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# How to ventilate critically ill children with cancer?: a narrative review

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**Abstract**

The management of respiratory failure and hypoxemia in children with cancer presents a critical challenge. Choosing between invasive and noninvasive mechanical ventilation can profoundly impact mortality rates, especially in resource-limited settings. Choosing between invasive and noninvasive mechanical ventilation can impact mortality rates, particularly in resource-limited settings. Extensive clinical studies are imperative to thoroughly evaluate the efficacy of invasive mechanical ventilation (IMV) and noninvasive ventilation (NIV) during the early stages of treatment. Further research is crucial to determine the most optimal therapeutic approach. Early implementation of IMV or NIV could significantly reduce mortality rates in these patients.[1] Additionally, this article examines the admission of children with terminal cancer, evaluating their use of invasive and noninvasive ventilatory support versus palliative care. The interdisciplinary medical team, in collaboration with the family, must carefully consider the benefits and risks of these interventions, whether in the early or terminal stages of the disease. Furthermore, the article delves into the controversies surrounding the utilization of ventilation in critically ill children with cancer.

**Keywords:** Child, Mechanical ventilation, Pediatric oncology, Pediatric intensive care unit

## Invasive versus noninvasive mechanical ventilation in critically ill oncology children

Respiratory support via noninvasive ventilation (NIV) and humidified high-flow oxygen via a nasal cannula are promising options for patients with malignant neoplasms.[2] The advantages of NIV for immunocompromised pediatric patients are well-documented.[3] For children, an invasive ventilation strategy that maintains very high carbon dioxide levels to allow for low tidal volumes and minimal inspiratory pressures is viable; this method could improve survival rates for immunocompromised children with severe acute respiratory distress syndrome (ARDS).[4] However, a personalized approach is essential since specific ventilation guidelines for this critically ill oncohematological group do not exist.[5] Current guidelines from the Second Pediatric Acute Lung Injury Consensus Conference do not include recommendations for ventilatory management in children with cancer, underscoring the need for targeted research on this vulnerable group.[6] The prognosis for immunocompromised children with acute respiratory failure (ARF) remains uncertain. Even if NIV initially appears successful or unsuccessful, ARF often recurs.[7] Noninvasive ventilation is feasible and generally well-tolerated in immunocompromised children with ARDS. Conducting a trial of NIV within the first 6 hours of treatment can help assess its effectiveness.[6,8] A small study by Ofer Schiller et al.[8] found that 75% of bilevel positive airway pressure (BiPAP) interventions (11 out of 16 patients) resulted in discharge from the pediatric intensive care unit (PICU) without the need for invasive ventilation, indicating that BiPAP ventilation is well-tolerated and may lead to better outcomes if started early and monitored closely to prevent desynchronization, a common cause of NIV failure.[9]

Another study by Piastra et al.[8] found that children undergoing NIV experienced shorter hospital stays and reduced time in the PICU. Additionally, the success of NIV not only decreased the duration of use but also the length of stay in the PICU for children with cancer, making it a viable first option for those experiencing ARF.[10]

The decision to initiate mechanical ventilation in patients with cancer becomes necessary when complications such as pulmonary or airway collapse occur due to tumor infiltration, space-occupying masses in the thoracic cavity (typical with teratoma and ganglioneuroma), or partial to complete obstruction of the upper airway caused by conditions like nasal fibroma or hemangioma. In cases of fibromatosis or adenopathy secondary to acute lymphoblastic leukemia or lymphoma, it is crucial to decide whether to start chemotherapy, administer palliative radiation therapy to reduce the tumor, and avoid orotracheal intubation or first secure the airway due to the restrictive pattern.[11] In cases involving acute lymphoblastic leukemia or lymphoma, urgent surgery may also be required.

Given the recent increases in cancer patient survival rates and advancements in intensive care over the last decade, it is crucial to re-evaluate the roles of IMV and NIV, even considering the limited resources available at many hospitals (Fig. 1). A recent study indicates that mortality rates in pediatric patients can be reduced using NIV. However, the mortality rate was notably high (93.33%) among

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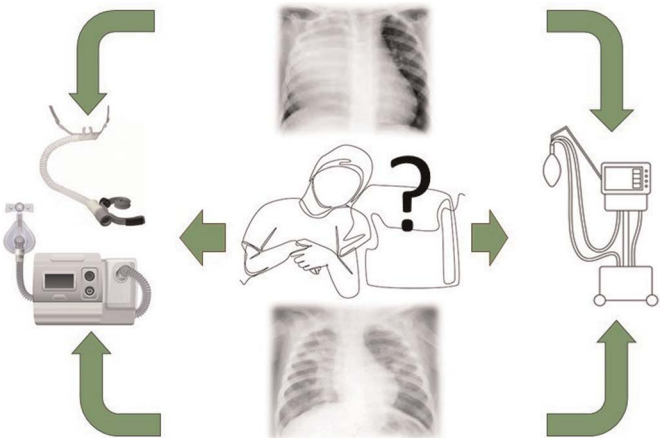

Figure 1. Noninvasive ventilation versus invasive ventilation in pediatric cancer?

patients with hemodynamic instability in whom NIV failed, compared with others in the group.[12] Pancera et al.[13] reported that NIV was not feasible for most patients with deteriorating hemodynamic status. Currently, no studies are available to compare the effectiveness of high-flow nasal cannulas versus NIV in children with cancer. However, research conducted by García-Salido et al.[1] shows that among their sample of 88 pediatric patients with oncohematological conditions, high-flow oxygen nasal cannulas were the most common respiratory support method upon admission to the PICU, followed by NIV and nasal oxygen cannula, in decreasing order of frequency (50/88, 13/88, and 16/88, respectively). IMV was necessary in 47 out of 88 cases, with 38 out of those 47 requiring it after receiving other forms of respiratory support. Of the 18 out of 28 children who initially received NIV, IMV was needed later on.[1]

## Discussion

The decision to use invasive or NIV is based on the clinical judgment of pediatric intensivists, supported by pediatric oncohematologists. It is determined by the clinical presentation of the child with cancer, considering potential complications from prolonged use of masks or interfaces, hematological and metabolic changes, mass effects, and airway infiltration. Both invasive and noninvasive positive pressure ventilation can compensate for respiratory muscle weakness and help recruit lung alveoli to restore normal minute ventilation. Additionally, by maintaining positive pressure, mechanical ventilation prevents upper airway collapse.[14] Positive pressure ventilation also enhances $CO_2$ removal from arterial blood, reverses pulmonary atelectasis, and normalizes ventilation-perfusion mismatch.[15]

Due to the unavoidable leaks associated with noninvasive interfaces and patient desynchronization, invasive ventilation offers better control over minute ventilation and upper airway patency. However, invasive mechanical ventilation increases the risk of hospital-acquired pneumonia, barotrauma, laryngeal and tracheal stenosis, weaning failure, and prolonged ventilator dependence in critically ill oncohematologic patients. Additionally, the use of IMV, compared with NIV, carries increased risks of infectious complications, end-organ damage, and lung injury.[16]

In our experience managing oncohematological patients with hypoxemic respiratory failure and severe thrombocytopenia, the use of a noninvasive mask sometimes carries a high risk of failure due to active bleeding lesions or the lack of suitable pediatric masks. Consequently, many of these patients require invasive mechanical ventilation. Similarly, solid intrapulmonary tumors can cause mechanical effects and airway instability, necessitating mechanical ventilation. In cases of severe neurological deterioration caused by neuro-oncological tumors, we prefer to initiate invasive mechanical ventilation. For post bone marrow transplant patients, many of whom are immunosuppressed, we opt for NIV.

Bhosale et al.[17] found in their retrospective cohort of 200 children with malignancies that those with hematological cancers had a considerably higher in-hospital mortality rate than those with solid tumors. The requirement for mechanical ventilation was an independent predictor of mortality.[17] The prognosis for patients admitted to the PICU in developing countries continues to be worse than that in developed nations. Delayed referral, especially for patients with respiratory failure requiring urgent oxygen therapy and mechanical ventilation, is significantly associated with adverse outcomes, particularly in patients with hematological malignancies.[18]

For children with cancer who have ARF, we recommend using NIV as the initial form of ventilatory support, regardless of the standard criteria for NIV usage, including the exclusion of ARDS or multiple organ dysfunction. This approach is advocated because most of these patients already exhibit organ dysfunction upon admission to the unit.[19] For children with terminal cancer, the use of NIV is crucial for providing consistent support, comfort care, and higher doses of analgesia and sedation solely for palliative care purposes.

In pediatrics, end-of-life care for children with terminal cancer has improved significantly, particularly with the development of palliative care that supports patients at home or in the general ward.[20] The palliative use of NIV in this setting can alleviate respiratory symptoms and/or facilitate communication with parents and acceptance of death during family accompaniment in the general ward. Conversely, the use of NIV can cause discomfort and may unnecessarily prolong the dying process. Indeed, some family members have opted to withhold all life-sustaining treatment, choosing only palliative care. However, there are end-of-life situations where the

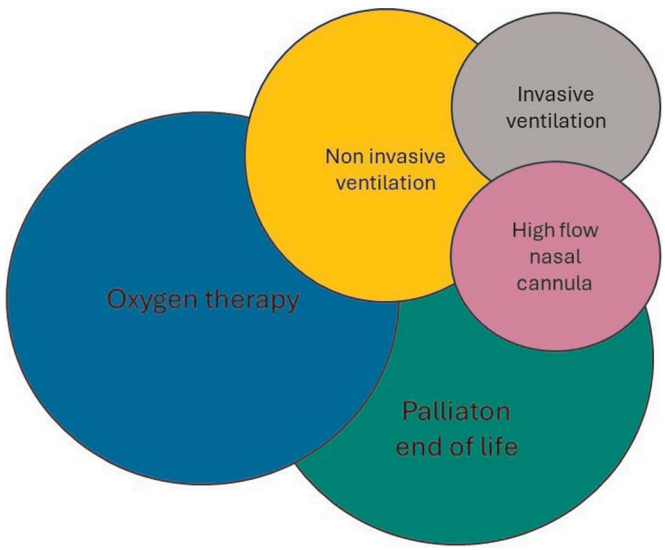


Figure 2. Nonpharmacologic therapeutic options for children with cancer and acute respiratory failure.

intensivist, pediatrician, oncohematologist, respiratory therapist, and family members must discuss all the benefits and risks, evaluate the futility of established treatments, and assess the appropriateness of suspending or withdrawing life support if the patient's condition warrants it (Fig. 2).

## Conclusion

Emphasizing the availability of NIV, continuous positive airway pressure (CPAP), and/or HFNC as primary treatments in pediatric oncology intensive care units is crucial. Nonetheless, a comprehensive evaluation of the benefits and drawbacks of these interventions in children with terminal cancer is warranted. Further research is imperative to explore the effectiveness of HFNC or early NIV in pediatric oncology through rigorous clinical studies.

## Conflict of interest statement

The authors declare no conflict of interest.

## Author contributions

All authors assisted in study conceptualization and design, analysis, and interpretation, and drafted and critically revised the manuscript. Authorship requirements have been met and the final manuscript was approved by all authors.

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