The Frequency, Severity, and Risk Factors of Hickman Catheter-Related Complications in Pediatric Acute Leukemia Patients: A Single-Center Experience from Bosnia and Herzegovina

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Introduction:

Pediatric acute leukemia is one of the most common childhood cancers, often requiring chemotherapy and other treatments that necessitate long-term central venous access.

This study seeks to evaluate the frequency and severity of Hickman catheter-related complications and identify significant risk factors in pediatric acute leukemia patients.

Patients and Methods:

Study Design: In this retrospective cohort study all Hickman catheters were inserted by the Department of Pediatric Surgery at KCUS, and included 88 pediatric patients between January 2019 and July 2024

Of these, 40 patients (45.5%) were diagnosed with ALL, and 28 patients (31.8%) with AML.

Data Collection:

Data were retrospectively collected from medical records to analyze Hickman catheter-related complications, including mechanical, infectious, and thrombotic complications. The median follow-up period and total catheter days were recorded for each patient.

Definitions of CVC-Associated Complications:

- Mechanical Complications:.
- Infectious Complications:
- Thrombotic Complications:.

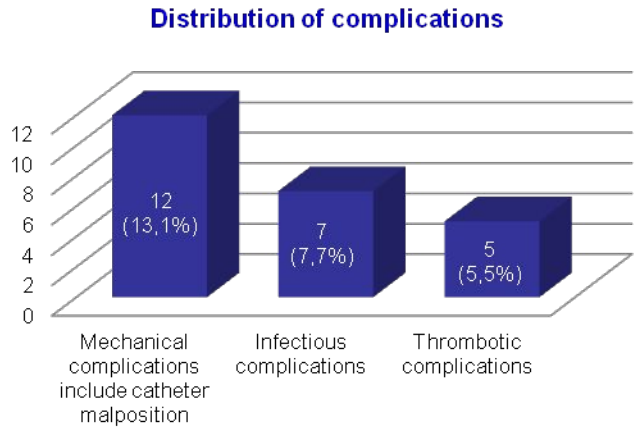
Results:

Catheter Insertion and Follow-Up:

A total of 91 Hickman CVCs were inserted in 88 patients, with a median follow-up of 190 days (95% CI: 160–212), resulting in a total of 12,644 catheter days.

Complications:

Complications occurred in 24 patients (27.3%), distributed as follows:



The incidence rates of complications per 1000 catheter days were:

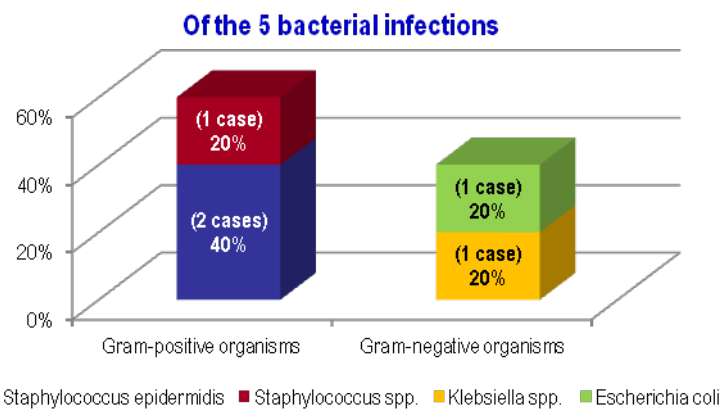
- Mechanical: 0.8 per 1000 catheter days
- Infectious: 0.48 per 1000 catheter days
- Thrombotic: 0.08 per 1000 catheter days

Children with AML experienced a higher complication rate (1.59 per 1000 catheter days) compared to those with ALL (1.22 per 1000 catheter days).

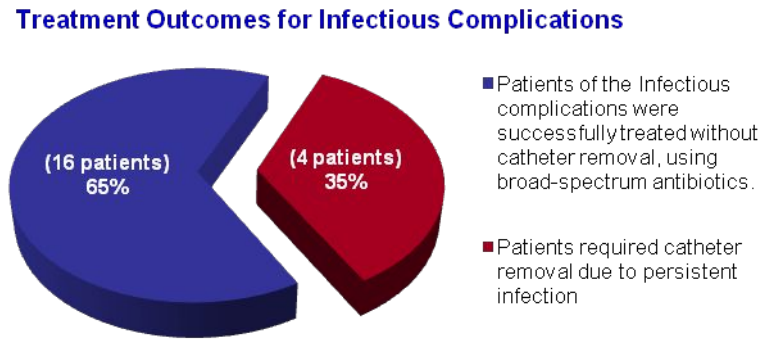
Infectious Complications:

Among the 7 cases of infectious complications:

- Vascular circulation infections: 7 cases (100%)
- Tunnel site infections: 2 cases (28.6%)
- Exit site infections: 2 cases (28.6%)



Fungal infections were found in 15% of catheter cultures (2 out of 7 cases), with the majority caused by Candidemia.



In children with infectious complications, the median absolute neutrophil count (ANC) at the time of catheter insertion was significantly lower (0.57 K/µL vs. 1.06 K/µL, $P < 0.01$).

Vascular Complications:

Five cases (5.5%) of thrombotic complications were identified, mostly involving upper extremity venous thrombosis. All cases were treated with recombinant tissue plasminogen activator, enoxaparin, and heparin; However, all catheters were removed due to unresponsiveness to anticoagulation therapy.

DISCUSSION:

Complication Rates and Types:

Overall, 27.3% of the pediatric patients in our cohort experienced Hickman catheter-related complications, with a total of 24 complications recorded. Mechanical complications were the most common (13.1%), followed by infectious complications (7.7%) and thrombotic complications (5.5%). When comparing these results to prior studies, our mechanical complication rate is consistent with published data, which reports rates ranging from 10% to 30% in pediatric populations with central venous catheters (CVCs). Infectious complication rates were also within the range observed in other studies, where rates generally fall between 5% and 25%, depending on the study population and infection control measures.

Thrombotic complications, though less frequent (5.5%), present significant risks, especially in pediatric leukemia patients who may already have a hypercoagulable state due to their disease and treatment regimens. Our thrombotic complication rate is similar to other pediatric oncology studies, where rates are typically reported between 3% and 10%.

Risk Factors for Complications:

A notable finding in this study was the higher incidence of complications in children with acute myeloid leukemia (AML) compared to those with acute lymphoblastic leukemia (ALL). AML patients experienced 1.59 complications per 1000 catheter days, while ALL patients experienced 1.22 per 1000 catheter days. This trend is consistent with the literature, where AML patients often have more severe neutropenia, longer treatment durations, and increased susceptibility to infections. The higher complication rate in AML patients may be due to the aggressive nature of the disease, intensive chemotherapy protocols, and prolonged immunosuppression.

Furthermore, infectious complications were more likely to occur in children with lower absolute neutrophil counts (ANC) at the time of catheter insertion, which mirrors findings from other studies that have identified neutropenia as a significant risk factor for catheter-related infections. In our study, the median ANC at catheter insertion for patients with infectious complications was 0.57 K/µL, significantly lower than the ANC of patients without infections (1.06 K/µL).

Management of Infectious Complications:

Infectious complications, primarily vascular circulation infections, were successfully managed without catheter removal in 65% of cases, reflecting effective infection control practices and timely antibiotic intervention

Conclusion:

Hickman catheter-related complications in pediatric patients with acute leukemia present significant challenges to treatment management. In our study, 27.3% of patients experienced complications, with mechanical complications being the most prevalent, followed by infectious and thrombotic complications. Notably, patients with acute myeloid leukemia (AML) faced a higher incidence of complications, particularly infections, likely due to their more severe underlying conditions and intensive treatment regimens. While many infectious complications were successfully managed without catheter removal, a notable percentage still necessitated intervention, underscoring the importance of effective infection control measures in clinical practice.

Future studies should focus on optimizing catheter care protocols, investigating prophylactic measures for high-risk patients, and enhancing management strategies for catheter-related infections and thrombosis. Improving our understanding of these factors will ultimately lead to better patient outcomes and more effective treatment pathways for pediatric patients with acute leukemia.