study, reported separately in this symposium. The results indicate that there is no significant difference, in the incidence of blocked catheters or other complications, between the two forms of care.

OBJECTIVE: To investigate a perceived increase in central venous catheter (CVC)-associated bloodstream infections (BSIs) among pediatric hematology-oncology outpatients.

DESIGN: A case-control study.

SETTING: A pediatric hematology-oncology outpatient clinic at Fresno Children's Hospital.

PATIENTS: Pediatric hematology-oncology clinic outpatients with CVCs at Fresno Children's Hospital between November 1994 and October 1997.

METHODS: A case-patient was defined as any hematology-oncology outpatient with a CVC-associated BSI at Fresno Children's Hospital from November 1996 to October 1997 (study period) without a localizable infection. To identify case-patients, we reviewed Fresno Children's Hospital records for all hematology-oncology clinic patients, those with CVCs and those with CVCs and BSIs. Control-patients were randomly selected hematology-oncology outpatients with a CVC but no BSI during the study period. Case-patient and control-patient demographics, diagnoses, caretakers, catheter types, catheter care, and water exposure were compared.

RESULTS: Twenty-five case-patients had 42 CVC-associated BSIs during the study period. No significant increase in CVC-associated BSI rates occurred among pediatric hematology-oncology patients. However, there was a statistically significant increase in nonendogenous, gram-negative (eg, Pseudomonas species) BSIs during summer months (May-October) compared with the rest of the year. Case-patients and control-patients differed only in catheter type; case-patients were more likely than control-patients to have a transcutaneous CVC. Summertime recreational water exposures were similar and high in the two groups.

CONCLUSIONS: Hematology-oncology clinic patients with transcutaneous CVCs are at greater risk for CVC-associated BSI, particularly during the summer. Caretakers should be instructed on proper care of CVCs, particularly protection of CVCs during bathing and recreational summer water activities, to reduce the risk of nonendogenous, gram-negative BSIs.


The use of central venous catheters (CVCs) in children is increasing. However, they can cause serious, sometimes life-threatening complications. This review discusses the clinical use of CVCs in children and the thrombotic and infectious complications related to this type of catheter. Percutaneously placed short-term CVCs have been the primary means of central venous access in critically ill children. Long-term CVCs are often used in children with cancer and in those who require total parenteral nutrition. The incidence of CVC-related venous thrombosis (CVC-VT) varies widely and depends on underlying conditions and the diagnostic tests used. Thrombotic symptoms include loss of CVC patency, swelling, pain, discoloration of the limb and signs of CVC-related bloodstream infection (CRBSI). Clinical suspicion of CVC-VT requires urgent proper assessment of the vessel. In cases of CVC-VT, the CVC can remain in situ only if access to the vessel is still required and the CVC is patent. Initial anticoagulation therapies include low molecular weight or unfractionated heparin, followed by vitamin K antagonists or low molecular weight heparin for a minimum of 3 months. The clinical symptoms of CRBSI are scarce and nonspecific. Definite diagnosis is made by examining simultaneous peripheral and CVC blood cultures. There is no clear evidence on whether a CVC should be removed on suspicion of CRBSI. Empirical antibiotic therapy should cover both Gram-positive and Gram-negative micro-organisms. copyright 2007.
The use of vascular access systems in patients with cystic fibrosis (CF) is well accepted, with lower overall complications and maintenance costs than percutaneous silastic catheters. We report our 6 year experience with 22 infusaports in 15 CF patients. Our patients had indwelling catheters for an average of 539 days per catheter (range, 14-2,224 days). These infusaports were used for home antibiotic therapy, blood sampling, and total parenteral nutrition. The overall complication rate was relatively low, 1 in every 1,483 catheter days. Infectious complications were extremely infrequent at a rate of 1 in 5,929 catheter days. The rate of mechanical complications was 1 in 1,976 catheter days. However, superior vena caval syndrome or deep venous thrombosis was associated with 3 of 22 catheters (13.6%). Due to this high incidence of major thrombotic events with the attendant risk of pulmonary embolism, all patients with CF using infusaports and without evidence of liver disease or bleeding problems receive aspirin prophylaxis.


OBJECTIVE: We discuss the feasibility of long-term femoral venous access by means of a cuffed subcutaneously tunneled central venous catheter (Broviac catheter) in selected pediatric cancer and stem cell transplant patients in whom access via the veins of the upper part of the torso is difficult or contraindicated and in whom alternative routes must be used.

PATIENTS AND METHODS: We report on our experience with 9 patients (3 of whom underwent stem cell transplantation) who received femoral Broviac catheters between December 1990 and November 1999.

RESULTS: Time in place ranged from 4 to 155 days with a median of 58 days (mean: 71.2 days). Three catheters had to be removed: 1 because of infection of the subcutaneous tunnel and 2 because of catheter obstruction. The remaining 6 catheters functioned well without problems as long as they were needed; 1 of them got accidentally dislodged while the patient was off treatment. No episodes of catheter-related septicemia, thrombosis, kinking, or drug extravasation were noted; there were no catheter-related infectious complications in the transplant patients.

CONCLUSIONS: Our experience indicates that in those instances in which customary access to the superior vena cava is precluded, long-term venous access by way of the femoral vein is a feasible and safe alternative in children, even in the setting of stem cell transplantation.


Bacillus species are increasingly recognized as pathogens in immunocompromised patients. The authors report a case of Bacillus cereus infection of a central line in an immunocompetent patient with hemophilia, which required line removal for complete cure.

Infectious complications are frequently encountered following Hickman-Broviac (H-B) catheter insertion. The medical records of 164 children with malignancies who underwent H-B catheter insertion from March 1, 1988 to December 31, 1997 were reviewed retrospectively. During a 35,697 catheter-day period, 77 catheter-related infections occurred, including 50 catheter-insertion-site infections and 27 bloodstream infections. The risk for the development of catheter-related infections was 2.15 per 1000 catheter-days (1.4 and 0.75 per 1000 catheter-days for catheter-insertion-site and bloodstream infections, respectively). In 17 (63%) of 27 episodes of bloodstream infections, antimicrobial treatment controlled the infection without catheter removal. A previous catheter-insertion-site infection caused by Staphylococcus epidermidis (p=0.01), the occurrence of mechanical catheter complications (p=0.007), and a normal coagulation status of the host (p=0.03) were significantly associated with the development of catheter-related bloodstream infections. H-B catheters remain important in pediatric oncology. Due to the significant morbidity associated with the development of catheter-related bloodstream infections, risk factors found to increase the incidence rate of such infections must be identified and properly managed.


Central venous lines were placed in 47 children whose age ranged from 7 days to 16 years. All except one were of the Broviac type, and installed through a subcutaneous tunneling, via the internal or external jugular vein. The indications for central venous cannulations were chemotherapy, TPN, prolonged parenteral antibiotics, and repeated blood transfusions. In 13 patients (28%), 11 of which were immune compromised, infection originated from the catheter. The commonly identified bacteria were Staphylococcus aureus, Pseudomonas aeruginosa, Staphylococcus coagulase negative, and various gram negative rods. All cases were treated with antibiotics via the catheter. In 10 children, treatment was successful, omitting the need of removing the line. In two children, tunnel infection developed and hence, the catheter was extracted. One child accidently removed his catheter prior to initiation of treatment. No other complications were detected in the infected group treated conservatively except for one case who developed a superior vena cava thrombosis. In 7 out of 13, treatment was completed at home, saving 65 days of hospitalization. We conclude that in most instances of catheter related infection, a conservative approach should be considered and applied. However, in cases associated with tunnel infection, the catheter should instantly be removed. In selected cases, treatment can be carried out at home; this is cost effective and well accepted both by the children as well as by their families.


Ochrobactrum anthropi is an emerging pathogen in immunocompromised hosts, particularly in patients with indwelling catheters. We report the characteristics of 14 O. anthropi bacteremic episodes in 11 children with Hickman-type central catheters. Children presented with fever and nonspecific clinical manifestations. Bacteremia was successfully treated with antibiotics, but catheter removal was necessary to achieve cure in four cases.

We determined the rate and risk factors for colonization of 103 peripheral intravenous catheter and 32 central venous catheters. 52.5% peripheral catheters had colonization. Common organisms isolated were Pseudomonas (33.3%) and coagulase negative Staphylococci (29.6%). Colonization was higher in catheters inserted in the lower limb. Overall 62.5% of the central catheters were colonized, chiefly by coagulase negative Staphylococci, Pseudomonas and Candida. All central catheters in place for more than 11 days were colonized. Subclavian vein catheters had a higher rate (68.2%) of colonization in comparison to femoral vein insertions (40%). We conclude that upper limb placements are preferable to lower limbs when using peripheral lines. Changing peripheral intravenous catheters every 48 hours and central venous catheters every 10 days may decrease the rate of colonization.


BACKGROUND: Infections remain the major cause of death among patients with acute renal failure (ARF), especially in severe ARF necessitating dialysis therapy (ARF(d)). Although the clinical features and outcomes of candidaemia in various patient populations have been described, data concerning candidaemic episodes among patients with ARF(d) are scarce. This study investigated the aetiology, predisposing, and prognostic factors for candidaemia in the ARF(d) patient population. Three patient groups were investigated in this study.

METHODS: During an 8-year study period from January 1992 to December 1999, 37 candidaemic episodes that developed among 653 ARF(d) patients were assigned to ARF(d) candidaemic group, and 170 candidaemic episodes developing in patients without ARF(d) or chronic uraemia as the non-ARF(d) candidaemic group, and 28 matched ARF(d) patients without candidaemia were assigned to the ARF(d) control group. Among these groups, clinical characteristics in ARF(d) candidaemia patients, predisposing factors, and outcomes were compared. Four management strategies including central catheter removal, anti-fungal therapy, both, or neither were applied. The prognostic factors for attributable death were evaluated by univariate analysis followed by the multivariate logistic regression analysis.

RESULTS: The proportion of ARF(d) patients with candidaemia was significantly higher than in patients who had no ARF(d) or chronic uraemia (5.7% vs 0.15%, P<0.001). Compared with the non-ARF(d) candidaemic group, systemic lupus erythematosus (SLE), administration of corticosteroid, and central venous catheter-associated candidaemia were more common in the ARF(d) candidaemic group (P<0.05). In matched case-control study, multiple antibiotic usage was shown to be a predisposing factor for developing candidaemia in patients with ARF(d), and corticosteroid therapy has a marginal significance (P=0.059). The occurrence of candidaemia increased the mortality rate of ARF(d) (71% vs 39.2% in ARF(d) control group, P<0.05). By multivariate logistic analysis, the variables associated with attributable death in ARF(d) candidaemic group were identified to be an APACHE II score of >or=18, and anti-fungal therapy for >48 h. Central venous catheters were removed in 32 (86.5%) of the 37 ARF(d) candidaemic patients, among whom the 18 patients who had received anti-fungal therapy for >48 h had a lower attributable death rate than those patients who had not (27.8% vs 64.3%, P<0.05). Of the remaining five patients who did not have their catheter removed, three patients subsequently died and two patients improved only after catheter removal.

CONCLUSIONS: The higher prevalence of candidaemia in ARF(d) patients is due to their underlying illnesses and multiplicity of predisposing factors, rather than ARF and dialysis therapy per se. Predisposing factors include SLE, indwelling central venous catheter, multiple antibiotic usage, and corticosteroid therapy. Prompt anti-fungal therapy and catheter removal should be mandatory for ARF(d) patients with candidaemia.
Paecilomyces lilacinus catheter-related fungemia in an immunocompromised child is reported. The presence of a central venous catheter and the patient's immunocompromised status were felt to be predisposing factors for this unusual infection. To our knowledge, this is the first description of P. lilacinus catheter-related fungemia, and our patient may be the youngest reported patient with this mycosis who was cured.


PURPOSE: To analyse the risk factors for infection associated with central venous access device (CVAD) use in children with haemophilia.

METHODS: Risk factors for CVAD infection among patients with congenital haemophilia who had had a CVAD implanted at a single institution were evaluated utilizing the following variables: age at CVAD placement, age at end of study, number of days with a CVAD, percentage of lifetime with a CVAD, and history of inhibitor.

RESULTS: Fifty-nine patients had a total of 97,936 (median 1768 days per patient) CVAD days in the study period. The median age at CVAD placement was 2.7 years (range 0-14.0). Twenty-six (44%) patients reported CVAD infections during the study period from January 1993 to October 2000. Twenty-four patients had their CVAD replaced, 17 (71%) of whom reported having infections and seven (29%) of whom had a history of inhibitor. The strongest predictor for having any infections was inhibitor status (P=0.16), although none of the risk factors had statistically significant effects. Among the 26 patients reporting infections, 42% had more than one CVAD-related infection. Seven patients had multiple infections involving the same organism. The mean rate of infection was 0.45 per 1000 catheter days, with a 95% confidence interval of 0.33-0.60. Those with a history of inhibitor had an infection rate of 0.66 compared with 0.38 per 1000 catheter days (P=0.09) for those without a history of inhibitor. Patients who were older (greater than the median age of 2.7) at CVAD placement had a lower rate of infection (0.29 vs. 0.65, P<0.01) compared with those < or =2.7 years. Adjustment for inhibitor status had little impact on these results. For the group as a whole, the median time to first infection was 1977 days from CVAD placement. Patients who were older at CVAD placement or study exit had lower relative hazards of infection (P=0.05 and P=0.09 respectively), while those who had inhibitors had a higher but not statistically significant relative hazard of 1.88 (P=0.13).

CONCLUSIONS: These data reveal that while considerable numbers of patients develop CVAD-related infection, the interval between catheter placement and infection can be quite long. In addition, the earlier in life a CVAD is placed, the higher the risk of infectious complications, as evidenced by the tendency towards a higher infection rate. Measures to prevent CVAD-related infection might be focused on very young patients who appear to be at higher risk.
Although the use of occlusive dressings in adults has been criticized in the literature, there has been little written on their use in the pediatric population. Management of dressing sites requires nursing judgement unique to this population. This study focused on the progression of microbial colonization and signs of inflammation occurring beneath repeated occlusive dressings applied to central venous catheter (CVC) insertion sites among 104 hospitalized children (neonate to 18 years). A noninvasive skin culture was obtained within 24 hours of CVC placement, 3 to 7 days later before the next routine dressing change, and at the time the CVC was discontinued or the child was discharged, whichever occurred first. Results showed a significant increase in microbial growth \( p < 0.001 \) at the second dressing change, when serosanguinous drainage was heaviest, and continued significant growth \( p < 0.001 \) when the dressing was discontinued. This microbial growth pattern was curious in the face of a 0.3% systemic sepsis rate. When neonates under 1,800 g were excluded from calculation, the pattern was not notable \( p = 0.2119 \). Findings suggest the use of occlusive dressings during prolonged hospitalization for tunnelled CVCs does not lead to increased site infections in children over 1,800 g.


BACKGROUND: Peripherally inserted central venous catheters (PICCs) are commonly used intravenous access devices in children. Although PICCs are intended to be placed in central veins, many fail to reach this location. These noncentral PICCs are used for administration of medications and isotonic solutions.

OBJECTIVES: To examine the efficacy of noncentral PICCs for completion of therapy, the complications associated with their use, and the effectiveness of noncentral PICCs as compared with PICCs placed in a central vein.

DESIGN: A prospective cohort study of children in whom PICCs were inserted, from January 1, 1994, to January 1, 1996. SETTING: A university-affiliated teaching institution.

MAIN OUTCOME MEASUREMENT: Completion of intravenous therapy.

RESULTS: A total of 587 PICCs were studied. Thirty-nine percent of PICCs were placed in noncentral veins. Centrally placed PICCs had significantly longer catheter duration compared with those placed noncentrally (16.6 vs 11.4 days, respectively). However, central and noncentral PICCs had similar therapy completion rates (73% and 69%, respectively). Catheter failure because of occlusion and accidental dislodgment were similar for central and noncentral PICCs. Likewise, complications caused by exit-site infection, phlebitis, and catheter-associated sepsis were also similar for catheters in the 2 locations. Catheter survival curves were similar for central and noncentral PICCs.

CONCLUSIONS: Our study demonstrates that PICCs placed in noncentral veins provide reliable and safe intravenous access for administration of many medications and isotonic solutions for about 2 weeks' duration. The placement of PICCs in central veins may be restricted to those children who need central vascular access because of the type of intended therapy.

**OBJECTIVE**: Use of peripherally inserted central venous catheters (PICCs) to provide prolonged intravenous (IV) access in children is increasing. Our goal was to describe the children treated with PICCs in our institution, and to study catheter features such as catheter life, completion of therapy, and complications. Furthermore, we also evaluated PICC use in children completing therapy after discharge from our institution.

**METHODS**: A prospective study of all PICCs inserted at the Children's Hospital and Medical Center (CHMC), a university-affiliated teaching institution, during a period of 18 months (January 1994 to July 1995).

**RESULTS**: A total of 441 PICCs were inserted in 390 patients. Patient age ranged from 0 to 22 years with a mean of 5.4 +/- 6.0 years. No insertion complications occurred. Treatment of infectious disease (46%) was the most frequent reason for PICC insertion. All pediatric medical and surgical services used PICCs. Average catheter life was 13 +/- 12 days. Sixty-one percent of PICCs were used entirely at CHMC, while 39% were also used at home or at an outside hospital. Completion of therapy was achieved in 69% of PICCs. Among children who completed therapy outside our hospital, there was no difference in the rates of occlusion, accidental dislodgment, or infection. One hundred twenty-nine (29%) PICCs were removed for complications. Occlusion (7%), accidental displacement (8%), and suspicion of sepsis (8%) were the most common complications. Only 2% of PICCs had documented catheter-associated sepsis.

**CONCLUSIONS**: PICCs provide reliable and safe access for prolonged IV therapy in neonates and children. The low incidence of complications with PICCs make them an attractive device for prolonged IV access. Similar complication rates with use in and out of hospital suggest that home IV therapy can be safely delivered with PICCs, avoiding expensive hospitalization.


**OBJECTIVE**: Complications of indwelling central venous access devices (CVAD) were assessed in 63 children with cancer and 35 without cancer.

**METHODOLOGY**: Central venous access devices placed surgically in 1991 were reviewed for complications.

**RESULTS**: In cancer patients, the median CVAD duration was 211 days (range 9-924), compared to 37 days (range 3-339) in the non-cancer patients. Although significantly more CVAD, 41 of 72 (57%), were infected in the cancer patients compared to 14 of 40 (35%) CVAD in the non-cancer patients (OR = 2.46, 95% CI 1.03-5.93), the rate of line infection in cancer patients was lower: 2.8 per 1000 catheter days compared with 7.6 per 1000 in non-cancer patients (P = 0.0014). Infection was significantly more common in intensive chemotherapy cancer patients (P = 0.0002).

**CONCLUSIONS**: Treating infected CVAD with antibiotics or hydrochloric acid (HCl), clearing occluded lines with streptokinase/HCl and repairing fractured lines, when successful, resulted in a considerable gain in the number of days of use for the CVAD.

Cystic fibrosis (CF) is a common fatal genetic disorder characterized by chronic pulmonary infections, some of which require intravenous (i.v.) antibiotics. Peripherally inserted central catheters (PICCs) have proven to be an effective means of i.v. delivery in a variety of populations. An evaluation of the effectiveness of the use of PICCs for patients at a CF center in New England was conducted over a 25-consecutive month period. During this time, 61 PICCs were placed in 32 patients with CF requiring i.v. antibiotics. The catheters were in place for a median of 15 days (range 1-155 days). The total number of catheter days in this series was 1,139. Although no serious complications were encountered, minor complications or technical problems occurred in 18 (29.5%) of the 61 catheters. Complications included external breaks in the catheters, shoulder pain, phlebitis, catheter occlusion, accidental dislodgement, local irritation at the insertion site, and yeast infection at the insertion site. No long-term sequelae resulted, and the rate of i.v. antibiotic completion with this mode of i.v. access was high. As a result of the evaluation, PICC access remains the standard of care at this institution for patients with CF requiring i.v. antibiotics for pulmonary exacerbations.


This report describes a 2-year-old child with neuroectodermal tumor presenting with febrile neutropenia. Blood cultures drawn from the peripheral vein and Hickman catheter revealed Kluyvera cryocrescens growth. The Hickman catheter was removed and the patient was successfully treated with cefepime and amikacin. Isolation of Kluyvera spp. from clinical specimens is rare. This saprophyte microorganism may cause serious central venous catheter infections, especially in immunosuppressed patients. Clinicians should be aware of its virulence and resistance to many antibiotics.


AIMS: To investigate teicoplanin added to pediatric parenteral nutrition solutions in terms of its stability, its compatibility with parenteral nutrition solution components and its diffusion through an antibacterial filter material.

METHODS: Three binary solutions with and without teicoplanin were studied. Different solution compositions and teicoplanin concentrations were used: A (98.3 +/- 8.2 mg/l), B (116.3 +/- 12.4 mg/l), and C (162.7 +/- 16.2 mg/l). Concentrations of teicoplanin and of solution components, osmolality, and pH of each solution were measured at H0, after 24 h at room temperature, after 24 h at +4 degrees C followed by 24 h at room temperature, and after 144 h at +4 degrees C followed by 24 h at room temperature (H168). Teicoplanin concentrations were also measured before and after passage of each solution through a 0.22 micro filter.

RESULTS: Teicoplanin concentrations remained unchanged from H0 to H168 in solutions A (99.6 +/- 8.3 mg/l), B (116.9 +/- 12.3 mg/l), and C (162.4+12.9 mg/l). During the H0-H168 interval, iron and methionine were the only components that showed significant decreases, which were similar in solutions without teicoplanin [iron, -6.1% (A), -6.8% (B), and -4.5% (C); methionine, -7.3% (A) and -8.7% (B)] and in those with teicoplanin [iron, -6.2% (A), -7.1% (B), and -4.0% (C, nonsignificant); methionine, -10.5% (A) and -10.7% (B)], indicating that they were not dependent on the presence of teicoplanin. Teicoplanin levels after filtration were identical to prefiltration values in solutions A (86.4 +/- 5.0 vs 89.8 +/- 3.4 mg/l) and B (112.6 +/- 4.3 vs 115.3 +/- 9.0 mg/l) but were 10.0% lower in solution C (161.6 +/- 3.9 vs 145.4 +/- 4.0; P << 0.001).
CONCLUSIONS: Teicoplanin can be added to pediatric parenteral nutrition solutions to treat central venous catheter-related infections due to teicoplanin-susceptible organisms since its concentrations and those of solution components remain stable over time. Copyright 1999 Harcourt Publishers Ltd.


A cross sectional audit of central venous catheter (CVC) use was performed in United Kingdom Children's Cancer Study Group oncology centres. There were wide variations in choice of line, insertion technique, aftercare practice, and diagnosis of CVC related sepsis. These variations highlight the difficulty in interpretation of published data on CVC efficacy.


In this report, we describe an 11-y-old girl who developed jugular venous thrombosis after allogeneic bone marrow transplantation for lymphoma and then experienced dissolution of the thrombosis following catheter-related Stenothrophomonas maltophilia bactearemia. The lysis of the old thrombosis around the central venous catheter suggested a local fibrinolytic activity of S. maltophilia. The global fibrinolytic capacity (GFC) was also tested in vitro by using S. maltophilia cultures obtained from the present patient; GFC of the patient was compared to that of another isolate of S. maltophilia, other bacteria (S. pyogenes and E. coli), and control plasma. The fibrinolytic capacity of S. maltophilia was significantly higher than that of the control plasma (p<0.05) and almost equal to that of S. pyogenes (p>0.05). Thus, if a potent local fibrinolytic activity of S. maltophilia is evident, the use of the fibrinolytic enzyme of S. maltophilia as a thrombolytic agent may be a useful therapeutic adjunct in the future. Further studies are needed to confirm the results obtained in the present study.


We studied infectious and mechanical complications occurring with 55 central venous catheters (CVCs) managed in hospital and at home, in 53 children with hematological malignancies who underwent bone marrow transplantation (BMT). The total catheter life span was 6906 days (median 111), 2359 days (median 40) in hospital and 4547 days (median 78.5) at home. Duration of neutropenia was 1241 days (median 20), mostly in hospital. We observed 21 CVC-related infections from 17/55 CVCs (31%): 0.30 episodes/100 days of CVC use with 0.55 /100 days in hospital vs 0.17 /100 days at home. Antibiotic treatment resolved 72% of infections without CVC removal, which was required in six instances. There were 14 mechanical complications (0.20 episodes/100 days of CVC use) in 6/55 CVCs (11%), with three removals. Interventions to resolve mechanical problems included catheter declotting by urokinase, repair and replacement. We conclude that CVC is an essential component of care of children with cancer undergoing BMT and that it has a relatively low complication rate. Most complications can be resolved by an appropriate CVC handling and by a multidisciplinary intervention in the critical post-BMT phase.
Children with osteomyelitis need treatment with intravenous antibiotics for protracted periods. An implanted central venous line (CVL) is a good method to deliver this treatment. Between 1992 and 1996, 17 patients with osteomyelitis had 20 surgically inserted Hickmann-type CVLs. The outcome of these lines was studied. Patients ranged from 1 month to 14 years of age and the duration of use of the CVL ranged from 6 to 180 days. One CVL was removed because of line sepsis and 1 was removed because of exit-site infection. We conclude that surgically inserted Hickmann-type CVLs in children with a pre-existing focus of infection in the form of osteomyelitis did not result in increased morbidity in terms of line sepsis, and served the purpose of prolonged administration of antibiotics very well.


**BACKGROUND:** Long-term tunnelled central venous catheters (TCVCs) are increasingly used when treating oncology patients. Despite international guidelines on sterile insertion, appropriate catheter maintenance and use, infections still a complication of TCVC. These infections are mainly caused by Gram-positive bacteria. Antimicrobial prevention strategies aimed at these micro-organisms could potentially decrease the majority of TCVC infections. The aim of this review was to evaluate the efficacy of antibiotics in the prevention of early TCVC infections.

**OBJECTIVES:** To determine the efficacy of administering antibiotics prior to insertion of a TCVC with or without vancomycin/heparin flush technique in the first 45 days after insertion of the catheter to prevent Gram-positive catheter-related infections in oncology patients.

**SEARCH STRATEGY:** We searched the Cochrane Central Register of Controlled Trials (CENTRAL) to July 2006. MEDLINE (1966 to 2006) and EMBASE (1966 to 2006). Reference lists from relevant articles were scanned and conference proceedings were hand searched. The authors of eligible studies were contacted to obtain additional information.

**SELECTION CRITERIA:** We selected RCTs which administered prophylactic antibiotics prior to insertion of the TCVC, and RCTs using the combination of an antibiotic and heparin to flush the CVC in oncology patients (both adults and children).

**DATA COLLECTION AND ANALYSIS:** The studies identified were assessed and the data extracted independently by the two authors. Authors were contacted for details of randomization, and a quality assessment was carried out. The analysis was carried out using the standard Cochrane software package, RevMan 4.2.

**MAIN RESULTS:** We included nine trials with a total of 588 patients. Four reported on vancomycin/teicoplanin prior to insertion of the TCVC compared to placebo, and five trials reported on antibiotic flushing combined with heparin, compared to heparin flushing only. The overall effect of administering an antibiotic prior to insertion of the catheter decreases the number of Gram positive TCVC infections (odds ratio [OR] = 0.42, 95% confidence interval (CI) 0.13 to 1.31), this effect is not significant. Flushing the TCVC with antibiotics and heparin proved to be beneficial (OR = 0.43, 95% CI 0.21 to 0.87). For intraluminal colonization the baseline infection rate is 15% which leads to a number needed to treat (NNT) of 13 (95 % CI 5 to 23).
AUTHORS’ CONCLUSIONS: Flushing of the catheter with a vanco/heparin lock solution leads to a positive overall effect. Depending on the baseline TCVC infection rate it is justified to flush the catheter with a combination of an antibiotic and heparin, if the catheter related infection-rate is high. [References: 38]


Port-A-Caths have been used increasingly in children with severe haemophilia. In non-inhibitor patients where Port-a-Caths were used to facilitate long-term prophylaxis, the infection rate is rather low and ranges in the various studies from 0 to 29%, with a median follow-up time of about 27 months. Patients that received the Port-A-Cath for the induction of immune tolerance (inhibitor patients) have a high infection rate of 50% to 83%. Although this percentage is high, good venous access is extremely important, especially in this group. The number of both inhibitor and non-inhibitor patients in the studies are very small, and a prospective survey is important to obtain more adequate data.


BACKGROUND: Outpatient parenteral antibiotic therapy with peripherally inserted central catheters (PICCs) is safe, clinically effective, and cost effective in pediatric populations cared for at academic and free-standing pediatric hospitals. Our study evaluates the transferability of these findings to a community hospital setting.

METHODS: Data were retrospectively collected on PICCs used in children at a community hospital from December 2003 to September 2006. The Fisher exact test and a logistic regression were used for statistical analysis.

RESULTS: Thirty-nine PICCs were placed in 34 patients. The total number of catheter days at home was 800 (mean 20.5 +/- 13.9). We demonstrated a 97% success rate in completing therapy at home, with 82.3% completion with a single PICC. Our overall complication rate was 33.3%, consisting of occlusion, accidental displacement, cracks in the catheters, and local irritation. There were no instances of phlebitis or suspected or confirmed catheter infection or sepsis. There were no statistically significant differences in these values compared with reports from major pediatric centers. The cost savings was $1070 per day of home health care when compared with costs of inpatient hospitalization.

CONCLUSIONS: We believe that this is the first study to demonstrate the effectiveness of PICC use for outpatient parenteral antibiotic therapy in pediatric patients in a community hospital setting, and demonstrates the ability for this to be done at the standard of care expected at major pediatric centers.

Fusarium infection is increasingly reported in immunocompromised patients. The role of central venous catheters as potential portals of entry for Fusarium is possibly underestimated. Four cases of catheter-related fusarial infection in children with acute leukemia or a solid tumor are described. These patients had an excellent response to removal of the central venous catheter and treatment with amphotericin B.


The success rate and complications from femoral arterial and venous catheterization in infants and children in a university affiliate pediatric intensive care unit were determined prospectively over a 2-year period. We also performed a meta-analysis from published literature to determine the combined estimates of noninfectious and infectious complications (with 95% confidence limits) using the inverse variance-weighted method. Success rates were 94.5% and 94.4% for femoral arterial (n=110) and venous (n=89) catheterizations, respectively, and were related to operator expertise, age, and hemodynamic status. Median age was 2.4 years and 1.1 year for arterial and venous catheterizations, respectively. Immediate complications were hematoma (10.9% arterial, 16.8% venous) and minor bleeding (13.6% arterial, 13.5% venous). Decreased pulses occurred with 7.7% of arterial catheterizations, and lower limb swelling occurred in 9.5% of venous catheterizations. Vascular complications occurred only in infants and resolved within 7-14 days. Catheter-related infections occurred in 1.9% of arterial and 3.6% of venous catheterizations. The mean duration of catheterization was 5.3 days and 6.3 days with femoral arterial and venous catheterizations, respectively. Meta-analysis of published studies shows that the estimates for noninfectious complications were 5.0%, 10.1%, 1.1%, and 1.8% for femoral arterial, femoral venous, axillary arterial, and nonfemoral venous catheters, respectively. The estimates for catheter-related infection were 2.5%, 3.7%, and 3.0% for femoral arterial, femoral venous, and nonfemoral venous catheters, respectively. The meta-analytic estimates for complication rates from published literature are not significantly different from the rates observed in our study. Femoral arterial and venous catheterization in infants and children are safe with an expected high success rate and acceptably low complication rates.


A 12-month-old child on total parenteral nutrition via a central venous access device developed an infected thrombus and endocarditis. The vegetation disappeared on conservative management. The device was left in place.


Flavimonas oryizihabitans bacteremias, which occurred immediately after the flushing or use of an implanted central venous catheter (Port-A-Cath) in two patients at the same pediatric ward, were studied by arbitrarily primed PCR. We conclude that the colonization of the Port-A-Cath with F. oryizihabitans described here lasted for several months.

**OBJECTIVES**: To identify risk factors for short-term percutaneously inserted central venous catheter-related infections in children and to evaluate the accuracy of a mortality score in predicting the risk of infection.

**METHOD**: After reviewing the charts of patients who developed catheter-related infection in a university hospital's pediatric intensive care unit, we conducted a case-controlled study with 51 pairs. Variables related to patients and to catheter insertion and use were analyzed. Risk factors were defined by logistic regression analysis. The accuracy of the Pediatric Risk of Mortality score to discriminate the risk for infection was tested using the Receiver Operating Characteristic curve.

**RESULTS**: Infection was associated with respiratory failure, patient's length of stay, duration of tracheal intubation, insertion of catheter in the intensive care unit and parenteral nutrition. Insertion site (femoral or internal jugular) was unimportant. Multivariate logistic regression analysis identified the following variables. Risk factors included more than one catheter placement (p=0.014) and duration of catheter use (p=0.0013), and protective factors included concomitant antibiotic use (p=0.0005) and an intermittent infusion regimen followed by heparin filling compared to continuous infusion without heparin (p=0.0002). Pediatric Risk of Mortality did not discriminate the risk of infection.

**CONCLUSIONS**: Central parenteral nutrition and central venous catheters should be withdrawn as soon as possible. Femoral vein catheterization carries a risk of infection similar to internal jugular catheterization. The Pediatric Risk of Mortality score should not be used to predict the risk of central catheter-related infections.


From June 1982 until December 1989, 93 permanent central venous catheters [59 external catheters (ECs) and 34 implanted catheters (ICs)] were placed in 69 patients. The median age of these patients at placement was 5.6 years for ECs and 8.8 years for ICs (P less than 0.05). Follow-up evaluation was possible on 86 catheters (58 ECs and 28 ICs). The median time of insertion was 236 days and 316 days for ECs and ICs, respectively (P less than 0.05). The median number of open days was 58 for ECs and 66 for ICs (not significant). 17 catheters (6 ECs and 11 ICs) were transiently obstructed (P less than 0.005). 30 episodes of bacteraemia were documented in 20 patients. The incidence of catheter sepsis and bacteraemia of unknown source was one in 278 and 283 open days for ECs and ICs, respectively (not significant). In this retrospective study, ECs appeared to be as safe as ICs when infection was correlated with use of the catheter, but this finding should be confirmed in a randomised design.


A 7-y-old boy with relapsed acute lymphatic leukaemia developed fungaemia due to Acremonium strictum, a fungus belonging to the group of the hyaline hyphomycetes. Initially, the fungus was misdiagnosed as Candida sp. due to the presence of abundant adventitious forms. At the time of diagnosis the patient was neutropenic and had a central venous catheter (CVC) in situ. The formation of an occlusive thrombotic mass in the v. subclavia dextra complicated the infection. Treatment consisted of amphotericin B, fluconazole, granulocyte colony-stimulating factor (G-CSF) and removal of the CVC. However the patient responded
clinically only after the intravascular thrombus had been removed surgically. Amphotericin B, voriconazole and terbinafine showed high activity in vitro against the Acremonium isolate. A literature review revealed 5 other immunocompromised paediatric patients with a systemic or localized infection due to Acremonium spp.


Acute lymphoblastic leukemia was diagnosed in a 7-year-old girl. Two months after insertion of a central venous catheter, she developed fever and complained of headache and abdominal pain. Physical examination revealed no focus of infection. A gram-negative nonfermenting bacillus was recurrently cultured from blood. Extensive biochemical testing and 16S ribosomal DNA sequencing led to the identification of Ralstonia gilardii.


Long-term intermittent venous access was established in 77 children by means of a central venous catheter (CVC) with a subcutaneous injection port (Port-A-Cath; PAC). Seventy of these children were included in this follow-up study. Sixty-three were treated for different malignant diseases, five for cystic fibrosis, one for severe hemophilia and one for central nervous system disease with seizures as the main problem. As of April, 1992, PACs had been in place for 3/12 to 8 3/12 years (cumulative 175 5/12 years) with 2,206 entries into the system. The PACs were used for blood sampling and administration of chemotherapy, antibiotics, fluids, total parenteral nutrition (TPN) and blood products. Portal infection was observed in four patients of which two patients had their PAC removed. Catheter dislocation was observed in two and catheter breakage in one. Portal occlusion, extravasation, thrombosis leading to removal of the PAC or other technical or psychological complications were not observed. The children continued normal activities, and the easy venous access decreased emotional stress during treatment. Local doctors were trained to use PACs, through which they administered maintenance chemotherapy. We conclude that long-time use of PACs in children is safe and has many advantages compared to traditional CVCs in use. Strict indications, meticulous implantation techniques and adequate handling are, however, mandatory.


Long-term central venous access is an integral part of managing children with cancer, certain congenital malformations, and gastrointestinal malfunction, as well as for those who need long-term access to medications or blood products. Disease and patient-specific selection of access device type is important in minimizing complications and obtaining optimal outcomes. Because infection is the most common complication, enthusiasm has increased for developing methods to prevent infection, although without clear impact. Most infections can be treated successfully without device removal. Premature removal occurs more frequently with external catheters and may be minimized by techniques used for insertion and catheter care. Occlusion, if detected early, usually can be successfully managed by clot lysis. [References: 103]

This is an interval analysis of the 2-year prospective multicenter Childrens Cancer Study Group study of 1,141 chronic venous access devices in 1,019 children with cancer. Device type was external catheter (EC) 72%, totally implantable (TID) 28%, and did not differ for diagnosis or age except more double-lumen devices in bone marrow transplant protocols (77%) and more TIDs in children less than 1 year old (17.7%). Insertion characteristics evaluated in 1,078 (95%) were: operating room placement 99%; general anesthesia 98%; cutdown 67%; percutaneous 33%; atrial position 50%, caval position 50%; and perioperative antibiotics 48%. Vein entry was the external jugular 33%, internal jugular 22%, subclavian 35%, cephalic 7%, and saphenous 3%. Insertion was difficult or very difficult in only 10% and operative complications occurred in only 0.7%. Degree of difficulty bore no relationship to device type or patient age. The reasons for removal in 736 devices (67%) were due to complications in 39%, of which infections were the most frequent. There was some variance between centers ranging from 8.5% to 31% for infection; 2.8% to 24% for dislodgment; and 0% to 13% for occlusion. ECs had a higher risk of dislodgment; elective removals were more frequent in TIDs; there was no difference in infection as a cause for removal between ECs and TIDs. Dislodgment was associated with the shortest distance of the cuff to the skin exit (mean, 4 cm): less than or equal to 2 cm, 49%; greater than 2 cm, 28% (P = .009) and occurred most frequently in the younger patient (18.9%, 0 to 1 years; 0.5%, greater than 8 years.


In a double-blind, randomized controlled trial, children with malignant diseases had their tunneled right atrial catheters flushed with either sterile saline or bacteriostatic saline, once per week for 26 weeks. There was no significant difference in the rates of catheter colonization between the two groups, which did differ, however, in terms of the time from entry into the study to the first infective event (64 +/- 34 days vs. 146 +/- 27 days; p less than 0.001). This was strongly suggestive of a seasonal effect, as all of the colonizations in the bacteriostatic saline group were delayed until the summer months. We conclude that the use of a bacteriostatic saline flush solution for tunneled right atrial catheters is beneficial in efforts to prevent catheter colonization.


**OBJECTIVE:** To determine whether thrombi or vascular occlusion represent a late complication persisting several years after removal of central venous lines (CVLs) in children and adolescents treated for childhood cancer.

**METHODS:** Children whose treatment for malignancy included placement of a CVL that had been removed at least 2 months previously were studied during scheduled follow-up that included contrast-enhanced computed tomography. Spiral volume acquisition was used to obtain 3-mm images from the chest apices through the right hilum, and three-dimensional reconstruction of angiograms was performed. Thrombosis/occlusion was defined as narrowing, obstruction, or filling defect of the deep venous system, with or without the formation of collateral veins. Charts were reviewed to document patient characteristics, previous CVL complications, administration of hyperalimentation, use of urokinase, and family history of venous thrombosis.
RESULTS: Twenty-three patients treated for solid tumors and 2 treated for B-cell acute lymphocytic leukemia or lymphoma were studied. Lines had been in place from 0.2 to 36 months (median, 7.4) and were removed at 2.3 to 121.8 months (median, 32.5) before study. Nine patients received hyperalimentation for periods ranging from 2 to 38 weeks (median, 12). Four patients had required urokinase instillations, and one developed superior vena cava syndrome; 4 had a CVL-related infection (two superficial and two Candida line infections). Occlusion was seen on computed tomography angiograms in 3 of the 25 patients (12%; 95% confidence interval: 4.5-31%). One of the patients with occlusion had superior vena cava syndrome; none had a family history of thrombosis, use of a double lumen CVL, or multiple instillations of urokinase.

CONCLUSIONS: Persistent asymptomatic vascular occlusion does occur as a late complication of CVL placement for treatment of childhood malignancies, although the frequency appears low among patients treated primarily for solid tumors. Prospective studies of large numbers of patients with a broader spectrum of diagnoses are necessary to define the incidence of and risk factors for this complication and to assess the need for prevention with anticoagulation or other therapy. Pediatricians caring for patients with a history of cancer and CVLs should be aware that these patients may have persistent vascular occlusion that could predispose them to recurrent thrombosis or postphlebitic syndrome.


A paediatric oncology patient presented with central line sepsis caused by Vibrio harveyi, a gram negative bioluminescent marine bacterium known to be pathogenic to fish and marine invertebrates, after swimming in the sea. (c) 2008 Wiley-Liss, Inc.


A rapidly growing pigmented mycobacterial strain with an ambiguous biochemical profile was isolated from the blood culture taken through the Hickman catheter of a 9-year-old girl with acute lymphoblastic leukemia. Whole-cell fatty acid analysis showed that the best match profile was that of Mycobacterium aurum, but the similarity index was only 0.217, meaning that there were no good matches between the isolate and the organisms in the database of the Microbial Identification System. The 16S rRNA gene of the mycobacterial strain was amplified, agarose gel purified, and sequenced. There were 44 base differences between the gene sequence of the isolate and that of M. aurum but only one base difference between the sequence of the isolate and that of Mycobacterium neoaurum, showing that the isolate was indeed a strain of M. neoaurum by using this "gold standard." This represents the first case of M. neoaurum infection documented by 16S rRNA sequencing. [References: 3]


During August and September, 1992, we experienced 4 cases of Hansenula anomala (H. anomala, synonym Pichia anomala) fungemia in immunocompromised patients. Two patients had been suffering from a malignant disease, 3 of them had received broad-spectrum antibiotics and a central venous catheter (CVC) had been inserted in all of them. H. anomala was isolated as the sole pathogen from all 4 patients. Three of
them responded favorably to fluconazole after withdrawal of the catheter, but one failed. H. anomala should be considered as a possible cause of catheter-related infections. [References: 16]


BACKGROUND: Sepsis is the most frequent serious complication during total parenteral nutrition (TPN), resulting in increased morbidity, mortality and health care costs. Existing reports have not documented the risk factors of sepsis during TPN. The objectives of this study were to determine the rate of sepsis in our practice and to explore the risk factors for sepsis during TPN. We also determined the role and efficacy of using peripherally inserted central venous catheters (PCVC) as insertion catheters to administer TPN.

METHODS: From October, 1994, to May, 1996, we administered TPN to 378 pediatric patients hospitalized at Mackay Memorial Hospital. We followed all cases for the occurrences of any complications while administering TPN. We studied all patients who had fever, a clinical presentation of sepsis and a positive blood culture during their course of TPN.

RESULTS: During the 20-month period 378 patients received TPN for a total of 6562 days. Fifty-six patients presented with clinical sepsis and positive blood cultures. Significant features in the sepsis group included longer duration of TPN, age < 3 months, usage of central venous catheters, gastrointestinal diseases as indication for TPN, low birth weight and short gestational age in prematurity. Seven patients died despite prompt antimicrobial therapy. One hundred eleven patients received TPN via PCVC for a mean duration of 17.1 days, significantly longer than 10.4 days in the peripheral intravenous catheter group but no difference between the sepsis rates.

CONCLUSION: Considering the high incidence of sepsis during TPN, every attempt should be made to minimize the length of TPN therapy and encourage early enteral feeding. We also recommend the use of PCVC in patients requiring prolonged nutritional support.


We report Mycobacterium fortuitum (M. fortuitum) catheter-related sepsis in a five-year-old boy with acute lymphoblastic leukaemia (ALL). This is the first reported case of M. fortuitum infection seen in our paediatric oncology patients. The patient was in haematological remission and receiving maintenance chemotherapy via an indwelling central venous catheter (Port-a-Cath). He was febrile, toxic-looking and was in respiratory distress. Clinically, he had a right pleural effusion and gross hepatomegaly. The patient was lymphopaenic and had deranged liver function test. Repeat paired blood cultures were positive for M. fortuitum. The catheter was promptly removed and he was treated aggressively with intravenous amikacin, cefoxitin, ciprofloxacin, trimethoprim-sulfamethoxazole and oral clarithromycin, with good clinical response. The patient remained well without further complications while on chemotherapy. M. fortuitum is an uncommon cause of catheter-related infection in patients with malignancies. Removal of an infected catheter is necessary for complete control of atypical mycobacterial infection in an immunosuppressed patient.
Central Venous Catheter (CVC) allows the administration of drugs, parenteral nutrition and blood sample taking for laboratory tests, avoiding continuous damage to the peripheral veins. Most of the psychological traumas caused by crude treatments also decrease and therefore CVC may initially be experienced as the end of continuous physical injuries. Nevertheless, it often happens that other sorts of psychological trauma, due to fantasies and fears elicited by the CVC, arise in children and their families. The CVC is often felt as a dangerous and invasive "foreign body". Moreover after it has been used for a long time it may create a psychological state of dependency and it frequently becomes the only means of salvation. This makes removal particularly difficult and it is felt as a "cutting" of the CVC at the end of the therapy. Young patients elaborate complex fantasies about the starting point, the route and the end point of the catheter. Their parents are often unknowing accomplices of these fears, partially because they project their own experience and also because they are conditioned by the way they have elaborated the information provided by the assistance staff. Since the handling of CVC is under the parent's responsibility when the child is not in Hospital, we should be able to help the patients and their families to cope with this experience in the most suitable way. This makes it possible to avoid both excessive worries and the tendency to underestimate the risk of infection. This is why we consider that submitting children and their family members to interviews, surveys and spontaneous drawing is wise in order to evaluate the existence, nature and extent of the fantasies. This helps to modify possible distortions both of perception and behavior. [References: 6]


Central venous catheters provide an easy access for intravenous medications. Having a central line in place will relieve a child from the discomfort and danger of multiple regular intravenous lines for chemotherapy. The use of indwelling central venous catheters has become commonplace in the management of children undergoing oncological treatment. There are two types of central lines commonly used. There are Broviac catheters and Port-A-Cath (PAC) catheters. In the last 5 years we inserted 194 catheters in 175 children. We inserted 121 Broviac catheters and 73 PAC catheters. During the follow up of 39382 catheter days 44 complications were observed. In Broviac group the median follow up was 155 days and in PAC group was 230 days. We observed differences in the incidence between two devices. In Broviac group infections were more frequent and in PAC group other complications were more frequent than infections.


Intensive chemotherapy and supportive care for paediatric oncology/haematology patients often requires a reliable venous access. The externally exiting central venous catheters are prone to infection and require special care of external tubings. In an attempt to circumvent these problems, a totally implantable device was inserted in 31 paediatric oncology/haematology patients. In 16 patients the device was electively removed at the completion of therapy. In 9 patients the device is still in use while 4 patients died of their underlying disease, with the device in place and functioning. Only 2 devices required premature removal; one for catheter-related sepsis and the other for refractory occlusion. Ease of nursing care, absence of
external tubings, low infection rates and improved patient acceptance because of compatibility with normal activities make them suitable for long-term intermittent venous access in children.