

Clinical Characteristics and Outcome of Pediatric Oncology ICU Admissions

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Abstract:

Pediatric oncology patients admitted to the pediatric intensive care unit (PICU) represent a high-risk group due to the combined effects of malignancy, immunosuppression, and treatment-related complications. These patients frequently develop life-threatening conditions such as sepsis, respiratory failure, and multiorgan dysfunction, necessitating advanced critical care support. This review highlights the clinical characteristics, common indications for PICU admission, and major prognostic factors affecting Outcome in pediatric oncology patients. Evidence from recent studies indicates that mortality is closely related to the severity of acute illness, number of failed organ systems, and the need for organ support, including mechanical ventilation and vasopressors. Early PICU admission and timely interventions significantly improve survival, whereas delayed referral is associated with worse Outcome. Additionally, conventional scoring systems have limited predictive value in this population, emphasizing the need for oncology-specific prognostic tools. Advances in supportive care, multidisciplinary management, and risk stratification have contributed to improved short-term Outcome.

Keywords: Pediatric oncology; PICU; critical illness; mortality; organ failure; sepsis; prognosis; critical care.

Introduction:

The clinical profile and Outcome of oncology patients requiring critical care admission have garnered increasing attention in recent years due to the complex interplay between cancer-related complications, comorbidities, and critical illness. As the incidence of cancer continues to rise globally, so does the likelihood of oncology patients require ICU admission for management of acute medical conditions, treatment-related complications, or end-of-life care. Understanding the unique clinical characteristics and prognostic factors associated with critical illness in this patient population is essential for optimizing care delivery and improving patient Outcome (**Zampieri et al., 2021**).

Oncology patients presenting to the ICU often exhibit distinct clinical profiles characterized by a high burden of comorbidities, compromised immune function, and susceptibility to treatment-related toxicities. Common indications for critical care admission include sepsis, respiratory failure, neutropenic fever, and acute organ dysfunction, reflecting the diverse spectrum of medical emergencies encountered in this population. Additionally, the presence of advanced-stage cancer, performance status, and the extent of organ dysfunction are important prognostic determinants that influence clinical decision-making and treatment Outcome (**Aljizani et al., 2025**).

The management of critically ill oncology patients poses unique challenges due to the need for tailored treatment approaches that balance the risks of cancer progression, treatment-related toxicities, and ICU-associated complications. Multidisciplinary collaboration between oncologists, intensivists, palliative care specialists, and allied healthcare professionals is essential for developing personalized care plans that address the complex needs of these patients. Furthermore, advanced supportive care measures, such as early goal-directed therapy,

antimicrobial stewardship, and symptom management, are crucial in optimizing Outcome and enhancing quality of life (Azoulay et al., 2017).

Despite advances in cancer treatment and critical care medicine, oncology patients requiring ICU admission continue to experience high rates of morbidity and mortality. Prognostication in this population is challenging due to the heterogeneity of cancer types, disease trajectories, and treatment responses. Predictive models incorporating clinical, laboratory, and imaging parameters have been developed to assist clinicians in risk stratification and treatment decision-making (Zampieri et al., 2021).

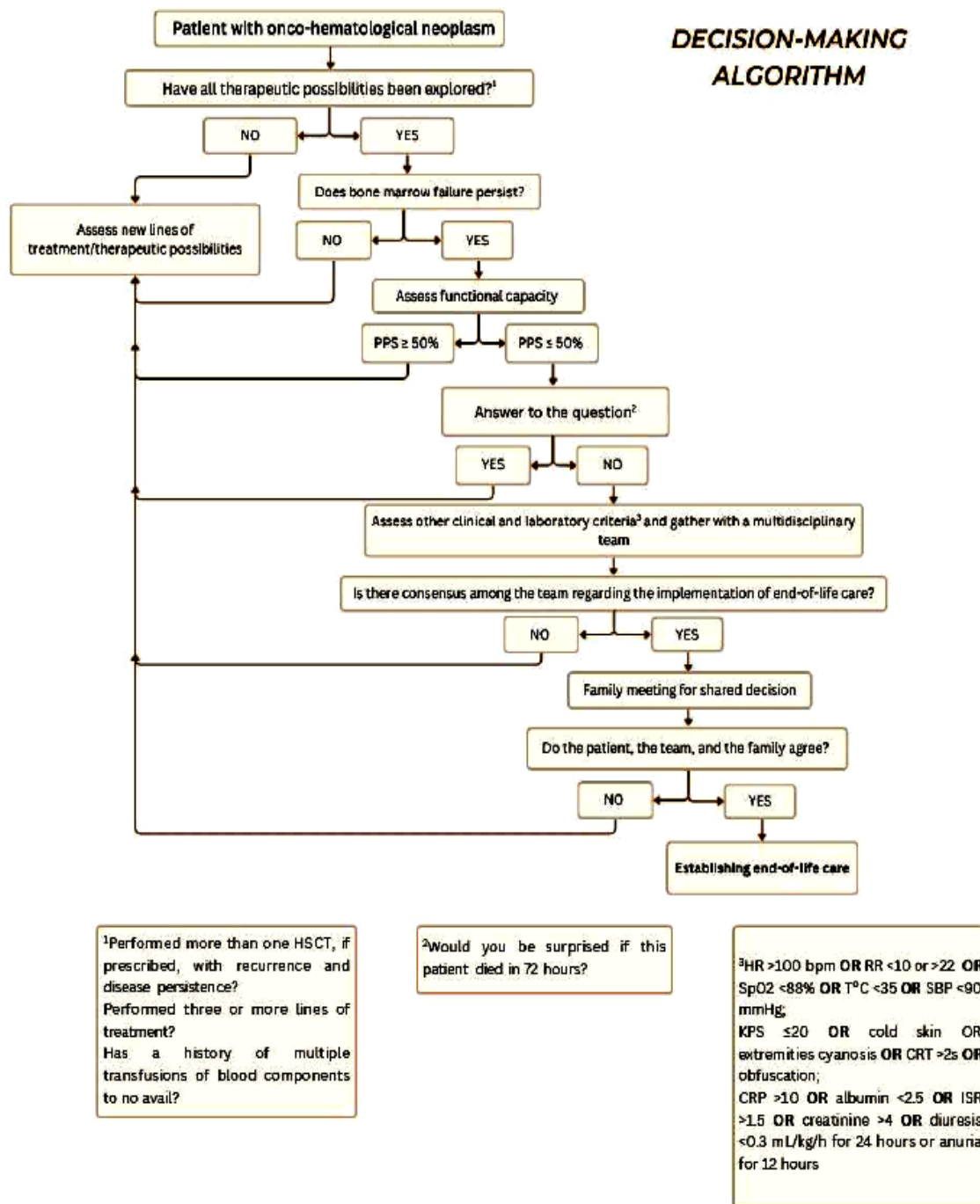


Figure (1): Proposal for a decision-making algorithm of end of life care. HSCT: hematopoietic stem cell transplant; PPS: Palliative Performance Scale; HR: heart rate; RR: respiratory rate; SpO2: blood oxygen saturation; T°C: temperature; BP: blood pressure; KPS: Karnofsky Performance Status; CRT: capillary refill time;

CRP: C-reactive protein; and ISR: international standardized relationship (assesses liver function) (**Zampieri et al., 2021**).

Zampieri et al. (2021) evaluated the outcome of pediatric patients with underlying malignancies admitted to the PICU. The overall mortality was 51 % and was especially high in patients admitted for acute organ system failure (OSF). Acute respiratory failure was the most frequent OSF and the most common cause for PICU admission. A poor outcome was associated with severe leucopenia, acute renal failure and central nervous system deterioration. When the outcome was predicted using a quantitative algorithm, the observed mortality was significantly higher than the predicted for all admissions with a PSI higher than 5. They concluded that the mortality of pediatric oncology patients requiring intensive care is unexpectedly high when assessed against the rate predicted by existing objective methods. These general scoring methods cannot be applied to this population without considering the nature and severity of the underlying disease and the magnitude of bone marrow failure.

Cawood et al. (2022) described the incidence, clinical characteristics and severity of illness in pediatric oncology patients admitted to the PICU. They reported that the increased mortality associated with sepsis, organ dysfunction and need for organ support underscores the need for earlier recognition of and intervention in pediatric oncology patients requiring intensive care.

Amigoni et al. (2025) analyzed risk factors associated with mortality and PICU Length of Stay (LOS) in a pediatric cancer population. They stated that a history of HSCT or non-solid tumors, higher PIM-3 score and POPC at admission, presence of MOF and history of cardiac arrest are confirmed factors associated with mortality. The use of MV does not appear to be associated with increased mortality in this population.

Abdelrady et al. (2025) evaluated the performance status of cancer patients admitted to the intensive care unit and indicated that cancer negatively influences the functional status of patients admitted to the ICU. **Dehghani-Ghorbi et al. (2024)** determined the clinical characteristics of cancer patients admitted to the ICU. They found that identifying the clinical characteristics of cancer patients can help health policymakers and medical staff to improve the health status of patients.

Jalil et al. (2025) reported the rate of admission of pediatric oncology patients to the PICU in a tertiary university oncology center in a developing country. They concluded that prognosis of patients admitted to the PICU in developing countries is still behind those in developed ones. Late referral, especially of patients presenting with respiratory failure, sepsis, and multiorgan failure usually, requires urgent intervention with inotropic support, oxygen therapy, and mechanical ventilation and is significantly associated with poor Outcome, especially in patients with hematological malignancies.

Patel et al. (2021) analyzed the clinical profiles and Outcome of oncology patients admitted to a tertiary care hospital's Intensive Care Unit (ICU). They illuminated the complex challenges this patient population faces, including diverse clinical presentations, the prevalence of comorbidities, and the need for intensive treatment interventions. They underscored the importance of tailored management strategies and interdisciplinary collaboration in optimizing patient care.

Recent advances & improvements in care:-

1. quality improvement in onco-critical care

Proactive tool a consensus capacity assessment tool developed to evaluate and improve pediatric onco-critical care (pocc) services Fostering interdisciplinary communication and guideline implementation to strengthen care systems. (**arias av et al.,2023**).

2. Oncology Treatment Advances

Although cancer remains the leading nonaccidental cause of mortality in children, substantial advances in care have led to 5-year overall survival exceeding 85%. However, improvements in Outcome have not been uniform

across malignancies or strata of social determinants of health. The current review highlights recent areas of advancement and anticipated directions for future progress.

Recent findings: Incorporation of rational targeted agents into upfront treatment regimens has led to incremental improvements in event-free survival for many children, sometimes with potential reductions in late effects. For rare or challenging-to-treat cancers, the increasing feasibility of molecular profiling has provided specific treatment options to patients with some of the greatest needs. Simultaneously, increased focus is being given to patient-reported Outcome and social determinants of health, the importance of which are becoming readily recognized in providing equitable, quality care. Finally, as survival from malignant diseases improves, breakthroughs in the prevention and management of adverse late effects will promote long-term quality of life.

Summary: Multi-institutional collaboration and risk-adapted approaches have been crucial to recent advancements in the care of children with cancer and inform potential directions for future investigation. **(Ward et al 2014).**

3. Risk Stratification and Prognostication

Work is ongoing to develop better prognostic tools specific to pediatric oncology critical care, beyond general severity scores (e.g., PRISM). Some studies suggest tailored risk models may predict deterioration earlier, enabling timelier PICU admission and interventions. **(Zinter et al 2019).**

Cancer and extracorporeal life support (ECLS):

Patients with cancer should not receive ECLS **(Paden et al., 2013)**. **Barbaro et al. (2020)** showed that the rate of infectious complications was not higher than that observed in children without oncologic disease on ECLS. However, cardiovascular and renal complications (renal failure requiring replacement therapy, arterial hypertension, cardiovascular failure requiring inotropic support, and cardiorespiratory arrest) seem to be more common in children with cancer. Based on these data, it does not seem unreasonable to consider ECLS in children with cancer who meet the necessary criteria, including reversible pulmonary and/or heart failure persisting despite maximal medical therapy.

In practice, most centers do not exclude children with cancer from their ECLS programs as evidenced by a survey conducted in 118 centers belonging to the Extracorporeal Life Support Organisation. Seventy-eight percent of the surveyed centers stated that cancer was not a contraindication for ECLS, although it was considered a relative or absolute contraindication in 17% and 5% of the centers, respectively. Despite the inherent selection bias (all respondents practiced ECLS), ECLS may be considered as part of the PICU treatment offered to children with cancer **Barbaro et al. (2020)**.

Improved prognosis of cancer patients:

Over the last decade, oncological therapies have made tremendous progress, significantly changing the prognosis for cancer patients, even those in advanced stages. Patients profit from improvements in therapeutic schemes and protocols, as well as from novel, targeted therapies, which improve overall survival and quality of life. Progress in immunotherapy has exceeded expectations, leading to successful management with immunotherapeutic agents both alone and in combination. Side effects, which strongly influence quality of life, have been markedly reduced. New molecular insights are being gained rapidly and the scientific progress translated to the clinic is enormous. Cancer entities that were considered to have a very poor prognosis (such as small cell or cerebral cancers) are now in a new era of great therapeutic results with a manageable safety profile **(Topalian et al., 2016)**.

Furthermore, symptom management of advanced cancer has also improved, allowing patients to reduce their hospital stays, physician visits and psychosomatic burden. Metastatic bone pain, cerebral symptoms due to brain metastasis, hypercalcaemia, anorexia, insomnia, neuropathy and many other conditions can now be successfully managed with a variety of methods, from medication to invasive approaches or radiotherapy **(Paice et al., 2011)**.

Improved short-term outcome of cancer patients at the ICU:

When cancer patients become critically ill, ICU care is often considered futile. However, it is crucial to understand whether the outcome of cancer patients differs from that of noncancer patients. Perceptible improvements in the prognosis of acutely ill oncological patients, including paediatric patients, have been achieved (**Zampieri et al., 2021**).

Zampieri et al. (2021) have mentioned ICU admission as an independent favourable prognostic factor for short-term outcome. Admission to the ICU worsens the prognosis of a cancer patient substantially; however, the stage of the malignancy has little or no impact on short-term survival. As for noncancer patients, the ICU outcome depends on the need for organ support, severity of the acute illness and the number of failed organ systems. These facts had already been reported over 30 years ago.

Oncology patients who require mechanical ventilation for acute respiratory failure experience an ICU mortality of >40% that increases to >60% when respiratory failure is due to acute respiratory distress syndrome. Not requiring mechanical ventilation lowers the in-hospital mortality rate to 25%; intubation immediately increases the percentage, regardless the indication for mechanical ventilation. Multiple organ dysfunction syndrome has the worst prognosis. The outcome of septic shock has also improved for cancer patients, which is related to implementation of new adjuvant therapies (**Zampieri et al., 2021**).

Advances in sepsis diagnosis and management led to a significant reduction in mortality rates due to sepsis in critically-ill adult patients with cancer, to as low as 28%. The Sepsis Occurrence of Acutely Ill Patients study (SOAP) reported similar mortality in patients with and without cancer (27 vs 23%) (**Puxty et al., 2015**).

Topalian et al. (2016) reported that the worst Outcome are to be expected in patients who were mechanically ventilated, on vasopressor support, or receiving renal replacement therapy. Poor performance status has also been shown to be a predictor of poor outcome.

Earlier ICU admission and management of critically ill cancer patients is associated with higher survival. The 30-day survival was 26% for cancer patients who were considered “too sick” and 78.7% for patients considered “too well” for ICU admission. Strikingly, as many as 60% of critically ill patients with advanced cancer admitted to the ICU are never discharged home; those who are have a median survival of only 33 days. Furthermore, 55 to 75% of ICU cancer survivors report severe symptoms such as pain, discomfort, anxiety and sleep disorders (**Levesque et al., 2014**).

Although aggressive treatment is not recommended for this group, ICU admission may be appropriate for the treatment of reversible conditions such as cardiac tamponade, severe dehydration, or respiratory insufficiency that can be managed with noninvasive ventilation (**Azevedo et al., 2014**).

Azevedo et al. (2014) suggested that cancer patients with good prognosis and nonprogressive disease requiring ventilatory support should receive full intensive care, because one-half of these patients survive. Among patients admitted to ICU because of complications of their therapy, respiratory failure is the most common indication for admission, with a reported ICU mortality of approximately 50%. In general, prognosis associated with the aetiology of the acute illness in the context of life expectancy from the underlying malignancy should be discussed before or soon after admission to the ICU.

Last but not least, improved outcome in critically ill cancer patients is also a consequence of a better selection of patients admitted to the ICU (**Biskup et al., 2017**).

Available scoring systems and predictive factors:

As for any other disease entity, scores are reliable for cohorts, but not for individuals. In the case of cancer patients, this problem is even more complicated, as it merges diffusely with ethical and open questions, combined with gaps in our knowledge due to trial limitations and insufficient understanding of many cancer mechanisms. One could even provocatively ask whether scores account for cancer. And with a given score, does additional cancer matter?

Cancer-specific features have a minimal effect on short-term prognosis during an acute critical illness. Traditional physiological scores such as Acute Physiology and Chronic Health Evaluation (APACHE), Simplified Acute Physiology Score (SAPS) and Mortality Probability Models (MPM) are of limited assistance for ICU triage (**Sprung et al., 2014**).

In cancer patients, assessment of the critical illness and risk stratification is even more challenging, especially in the light of the difficulty in accurately predicting the outcome. However, several studies have addressed this problem and reported that the number of failed organ systems is the main prognostic factor. Higher APACHE II and Sequential Organ Failure Assessment (SOFA) scores were also associated with an increased ICU mortality (**Orsini et al., 2016**).

Nevertheless, three general models – APACHE II, SAPS II and SOFA – were fairly accurate predictors of mortality in critically ill cancer patients. They can predict clinically meaningful outcome for adult ICU patients and can be used for investigational purposes (**Sprung et al., 2014**).

Gudiol et al. (2021) reported that sepsis, aplasia, previous bone marrow transplantation, metastatic disease or previous admission to ICU were not associated with a poorer prognosis or increased mortality risk. However, mortality was higher when time to antibiotic treatment was >2 hours or when initial antibiotics were not adapted. Larche et al. studied the Logistic Organ Dysfunction (LOD) score of ICU cancer patients. LOD calculated at day 3 seems to be a useful predictive tool and to be superior to the SAPS II.

The need for vasopressors and APACHE II score were reported to be independent prognostic factors for in-ICU mortality, whereas the length of stay in the ICU, Charlson comorbidity index score greater than 2 and the need for vasopressors were independent predictors of death after ICU discharge (**Chhangani et al., 2015**).

Basic bedside evaluation by physicians has been deemed a poor tool for predicting outcome in ICU cancer patients. Sepsis increases the mortality risk from 28 to 60%, but the prognosis is strongly influenced by the time of admission and initiation of antibiotics. Multiple organ failure (>3 organs) has a higher mortality in oncological patients than in those without cancer (75 vs 50%). The SOFA score includes this factor in the calculation. Sepsis due to pulmonary infection was associated with a 56 to 62% mortality rate and described in a retrospective study as an independent predictor of death at 28 days. Analogously, an independent predictor of death was fungal sepsis, especially invasive aspergillosis, with particularly high rates of mortality (up to 80%) (**Ma et al., 2023**).

Poor response to chemotherapy, cancer relapse after an initial response, progressive or recurrent disease, malignant infiltration of vital organs or the airway, poor marrow recovery post haematopoietic cell transplantation, active graft-versus-host disease, delayed ICU admission, and need for advanced cardiac life support protocol have been identified as disease-related predictive factors for mortality, whereas diagnostic and therapeutic procedures (e.g., bronchoscopy with biopsy and surgical lung biopsy) are procedure-related predictive factors (**Gilbert et al., 2013**).

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