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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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Abstract

Objectives: This study aimed to evaluate the frequency, severity, and risk factors associated with Hickman catheter-related complications in pediatric patients with acute leukemia at a tertiary pediatric care center in Bosnia and Herzegovina.

Patients and methods: This retrospective study was conducted with 88 pediatric patients (54 males, 34 females; mean age: 5.9±4.6 years; range, 0 to 18 years) diagnosed with acute leukemia who had Hickman catheters inserted between January 2019 and July 2024. Data on complication rates, types, and outcomes were collected.

Results: A total of 91 Hickman central venous catheters were inserted in 88 children. The cohort included 60 (68%) children with acute lymphoblastic leukemia (ALL) and 28 (32%) children with acute myeloid leukemia 14 (AML). The median follow-up was 190 days (95% confidence interval, 160-212), spanning 12,644 catheter days. Complications occurred in 24 (27.3%) patients. Twelve (13.1%) of these were mechanical, seven (7.7%) were infectious, and five (5.5%) were thrombotic; the incidence rates were 0.8, 0.48, and 0.08 per 1,000 catheter days, respectively. Notably, AML patients had a higher complication rate (1.59 per 1,000 catheter days) compared to ALL patients (1.22 per 1,000 catheter days).

Conclusion: Hickman catheter-related complications in pediatric leukemia patients are relatively common, with AML patients facing a higher risk. Understanding these complications can help improve patient management and outcomes.

Keywords: Catheter-related infections and thrombosis, Hickman catheter related complications, pediatric acute leukemia patients.

Pediatric acute leukemia is one of the most common childhood cancers, often requiring intensive chemotherapy and other treatments that necessitate long-term central venous access.[1] Hickman catheters are frequently used for chemotherapy administration, blood transfusions, and supportive care due to their reliability and ease of use.[2] However, these devices can be associated with various complications, including mechanical, infectious, and thrombotic issues, which may impact the course of treatment and patient outcomes.[3,4]

Previous studies have reported complication rates ranging from 10 to 30% in pediatric populations with central venous catheters (CVCs), highlighting the need for ongoing evaluation and improvement of catheter management protocols.[5] Identifying the frequency, severity, and risk factors of Hickman catheter-related complications is essential for developing strategies to minimize these risks and enhance patient care.[6]

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This study aimed to evaluate the frequency and severity of Hickman catheter-related complications and identify significant risk factors in pediatric acute leukemia patients at a single tertiary care center in Bosnia and Herzegovina.

PATIENTS AND METHODS

This retrospective cohort study was conducted at the pediatric surgery clinic of the Clinical Center University of Sarajevo between January 2019 and July 2024. All Hickman catheters were inserted by the Department of Pediatric Surgery at KCUS (Department of Pediatric surgery at Clinical center University of Sarajevo) following standardized insertion protocols to minimize complications. The study included 88 pediatric patients (54 males, 34 females; mean age: 5.9±4.6 years; range, 0 to 18 years) diagnosed with acute leukemia. 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. Complications were categorized and defined according to standardized criteria to ensure consistency with previous research. A written informed consent was obtained from the parents and/or legal guardians of the patients. As the study is retrospective in nature, the Ethics Committee of the institution determined that obtaining informed consent was not necessary. The study was conducted in accordance with the principles of the Declaration of Helsinki.

The definitions of CVC-associated complications were outlined in this paragraph. Mechanical complications included pneumothorax, hemothorax, or arterial puncture, along with malposition requiring catheter adjustment, removal, or reinsertion. Infectious complications included bloodstream infections and CVC-related bloodstream infections, which were diagnosed based on blood cultures taken from both peripheral and catheter lumens. Tunnel and exit site infections were documented based on tenderness, erythema, or purulent drainage without concurrent bloodstream infection. Thrombotic complications were diagnosed through Doppler ultrasound in patients with symptoms of venous thrombosis, such as limb pain or swelling.

RESULTS

Of the patients, 60 (68%) patients were diagnosed with ALL, and 28 (32%) patients were diagnosed with acute myeloid leukemia (AML). A total of 91 Hickman CVCs were inserted in 88 patients, with a median follow-up of 190 days (95% confidence interval: 160-212), resulting in a total of 12,644 catheter days. This duration aligns with previous studies that report extended catheter use in pediatric leukemia patients due to the prolonged nature of chemotherapy.[7] Complications occurred in 24 (27.3%) patients. Mechanical complications included catheter malposition in 12 (13.1%) patients, infectious complications in seven (7.7%) patients, and thrombotic complications in five (5.5%) patients. The incidence rates of complications per 1,000 catheter days were 0.8 for mechanical, 0.48 for infectious, and 0.08 for thrombotic complications.

Children with AML experienced a higher complication rate (1.59 per 1,000 catheter days) compared to those with ALL (1.22 per 1,000 catheter days). This finding is consistent with literature indicating that AML patients often undergo more intensive treatment regimens, which may increase the risk of complications.[8]

Among the seven patients with infectious complications, vascular circulation infections were observed in seven (100%), tunnel site infections were observed in two (28.6%), and exit site infections were observed in two (28.6%) patients. Of the five bacterial infections, gram-positive organisms were isolated in three (60%) cases, *Staphylococcus epidermidis* in two (40%), and *Staphylococcus spp.* in one (20%). Gram-negative organisms were isolated in two (40%) cases, *Klebsiella spp.* in one (20%), and *Escherichia coli* in one (20%). Fungal infections were found in 15% of catheter cultures (two out of seven cases), with the majority caused by Candidemia. These microbial distributions are in line with previous studies that highlight Staphylococcus species as the most common pathogens in CVC-related infections.[9-11]

Sixty-five percent (n=16) of the infectious complications were successfully treated without catheter removal using broad-spectrum antibiotics. Thirty-five percent (n=4) required catheter removal due to persistent infection.

TABLE 1
Sample data (n=88)

Category	Metric	n	%	Mean±SD	Median	95% CI
Study population	Mean age (year)			5.9±4.6		
	Sex distribution Male Female	 54 34				
	Leukemia type ALL AML	 60 28	 68 32			
	Total Hickman catheters	91				
	Total catheter days				12,644	
Follow-up	Median follow-up (day)				190	160-212
Complications	Total complications	24	27.3			
	Mechanical complications	12	13.1			
	Infectious complications	7	7.7			
	Thrombotic complications	5	5.5			
Microbial profile	Gram-positive isolates	3	60			
	• *Staphylococcus epidermidis*	2	40			
	• *Staphylococcus spp.*	1	20			
	Gram-negative isolates	2	40			
	• *Klebsiella spp.*	1	20			
	• *Escherichia coli*	1	20			
	Fungal infections					
	• Candidemia (majority)	2	15			

SD: Standard deviation; ALL: Acute lymphoblastic leukemia; AML: Acute myeloid leukemia.

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). This supports findings from other research indicating that neutropenia is a significant risk factor for catheter-related infections.[9]

Five (5.5%) cases of thrombotic complications were identified, mostly involving upper extremity venous thrombosis. All patients were treated with recombinant tissue plasminogen activator, enoxaparin, and heparin; however, all catheters were removed due to unresponsiveness to anticoagulation therapy. This high rate of catheter removal despite anticoagulation is comparable to other studies where thrombotic complications often necessitate catheter removal to prevent further complications.[10]

DISCUSSION

The results of this study offer valuable insights into the frequency, severity, and risk factors associated with Hickman catheter-related complications in pediatric patients with acute leukemia at a single center in Bosnia and Herzegovina. This study highlights key findings regarding mechanical, infectious, and thrombotic complications, contributing to the understanding of these challenges in clinical practice.

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%). The mechanical complication rates in our

study are consistent with published data, which reports rates ranging from 10 to 30% in pediatric populations with CVCs.[5,11] 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.[3,12]

Thrombotic complications, although less frequent (5.5%), present significant risks, particularly in pediatric leukemia patients who may already have a hypercoagulable state due to their disease and treatment regimens.[13] Our thrombotic complication rate is similar to other pediatric oncology studies, where rates are typically reported between 3% and 10%.[14]

A notable finding in this study was the higher incidence of complications in children with AML compared to those with ALL. Patients with AML experienced 1.59 complications per 1,000 catheter days, while ALL patients experienced 1.22 complications per 1,000 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.[8,15] The higher complication rate in AML patients may be due to the aggressive nature of the disease, intensive chemotherapy protocols, and prolonged immunosuppression.[16]

Furthermore, infectious complications were more likely to occur in children with lower ANCs 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.[9,17] 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). This underscores the importance of close monitoring and preventive strategies for patients with severe neutropenia.[18]

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. This aligns with other studies that emphasize the role of prompt antibiotic therapy in managing CVC-related infections while preserving the catheter when possible.[19]

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 AML faced a higher incidence of complications, particularly infections, likely due to their more severe underlying conditions and intensive treatment regimens.

In conclusion, the findings highlight the critical role of ANCs in predicting the risk of infectious complications, emphasizing the need for vigilant monitoring and tailored preventive strategies in patients with severe neutropenia. 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. Given the complexities associated with Hickman catheters in this vulnerable population, further research is warranted to explore strategies for reducing complication rates. 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.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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