Outcome and associated factors in critically ill cancer patients admitted to the pediatric intensive care unit

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ABSTRACT

Background: Despite advances in pediatric oncology, critically ill children with cancer still require PICU admission and face high mortality.

Objective: To assess outcomes and identify mortality-associated factors in pediatric oncology patients admitted to the PICU.

Methods: A five-year retrospective study (2020–2025) was conducted in the PICU of Farhat Hached Hospital, Sousse. Children aged 0–15 years with confirmed cancer were included. Clinical and biological data were analyzed using appropriate statistical tests.

Results: Thirty-eight patients (3.7% of admissions) were included; 60.5% had hematological malignancies, mainly acute lymphoblastic leukemia (44.7%). The main admission reasons were respiratory distress (39.4%) and hemodynamic instability (34.2%). Mechanical ventilation was required in 52.6% and vasoactive support in 26.3%. PICU mortality was 36.8%. Mortality was significantly associated with delayed PICU transfer (>24 h), multiple organ dysfunction, mechanical ventilation, and vasoactive drug use (< 0.001).

Conclusion: Mortality remains high in critically ill pediatric oncology patients, particularly in cases of organ failure or delayed PICU admission. Early detection and timely transfer to the PICU are essential to improve outcomes.

Keywords: Pediatric intensive care, prognosis, mortality, cancer, child.

INTRODUCTION

Over the past few decades, considerable progress in oncology has markedly improved the overall survival of patients with cancer, with cure rates exceeding 80% for certain tumour types (1-3). However, despite these advances, a significant proportion of cancer patients still experience acute, potentially life-threatening complications that require admission to the pediatric intensive care unit (PICU) (2) . These complications may arise from the underlying malignancy itself, from anticancer treatments such as chemotherapy, immunotherapy, or stem cell transplantation, or from secondary infections occurring in the context of treatment-induced immunosuppression. Understanding the outcomes and identifying associated factors in critically ill cancer patients admitted to the PICU are therefore essential to optimize clinical management, guide therapeutic decisions, and improve prognosis. The aim of this study is to evaluate the outcomes of critically ill cancer patients admitted to the PICU and to identify the clinical and biological factors associated with their prognosis.

PATIENTS AND METHODS

This study is a retrospective, descriptive, cross-sectional analysis conducted over a five-year period, from 31 January 2020 to 31 January 2025, in the PICU of the Paediatrics Department at Farhat Hached Hospital in Sousse. The study included children aged 0–15 years with a confirmed cancer diagnosis who required at least one admission to the pediatric intensive care unit during their illness. Children were excluded if their medical records were incomplete or if key clinical or biological data were missing (Figure1).

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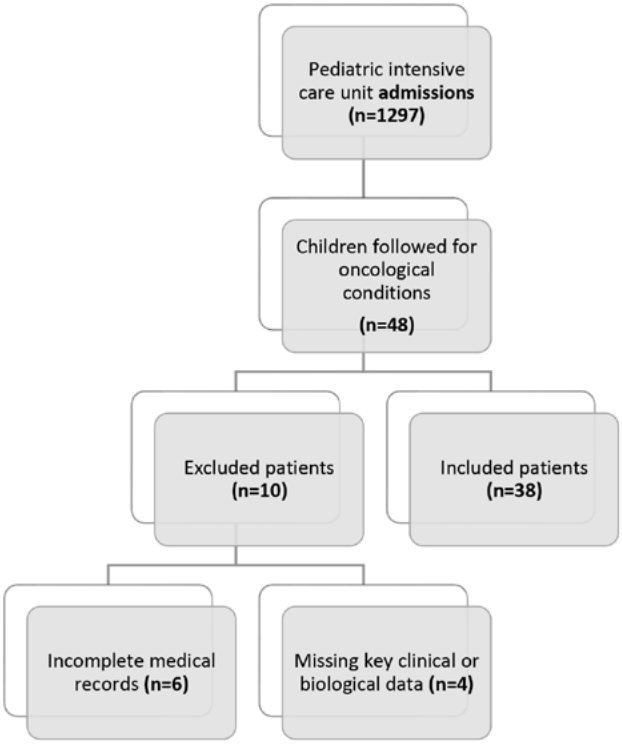
Figure 1 : Flowchart of Patient Selection in the Pediatric Intensive Care Unit



Of the 48 children initially admitted, 38 fulfilled all inclusion criteria and were included in the final analysis.

The study unit was the patient. For patients admitted to the PICU on several occasions at different stages of their disease, only the last hospitalization was included in the analysis. Clinical, biological, and therapeutic data were collected to evaluate outcomes and to identify potential prognostic factors influencing survival and recovery.

Admission to the PICU followed institutional protocols and was based on clinical severity, the need for organ support, or close monitoring. Organ dysfunction was assessed using the

Pediatric Logistic Organ Dysfunction-2 (PELOD-2) score and defined as a PELOD-2 score > 0 for the corresponding organ system. Multiple organ dysfunction syndrome (MODS) was defined as the simultaneous presence of dysfunction in two or more organ systems, either at PICU admission or during the PICU stay (4). Neutropenia was defined as an absolute neutrophil count < 500 cells/mm³, or < 1,000 cells/mm³ with a predicted decrease below 500 cells/mm³ (5), and biological inflammatory syndrome was defined by the presence of at least one elevated inflammatory marker, including C-reactive protein (CRP) > 90 mg/L (6) and/or procalcitonin (PCT) > 2 ng/mL.(7)

Categorical variables were compared between survivors and non-survivors using statistical tests appropriate for the sample size. The Chi-square test was used when all cells had sufficient counts, while the Fisher's exact test was applied for variables with small counts or cells containing zero events. Odds ratios (OR) with 95% confidence intervals (CI) were calculated when possible. For variables with zero events in one category, the OR and CI were not calculated, and the p-value was obtained solely using Fisher's exact test. All statistical analyses were performed using SPSS version 25. A p-value < 0.05 was considered statistically significant.

RESULTS

During the study period, 48 children were admitted to our department, of whom 38 met the inclusion criteria, representing 3.7% of all paediatric intensive care admissions. The patients were referred mainly from the haematology department (71%), followed by paediatric oncology (16%) and general paediatrics (13%).

At the time of tumour diagnosis, the mean age of the study population was 4.2 ± 3.7 years, while the median age at admission to intensive care was 6.5 years. The average delay between the onset of symptoms and admission was 2.2 ± 1.2 days, and the mean hospital stay lasted 11.6 ± 14 days.

Most patients were being managed for haematological malignancies (60.5%, n=23), predominantly acute lymphoblastic leukaemia (ALL) (44.7%, n=17), followed by acute myeloid leukaemia (AML) (15.8%) and lymphoma (5.3%, n=2). The remaining cases included brain tumours (7.8%, n=3) and solid tumours (26.2%), such as neuroblastoma (18.4%, n=7), masseteric rhabdomyosarcoma (2.6%, n=1), hepatoblastoma (2.6%, n=1) and Ewing's sarcoma (2.6%, n=1).

Treatment modalities consisted mainly of chemotherapy alone in 84.6% (n=32), with combined chemo-radiotherapy in 7.6% (n=3), and surgical intervention in one case.

The primary reason for transfer to intensive care was respiratory distress (39.4%, n=15), followed by haemodynamic instability (34.2%, n=13), mainly due to hypovolaemic or septic shock. Tumour lysis syndrome (18,4%, n=7) represented the main metabolic complication, whereas neurological disorders (18.4%, n=7) including seizures (15.6%) and intracranial hypertension (2.6%)—were also reported. Acute pancreatitis occurred in one patient.

Upon admission, 53% of the children presented with at least one organ failure, and MODS was observed in 36.8% of cases (see Table 1 for main clinical features).

Table 1 : Factors Associated with the Risk of Death in the PICU

Variables	Survived (N=24)	Deceased (N=14)	OR [95% CI]	p-value
Length of stay > 7 days	19	9	0.47 [0.11 – 2.07]	0.449
Transfer delay > 24 h	6	12	16.7 [3.1 – 83.3]	**0.001**
Solid tumor	8	6	1.5 [0.39 – 5.88]	0.729
MODS	1	13	-	**<0.001**
Neutropenia	3	2	1.17 [0.17 – 7.69]	1.000
Biological inflammatory syndrome	18	12	2.00 [0.34 – 11.1]	0.684
Respiratory failure	10	12	8.33 [1.54 – 45.5]	0.061
Hemodynamic failure	3	10	16.7 [3.2 – 87.0]	**<0.001**
Tumor lysis syndrome	6	1	0.23 [0.02 – 2.18]	0.227
Neurological failure	6	3	0.90 [0.18 – 4.35]	1.000
Hematologic failure	12	6	0.75 [0.20 – 2.85]	0.745
Invasive mechanical ventilation	6	14	-	**<0.001**
Non-invasive ventilation	5	0	-	0.137
Vasoactive drugs	1	9	-	**<0.001**
Blood transfusions	12	12	0.44 [0.23 – 0.81]	0.093

MODS : Multiple organ dysfunction syndrome

Biologically, neutropenia was detected in 13.1% (n=5) of the patients, three of whom also exhibited bone marrow failure affecting the erythroid and platelet cell lines. Laboratory-confirmed tumour lysis syndrome occurred in seven patients. The microbiological findings revealed mainly multidrug-resistant Escherichia coli and Corynebacterium spp. In three of the seven positive cases, a multiresistant bacterial profile was found—two with Serratia marcescens and one with Klebsiella pneumoniae. Other cultures were negative or contaminated.

In terms of management, oxygen therapy was provided using various methods, with mechanical ventilation required in 20 of 38 patients. Vasoactive drugs were used in 10 cases. Almost all patients received empirical broad-spectrum antibiotics, later adjusted according to culture results. Two children (5.2%) underwent neurosurgical procedures—one decompressive craniectomy and one ventricular shunt.

The mortality rate in intensive care was 36.8%, with an average time to death of 4.4 ± 3.1 days post-admission. Among patients with haematological malignancies, 8 died, while 6 deaths occurred among those with solid tumours. , using the Pediatric Risk of Mortality (PRISM) score calculated individually for each patient, the predicted mortality rate was 7.6% [0.5 to 32.6%]; this figure was only 11.7% [2 to 32.6%] when calculated solely on the basis of patients who died. The observed mortality rate in our cohort was 36.8%, while the average mortality predicted by PRISM was only 7.6%, suggesting a significant underestimation of the actual risk.

Analysis of prognostic factors revealed that a transfer delay exceeding 24 hours (defined as the time elapsed between the first documented occurrence of organ dysfunction and admission to the PICU) was significantly associated with higher mortality (p = 0.001). Similarly, MODS at admission (p = 0.001), the requirement for mechanical ventilation (p<0.001), and the use of vasoactive agents (p<0.001) were strong predictors of death. These findings highlight that disease severity at admission and the need for organ support were key determinants of outcome.

Conversely, no significant correlation was observed between mortality and variables such as hospital stay >7 days (p = 0.449), use of non-invasive ventilation (p = 0.137), neutropenia (p = 0.1), or presence of an inflammatory syndrome at admission (p = 0.684).

DISCUSSION :

In our series, the children had a median age of 6.5 years. The predominance of this age group has been observed in several studies, which report an increased frequency of intensive care admissions among children under 7 years old, due to their physiological vulnerability, limited functional reserve, and the aggressiveness of oncological treatments in this age group (8). A slight male predominance was also observed, a phenomenon regularly described in the epidemiology of pediatric cancers, particularly in leukemias and lymphomas (9).

On the oncological level, malignant hematological diseases, notably ALL, were the most represented among patients admitted to intensive care, followed by intra-abdominal solid tumors and central nervous system tumors. This profile is consistent with the literature, which indicates that leukemias are not only the most frequent pediatric cancers but also those associated with the most severe acute complications, such as febrile neutropenia, sepsis, or life-threatening conditions, particularly respiratory, requiring intensive care management (10). The intensive care mortality rate in our study was 36.8%. A recent meta-analysis of pediatric oncology patients admitted to intensive care units reported a pooled PICU mortality of approximately 27.8 % (95 % CI 23.7–31.9).The same study showed strong associations between mechanical ventilation, inotropic/vasoactive support, continuous renal replacement therapy, and mortality (11). In low- and middle-income countries, another systematic review found a PICU mortality around 30.3 % (95 % CI 21.7–40.6 %) and identified mechanical ventilation and vasoactive infusions as significantly associated with higher mortality risk (12).

In our study, observed mortality (36.8%) was substantially higher than PRISM-predicted mortality (7.6%). While PRISM is a validated tool for risk stratification in pediatric intensive care, its predictive performance may vary across populations and settings, and calibration issues with PRISM have been reported in different cohorts (17). Delays in transfer and late presentation to the PICU likely contributed to higher mortality, as many patients arrived at an advanced stage of critical illness. Differences in case severity may not be fully captured by PRISM, particularly when variables are collected only at admission or some data are missing. The characteristics of the patient population, including complex oncology cases, and systemic constraints such as resource availability or reference care models may also influence outcomes. Potential variations in the structure or delivery of care could further affect mortality, underscoring the multifactorial nature of outcomes in this setting. Taken together, the gap between predicted and observed mortality likely reflects a combination of delayed presentation, case complexity, limitations in predictive modeling, and systemic factors, rather than a limitation of PRISM alone.

Among the deceased patients, 91.6% presented with at least two organ failures at admission, particularly respiratory and hemodynamic. Conversely, children who were transferred early and required only non-invasive support or close monitoring had a favorable outcome. These results emphasize the importance of early transfer to intensive care, before the onset of shock, to improve prognosis (13-15). The prognosis is particularly poor for patients with acute leukemia in the induction phase or in relapse, or for those requiring invasive ventilation (16). For instance, vasoactive support has been identified in other studies as an independent risk factor for PICU mortality in oncology patients (11). Moreover, the association of ventilation and inotropes with death has been repeatedly confirmed (12).

The absence of a significant relationship between certain parameters—such as length of stay over seven days, neutropenia, use of non-invasive ventilation, and inflammatory syndrome at admission—and mortality suggests that patient outcomes in this population are primarily
determined by the severity of illness at presentation rather than by treatment duration or initial laboratory findings. It is also possible that the limited sample size reduced the statistical power to detect weaker associations.

Our results suggest several actionable priorities. Improving early detection of deterioration on wards, reducing transfer delays, and ensuring rapid escalation to intensive care may reduce mortality. Developing institutional risk-scoring or trigger protocols in haematology / oncology wards might help. Additionally, further research is needed in comparable settings to compare outcomes, to stratify according to treatment phase (induction chemotherapy, post-transplant, etc.), and to validate predictive factors such as ventilation requirement, vasoactive support, and transfer timing.

CONCLUSION :

This study highlights the significant burden of oncologic and hematologic emergencies among children admitted to intensive care. The findings show that mortality remains high, particularly in patients presenting with multiple organ dysfunction, delayed transfer, or the need for invasive organ support such as mechanical ventilation and vasoactive drugs. Early recognition of clinical deterioration, prompt transfer to intensive care, and timely initiation of supportive therapy appear crucial to improving outcomes in this vulnerable population. Strengthening collaboration between oncology, hematology, and intensive care teams may help reduce delays in management and enhance survival rates among pediatric patients with cancer-related critical illnesses.

Ethics and Conflict of Interest We confirm that all data were anonymized and handled in accordance with ethical standards. The authors declare that they have no conflicts of interest.

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