

Prevention of Complications During Central Venous Catheterization in Children

Shamsiev Zhamshid Azamatovich¹

Unaboev Zhasur Oromovich²

Shodmanov Odiljon Tolibovich³

Samarkand State Medical University

Annotation: 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.

Key words: catheterization, children, complication, common, catheter sizing, care

According to literary data the use of central venous catheters (CVC) is burdened with a significantly higher number of complications than a peripheral venous approach. The management of these complications is difficult and may increase the morbidity and even mortality of critically sick patients. This is why there is such emphasis on the prevention of these serious complications. Strict antiseptic procedures are an absolute must when handling such catheters. To prevent catheter sepsis, as well as any contamination and colonization of a central venous catheter, it is essential to insert such a catheter under aseptic conditions; it calls for handling in a sterile manner and the same applies to all tubing and other connecting systems and to the preparation of infusion liquids and drugs. Moreover, the site of insertion has to be correctly selected and the catheter left in place only for the absolutely necessary time. Most effective in the prevention of catheter infections are the so-called maximum barrier measures applied to the insertion of CVCs.

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)

¹ Doctor of Medical Sciences, Professor, Head

Department of Pediatric Surgery and Pediatric Anesthesiology and Reanimatology, Faculty of Postgraduate Education

² Assistant at the Department of Pediatric Surgery and Anesthesiology and Reanimatology, Faculty of Postgraduate Education

³ Doctor - resident of the department of pediatric anesthesiology and resuscitation of a specialized children's surgical clinic



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). 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.

Central venous catheterization is a common procedure in pediatric patients for various medical indications, such as administration of medications, fluids, parenteral nutrition, and monitoring of hemodynamic parameters. However, this procedure can be associated with several complications, especially in children, due to their smaller size and unique anatomical considerations. Here are some strategies to prevent complications during central venous catheterization in children:

1. Proper Patient Selection: Careful patient selection is crucial to minimize complications during central venous catheterization. Consider the child's age, size, medical condition, and coagulation status before proceeding with the procedure.
2. Use of Ultrasound Guidance: Utilizing ultrasound guidance during central venous catheterization can improve the accuracy of catheter placement, reduce the risk of complications such as arterial puncture or pneumothorax, and increase the success rate of the procedure.
3. Strict Aseptic Technique: Maintaining strict aseptic technique during catheter insertion and maintenance is essential to prevent catheter-related infections, which are a significant source of morbidity in pediatric patients. Adherence to hand hygiene, sterile draping, and proper skin preparation are critical.
4. Optimal Site Selection: Choosing the appropriate site for central venous catheterization in children is essential to minimize complications. Consider factors such as the child's age, medical condition, anticipated duration of catheter use, and risk of infection when selecting the insertion site (e.g., internal jugular, subclavian, or femoral vein).
5. Proper Catheter Sizing: Selecting the correct catheter size based on the child's age, weight, and intended use is important to prevent complications such as catheter malposition, thrombosis, and vessel injury. Avoid using oversized catheters that can increase the risk of mechanical complications.
6. Regular Catheter Care and Maintenance: Implementing protocols for routine catheter care, dressing changes, and monitoring for signs of infection or malfunction can help prevent catheter-related



complications in pediatric patients. Educate caregivers on proper care techniques and signs of potential issues.

7. Prompt Removal of Unnecessary Catheters: Timely removal of central venous catheters that are no longer needed can reduce the risk of complications such as catheter-related bloodstream infections and thrombosis. Develop criteria for catheter removal and adhere to them consistently.

8. Continuous Training and Education: Ensure that healthcare providers performing central venous catheterization in children receive adequate training and ongoing education on best practices, guidelines, and advancements in catheter insertion techniques to enhance patient safety and outcomes.

By implementing these strategies and emphasizing a multidisciplinary approach involving pediatric specialists, nurses, and caregivers, healthcare providers can effectively prevent complications during central venous catheterization in children and optimize the quality of care provided to pediatric patients requiring vascular access for medical management.

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