CVAD Insertion Literature

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.


BACKGROUND: Although the equimolecular mixture of oxygen and nitrous oxide (EMONO) seems a good choice to relieve procedure-related pain in children, it has not been evaluated for insertion of central venous catheters in children. To assess the safety and the effectiveness of this gas mixture for insertion of central venous catheters, we conducted a prospective observational study.

PROCEDURE: This study was performed by the "Centre National de Greffe de Moelle Osseuse." Procedure and inhalation characteristics, as well as pain evaluations and side effects, were reported.

RESULTS: Fifty central venous catheters were inserted in 50 consecutive children. Median age was 7 (range, 4-13) years. An anesthesiologist was responsible for delivering EMONO, and provided constant surveillance throughout the procedure. EMLA cream was applied 2 hr before EMONO inhalation. No associated drugs were used. All catheters were inserted by the same experienced physician in the operating theater. Median inhalation length was 5 min (range, 3-6) before starting catheter’s insertion and 12 min (range, 9-25) for the total inhalation. Median procedural pain evaluations were 10 (range, 0-30) for children on a 0-100 visual analog scale (VAS). Minor side effects were observed during eight (16%) inhalations. These side effects were euphoria (14%), deep sedation (4%), nausea and vomiting (2%), hallucinations (2%). All side effects were transient and resolved within 5 min after removing the inhalation device.

CONCLUSIONS: This study which shows that EMONO is effective for insertion of central venous catheters in children and represents a simple and safe alternative to general anesthesia. 2004 Wiley-Liss, Inc.

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.


Current guidelines for children still mandate routine postprocedural chest x-ray to confirm placement and detect complications. This is in spite of the risk of unnecessary exposure to radiation, the additional stress to children and their parents, and the cost of this practice. We studied the impact and cost-effectiveness of this practice on the management of children after percutaneous fluoroscopically guided central venous catheter (CVC) insertions. METHODS: A retrospective review of children who underwent percutaneous fluoroscopically guided CVC insertions between January 2000 and December 2005. Only patients with reported postprocedural radiographs in the electronic database were included, and we referred to the medical notes when the report indicated a complication. RESULTS: Two hundred eighty consecutive patients aged between 4 and 16 years were identified. Two hundred seventy-eight (99.3%) of the reports indicated absence of complications, whereas only 2 reports (0.7%) indicated any form of complications. Of the 2 complications detected, 1 was an asymptomatic pneumothorax, and the other was a slight kink in the line; on review of the medical notes, both lines were fully functional and neither required treatment. CONCLUSION: After percutaneous fluoroscopically guided CVC insertions and in the absence of clinical indications, the use of routine postprocedural radiographs in children cannot be justified and is not cost-effective.


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]


Central venous devices are frequently used in children to monitor haemodynamic status, to administer fluids, medication, parenteral nutrition and for blood sampling. Life-threatening complications that may occur on insertion if the central venous catheter (CVC) is misplaced, are cardiac tamponade or a hydro-/haemopericardium. There is still controversy over the optimum catheter tip position in paediatric patients, whether to place the CVC tip in the superior vena cava, outside the pericardial boundaries or in the right atrium. However, the exact location of the pericardium cannot be seen on a normal chest x-ray. The carina is a radiographic marker for CVC placement, suggested on the basis of studies with conserved and fresh adult cadavers. In order to confirm this landmark for children, the present study was performed with 31 fresh cadavers of small children (mean age 12.5+/−3.4 months) that had been selected for autopsy in the Institute of Legal Medicine. Results clearly demonstrate that the carina was 0.5+/−0.04 cm above the pericardial duplication as it transversed the SVC. In no infant cadaver was the carina inferior to the pericardium. Thus, the results are analogous to those in adults and confirm that the carina is a simple anatomical-radiological landmark, superior to the pericardial reflection, that can be used to identify the placement of CVC even in newborn and small children.


Percutaneous cannulation of the internal jugular vein in paediatric patients may be technically difficult and is prone to complications. To investigate the possibility that anatomical factors contribute to these difficulties, we used a two-dimensional ultrasound scanner to examine venous anatomy in children aged up to 6 yr. We found that 18% of our children had anomalous venous anatomy that may account for some of the difficulties reported previously. The diameter of the internal jugular vein was predicted poorly by the patient’s age (r<sup>2</sup>=0.259) or weight (r<sup>2</sup>=0.155). We also evaluated the use of this ultrasound scanner during percutaneous central venous cannulation in neonates and infants. Determining the course of the internal jugular vein with the scanner and then marking it on the overlying skin reduced both the time and number of needle insertions required to aspirate jugular venous blood and increased the chance of a complication-free cannulation.

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.


BACKGROUND: In children who require prolonged and multiple venous catheterizations, the superior vena cava and iliofemoral veins may become occluded, making central venous access a difficult challenge. We report an innovative technique of catheter insertion percutaneously from the neck into the right atrium traversing a thrombosed superior vena cava using video-assisted thoracoscopic surgery.

METHODS: Two children with irreversible intestinal failure had 4 central venous accesses insertions using the above-mentioned technique. Both had occluded major central veins after multiple catheterizations. An interventional radiologist and cardiologist failed to establish a central venous access in both patients.

RESULTS: A 9-year-old boy has a long-term catheter functioning for 8 months, and in an 18-month-old girl, the line was removed accidentally 6 weeks from its insertion and 2 months later for a line leak. It was then reinserted each time using the same technique.

CONCLUSION: This technique of catheter placement into the right atrium using video-assisted thoracoscopic surgery when other conduits are unavailable can be lifesaving in children depending on total parenteral nutrition.

Incorrect positioning of central venous catheters (CVC) in infants and children may lead to serious complications such as perforation of the heart or great vessels. CVC position is not usually assessed until the first postoperative chest radiograph, potentially leaving malposition undetected for several hours. We studied a series of 452 right internal jugular and subclavian catheter placements in infants and children undergoing surgery for congenital heart disease, and measured the distance from the skin insertion site to the radiographic junction of the superior vena cava and right atrium (RA). Based on these data, the following formulae predict that a CVC will be positioned above the RA 97% of the time: correct length of insertion (cm) = (height in cm/10) - 1 for patients [less-than or equal to]100 cm in height, and (height in cm/10) - 2 for patients >100 cm in height. Weight-based recommendations were also developed which predict placement of CVC above the RA 98% of the time.


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(R)), 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.


AIM: The ultrasound-guided percutaneous technique of Hickman line insertion has not been widely adopted in pediatric surgical practice. We wished to review our own experience of using this technique for insertion into the internal jugular vein.
**METHODS:** Our vascular access team consists of a consultant surgeon and 2 consultant anesthetists. All procedures were prospectively recorded on a database and were either performed or directly supervised by our team.

**RESULTS:** Five hundred consecutive Hickman lines were inserted between June 2004 and October 2006. Patients' ages ranged from 14 days to 19 years (median, 44 months). Patients weighed between 600 g to more than 100 kg. Lines inserted were all tunneled silicone Hickman lines with a Dacron cuff (size 2.7F-10F, with 1-3 lumens), of which 60% were 7F double-lumen lines. Successful cannulation occurred in 99.8%. Perioperative complications (within 30 days) occurred in 12 patients (2.4%) and were all treated conservatively with no need for either blood transfusion or chest drain. Catheter-related sepsis rate was 3.16 per 1000 line days.

**DISCUSSION:** 1. The technique of ultrasound-guided percutaneous insertion of Hickman line to the internal jugular vein is safe and is applicable to all children regardless of size, age, or diagnosis. 2. Pediatric surgeons and anesthetists can learn this technique without specific training in interventional radiology. 3. A learning curve does exist, and we recommend concentrating pediatric vascular access procedures to a specialist team.


**BACKGROUND:** Percutaneous central venous cannulation in infants and children is a challenging procedure. Traditionally, an external landmark technique has been used to identify puncture site. An ultrasound-guided technique is now available and we wanted to evaluate this method in children and infants, looking specifically at the ease of use, success rate and complications.

**METHODS:** Forty-two consecutive infants and children (median 16.5 [0-177] months and 10 [3-45] kg) scheduled for central venous catheter placement were registered. An ultrasound scanner made for guiding puncture of vessels was used. After locating the puncture site, a sterile procedure was performed using an accompanying kit to aid puncture of the vessel.

**RESULTS:** Cannulation was successful in all patients and we had no complications during insertion of the catheters. The right internal jugular vein was preferred in most patients, and in 95% of the patients the vein was punctured at the first attempt. The median time from start of puncture to aspiration of blood was 12 (3-180) seconds.

**CONCLUSION:** The ultrasound-guided technique for placement of central venous catheters was easy to apply in infants and children. It is our impression that it increased the precision and safety of the procedure in this group of patients.


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 = 0.009; P less than .001). This study demonstrates a significant decrease in catheter-related sepsis when CVCs are not changed on a routine frequent basis.


The insertion of central venous catheters (CVCs) is an established practice in the management of children who need long-term total parenteral nutrition or chemotherapy. Inadvertent falling out of CVCs before the cuff becomes incorporated in the tissues is a commonly encountered problem. The technique described involves inserting a circular stitch in the subcutaneous plane before the catheter is placed. Once the CVC is pulled into position, the "cuff-stitch" lays around the catheter distal to the cuff, narrows the tunnel, and prevents accidental dislodgement.


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 over all 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.


Catheter-related sepsis (CRS) is a major cause of morbidity in patients receiving chemotherapy and prolonged parenteral nutrition. To determine whether avoiding emergency insertions by using a planned elective list and adopting a 'no-touch' technique has a role in reducing CRS, all cuffed central venous catheters inserted by the open method between 1999 and 2000 were prospectively followed for a total duration of 12 months. The incidence of early sepsis (within 30 catheter days) that could be attributed to surgical factors was studied. CRS was defined as the presence of any two of the following: (1) signs of clinical sepsis without an obvious focus; (2) positive cultures in blood obtained from the catheter; and (3), clinical improvement following removal. A total of 146 catheters were inserted in 130 patients; 15 had a second and 1 had a third catheter inserted. Early CRS was encountered in 13 cases (9%); 95 catheters were inserted on an elective list and 51 on an emergency basis. The distributions of age, sex, number of lumens, neutrophil count, and underlying diagnosis were similar between the groups. There was no significant difference ($P = 1$) between elective (9/95) and emergency (4/51) insertions. A total of 47 catheters were inserted by the 'no-touch' technique and 48 by the manual technique. There was no significant difference in early sepsis ($P = 0.7$) between the two techniques (6/47 vs 3/48). Thus avoiding emergency insertion or adopting a 'no-touch' technique does not reduce early CRS. Larger prospective studies are warranted to identify surgical risk factors.


Central venous access is increasingly becoming the domain of the radiologist, both in terms of the insertion of central venous catheters (CVCs) and in the subsequent management of these lines. This article seeks to provide an overview of the CVC types available for paediatric patients and a more detailed explanation of the spectrum of complications that may lead to catheter malfunction. A standard catheter contrast study or 'linogram' technique is described. The normal appearances of such a study and a detailed pictorial review of abnormal catheter studies are provided, together with a brief overview of how information from catheter investigations can guide the management of catheter complications. [References: 55]


BACKGROUND: The authors report the results of a prospective, multicenter, multidisciplinary study of central venous catheters (CVCs) in pediatric oncology patients analyzing factors involved in early failure.

METHODS: Information was collected from parent-held records on the fate of 824 devices inserted over a 20-month period, 415 of which were no longer in situ.

RESULTS: Within the first 7 weeks after insertion, there were 66 failures, all occurring in external lines. Accidental dislodgement was the principal reason for CVC failure (44 of 66, 67%). Detailed analysis of the
reason for failure of this large subgroup showed 11 factors individually associated with early dislodgement, of which, 4 were independently associated with failure by multivariate analysis. These 4 variables were the use of multilumen catheters, the absence of a skin exit site suture, platelet transfusion at the time of insertion, and patient age less than 2 years.

**CONCLUSIONS:** This study confirms the multiple influences on successful CVC usage. Our analysis supports the principle of only using multilumen lines when clinically essential. The findings also support the inception of randomized studies of fixation, particularly in infants.


Erosion of the skin over a totally implanted vascular access device (TIVAD) is a rare event that may lead to life-threatening sequelae. From 1994 to 2007, we reviewed the medical records and central line database of 960 central line insertions for the complication of skin erosion over the TIVAD. Outcome measures included age, gender, and nutritional status, number of days until complication, insertion site, and attending surgeon. A total of 540 of the 960 central lines were TIVAD. Skin erosion occurred in 9 patients for an incidence of 1.67%. Average age at insertion was 51 months (range 25-116.5 months). The average catheter duration use in days was 335 with a range of 39-1575 days. Malnutrition defined as BMI <5% or a decrease in BMI percentiles occurred in 2 and 4 patients, respectively, and contributed to the thinning of the subcutaneous fat. Skin erosion over TIVAD is a rare complication. Most cases can be prevented by inserting the device in a subfacial location in the very young child or in the child with expected weight loss. Furthermore, the device should be placed at a fair distance from the skin incision to prevent early skin erosion through the wound.


We report a case of four-year-old girl who suffered a cardiac arrest under anaesthesia, due to complete heart block without ventricular escape, during the flushing of an errantly placed longterm central venous catheter. It was subsequently found that the central line was placed in a persistent left superior vena cava (LSVC) draining directly into the coronary sinus. Diagnosis was suspected by a chest x-ray and confirmed by two-dimensional echocardiography. The patient made a complete recovery from the event and was discharged from hospital three days later.


**OBJECTIVE:** To estimate the incidence and to characterize risk factors for central venous catheter (CVC)-related deep vein thrombosis (DVT) in a pediatric intensive care unit.

**STUDY DESIGN:** Consecutive children admitted to a pediatric intensive care unit who required a CVC for more than 48 hours were examined by Doppler ultrasonography of the catheterized vein at days 2, 4, 6, or 7 after insertion and weekly thereafter until CVC removal. **RESULTS:** The incidence of CVC-related DVT was 18.3% (17 of 93) (95% confidence interval = 10.2% to 25.8%). Thromboses were diagnosed within the first 4 days of catheter placement for 15 of 17 CVC-related thromboses. Multivariate analysis showed that risk factors most predictive of CVC-related DVT were presence of a cancer (odds ratio = 17.23, 95% confidence interval = 1.5 to 194) and young age (odds ratio for age = 0.72, 95% confidence interval = 0.54 to 0.96).
CONCLUSION: The frequency of CVC-related DVT is substantial in pediatric intensive care units. Risk is highest during the 4 days after insertion and decreases thereafter. The clinical impact, optimal prevention, and therapy of these thromboses remain to be determined.


The lack of published literature specific to the pediatric population (1 month to 18 years) was a major deterrent to the initiation of a peripherally inserted central catheter (PICC) and midline catheter program in a 260-bed pediatric hospital. The intravenous team assumed responsibility for the program initiated by the physicians. The following challenges were encountered: administrative issues, insertion-related discomfort, adverse clinical reactions, equipment inadequacies, catheter maintenance, and staff education. To date, the i.v. team has successfully placed 84 catheters and concludes that the procedure is invaluable for pediatric patients requiring an extended course of i.v. therapy.


This descriptive, exploratory study assessed parents' satisfaction with the education and support they received before and after their children had central venous access devices (CVADs) inserted for cancer treatment. Decisions regarding the type of CVAD and parent satisfaction with that choice were also evaluated. Parents of children who experienced a CVAD during the six-year period 1992-1997 participated. Data were collected through telephone interviews using a questionnaire specifically designed for the purposes of the study. Results suggest that parents were satisfied with the teaching and support received both prior to and following CVAD insertion. Other findings reveal that not all parents take part in decisions about the type of device used, and that if given a choice, based on their experience, they would likely choose implanted ports over Hickman catheters.


Central venous lines (CVL) are a necessary condition in the modern treatment of malignant disease. In children, the need for permanent venous access is even more important. However, CVL can also be the reason for severe and life-threatening complication. These complications may even lead to serious problems and delays in the treatment of the main disease and thus worsening the patient's prognosis. Septic complications and complications due to thrombosis/microthrombosis associated with CVL belong to the most serious ones. Moreover, they probably influence each other. The risk of such complications is individual and influenced not only by main diagnosis and the therapeutical protocol used, but also by epidemiological circumstances, by the immune status of the patient, and his/her tendency to thrombosis (thrombophilia). The possibility of predicting the risk of serious CVL-associated complications before the beginning of the treatment and before insertion of the first CVL could increase the chance of successful treatment and even prevention of such complications. This work is targeted on creating a model for the prediction of the risk of thrombotic and/or septic CVL complication based on several haemocoagulation parameters examined at the time of diagnosis in children with malignant disease. The model was created
based on a retrospective analysis of 410 episodes/complications leading to extraction of CVL in 168 children. With the help of probabilistic risk scoring of CVL complications and analysis of the time to extraction (TTE) of CVL, we identified coagulation parameters mentioned below. The positivity of these parameters at the time of diagnosis is associated with the increased risk of CVL complications during oncology treatment: - decreased plasmatic level of Protein C (PC) at the time of diagnosis. - decreased plasmatic level of Protein S (PS) at the time of diagnosis. - positivity of Pro C Global test at the time of diagnosis. - increased D dimmers at the time of diagnosis. - increased plasmatic level of Lipoprotein (a) (Lp(a)) at the time of diagnosis. This predictive model will have to undergo further validation and introduction of more parameters (e.g. pathogens causing sepsis, type of CVL, and place of its insertion), but our pilot data may be a first step toward further prospective analyses and may also become the cornerstone for a different and "tailored" preventive and therapeutic care of severe complications associated with CVL in children with malignancy.


BACKGROUND: The introduction of a central venous catheter in haemodialysis patients is an unpleasant procedure for the patient. Intravenous sedation is accepted practice in complicated endoscopic procedures but not often used in haemodialysis patients.

METHODS: We developed a protocol for the use of stepwise sedation in these patients with the use of midazolam and fentanyl.

RESULTS: Stepwise sedation with midazolam and fentanyl was used in 155 procedures. No or minor movements were observed in 94% of 154 procedures. 88% of the 155 procedures were graded as very easy or easy. No or only very slight recall of the procedure were noted in 86% of 133 procedures. Only in 7% of 132 procedures were the patients able to recollect most of the procedure. No, or only a small amount of pain was recollected in 93% of 131 procedures. The most important complication was a slight decrease in oxygen saturation in 23 procedures. In the second part of the study we compared the effects of sedation with midazolam alone versus the combination of midazolam and fentanyl for the introduction of Tesio catheters. Amnesia, ease of procedure and the recollection of pain were equivalent. Oxygen desaturation occurred significantly less often with the use of midazolam alone.

CONCLUSION: We conclude that stepwise sedation is effective and safe in haemodialysis patients and leads to a complete amnesia for the procedure. copyright 2004 Van Zuiden Communications B.V. All rights reserved.


BACKGROUND: Recent guidelines from the UK National Institute for Clinical Excellence (NICE) recommend the use of ultrasound guidance for central venous catheter (CVC) insertion in children. We conducted a survey of pediatric anesthetists to determine current practice and opinion on the appropriate use of ultrasound guidance.

METHOD: A confidential postal questionnaire was sent to all members of the Association of Paediatric Anaesthetists working in the UK. After 4 weeks a follow-up questionnaire was sent to nonrespondents.
Members were questioned on availability and use of ultrasound, and its place in clinical practice and training.

**RESULTS:** A total of 250 questionnaires were returned, a response rate of 63%. Of those members who placed CVCs in children (n = 196), 85% had access to ultrasound, and 68% stated that they used ultrasound guidance. Thirty-nine percent of clinicians who used ultrasound did so routinely. The remaining 61% used either a landmark or an ultrasound technique depending on circumstances. Regarding its mandatory use, 76% of responders believed that ultrasound guidance was beneficial in certain circumstances but did not need to be used routinely. Seventy-five percent of responders agreed that all pediatric anesthetists should have training and access to ultrasound for CVC placement.

**CONCLUSIONS:** In the UK most pediatric anesthetists placing CVCs in children currently have access to ultrasound guidance. Despite a lack of widespread support for its routine use, most agree ultrasound is a useful tool, and that all pediatric anesthetists should have access and training in the use of this technology.


**OBJECTIVE:** To determine if vein localization with an audio Doppler increases successful central venous cannulation and decreases complications in infants and children when performed by inexperienced operators, compared with vein localization by anatomic landmarks (ALs).

**DESIGN:** A prospective cohort of infants and children undergoing central venous cannulation for cardiac surgery.

**SETTING:** A university-affiliated children's hospital with a pediatric anesthesia fellowship program.

**PARTICIPANTS:** All infants and children undergoing cardiac surgery between July 1, 1996, and January 1, 1997.

**INTERVENTIONS:** Subjects had central venous catheters (CVCs) placed by an anesthesia fellow by either ALs or audio-Doppler localization of the veins.

**MEASUREMENTS AND MAIN RESULTS:** Eighty-four children were studied. Internal jugular vein (IJV) cannulation was attempted in 71 (85%) children and femoral vein cannulation in 13 (15%) children. Time to catheter insertion, number of needle passes, and artery puncture were noted. Sixty-one of 63 (97%) children had successful central venous cannulation by an anesthesia fellow using audio-Doppler vein localization. This was significantly greater than the 13 of 21 (62%) successful cannulations among children who had veins localized by ALs. Time to insertion did not differ by method of vein localization; however, the number of needle passes was significantly greater in the AL group. Artery puncture did not differ significantly by method of vein localization.

**CONCLUSION:** Vein localization by audio Doppler significantly increases the rate of successful central venous cannulation and decreases the number of needle passes in pediatric patients when used by inexperienced operators.

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.


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.

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 (dislocation 18, 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: 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.


For successful catheter placement, central venous cannulation (CVC) through internal jugular vein and subclavian vein has been recommended in both adult and pediatric patients. But it carries a risk of serious complications, such as pneumothorax, carotid, or subclavian artery puncture, which can be life-threatening, particularly in critically ill children. So a prospective study was carried out to determine the success rate of correct catheter tip placement during CVC through antecubital veins in pediatric neurosurgical patients. A total of 200 pediatric patients (age 1-15 years) of either sex were studied. Basilic or cephalic veins of either arm were selected. All the patients were cannulated in the operation room under general anesthesia. Single lumen, proper size catheters (with stillete) were used for cannulation. The catheter was inserted in supine position with the arm abducted at right angle to the body and neck turned ipsilaterally. The length of insertion was determined from cubital fossa to the right second intercostal space. The exact position of the tip of the catheter was confirmed radiologically in ICU. Correct catheter tip placement was achieved in 98 (49%) patients. Multivariate logistic regression analysis of data shows that there was no statistically significant difference among correct and incorrect catheter tip placement in relation to factors including sex, side of cannulation (left or right), and type of vein (basilic or cephalic). The analysis of correct catheter tip placement in relation to age showed that the highest success rate was achieved in children of age group 6 to 10 years (60.2%) followed by 30.6% in the 11 to 15 year group. The lowest success rate of tip placement of only 9.2% was observed in younger children of age 1 to 5 years, which is statistically significant (P = 0.001). Of 102 incorrect placements reported, 37% were in 1 to 5 year age group versus 9.2% correct tip placements. The most common unsatisfactory placements were either in the ipsilateral internal jugular vein (N = 38, 37.2%) or in the ipsilateral subclavian vein (N = 27, 26.4%). In 10 patients the catheter crossed over to the opposite subclavian vein, in 16 patients the catheter tips were found in the axillary vein, and in 10 patients each the catheter tip was observed in right atrium and right ventricle. No major complication during and following CVC was observed. To conclude, CVC using single orifice catheter through arm veins in pediatric patients is easy to perform, but the proper catheter tip placement is highly unreliable, particularly in younger children 1 to 5 years of age.


**OBJECTIVE**: To describe the incidence, indications, insertion sites, duration, and complications of central venous catheter (CVC) insertion in patients in a pediatric emergency department (ED).

**METHODS**:  

**DESIGN**: Retrospective chart review.
SETTING: ED of an urban pediatric teaching hospital.
SUBJECTS: Patients who had a CVC inserted in the ED from January 1992 to July 1997.

RESULTS: During the 5.5-year study period, 121 patients were identified. Indications for insertion were cardiac/respiratory arrest in 20 patients (17%), lack of peripheral vascular access in 78 (64%), and inadequate peripheral vascular access in 23 (19%). Presenting diagnoses included cardiac/respiratory arrest (20), dehydration (19), lower respiratory tract disease (15), seizure (15), sepsis (13), trauma (10), and other (29). Prior to the CVC insertion, 80 (66%) patients had no venous access, 28 (23%) had a peripheral intravenous catheter, and 13 (11%) had an intraosseous needle. One hundred one (83%) CVCs were inserted into the femoral vein, 12 (10%) into the subclavian, 7 (6%) into the internal jugular, and 1 (1%) into an axillary vein. There were four reported complications requiring the CVC to be removed, and all occurred with femoral line placement. There were no long-term sequelae or life-threatening or limb-threatening complications (95% CI = 0-2.5%).

CONCLUSIONS: Central venous catheterization, particularly using the femoral approach, appears to a safe method of obtaining central venous access in the critically ill infant, child, or young adult.


OBJECTIVES: To document and characterize fracture and embolization of peripherally inserted central catheters (PICCs) in the pediatric population and define predisposing features for these complications.

STUDY DESIGN: A case series was assembled by examining the records of PICC insertions in a single tertiary care pediatric hospital over a 6-year period. A control group was selected by simple random sampling of eligible PICC insertions.

RESULTS: Among approximately 1650 PICCs, 11 children were identified with a fractured line, requiring invasive retrieval. Patient characteristics did not reveal any specific risk factors compared with the control group. Likewise, catheter size, site, and medications infused through the line were not significant predisposing factors for fracture. However, duration of placement and a line complication (blockage of the line or leaking at the insertion site) were significantly associated with catheter fractures. In all cases, the embolized line fragment was successfully retrieved by percutaneously inserted catheters and snares. No major complications arose from these fractured catheters.

CONCLUSIONS: Fracture and embolization of PICCs occur and may pose a potential risk of serious consequences. It is prudent to list PICC fracture as a rare but potentially serious complication of this device when obtaining informed consent for its insertion.


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.


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 tunnelled silicone rubber Groshong catheter inserted percutaneously in the subclavian vein (91.1%), the internal jugular vein or in the femoral vein. The median 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

BACKGROUND: Insertion of long-term central venous catheters (CVC) plays a vital role in providing continuous venous access for therapy in children. CVC line fractures are most commonly seen after long-term periods of therapy during removal. Usual place of rupture is proximal, at the point of entrance of the catheter into the vein, when the subclavian approach is utilized. We discuss a case that shows that CVC can also fracture in places different than the most common location and is possible not to detect that a fracture has occurred if a substantial portion of catheter is removed.

METHOD: We report a two-year-old child that was incidentally found to have a distal fragmented piece of CVC left after previous "successful" removal on simple chest films. At time of removal the catheter length was deemed properly. A CT Scan confirmed the suspected diagnosis. Fragment of catheter was successfully removed via femoral percutaneous endovascular technique.

RESULTS: CVC fractures can be suspected when there is resistance during removal or the length retrieved is too short. In this case the ease of retrieval and unusual site of rupture was the cause of not noticing that a part of catheter remained fixed to the vessel wall. Different potential mechanisms of CVC rupture include mechanical trauma, manufacturing defect or material degradation. Ruptures should be detected early to prevent complications such as sepsis, endocarditis, thrombosis, embolization, vessel stenosis and dysrhythmia. Best method to remove the fragmented catheter is via percutaneous endovascular retrieval method. After catheter removal a hyperdensity silhouette on a CXR can mimic the fragmented portion of a catheter known as a calcified cast or "ghost". To differentiate a "ghost" from an actual fragmented portion of catheter a CT Scan or echocardiogram is needed.

CONCLUSION: Most important single step in preventing such complication is to keep record of the patient length of catheter that was inserted to be able to measure it after removal confirming it still has the same length. Fragmented CVC should be removed using percutaneous endovascular techniques. [References: 16]


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.


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) 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 nonports 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%).


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 Pedriatria.


Central venous occlusion in children is a challenging problem that can occur after a central venous catheter insertion. Long-term catheter-related complications include sepsis and venous thrombosis with consequent loss of central access. We describe 2 cases of children younger than 1 year who were dependent on a central venous catheter for total parenteral nutrition. They developed a chronic extensive obstruction of the right and left brachiocephalic veins with a superior vena cava syndrome. The patients' survival was dependent on the restoration of central venous access until the planned intestinal transplantation could be performed. Retrograde recanalization of the superior vena cava was successfully achieved using a pathway created under general anesthesia from the femoral vein to, respectively, the right thyroid vein and the right subclavian vein.


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]


Central venous catheter (CVC)-related thrombus formation has been increasingly recognized as a complication in adults and somewhat less frequently in children and neonates. However, the association of CVC thrombus and pulmonary embolism (PE) has rarely been reported in infants or children, and the few existing reports primarily involve chronic, indwelling CVCs such as Broviac or Hickman catheters. During an 18-month-period of autopsy review, we found that 5 of our pediatric intensive care unit patients had autopsy-proven CVC thrombus and pulmonary embolism. All of them had prolonged mechanical ventilation for respiratory failure and required insertion of one or more short-term, temporary CVCs during the course of routine critical care management. In retrospect, signs related to CVC thrombus were present in 4 patients (3 had positive blood cultures and 1 had persistent hypertension). PE was not diagnosed until autopsy in every case. The diagnosis may have been missed because the symptoms of PE are the same as those of severe lung disease. We, therefore, advocate a heightened suspicion of CVC thrombus formation and PE in critically ill children with respiratory failure and temporary CVCs and recommend early diagnostic ultrasound to confirm the diagnosis. Once a CVC thrombus is found, subsequent pulmonary deterioration may necessitate evaluation for acute PE.


PURPOSE: Implantable vascular access devices (ports) are well accepted in the management of many pediatric conditions. Modifications have improved port function, patient satisfaction, and enhanced compatibility with imaging studies. We reviewed our experience with a port system and identified unique mechanical complications.

METHODS: From 1998 to the present, 301 patients underwent 296 port insertions and 175 port removals. We assessed medical records, radiographs, and operative findings. The 6.6F MRI Low-Profile Implanted Port (Bard Access Systems, Salt Lake City, Utah) was used almost exclusively and was assembled by the operating surgeon. Outcome measures included port reservoir leakage, catheter dislodgment, and number of device days until complication. Ports were implanted for multiple medical problems including 74.2% in hematology/oncology patients.

RESULTS: For 296 port insertions, 15 complications (5.1%) were identified in 13 patients (mean age, 8.4 years). Eleven leaks (3.7%) in 9 patients were found, with 9 leaks resulting from needle perforation of the port base and 2 leaks seen at the catheter connection site. Average port duration was 425 days (range, 12-1266 days) before leakage. Four patients had catheter dislodgment (1.4%), with 3 of 4 catheters embolizing to the heart or pulmonary artery. Patients were asymptomatic, and catheters were retrieved by interventional radiology. Dislodgment at the catheter-port connection site was seen in 3 of 4 cases, and
average port duration was 1075 days (range, 269-2657 days) until catheter separation. Twelve of 13 patients had successful implantation of a new port system.

**CONCLUSIONS:** This study identifies that (1) mechanical port complications (5.1%) are not rare for this device; (2) regardless of port age, the thin plastic base may result in a risk of perforation not seen in other devices; (3) the extended period before embolization likely indicates device wear rather than faulty assembly; and (4) complications could be successfully managed including retrieval of embolized catheters.


Ultrasound (US)-guided peripheral venipuncture was performed for peripheral insertion of 222 central venous catheters over a 12-month period. Initial placement was successful in 218 patients but unsuccessful in eight; placement was successful in four the next day (success rate, 98%; complication rate, 5%). Catheters were in place from 3 days to 6 months (mean, 36 days). US guidance allowed successful venipuncture for placement of central venous catheters in children.


**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.

BACKGROUND: Peripherally inserted central catheters (PICC) in children and adolescents are being used with increasing frequency. We sought to determine the incidence and characterize risk factors of deep vein thrombosis associated with peripherally inserted central catheters in a pediatric population.

METHODS: We conducted a prospective study involving consecutive patients referred to the radiology department of a tertiary care university-affiliated hospital for insertion of a peripherally inserted central catheter. We included patients aged 18 years or less who weighed more than 2.5 kg and had a peripherally inserted central catheter successfully inserted in his or her arm between June 2004 and November 2005. The primary outcome was the occurrence of partial or complete deep vein thrombosis evaluated by clinical examination, ultrasonography and venous angiography.

RESULTS: A total of 214 patients (101 girls, 113 boys) were included in the study. Partial or complete deep vein thrombosis occurred in 20 patients, for an incidence of 93.5 per 1000 patients and 3.85 per 1000 catheter-days. Only 1 of the cases was symptomatic. In the univariable analyses, the only variable significantly associated with deep vein thrombosis was the presence of factor II mutation G20210A (odds ratio 7.08, 95% confidence interval 1.11-45.15, p = 0.04), a genetic mutation that increases the risk of a blood clot and that was present in 5 (2.3%) of the 214 patients.

INTERPRETATION: The incidence of deep vein thrombosis related to peripherally inserted central catheters in our study was lower than the incidence related to centrally inserted venous catheters described in the pediatric literature (11%-50%).

Central venous catheters have been established as a reliable source of vascular access since the 1970s. Peripherally inserted central catheters became a popular central catheter in the early 1990s for adults and children. The management of vascular access in children is an essential part of inpatient and outpatient care. Assessing and inserting the appropriate catheter for the pediatric patient is just a part of the component for central catheter care. Care providers also need to assess these children for sedation or distraction for the procedure. This article discusses factors for catheter choice and points for assessing children for sedation or distraction for vascular access insertion. [References: 14]


OBJECTIVE: We describe an infrequent but potentially lethal complication: an iatrogenic injury of the internal mammary artery after central venous catheterization.

DESIGN: Report of cases.

SETTING: Pediatric intensive care unit.

PATIENTS: The first patient we report on is a 3-yr-old girl who was severely neurologically damaged and was admitted to the pediatric intensive care unit for aspiration pneumonia and septic shock. Immediately after vein cannulation on the left internal jugular vein, the patient suffered hypotension and cardiac arrest, secondary to an adequately drained massive hemothorax. Restoration of spontaneous circulation was initially achieved, and the patient was transferred to the angiographic suite. Selective angiography during
cardiopulmonary resuscitation for a second cardiac arrest revealed a laceration of the internal mammary artery. Resuscitation was not successful, and the patient died. The second case reported is a 7-yr-old girl admitted for bone marrow transplantation. She was electively taken to the angiographic suite for central venous insertion. An infraclavicular approach of the right subclavian vein was attempted, but radioscopy showed the guidewire inside the pleural space. Soon thereafter, the patient became hypotensive and was in shock. Radioscopy showed a large pleural effusion and a massive hemothorax was drained. Selective angiography demonstrated an injured internal mammary artery was embolized. Hemodynamics improved, and the patient was transferred to the pediatric intensive care unit, where she was extubated 12 hrs later.

INTERVENTIONS: None.

CONCLUSIONS: Central venous catheter placement in the intrathoracic vein may cause potentially lethal complications in the form of an injury to the internal mammary artery. Hypotension during or immediately after the procedure should be a warning of a serious adverse event, such as massive hemothorax, that may compromise life. Adequate drainage of the pleural cavity may not completely relieve vascular compression if some of the bleeding from an injured internal mammary artery is extrapleural. Early diagnosis and treatment by selective embolization of the injured vessel in interventional radiology is the first therapeutic choice and may be life saving.


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.


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 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.


The use of indwelling central venous catheters (CVCs) has become essential for managing children undergoing cancer treatment. Various types of CVCs are available, but reports on complications observed in pediatric series are scarce. We describe our experience concerning early mechanical complications at our institute by providing a prospective evaluation of three types of CVCs that were inserted over a 39-month period. Between January 1, 2000, and March 31, 2003, double-lumen (DL) or single-lumen (SL) Hickman-Broviac (HB) and single-lumen pressure-activated safety-valved (PASV) catheters were inserted and prospectively evaluated. Five groups of possible mechanical complications were defined a priori: dislodgement, migration, rupture, accidental removal, and blockage. We took into consideration complications occurring only within the first 30 days of insertion. A total of 272 CVCs (118 PASV, 57 DL-HB, and 97 SL-HB) were inserted in 232 children. A total of 29 early mechanical complications (10.7% of all CVCs) were diagnosed: 15.2% of the PASV, 10.5% of the DL-HB, and 4.1% of the SL-HB. Elective removal of the catheter due to complications was required in eight patients. SL-HB catheters had fewer complications, while the complication rate and the number of devices that were removed were significantly higher in patients with PASV catheters. We conclude that catheter type correlates with the risk of early mechanical complications and removal.


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.


We describe a case of inadvertent intrathecal cannulation with a central venous catheter in an infant, confirmed by three-dimensional computed tomography, which clearly demonstrated the track of the catheter. We believe that this complication could have been related to two major factors: depth of needle insertion and penetration of the vein by a straight-tip guidewire. To avoid this complication, the depth of needle insertion must be carefully checked, a "J"-tipped rather than a straight-tipped guidewire should be used, and puncture should be guided by ultrasound.


BACKGROUND: A technique for reinsertion of an inadvertently removed tunneled central venous catheter is presented. A 6-year-old boy with short-gut syndrome caused by necrotizing enterocolitis accidentally removed his tunneled central venous catheter.

MATERIALS AND METHODS: The existing subcutaneous catheter tract was recanalized using a hydrophilic guidewire and 5-French end-hole catheter with the child unter conscious sedation, and a new catheter was placed over a guidewire.

RESULTS: This obviated the need for a new venipuncture and creation of a new subcutaneous tunnel, which are performed under general anesthesia in our hospital.

This study examined variability in handwashing policy between hospitals, variability in handwashing practices in nurses and how practice differed from policy in tertiary paediatric hospitals in Australia and New Zealand. Eight of the possible nine major paediatric hospitals provided a copy of their handwashing and/or central venous access device (CVAD) policies, and 67 nurses completed a survey on their handwashing practices associated with CVAD management. A high degree of variability was found in relation to all the questions posed in the study. There was little consistency between policies and little agreement between policies and clinical practice, with many nurses washing for longer than required by policy. Rigour of handwashing also varied according to the procedure undertaken and the type of CVAD with activities undertaken farther from the insertion site of the device more likely to be performed using a clean rather than an aseptic handwashing technique. As both patients and nursing staff move within and between hospitals, a uniform and evidence-based approach to handwashing is highly desirable.


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.


OBJECTIVE: Analysis of infectious complications and risk factors in percutaneous central venous catheters.

SETTING: Twenty Spanish pediatric intensive care units.

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.


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.


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...
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 antibiotics (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.


We report two cases of ventricular tachycardia (VT) in children following the insertion of peripherally inserted central catheters (PICCs). These children had additional procedures requiring turning into the left lateral position after PICC insertion. In both cases sustained VT occurred after turning and flexion of the arm with the PICC. VT was terminated in both cases by withdrawing the catheter.


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.


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.


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]


A prospective observational study was carried out to investigate complications of arterial and venous indwelling catheters. All patients of a mixed NICU/PICU admitted during a 12-month period were enrolled in this study with a stringent protocol of catheter prophylaxis, using heparin via continuous infusion in a dose of 100 IU/kg/day body weight or at least 100 IU/kg/day for each arterial and/or central venous catheter.
Patients were regularly monitored for edema, thrombus, ischemia and catheter obstruction, i.e. complications amenable to heparinization. A total of 292 catheters in 130 patients were recorded. Patients' weight ranged between approximately 600 g to 10,000 g. Depending on the insertion site or type of catheter the frequency of complications was as follows: edema 0-12%; catheter obstruction 7-24%; ischemia 28-40%. No case of persistent thrombosis was detected. CONCLUSION: A stringent protocol of heparinization leads to a low incidence of complications potentially amenable to anticoagulation.


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.

BACKGROUND: Overlap of the femoral artery (FA) on the femoral vein (FV) has been shown to occur in pediatric patients. This overlap may increase complications such as arterial puncture and failed insertions of central venous lines (CVLs). Knowledge of the anatomic relationship between the FV and FA may be important in avoiding these complications.

OBJECTIVES: The objective was to evaluate the anatomic relationship of the FA and FV in straight leg position and frog leg position.

METHODS: This was a prospective, descriptive study of a convenience sample of 80 total subjects (16 subjects from each of five predetermined stratified age groups). Each subject underwent a standardized ultrasound examination in both the straight and the frog leg positions. The location of the FA in relation to the FV was measured at three locations: immediately distal, 1 cm distal, and 3 cm distal to the inguinal ligament. Overlap of the FA on the FV and the diameter of the FV was noted at each location. Measurements were repeated in both the straight leg and the frog leg positions.

RESULTS: For the left leg, immediately distal to the inguinal ligament, the FV was overlapped by the FA in 36% of patients in straight leg position and by 45% of patients in frog leg position. At 1 cm distal to the ligament, overlap was observed in 75% of patients in straight leg position and 88% of patients in the frog leg position. At 3 cm distal to the ligament, overlap was observed in 93% of patients in straight leg position and 86% of patients in the frog leg position. The percentage of vessels with overlap was similar in the right leg at each location for both the straight and the frog leg positions. Pooled mean (+/-SD) FV diameters for the left leg immediately distal to the inguinal ligament were 0.64 (+/-0.23) cm in the straight leg position and 0.76 (+/-0.28) cm in the frog leg position; at 1 cm distal to the ligament, 0.66 (+/-0.23) and 0.78 (+/-0.29) cm; and at 3 cm distal to the ligament, 0.65 (+/-0.27) and 0.69 (+/-0.29) cm. FV diameters for the right leg were similar to the left.

CONCLUSIONS: A significant percentage of children have FAs that overlap their FVs. This overlap may be responsible for complications such as FA puncture with CVL placement. Ultrasound-guided techniques may decrease these risks. Placing children in the frog leg position increases the diameter of the FV visualized on ultrasound.


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 infections.

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.


PURPOSE: The purpose of this study was to determine, in a pediatric population less than 5 years of age, which size catheter is ideal for central venous access via the subclavian and internal jugular vein based on the children's age, weight, and height.
METHODS: This was a retrospective chart review of children less than 5 years of age at The Children's Hospital in Denver, Colorado who underwent subclavian or internal jugular central venous catheter placement from January 1, 1998 through December 31, 2001. Age, height, weight, primary disease, access site, type of central venous catheter, size of central venous catheter, and complications were recorded. Age, weight, and height were stratified and compared with catheter size to determine any correlation between age, weight, height, and complications.

RESULTS: There were 430 central venous catheters placed via the subclavian or internal jugular vein in 331 patients less than 5 years old. One hundred ninety-five catheters (45.4%) were less than 6F in size, and 235 (54.6%) catheters were > or =6F in size. Children, who were between 0.5 and 0.99 years old, 5 to 7.49 kg in weight, 7.5 to 9.99 kg in weight, and 60 to 74.9 cm in height had higher complication rates (P <.05) when catheters > or =6F were inserted. Children who were greater than 1 year of age, greater than 10 kg in weight, and longer than 75 cm in height did not experience a significant difference (P >.05) in complications versus catheter size.

CONCLUSIONS: The choice of central venous catheter size should be predicated, not only on the primary disease, but also on the child’s age, weight, and height. Insertion of central venous catheters larger than 6F in children less than 1 year of age, less than 10 kg in weight, or less than 75 cm in height, was associated with higher complications compared with other settings. [References: 7]


PURPOSE: The aim of this study was to determine in a pediatric population whether a routine chest x-ray after central venous access is necessary when the central venous catheter is placed with intraoperative fluoroscopy.

METHODS: This was a retrospective review of the charts of all patients at Children's Hospital in Denver, Colorado who underwent subclavian or internal jugular central venous catheter placement from January 1, 1998 through December 31, 2001. Age, sex, primary reason for access, access site, number of venipuncture attempts, type of catheter, intraoperative fluoroscopy results, chest x-ray results, location of the tip of the catheter, and complications were analyzed.

RESULTS: There were 1,039 central venous catheters placed in 824 patients, 92.6% in the subclavian vein and 7.4% in the internal jugular vein. There were 604 (58.1%) children who had both fluoroscopy and a postprocedure chest x-ray, there were 308 (29.6%) who had only fluoroscopy, there were 117 (11.3%) who had only a postprocedure chest x-ray, and there were 10 (1.0%) who had neither fluoroscopy nor chest x-ray. On completion of the procedure, there were 12 (1.1%) children with misplaced central venous catheters, only 1 (0.1%) when intraoperative fluoroscopy was used. There were 17 (1.6%) complications; 9 (0.9%) were pulmonary (pneumothorax, hemothorax, or an effusion). All children with pulmonary complications experienced clinical signs and symptoms suggestive of the complication after their central venous catheter insertion but before their postoperative chest x-ray.

CONCLUSIONS: The number of complications encountered in children who had central venous access of the subclavian vein or internal jugular central vein with intraoperative fluoroscopy was infrequent, the number of misplaced catheters was minimized with intraoperative fluoroscopy, and all children with pulmonary complications showed clinical signs suggestive of pulmonary complications before postoperative chest x-ray. Therefore, children who have had central venous access of the subclavian and internal jugular vein with intraoperative fluoroscopy do not appear to require a routine chest x-ray after catheter placement unless clinical suspicion of a complication exists.

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.


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 bracheo-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.


Totally implantable venous devices (TIVD) are increasingly being utilized for venous access for chemotherapy of oncological patients. These devices considerably improve the quality of life of patients requiring long-term chemotherapy. However, despite the great usefulness of TIVDs, their insertion and maintenance is not free of complications. Many early as well as late complications associated with these devices have been reported. We report an unusual, silent, but potentially hazardous complication of catheter fracture and cardiac migration in a 16-year-old girl, in whom the port had been unused for 9 months before presentation. Percutaneous retrieval was unsuccessful as the catheter end was embedded in the myocardium. The catheter was removed via a midline sternotomy without any further complications. We have also reviewed the literature about the possible mechanism of this complication and discussed methods to recognize and avoid it.

BACKGROUND: Placement of central venous catheter is essential in the management of critically ill children. The purpose of the present paper was to evaluate the success rate, mechanical and thrombotic complications and risk factors associated with these complications from different central venous access sites in critically ill children.

METHODS: A prospective study was undertaken from February 2000 to March 2005 of 369 central venous catheterizations in children in a pediatric intensive care unit.

RESULTS: The veins most frequently used were femoral vein (45%), subclavian vein (32.2%), and internal jugular vein (22.8%). Mean +/- SD duration of catheterization was 9.5 +/- 6.5 days. The procedure was performed under emergency conditions in 18% of patients with an overall success rate of 92.4%. The success rate was significantly lower in younger patients with subclavian catheterization. Insertion-related complications were noted, including 33 arterial punctures (8.9%), 27 cases of malposition (7.3%), 19 hematomas (5.2%), 12 cases of minor bleeding (3.3%), and three cases of pneumothorax (0.8%), and they were more common in the subclavian vein than in the internal jugular and femoral vein. Multiple attempts and failed attempts significantly correlated with higher incidence of complications. Maintenance-related complications included obstruction (n = 26; 7%), accidental removal (n = 14; 3.8%), central venous thrombosis (n = 8; 2.2%), subcutaneous extravasation (n = 14; 3.8%), dislodgment (n = 1; 0.25%), and extravascular infusion (n = 1; 0.25%). The frequency of catheter maintenance-related complications was significantly higher in femoral catheterizations and increased significantly with an increase in the duration of catheterization. A total of five serious complications were seen (pneumothorax in three, dislodgment in one and extravascular infusion in one) in the present series.

CONCLUSIONS: Central venous catheterization in critically ill children is a relatively safe procedure, with a 1.3% rate of serious complications and no mortality. It seems safer to choose initially the femoral or internal jugular vein instead of the subclavian vein because of high success rate without serious insertion-related complications.


We report the successful insertion and subsequent retrieval of a Gunther-Tulip vena cava filter in a patient with an anomalous left-sided inferior vena cava, who developed a right ilio-femoral venous thrombosis prior to planned surgical resection of a right femoral osteosarcoma. The indication was for short-term prophylaxis against pulmonary embolism during manipulative leg surgery.


BACKGROUND: Central venous catheters are used for pressure measurement, and drug and fluid therapy in children. Several reports have described serious complications related to catheter positioning. We evaluated the possibility of using the right third intercostal space as an anatomic landmark for determining the optimal insertion depth of a central venous catheter from the right internal jugular vein.

METHODS: The distance between the skin puncture site and the right third intercostal space (SK-ICS) was measured in 83 children. The catheter was inserted to a depth equal to the measured distance. Postoperatively, the distance between the catheter tip and the radiographic junction of the superior vena
cava and the right atrium was measured. This was defined as the optimal catheter length, which placed the catheter tip at the SVC/RA junction (SK-SVC/RA).

**RESULTS:** A significant correlation was found between the SK-ICS and SK-SVC/RA (regression equation: SK-SVC/RA = 0.35 + 0.98 x SK-ICS, r² = 0.8554). Based on the data obtained, a simple formula, SK-ICS-1 (cm), predicted that a CVC would be positioned above the RA in 98.8% of patients.

**CONCLUSIONS:** Using the right third intercostal space as an anatomic landmark allows positioning of the catheter tip in the SVC near to but not in the RA in children.


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.


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 bacteraemia occurred. PFGE analysis revealed that bacteraemic episodes related to each catheter were caused by a distinct B. cereus strain.


**OBJECTIVE:** To compare the incidence of and factors associated with vascular thrombosis after placement of heparin-bonded and standard femoral venous catheters.
DESIGN: Prospective, masked, clinical study.

SETTING: Multidisciplinary, tertiary, pediatric intensive care unit.

PATIENTS: Consecutive cases (n = 50) of critically ill children admitted to a pediatric intensive care unit in whom either a heparin-bonded (n = 25) or a standard (n = 25) femoral venous catheter was placed.

MEASUREMENTS AND MAIN RESULTS: Patients were examined by ultrasonography within 3 days of catheter insertion, weekly while the catheter was in place, and after catheter removal for evidence of vascular thrombosis. Data were collected prospectively regarding clinical evidence of catheter thrombosis, infusate composition, and positive blood culture results. Of 50 patients, 13 (26%) had thrombotic complications, 11 (44%) of the 25 patients in the standard-catheter group, in comparison with 2 (8%) of the 25 patients in the heparin-bonded catheter group (p = 0.004). In addition, there was a significantly higher incidence of positive blood culture results among patients in the standard-catheter group (24% vs 0%; p = 0.009). Positive catheter blood culture results were obtained in 38% of patients with thrombosis versus 3% without thrombosis (p = 0.001). Clinical evidence of thrombosis was found in 69% of patients with, versus 27% of patients without, ultrasound-proved thrombosis (p = 0.007).

CONCLUSION: Heparin bonding of catheters is associated with significantly fewer thrombotic complications. A reduced incidence of positive catheter-related blood culture results may be associated with the absence of thrombosis.


The majority of life-threatening injuries secondary to the placement of central venous catheters, such as bleeding and pneumothorax, occur at the time of initial insertion. When a catheter extravasates in the neck, edema of the neck wall or chest is usually seen, and the pump indicates occlusion. We present four cases in which an uneventful, successful placement of four central lines (three superior vena cava, one inferior vena cava) were followed at greater than 48 hours by either hydrothorax or hydroperitoneum, which resulted in either cardiorespiratory collapse or intraabdominal sepsis. In reviewing these cases, all showed both a change in catheter location on a subsequent x-ray and poor or no blood return on aspiration; paradoxically, the infusion pump in each case did not sense a catheter malposition or occlusion. We conclude that, although the success of central line placement may be documented on insertion, a continual reappraisal of both the function and location of the line is necessary.


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], 0.89-1.622; 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.


**BACKGROUND:** After the insertion of a central venous catheter, a chest radiograph is usually obtained to ensure correct positioning of the catheter tip.

**OBJECTIVE:** To determine in a paediatric population whether B-mode and colour Doppler sonography after central venous access is useful to evaluate catheter position, thus obviating the need for a postprocedural radiograph.

**MATERIALS AND METHODS:** A prospective study of 107 consecutive central venous access procedures placed in a paediatric intensive care unit was performed. At the end of the procedure, B-mode and colour Doppler sonography were used to assess catheter position and check for complications. A postprocedural chest radiograph was obtained in all patients.

**RESULTS:** In 96 patients postprocedural B-mode and colour Doppler sonography showed colour Doppler signals within the vena cava. Among the 11 patients predicted to have a potential complication, there was one pneumothorax and ten malpositions. Chest radiography showed a total of 13 complications-1 pneumothorax and 12 malpositions. The concordance between colour Doppler sonography and chest radiography was 98.1% in the detection of catheter position; sonography had a sensitivity of 84.6% and a specificity of 100%.

**CONCLUSIONS:** The close concordance between B-mode and colour Doppler sonography and chest radiography justifies the more frequent use of sonography to evaluate catheter position because ionizing radiation is eliminated. Chest radiography may then be performed only when there is suspected inappropriate catheter tip position after sonography.


**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](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]

BACKGROUND: Procedural pain relief is sub-optimal in infants, especially small and vulnerable ones. Tetracaine gel 4% (Ametop, Smith-Nephew) provides pain relief in children and larger infants, but its efficacy in smaller infants and for peripherally inserted central catheters (PICC) remains uncertain. The objective of this trial was to assess the safety and efficacy of tetracaine gel on the pain response of very low birth weight (VLBW) infants during insertion of a PICC.

METHODS: Medically stable infants greater than or equal to 24 weeks gestation, requiring a non-urgent PICC, were included. Following randomization and double blinding, 1.1 g of tetracaine or placebo was applied to the skin for 30 minutes. The PICC was inserted according to a standard protocol. Pain was assessed using the Premature Infant Pain Profile (PIPP). A 3-point change in the pain score was considered clinically significant, leading to a sample size of 54 infants, with 90% statistical power. Local skin reactions and immediate adverse cardiorespiratory events were noted. The primary outcome, PIPP score at 1 minute, was analysed using an independent Student’s t-test.

RESULTS: Fifty-four infants were included, 27 +/- 2 weeks gestation, 916 +/- 292 grams and 6.5 +/- 3.2 days of age. Baseline characteristics were similar between groups. The mean PIPP score in the first minute was 10.88 in the treatment group as compared to 11.74 in the placebo group (difference 0.86, 95% CI -1.86, 3.58). Median duration of crying in non-intubated infants was 181 seconds in the tetracaine group compared to 68 seconds in the placebo group (difference -78, 95% CI -539, 117). Local skin erythema was observed transiently in 4 infants (3 in the treatment and 1 in the placebo group). No serious harms were observed.

CONCLUSION: Tetracaine 4% when applied for 30 minutes was not beneficial in decreasing procedural pain associated with a PICC in very small infants.


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


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.


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 thrombocytopenic 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.


INTRODUCTION: The importance of accidental catheter removal (ACR) lies in the complications caused by the removal itself and by catheter reinsertion. To the best of our knowledge, no studies have analyzed accidental removal of various types of catheters in the intensive care unit (ICU). The objective of the present study was to analyze the incidence of ACR for all types of catheters in the ICU.

METHODS: This was a prospective and observational study, conducted in a 24-bed medical/surgical ICU in a university hospital. We included all consecutive patients admitted to the ICU over 18 months (1 May 2000 to 31 October 2001). The incidences of ACR for all types of catheters (both per 100 catheters and per 100 catheter-days) were determined.

RESULTS: A total of 988 patients were included. There were no significant differences in ACR incidence between the four central venous access sites (peripheral, jugular, subclavian and femoral) or between the four arterial access sites (radial, femoral, pedal and humeral). However, the incidence of ACR was higher for arterial than for central venous catheters (1.12/100 catheter-days versus 2.02/100 catheter-days; P < 0.001). The incidences of ACR/100 nonvascular catheter-days were as follows: endotracheal tube 0.79; nasogastric
tube 4.48; urinary catheter 0.32; thoracic drain 0.56; abdominal drain 0.67; and intraventricular brain drain 0.66.

**CONCLUSION:** We found ACR incidences for central venous catheter, arterial catheter, endotracheal tube, nasogastric tube and urinary catheter that are similar to those reported in previous studies. We could not find studies that analyzed the ACR for thoracic, abdominal, intraventricular brain and cardiac surgical drains, but we believe that our rates are acceptable. To minimize ACR, it is necessary to monitor its incidence carefully and to implement preventive measures. In our view, according to establish quality standards, findings should be reported as ACR incidence per 100 catheters and per 100 catheter-days, for all types of catheters.


**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.


**BACKGROUND:** There is a lack of studies evaluating procedural sedation for insertion of central venous catheters (CVC) in pediatric patients in emergency departments or pediatric intensive care units (PICU). This study was designed to evaluate whether there is a difference in the total sedation time for CVC insertion in nonintubated children receiving two sedation regimens.

**METHODS:** Patients were prospectively randomized to receive either midazolam/fentanyl (M/F) or midazolam/ketamine (M/K) i.v. The Children’s Hospital of Wisconsin Sedation Scale was used to score the sedation level.
RESULTS: Fifty seven patients were studied (28 M/F and 29 M/K). Group M/F received midazolam (0.24 +/- 0.11 mg.kg(-1)) and fentanyl (1.68 +/- 0.83 microg.kg(-1)) and group M/K received midazolam (0.26 +/- 0.09 mg.kg(-1)) and ketamine (1.40 +/- 0.72 mg.kg(-1)). The groups were similar in age, weight, risk classification time and sedation level. Median total sedation times for M/F and M/K were 97 vs 105 min, respectively (P = 0.67). Minor complications occurred in 3.5% (M/F) vs 20.7% (M/K) (P = 0.03). M/F promoted a greater reduction in respiratory rate (P = 0.005).

CONCLUSIONS: In this study of nonventilated children in PICU undergoing central line placement, M/F and M/K provided a clinically comparable total sedation time. However, the M/K sedation regimen was associated with a higher rate of minor complications. A longer period of study is required to assess the efficacy and safety of these sedative agents for PICU procedures in nonintubated children.


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.


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 septicaemia (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.


OBJECTIVE: To find a body measurement that would serve as an index for determining the length of femoral venous catheter to be inserted to achieve a position near the right atrium.

METHODS: A candidate index measurement was chosen, and radiographic measurements of routine femoral venous catheter placements were compared with the placement that may have resulted from use of the index in a group of patients. In a subsequent group, the candidate index was used to choose catheter insertion length, the accuracy of which was again evaluated from routine placement radiographs.

RESULTS: The first series of radiographic measurements predicted that use of the sternal-umbilical-puncture (SUP) index would result in acceptable and accurate catheter tip placement. This was confirmed in the second group of patients in which 11 of 12 catheter tips were within 1 cm of the target position.

CONCLUSIONS: The use of the SUP index ensures acceptable accuracy in estimating the required insertion length of femoral catheter when tip placement near the right atrium is the clinical goal.


The way in which physicians are trained to do invasive practical procedures is an ongoing challenge for educators. Percutaneous insertion of a central line via the femoral vein using the Seldinger technique is an important practical pediatric procedure, and the need for physicians to be educated in the necessary skills is recognized in current training initiatives such as Pediatric Advanced Life Support (PALS) and Advanced Pediatric Life Support. Unfortunately, the majority of instruction in central venous access techniques is theoretic. This approach does not provide the hands-on training needed to give practitioners the necessary practical experience, or confidence in their skills. Practice using simulated tissue can enable physicians to perform practical skills with greater confidence. However, although commercially available models exist for peripheral venous access, a recent cross-Canada survey of the 13 PALS program coordinators and a similar inquiry to the American Heart Association indicated that none of them had a pediatric practice model for central venous access. We describe 1) how to construct from materials readily available a pediatric model for the insertion of central venous catheters into the femoral vein using the Seldinger technique, and 2) an evaluation of the change in confidence learning with the model engendered. In our experience, this model is inexpensive (less than $50) and can be replicated readily by others for use as a teaching aid. It provides inexperienced physicians the opportunity to learn the practical elements of the technique and acquire confidence in the Seldinger method. Our hypothesis was that the confidence and skill of physicians would be increased by practical experience of central line insertion using a realistic model. The model enables
trainees to be taught the technique described in the PALS manual to locate the femoral artery. They then can learn to introduce a thin-walled needle or over-the-needle catheter, one finger's breadth below the inguinal ligament and just medial to the location of the femoral artery. The needle or over-the-needle catheter then can be advanced at the correct angle if the needle is directed toward the model's umbilicus. As occurs in vivo, the model allows for a free flow of fluid to be obtained as the "vessel" is entered. If the Foley catheter simulating the vessel is transfixed, negative pressure applied as the needle is withdrawn will result in fluid being obtained as the needle tip reenters the "vessel." The syringe then can be removed from the needle, and the key elements of the procedure—correct insertion of the Seldinger guide wire and passage of the venous catheter over the guide wire into the vessel—can be practiced. If desired, instruction also can be given on the use of a dilator and techniques of taping the catheter in place and all the appropriate techniques to avoid potential air embolism. However, the model does not lend itself to instruction in suturing. The model has been used to teach the practical elements of this technique to 428 physicians (emergency physicians, 49%; pediatricians, 24%; other physicians, 20%; pediatric residents, 7%). Their success rate for cannula insertion in three or fewer attempts was 87%. The last 218 physicians were evaluated to assess the influence of learning with the model on their confidence to perform the technique successfully in an emergency. Before training they were asked, "Have you done a pediatric resuscitation course that taught this technique in theory?" and "Rate your confidence level for performing central vascular access in a patient from 0 to 5 (none, very little, some, moderate, good, complete)." This rating was repeated after the training session using the model. For 154 (71%) answering "yes" to a previous resuscitation course, mean scores were 1.52 (standard error [SE] +/- 0.91) after theoretic instruction and 4.06 (SE +/- 0.47) after practical education using our model. The 64 (29%) physicians...
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 thromboembolic events (VTEs) in children are associated with central venous lines (CVLs). The study objective was to assess whether CVL location and insertion technique are associated with the incidence of VTE in children. We hypothesized that VTE would be more frequent with (1). CVL location on the left body side, (2). CVL location in the subclavian vein rather than the jugular vein, and (3). CVL insertion by percutaneous technique rather than venous cut-down. This was a prospective, multicenter cohort study in children with acute lymphoblastic leukemia who had a CVL placed in the upper venous system during induction chemotherapy. Characteristics of CVL were documented prospectively. All children had outcome assessment for VTE by objective radiographic tests, including bilateral venography, ultrasound, echocardiography, and cranial magnetic resonance imaging. Among 85 children, 29 (34%) had VTE; 28 VTEs appeared in the upper venous system, and 1 was sinovenous thrombosis. Left-sided CVL (odds ratio [OR], 2.5; 95% confidence interval, 1.0-6.4; P =.048), subclavian CVL (OR, 3.1; 95% CI, 1.2-8.5; P =.025), and percutaneous CVL insertion (OR, 3.5; 95% CI, 1.3-9.2; P =.011) were associated with an increased incidence of VTE. Interaction occurred between CVL vein location and insertion technique. Subclavian vein CVL inserted percutaneously had an increased incidence (54%) of VTE compared with any other combination (P =.07). For CVL in the upper venous system, CVL placement on the right side and in the jugular vein may reduce the risk for CVL-related VTE. If subclavian vein placement is necessary, CVL insertion by venous cut-down appears preferable over percutaneous insertion.


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.

The placement of the Hickman catheter in the central veins is thought to be an effective method for providing venous access in various clinical situations in children. The catheter is usually inserted by the percutaneous approach, but in some cases various troublesome complications can occur, such as sheath introducer kinking or damage, in addition to other major ones. Therefore, some modified techniques, using vascular dilators, both to dilate the route and to avoid such complications, have been developed and investigated to obtain a smooth and safe percutaneous insertion of the Hickman catheter in children. A total of 41 Hickman catheters were inserted by the percutaneous method in 41 pediatric patients from 1996 to 2004 in our department. Sixteen catheters were inserted by means of a standard method, using the manufacturer's insertion kit, and 25 catheters were inserted by means of a modified method, namely, using various sized vascular dilators. The length of time for the procedure, the complication rate, and the changes in the serum C-reactive reaction (CRP) levels were then compared between the standard and the modified methods. Those parameters were also compared between a right-side and left-side approach using both methods, to clarify which side was better for the insertion of this catheter. The length of time for the catheter replacement procedure in the standard group was significantly longer than that in modified one. The occurrence rate for both the kinking and small damage to the sheath introducer in the standard group was higher than that in the modified one. The peak of serum CRP in the modified group was significantly lower than that in the standard one. When comparing a right-side and left-side approach, 7 catheters out of 16 were inserted by the right-side approach in the standard group, while 10 catheters out of 25 were done by the right-side approach in the modified group. The length of time for the procedure for the left-side approach was significantly shorter than that for the right-side one in both groups. No difference in technical complications was observed between the two different approaches in the modified group, while complications when using the right-side approach often occurred in the standard group. The peak of serum CRP in the left-side approach was lower than that in the right-side one in both groups. The use of the modified percutaneous method, using various sized vascular dilators and the left-side approach, was therefore found to be useful for the safe and smooth placement of the Hickman catheter in children.


Long-term venous access using Hickman catheters and implantable subcutaneous ports is a well established technique. These devices have customarily been inserted via the internal jugular, subclavian or cephalic veins. On occasions, these routes may be unavailable. This article reviews the outcome of 53 prolonged venous access catheters (39 Hickmans and 14 catheters attached to implantable ports) inserted percutaneously via the external iliac vein into 37 patients over a period of 5.7 years. The indications for insertion were chemotherapy (40%), total parenteral nutrition (36%), intravenous antibiotics (13%), poor venous access (7%) and bone marrow transplantation (4%). The main reasons for use of the external iliac vein were thrombosis of the subclavian veins or superior vena cava and subclavian central line sepsis. The only complication of insertion was one inadvertent puncture of the external iliac artery. Twenty-seven catheters (51%) remained complication free and functioning for the time for which they were required. Four catheters (7%) are still functioning in situ having been present for 1-5 years. Sixteen catheters (30%) became infected, with a 17% incidence of septicemia. Venous thrombosis was associated with three catheters (6%). Catheters remained in situ for a median period of 30 days (range 5-569 days). The authors conclude that long-term venous access using percutaneous external iliac vein insertion is a useful technique when other routes are unavailable, but there is a relatively high incidence of catheter-related sepsis.

**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.


This randomized, double-blind, placebo-controlled study evaluated midazolam syrup for reducing discomfort from intravenous placement in children 9 months to 6 years. Parents and observers rated the child's discomfort by using visual analogue scales. Median parents' pain scores were significantly lower in the midazolam than the placebo group (P =.002). Midazolam effectively reduces discomfort associated with intravenous insertion.


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.


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.


The long-term survival of children with irreversible intestinal failure is often dependent on adequate central venous access for the administration of parenteral nutrition. In children with occlusion of major central thoracic veins, innovative techniques to establish venous access have been described in the literature. The present report describes an innovative stereotactic technique of catheter insertion in children with occluded internal jugular and brachiocephalic veins. The catheter is inserted percutaneously from the neck into the distal patent stump of the superior vena cava communicating with the right atrium.

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.


Central venous cannulation through a peripheral vein is the technique of choice in awake nonsedated critically ill infants. Such a technique has a high failure rate. We undertook a retrospective study to determine whether a brachial plexus block performed via the axillary approach could improve the success rate for the insertion of a central venous catheter from a peripheral vein of the upper limb in small infants. Data from 128 infants, submitted or not submitted to the axillary block, were analysed. The failure rate for insertion of the central venous catheter was 27% in the group without the use of the axillary block and 9% with the axillary block (P<0.05). The use of brachial plexus block via the axillary route, although evaluated retrospectively, improves the success rate for the insertion of small diameter central venous silicon catheter from a peripheral vein of the upper limb in small infants.


The axillary vein was evaluated as an alternative access site for central venous catheterization in critically ill infants and children. Children were placed in the Trendelenberg position (when possible) with arm abducted 100 to 130 degrees. The vein was entered parallel and inferior to the artery. Success rate for catheterization was 79% (41/52). Catheter diameter range was 3 to 8.5 F and catheter length range was 5 to 30.5 cm. Median patient weight was 7.0 kg (3.0 to 59 kg). Median age was 0.91 years (14 days to 9 years). All central lines ended in the subclavian, innominate, or superior vena cava. Median catheter duration was 8 days (2 to 22 days). A total of 338 patient catheter-days were studied. Central venous pressure was successfully monitored in five of five attempts. Complications with insertion (3.8% of attempts) included one pneumothorax and one hematoma. Complications during catheter duration (9.8% of catheters, 1.1% per catheter-day) included one instance each of venous stasis, venous thrombosis, catheter sepsis, and parenteral nutrition infiltration. No complication contributed to a patient mortality. Success and complication rates were comparable with those in jugular catheterization studies in children. The axillary approach is an acceptable route for central venous catheterization in critically ill infants and children.

In a prospective study results of central venous catheter (CVC) placements in a consecutive group of 500 patients with less than 20 kg body weight undergoing cardiac surgery were evaluated. The incidence of previous cardiac surgery was 21% and the incidence of factors preventing the primary puncture of the right jugular or innominate vein was 13.4%. The anesthesiologists were free to select the catheterization technique, site of puncture, and catheter type. All CVC insertions were performed prior to surgery under continuous circulatory monitoring and optimal positioning of the anesthetized patient. Ninety-six percent of all catheterizations were successful, 81% of them on the first attempt. In the 4% of cases where catheterization failed, a CVC had to be placed by the surgeon. Of all catheters, 66% were positioned via the right internal jugular (IJV) or innominate vein (IV), 8% via the left, 16% via an external jugular vein (EJV), and 5% via other veins. Seventy-six percent of CVC insertions were performed with the Seldinger technique. Of the four catheter types used in this study, double lumen catheters were most frequently selected (38%). Placement of 22-ga single lumen catheters was preferred in infants with less than 5 kg body weight, in spite of their tendency to kink. Observed complications (10% arterial puncture, 4% hematoma, and 1% intrathoracic bleeding) never required immediate surgical intervention. Careful selection of appropriate catheters, as well as extensive experience and knowledge of the anatomical structures involved in special heart defects, helped to keep the risk of complications low.


Indwelling central venous catheters (CVC) are essential devices in the management of children with oncological/haematological diseases being treated with chemotherapy or undergoing bone marrow transplantation. Our study was aimed at detecting the incidence of important thrombotic events caused by CVC in children, and the coexistence of coagulation disorders in children affected with thromboembolic disease related to CVC. Therefore, we describe some antithrombotic strategies which have been successfully applied to solve functioning problems of correctly inserted CVC. We retrospectively evaluated the clinical records of 308 children (age range 2 months to 14 years) with oncological/haematological diseases undergoing insertion of 362 indwelling CVC from January 1994 to December 1998 at the Gaslini Children's Hospital. We collected data on seven serious asymptomatic thrombotic episodes diagnosed between 1994 and 1998 following catheter malfunctioning and one case of suspected lung embolism with symptoms. Coagulation tests allowed us to identify one case of probable heterozygosis of Protein C deficiency and one case of G20210A prothrombotic prothrombin mutation. This finding suggests the need for further evaluation for thrombophilia in all patients presenting with thrombotic complications of CVC. We therefore emphasise the importance of prophylaxis with low-dose heparin in children with malignancies receiving CVC. A prospective study, which has already been started, should identify the exact role of thromboembolic complications in children with indwelling CVC for oncological/haematological malignancies.

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.

**Munro, F. D., P. M. Gillett, et al. (1999). "Totally implantable central venous access devices for paediatric oncology patients." Medical & Pediatric Oncology 33(4): 377-381.**

**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.


**BACKGROUND:** Various methods have been recommended to decide a proper insertion depth of central venous catheter (CVC). The carina is recommended as a useful target level for the CVC tip position. We evaluated the sternal head of a right clavicle and the nipples as anatomic landmarks for determining the optimal depth of CVC in paediatric patients.

**METHODS:** Ninety children, <5 yr, undergoing catheterization through the right internal jugular vein were enrolled. The insertion depth was determined as follows. The insertion point was designated as 'Point I'. The sternal head of the right clavicle was called 'Point A' and the midpoint of the perpendicular line drawn from Point A to the line connecting both nipples was called 'Point B'. The insertion depth of CVC was determined by adding the two distances (from I to A and from A to B) and subtracting 0.5 cm from this. A chest radiography was taken and the distance of the CVC tip from the carina level was measured by the Picture Archiving and Communicating System.
RESULTS: The mean distance of the CVC tip from the carina level was 0.1 (1.0) (P=0.293) cm above the carina (95% CI 0.1 cm below the carina-0.3 cm above the carina). There was no specific relationship between the distance of the CVC tip from the carina level and the patients’ age, height, and weight.

CONCLUSIONS: The CVC tip could be placed near the carina by using the external landmarks without any formulae, images, and devices in children in our study.


OBJECTIVE: The migration of peripherally inserted central catheters (PICCs) from the superior or inferior vena cava into the right atrium can pose a significant risk of lethal pericardial effusion and tamponade secondary to myocardial perforation. Arm movement has been reported to cause displacement of the catheter tip toward the heart and lead to ventricular tachycardia in adults. The objective of this study was to investigate whether adduction or abduction at the shoulder and flexion or extension at the elbow affect the position of PICCs placed via upper limb veins. We also hypothesized that arm movements can be used to reposition malpositioned catheters.

METHODS: A total of 280 radiographs of 60 neonates with PICCs inserted via upper limb veins from July 2000 through June 2001 were reviewed. Differences in catheter tip position as a result of abduction versus adduction at the shoulder, flexion versus extension at the elbow, and combination changes in arm posture were determined by measurements in paired radiographs. Correction of malpositioned catheters was attempted in 10 patients by using arm movements without any alterations at the site of insertion.

RESULTS: Arm movements were associated with significant displacement of catheters. Catheters that were placed via the basilic or axillary vein migrated toward the heart with adduction of the arm, whereas those that were placed via the cephalic vein moved away from the heart with adduction. Flexion of the elbow displaced catheters that were placed in the basilic or cephalic vein below the elbow toward the heart but did not have any effect on catheters that were placed via the axillary vein. For catheters that were placed in the basilic vein, simultaneous shoulder adduction and elbow flexion caused the greatest movement toward the heart (15.11 +/- 1.22 mm). We were able to reposition correctly inappropriately placed catheters in 9 of 10 patients by using arm movements.

CONCLUSIONS: Arm movements significantly affect the position of the tip of the PICCs. Prevention of catheter migration into the right atrium requires radiographic determination of vein of insertion and monitoring of catheter tip position with upper extremity in position of maximum inward movement of catheter for that vein. Arm movements can be used to correct the malpositioned catheters.


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.


The insertion of central venous catheters has become an established practice in the management of children with different types of malignancies for the administration of chemotherapeutic agents, antibiotics, blood and blood products, as well as drawing blood for various investigations. A commonly encountered problem is that despite the catheter being patent it may be impossible to draw blood from it. We believe this is related to the cut of the catheter tip. To overcome this problem, a technique for cutting the tip of the catheter is described.


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
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]


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]


Ultrasound-guided placement of peripherally inserted central catheters has been well documented for adults who require infusion therapy. This same technology is surfacing in the pediatric population to improve outcomes when confronted with the challenges of the smaller vascular system and chubbier body shapes. The scope of practice is addressed in coupling peripherally inserted central catheters with ultrasound imaging, and recommendations are identified for the advancement of nursing practice within the field of imaging technology and application. Obstacles related to successful insertion of peripherally inserted central catheters are defined, and the benefits of ultrasound-guided placement of peripherally inserted central catheters are reviewed. [References: 26]


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.


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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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.


Placement of a peripherally inserted central catheter (PICC) is commonplace in infants and children for the infusion of medications, hydration, and nutritional solutions. Vein depletion caused by repeated and prolonged need for vascular access devices has forced practitioners to consider alternate veins for providing
The external jugular vein has a positive history of use for insertion of the PICC and is becoming increasingly popular for this purpose. Pertinent anatomy, patient selection criteria, preparation, and catheter insertion and maintenance processes related to the catheter placed and residing in the external jugular vein are discussed.


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.


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 \([\leq 3\) years of age. Implanted/tunneled devices (port catheters) were more likely to become infected in the first 30 days after insertion, 11 of 41 (26.8%), than external catheters (brovias/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 \([\leq 2\) 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]


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.


We report on our experience in the use of a new system of a totally implantable device for repeated vascular access in children, developed in 1989 by Pharmacia and named P.A.S. Port (Peripheral Access System Port). The P.A.S. Port is far smaller than other systems and has been designed for peripheral location in the arm. This avoids unsightly pectoral scars particularly in girls and allows insertion under local anesthesia. It is an interesting alternative to the Port-a-Cath for children older than 5 years of age. It is easily accepted by the patient as well as by the caring team.


Central venous lines are used in critically ill children and in children with chronic conditions for the administration of intravenous therapy, such as fluids, medications, total parenteral nutrition and blood products. Although the use of central venous lines has greatly improved the quality of care in these children, these catheters may cause serious mechanical, infectious and thrombotic complications. The reported frequency of catheter thrombosis in children is low as 5% in studies including only symptomatic cases and high as 50% in studies where patients are systematically screened for catheter-related thrombosis. The risk factors for catheter-related thrombosis in children are associated with the methods used for catheter insertion and with individual patient characteristics, underlying diagnosis and treatment. The management of catheter-related thrombosis is largely dependent on the requirement of the catheter. If
no longer required or nonfunctioning the catheter should be removed. If access is still required and the catheter is functioning, treatment with anticoagulation is recommended in the absence of contraindications. The management of radiographically detected asymptomatic thrombosis in children is less clear. Clinical studies of prophylaxis for catheter-related thrombosis are inconclusive and no definitive recommendations for prophylaxis in adults or in children with central venous thrombosis can be made. Properly designed studies are needed to assess the role of prophylactic anticoagulation for preventing catheter-related thrombosis. Copyright 2006 S. Karger AG, Basel [References: 56]


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.


The 3-year survival after small bowel transplantation (SBTx) has improved to between 73% and 88%. Impaired venous access for parenteral nutrition can be an indication for SBTx in children with chronic intestinal failure. AIM: To report our experience in management of children with extreme end-stage venous access. SUBJECTS: The study consisted of 6 children (all boys), median age of assessment 27 months (range, 13-52 months), diagnosed with total intestinal aganglionosis (1), protracted diarrhea (1), and short bowel syndrome (4), of which gastroschisis (2) and malrotation with midgut volvulus (2) were the causes. All had a documented history of more than 10 central venous catheter insertions previously. All had venograms, and 1 child additionally had a magnetic resonance angiogram to evaluate venous access. Five of 6 presented with thrombosis of the superior vena cava (SVC) and/or inferior vena cava. METHODS: Venous access was reestablished as follows: transhepatic venous catheters (5), direct intra-atrial catheter via midline sternotomy (4),azygous venous catheters (2), dilatation of left subclavian vein after passage of a guide wire and then placing a catheter to reach the right atrium (1), radiological recanalization of the SVC and
placement of a central venous catheter in situ (1), and direct puncture of SVC stump(1). Complications included serous pleural effusion after direct intra-atrial line insertion, which resolved after chest drain insertion (1), displacement of transhepatic catheter needing repositioning (2), and SVC stent narrowing requiring repeated balloon dilatation. OUTCOME: Four children with permanent intestinal failure on assessment were offered SBTx, 3 of which were transplanted and were established on full enteral nutrition; the family of 1 child declined the procedure. In the remaining 2 children in whom bowel adaptation was still a possibility, attempts were made to provide adequate central venous access as feeds and drug manipulations were undertaken. One of them received liver and SBTx nearly 3 years after presenting with end-stage central venous access, because attempts to achieve independence from parenteral nutrition had failed. The other child died immediately after a transhepatic venous catheter placement, possibly from a nutritional depletion syndrome as no physical cause of death was found. Direct intra-atrial catheters in transplanted children proved to be adequate for the management of uncomplicated transplantation, although the usual infusion protocol had to be modified considerably, and the lack of access would have been critical if massive blood transfusion had been required during the transplant procedure. CONCLUSION: It was possible to reestablish central venous access in all cases. However, this was time consuming and difficult to assemble a skilled team consisting of one of more: surgeon, cardiologist, interventional radiologist, and transplant anesthetist. Small bowel transplantation is easier and safer with adequate central venous access, and we advocate liaison with an SBTx center at an early stage.


BACKGROUND/PURPOSE: Central venous catheterization is among the most common procedures performed by pediatric surgeons. Significant morbidity and even mortality can ensue from the widespread approach to the deep veins of the neck and femoral region. The external jugular vein (EJV) is a low-morbidity alternative for percutaneous catheterization in children, but it has yielded a low success rate in previous reports. The authors show an improved success rate with this option.

METHODS: We performed an analysis of 33 patients’ charts in which central venous catheterization using Seldinger technique through the EJV was attempted in 2005. Age, diagnosis, maneuvers used for success, fluoroscopy usefulness, and types of inserted catheters were evaluated.

RESULTS: The procedure was successful in 26 (78.8%) patients without complications. Diagnosis was neoplasia in almost half of the patients (42%). In half of the successful cases, body maneuvers were used, namely, twisting the head of the patient to the side of the vein and stretching the ipsilateral arm and shoulder. All but one procedure were completed under fluoroscopic guidance. In 6 (23%) patients, a long-term catheter was inserted.

CONCLUSIONS: The EJV is an excellent option for central venous catheterization in children. The execution of simple maneuvers along with fluoroscopic assistance might allow for an improved success rate not only for short-term but also for long-term catheter insertion.


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.


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. (ABSTRACT TRUNCATED AT 400 WORDS) [References: 161]


We report the case of a seven-year-old girl with recently diagnosed acute lymphoblastic leukaemia (ALL) who suffered acute airway obstruction during insertion of a central venous catheter under general anaesthesia. The central airway obstruction was due to a mixture of leukaemic cells, blood clot and fibrin. There is discussion about airway obstruction both as a complication of central line insertion and secondary to ALL. The pulmonary complications of ALL, with particular reference to pulmonary haemorrhage, are detailed. The management of blood clot obstructing the central airway is discussed.


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.


Background: The prevalence of venous thrombosis (VT) in children with solid tumor and the role of different risk factors are not defined yet. Aim: A cross-sectional observational study was conducted to evaluate the prevalence of both symptomatic and asymptomatic catheter-associated thrombosis events in children affected with different solid tumors. Methods: Patients with a solid tumor, admitted as day-care, were consecutively enrolled over a period of 10 months. All of them had a central venous line. Physical examination, D-dimer serum tests, and eco-color-Doppler ultrasonography were performed once at any time before catheter removal. Results: Forty-two patients (14 females and 28 males)-mean age 115 months-were evaluated. Five of the 42 patients (12%) had VT. In 4 of these, VT was catheter-related: 3 asymptomatic and 1 symptomatic. In the last patient, VT was clinically symptomatic and not catheter related. Patients with longer duration of catheter insertion presented with a higher rate of VT (P=0.05). Moreover, patients affected with neuroblastoma showed a higher rate of VT than the others with different solid tumors (P<0.05). Conclusions: VT was visualized by echo-color-Doppler ultrasonography in 12% of the patients; it was asymptomatic in 7%. In our small series, VT was related to neuroblastoma disease and a longer duration of catheter insertion. Prospective and multicentric studies are required to select risk factors for VT in children with solid tumors. copyright 2008 by Lippincott Williams and Wilkins.


Peripherally-inserted central catheters (PICCs) are long-term IV catheters used for drug and fluid administration, blood sampling, or hyperalimentation. The short-term use of PICCs in postoperative patients has not been studied. In this randomized, controlled trial, patients received either a PICC or peripheral IV catheter (PIV). Our outcome measures were patient and parent satisfaction with care, complications of the venous access devices, number of postoperative venipunctures, and cost-effectiveness of use. Satisfaction was significantly more frequent in the PICC group (P < 0.05), and there were significantly fewer postoperative needle punctures in the PICC group compared with the PIV group (P < 0.05). Minor complications were common in the PIV group; major complications were uncommon in both groups. PICCs are more expensive, but better satisfaction can make them a cost-effective option. Additionally, insertion during surgical preparation time in the operating room (OR) means that cost is not increased by adding

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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 septicemia. During a total of 23,486 catheter days (64.4 years), 110 episodes of septicemia occurred. This represents one episode per 214 catheter days. In 43 of the 110 episodes of septicemia, blood cultures showed growth of bacteria of the kind usually found in the gastrointestinal and respiratory tracts. All septicemias were treated with intravenous broad-spectrum antibiotics and in 21 cases the catheters were removed due to septicemia. Thirty-four (22%) catheters were removed accidentally. There were two cases of subclavian vein thrombosis.


BACKGROUND/PURPOSE: Venous thrombosis is a well-recognised complication of central venous catheters (CVC). The aim of the study was to assess the value of magnetic resonance venography (MRV) in assessing venous patency in children with suspected venous thrombosis.
METHODS: Contrast studies through the CVC (linogram) and Doppler ultrasonography were the initial investigations performed in children with suspected CVC-related thrombosis. Two-dimensional gated inflow and phase contrast MRV also was performed to assess the extent of venous thrombosis and to locate patent veins for replacement CVC. When the MRV identified a suitable patent vein, the CVC was reinserted by direct venous cut down or the percutaneous method under a general anaesthetic.

RESULTS: A total of 25 children (median age, 5 years; range, 2 months to 17 years) who had multiple CVC insertions (median, 3; range, 1-9), underwent MRV for suspected venous thrombosis. Of 10 patients in whom the catheter was completely occluded, MRV identified extensive thrombosis of the central veins in 6. In 7 other children the linogram showed adherent thrombus at the tip of the CVC only. In 5 of these 7 children MRV showed extensive thrombosis of the vein in which the catheters were placed. Doppler ultrasonography diagnosed thrombotic occlusion of the neck veins in 7 children. The MRV studies showed more extensive thrombosis in 4 of these 7 patients. Additionally, MRV showed thrombosis of the intrathoracic veins in 11 patients who had patent neck veins on ultrasound scan. MRV identified a patent vein for reinsertion of CVC in 22 of 25 children. At operation, venous patency was confirmed in 20 patients (91%).

CONCLUSION: MRV in children with suspected CVC-related thrombosis is more accurate than Doppler ultrasonography, and contrast studies for defining the extent of venous thrombosis. MRV correctly shows venous anatomy and patency for reinsertion of CVC.


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


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.


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 18 years. Catheter sepsis occurred in 6.7%, 5.9%, 6.2%, and 4.6%, respectively (NS, P = .75). There was no difference in rates of infection or mechanical complication between younger and older children. When closely supervised by an experienced surgeon, a low rate of infection (5.8%), acute mechanical complication (0.3%), and deep venous thrombosis (0.6%) accompanies central venous cannulation of critically ill children.


BACKGROUND: The recommended insertion length of central venous (CV) catheter via the internal jugular or subclavian vein has been determined in infants and children. However, the insertion length via the femoral vein has not been well-studied. This study determined the optimal insertion length of CV catheter via the femoral vein.

METHODS: Infants and children, who had undergone cardiac catheterization via the right femoral vein, were the subjects of the study. After routine cardiac catheterization, the distance from the femoral puncture site to the third lumbar vertebral body (L3) level, was measured and recorded. The femoral-L3 length was termed as the optimal insertion length.

RESULTS: This length was measured in 78 infants and children (age: 1-101 months, weight: 3.1-33.8 kg). The body weight of the patient and the length correlated well: the optimal insertion length (cm) = 0.45 x body weight (kg) + 8.13, coefficient of determination (R2) = 0.84.

CONCLUSIONS: It has been recommended to place the tip of the catheter below the level of renal veins to avoid blocking free flow of those veins. Therefore, we chose the mid-point, L3 level as the optimal tip
position of the femoral venous catheter. The length derived from the above formula could be used as a
guideline for CV catheter insertion via the femoral vein in infants and children.


We present an unusual complication of left internal jugular vein catheterization in an 11-week-old infant
which we believe has not been described previously. After failed subclavian catheterization, a left internal
jugular catheter was placed without apparent difficulty. Confirmatory chest x-ray revealed that the tip of the
catheter was in the extradural space.

Skladal, D., E. Horak, et al. (1999). "Complications of percutaneous insertion of Hickman catheters in

BACKGROUND/PURPOSE: The aim of this study was a retrospective evaluation of insertion and
management complications of percutaneous Hickman catheter lines in pediatric patients to investigate
whether the complication rate is acceptable in comparison with other insertion methods or other age
groups.

METHODS: Over a period of 22 months a total of 27 Hickman catheters were inserted in 22 pediatric
patients (20 oncological, 2 nononcological; age 6 weeks to 17.5 years).

RESULTS: Twenty-three of 36 insertion attempts (63.9%) were successful at first attempt. In another 4
patients, catheters were placed after repeated attempts. In an additional 4 patients, catheters were inserted
by surgeons after percutaneous insertion failed. As immediate complications, 1 pneumothorax and 1
malposition were seen. Late complications included 1 to 29 (median, 8) days of fever in 15 patients,
corresponding to 53 of 1,000 catheter days. Fourteen patients showed 21 positive blood cultures, including
11 cases of Staphylococcus epidermides, which might be related to the catheter. Antibiotics were given for a
total of 1 to 130 (median, 35) days, that is 205 of 1,000 catheter days. No catheter was removed because of
infectious complications. The total life span of the Hickman catheters was 1 to 371 (median, 163) days, the
patients were in the hospital from 1 to 351 (median, 102) days because of their underlying disease. At the
end of the study period, 8 of 27 (29.6%) catheters remained functioning in situ; 9 (33.3%) had been
selectively removed. Two patients died with the catheter (7.4%) functioning well. Another 2 patients
showed catheter thrombosis. Six catheters (22.2%) in 5 patients showed inadvertent dislodgement.

CONCLUSION: Percutaneous Hickman catheter insertion in pediatric patients is effective; however,
complication rate is relevant, but not higher than percutaneous insertion of subclavian vein or Hickman
catheters in adults.


EPIDEMIOLOGY: 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 show 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.


Loss of central venous access in intestinal failure patients is a potentially fatal complication, and an indication for intestinal transplantation. Thrombosis of the superior vena cava (SVC) has historically been considered a contraindication to small bowel transplantation; however, unconventional central venous access can facilitate survival and eventual transplant procedure in patients with end-stage central venous access. We describe a technique for azygos vein central catheter insertion utilizing thoracoscopic guidance in a 14-year-old girl with thrombosis of the SVC and chronic idiopathic pseudo-obstruction syndrome awaiting multivisceral transplantation. The technique is simplified by utilizing carbon dioxide (CO(2)) insufflation of the thoracic cavity to collapse the lung instead of double-lumen endotracheal tube placement, and no postoperative chest tube drainage of the pleural space is required. Thoracoscopic-assisted central access can also be used in children requiring chronic hemodialysis with limited venous sites due to thrombosis or small size of vessels.


Although the achievement of central venous access in children is often difficult maintenance of access is often frustrated by the tendency of the small-caliber central venous line (CVL) to thrombose despite adequate heparinization or-worse yet-be inadvertently removed. Traditional replacement over wire (Seldinger technique) is often not an option for these "lost" CVLs. Over the past 7 years we have used a wireless technique of CVL replacement to re-establish central access in children. The charts of 125 children who underwent wireless CVL replacement at various institutions between January 1995 and July 2000 were retrospectively reviewed. The wireless technique involves replacement of CVL by direct insertion through the previous catheter tract marked by the old puncture site. Plain film was used to confirm the line position postprocedure. The technique was applied predominantly to percutaneously placed 3- to 4-F CVLs with distal port thrombosis or those that had been inadvertently removed. Successful replacement was defined as re-establishment of previous line position and the ability to flush/draw blood through all ports. Wireless replacement was successful in 120 of 125 cases (96.0%). Recannulization was successful in CVLs as new as 3 days old and those removed for as long as 24 hours. Of the five unsuccessful cases, however, two CVLs were >3 weeks old, but >6 hours had elapsed since removal. The remaining three cases were CVLs that were <3
There were no intra- or postoperative complications, notably air embolism. We conclude that wireless CVL replacement in children can be performed safely and successfully in children who have lost central access not amenable to replacement via the traditional Seldinger technique. The often difficult chore of re-establishing central access at a new site in small children can thus be avoided.


OBJECTIVE: To evaluate the feasibility and effectiveness of 3 different types of silastic catheters that were used for percutaneous central venous catheterization (PCVC) through peripheral veins.

DESIGN AND SETTING: The study was prospective and consecutive for 6 years at a pediatric/neonatal intensive care unit and pediatric ward in Veterans General Hospital-Taipei, a university-affiliated medical center, in Taiwan, ROC.

PARTICIPANTS AND INTERVENTIONS: The patients who had PCVC were consecutively enrolled from January 1988 to December 1993. Three types of silastic catheters were used. The classification was according to the caliber as small catheter (SC, 0.30 mm ID), mid-size catheter (MC, 0.51 mm ID) and large catheter (LC, 0.64 mm ID). The same insertion technique, catheter-through-needle, was used for all PCVC placements through the peripheral vein. After insertion, each catheter was connected to a conventional short cannula (24-, 22-, or 20-gauge) of compatible caliber, and then linked to the infusion system.

Results: 1318 PCVCs were used in 1126 consecutive patients, that included 754 SCs in 649 infants (among them 60.9% were less than 1500 g), 383 MCs in 319 toddlers, and 181 LCs in 158 children. Mean (SD) body weight at the time of catheter insertion was SC 1.7(0.9) kg, MC 12.1(6.5) kg and LC 19.3(7.6) kg. Overall, mean (SD) duration of these PCVC was 16.4(8.4) days. A significantly longer duration was noted in: (a) SC group with 19.7(10.4) days than the other two groups [MC 12.4(6.5) days, LC 11.2(5.0) days]; (b) patients with body weight equal to or less than 3.0 kg [18.7(8.6) versus 14.1(6.1)]; and (c) insertion sites other than external jugular vein (EJV) [18.8(9.7) versus 11.7(6.0)]. These PCVCs provided reliable venous access for multiple purposes such as hyperalimentation, venous access or sampling of blood, antibiotic therapy and chemotherapy. MC and LC were also used for monitoring the central venous pressure. Most of the time, SC and MC were inserted through the superficial peripheral vein of the scalp, neck and extremities, while LC was almost approached via the EJV. The overall success rate of insertion was 92.4% (1318 /1427). No significant difference was observed among the different catheter groups [93.4% (754/807) in SC, 90.5% (383/423) in MC and 91.9% (181/197) in LC] and the different insertion sites. Within each group of PCVC, more than eighty percent of catheters were removed electively: 83.3% in SC, 89.6% in MC and 84.5% in LC. Probable catheter-related sepsis accounted for 2.7% (36/1, 318) of all PCVCs. With this study, the cost of each PCVC set is 3.0 US dollars.

CONCLUSION: This study indicates that the use of three different calibers of silastic catheter is feasible and effective for PCVC in pediatric practice.


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.


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.


Horner’s syndrome is a rare complication following insertion of a central catheter into the internal jugular vein (IJV). A 5-year-old boy, who developed unilateral Horner’s syndrome postoperatively following IJV cannulation, is presented. The Horner’s syndrome resolved completely after 5 months.


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 < or = .001) at the second dressing change, when serosanguinous drainage was heaviest, and continued significant growth (p < or = .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 = .2119). Findings suggest the use of occlusive dressings during prolonged hospitalization for tunneled CVCs does not lead to increased site infections in children over 1,800 g.

Sixty-two children undergoing cardiac surgery were surveyed for the presence of external jugular veins. When present, these were used as a route for central venous catheterisation using a 'J' wire Seldinger technique. Only 54% of attempted insertions were successful but the results support greater efficacy in older children.


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.


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.


BACKGROUND AND OBJECTIVE: National Institute for Clinical Excellence guidance states that 2D imaging ultrasound guidance should be used when inserting internal jugular venous lines in adults and children in the elective situation and should be considered in most clinical circumstances requiring central venous catheter insertion. This survey explored the availability, training and use of ultrasound devices by consultant paediatric anaesthetists in the UK.

METHODS: A questionnaire was distributed to UK members of the Association of Paediatric Anaesthetists of Great Britain and Ireland.

RESULTS: There was a response rate of 63% and of those responding, 212 (81%) inserted paediatric central venous catheters. Ultrasound devices were available in the workplace of 216 (82%) and the average number of devices available per department was two. For elective paediatric theatre cases, 26% of paediatric anaesthetists with access to an ultrasound device always used it when inserting an internal jugular central venous line. The majority (74%) of respondents had received training in the use of 2D ultrasound.

CONCLUSIONS: National Institute for Clinical Excellence guidance on the use of ultrasound locating devices for placing central venous catheters is not universally adhered to. Among the reasons for this are problems with availability of equipment, lack of training in the use of ultrasound and non-acceptance of the guidelines.


The use of a central venous catheter (CVC) has become commonplace in the care of children with a wide variety of medical and surgical problems. Complications resulting from the insertion of these catheters are well recognized and can be life-threatening. When a temporary CVC or other catheter is inserted into the central venous system it is secured to the skin with a combination of sutures and sterile dressing. This fixes the catheter in place and does not allow it to retract, thereby putting pressure on the right atrial wall via the catheter tip if it is too long. The probability of wall penetration is increased if a catheter or device is tapered at the point of contact. The purpose of this case report is to present the bowed catheter sign and to review the anatomy of the cavotricuspid isthmus, a possible predisposing factor to cardiac perforation and tamponade.

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.


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]

The widespread use of central venous catheters in the treatment of pediatric patients has caused an increased incidence of complications. A rare, but potentially fatal complication occurs when the heart is perforated by the catheter tip causing a cardiac tamponade. This perforation of the heart generally is associated with the insertion procedure, but may also occur after some time because of displacement of the catheter tip. The authors present three cases in which the placement of a central venous catheter resulted in lethal cardiac tamponade. Proper positioning of the catheter tip in the superior vena cava and a high index of suspicion are essential in preventing this serious complication. Contrast-enhanced chest x-ray after insertion of the catheter must be performed to ascertain a correct position of the tip.


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.


We describe a case of hemothorax following central venous catheter (CVC) insertion in an infant. Presumably injury occurred as a result of perforation with the dilator. Strategies to reduce the risk of complications and possible factors influencing the unsatisfactory delay in diagnosis, including the role of 'Fixation Error', are discussed.


This study describes a modified Seldinger technique for 2- and 3-French peripherally inserted central venous catheters: A device similar to that used in heart catherisation with a standard micro-introducer serving as sheath and an arterial catheter serving as inner dilator was pushed forward over a wire guide that had before been inserted via a peripheral venous catheter. With this method 2-and 3-French catheters could be safely inserted into peripheral veins of 14 paediatric patients. In conclusion successful insertion of a small peripheral venous catheter offers in most cases a possibility for the placement of a central venous line.


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.


OBJECTIVE: Because cardiovascular perforation by a central venous catheter (CVC) is a serious complication of catheterization in pediatric patients, we conducted an in vitro study of the relative potential for perforation of a standard material by the tips of multilumen pediatric catheters. Since we could not simulate vessel tissue, we hypothesized that testing catheters on a standard material would show whether catheters varied in tendency to perforate such a material and thus indicate a "relative potential for perforation."

METHODS: Each CVC protruding from a support tube was suspended in a water-filled Plexiglas chamber at a 90 degrees incident angle to a polyethylene film, which was made to bulge 6 mm into the CVC tip 120 times per minute by hydropressure. Perforation of the polyethylene film was documented on a time-based, strip-
chart recording of pressure change on the opposite side of the film. We recorded the number of pulsations required for the following catheters to perforate the polyethylene: Arrow flex tip, Cook polyurethane, Viggo hydrocath polyurethane, and Cook silicone CVCs of 4- and 5-Fr size with 2 or 3 lumens (n = 5 catheters of each type, each catheter being tested 5 times).

RESULTS: The number of pulsations to perforation ranged from 1 +/- 0.4 SD to > 7000.

CONCLUSIONS: This in vitro study of the worst-case condition (90 degrees incident angle between CVC tip and polyethylene film) indicates that pediatric multilumen CVCs vary significantly in their relative potential to perforate a standard material. We suggest that, when central venous catheterization is contemplated in children, in addition to insertion site, catheter length, and depth of insertion, the type of catheter is another variable to consider in order to minimize the chance of cardiovascular perforation by the CVC tip.


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.
To investigate the value of Doppler ultrasound scan (USS) assessment of internal jugular vein (IJV) patency after previous open central-venous cannulation (CVC), a prospective study of 66 consecutive children (median age 4.5 years; range 4 months-17 years) who had previously undergone open insertion of at least one indwelling IJV line and required further CVC for completion of therapy was undertaken. All underwent Doppler USS examination prior to surgery. Where patency of the previously cannulated vein was suggested ultrasonographically, the accuracy of this finding was confined at open surgical exploration. Initial CVCs were in situ for a median of 9 months (1 month-4 years) prior to removal. The median interval to repeated CVC was 11 months (3 weeks-45 months). In 79 Doppler USS, 70 (88.6%) veins appeared patent, 3 (4.2%) stenosed, and 6 (7.6%) obliterated. Of the 70 "USS patent" veins, 66 were explored. Patency was confirmed surgically in 59 (89.4%) and a new CVC successfully inserted. Seven (10.6%) apparently patent veins on USS were found to be obliterated at open exploration. Review of USS images in these cases suggested that enlarged collateral veins were usually responsible. Overall, successful recannulation was possible in 74.6% of all previously accessed veins. In children requiring repeated CVC, Doppler USS of neck veins is a valuable but not entirely reliable guide to the presence of underlying vessel patency and should be interpreted with caution. At least three-fourths of previously cannulated IJVs remain patent after catheter removal and can be reused for CVC.

We describe a case of chronic renal failure developing life-threatening cardiovascular collapse during the insertion of central venous catheter for hemodialysis under general anesthesia in a 7-year-old boy. With timely resuscitation, he regained his vital signs within 20 min. However, after admission to the pediatric intensive care unit, visual impairment and four limb weakness were detected on the first postoperative day. Fortunately, symptoms resolved completely with close observation, psychological support and conservative management within 72 h without sequelae.

OBJECTIVE: To develop a clinical prediction rule that would be easy to apply and be useful for predicting success or failure of peripheral intravenous line insertion in children.

METHODS: This was a prospective cohort study of children aged 0 to 21 years undergoing peripheral intravenous placement by staff nurses in a pediatric emergency department. Information on candidate predictor variables was obtained before attempting intravenous placement, and the outcome was successful on first attempt. Backward stepwise logistic regression was used to identify factors independently predictive of success. Those factors remaining in the model were used in a set of linear scores. Receiver operating characteristic curves were constructed for each model, and the areas under the curve were calculated.

RESULTS: Six hundred fifteen subjects were enrolled. Success rate for intravenous insertion on first attempt was 75%. A 4-variable proportionally weighted rule (known as the difficult intravenous access [DIVA] score) was created (3 points for prematurity, 3 for younger than 1 year, 1 for 1-2 years of age, 2 for vein not
CONCLUSIONS: A clinical prediction rule that is easy to apply and is useful for predicting success or failure of peripheral intravenous insertion has been created. If externally validated, this DIVA score can be used to predict which children will have difficult intravenous access.


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.


A 2-month-old girl with severe pneumonia required a central venous line. Femoral vein catheterisation was attempted but insertion was difficult. Pneumoperitoneum developed, which is a rare complication of femoral vein catheterisation. It is important when undertaking femoral vein catheterisation to use the correct landmarks in the femoral triangle below the inguinal ligament and an appropriate size of catheter.

BACKGROUND: In pediatric patients, several studies have been undertaken to establish central venous catheter (CVC) tip optimal depth. Assessments of catheter tip position using chest radiographs may be misleading, whereas transesophageal echocardiography (TEE) has been shown to accurately monitor catheter tip placement at the superior vena cava-right atrial (SVC-RA) junction. The aim of this study was to issue a guideline for ideal catheter insertion depth, from the right internal jugular vein (IJV) using TEE to confirm the position of the catheter tip at the SVC-RA junction.

METHODS: Over a 6-month period, we studied 60 right internal jugular vein catheterizations in infants and children undergoing surgery for congenital heart disease. Positions of CVC tips were confirmed to be at the SVC-RA junction by TEE. Distance from the skin puncture site to the SVC-RA junction, height, weight, and age were recorded.

RESULTS: Distances measured were found to be highly correlated with patient height. The following guideline allows the CVC tip to be positioned above the RA in 97.5% of patients with an accuracy of 95%: optimal depth of insertion (cm) = 1.7 + (0.07 x height) in patients whose height is between 40 and 140 cm.

CONCLUSION: The model proposed for the insertion of the CVC tip in pediatric patients could be used to prevent inadvertent catheter tip placement into the atrium.


PURPOSE: The purpose of this study is to demonstrate the efficacy, safety and long-term advantages of catheter insertion via external jugular vein (EJV) cut down for implantable central venous port in children.

MATERIALS AND METHODS: Thirty-nine central venous ports were implanted with catheter insertion via subclavian puncture in the children (group 1) with average age of 4.2 years. Forty-three were done by inserting the catheter via EJV cut down in the children (group 2) with average age of 4.8 years. Ports remained functional for a total of 11,890 patient days in group 1 and 15,743 patient days in group 2.

RESULTS: The ports were unplanned removed in 28.2% of patients (11/39) in group 1 with comparison of 7.0% of patients (3/43; p < 0.01) in group 2. Five patients (12.8% of ports implanted) suffered an infectious complication in group 1 and just one patient (2.3% of ports implanted; p < 0.01) occurred in group 2. Permanent aspiration occlusion occurred in every two patients for each group with incidence of 5.1% in group 1 and 4.7% in group 2. Catheter fracture occurred in three patients in group 1 (7.7%). One case with catheter disconnected to the port was found in group 1 (2.6%). The disconnected catheter was removed from right ventricle by interventional therapy.

CONCLUSION: Insertion of the catheter via the EJV cut down for implantable central venous port is significant better than insertion of the catheter via subclavian puncture in children.