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Original Article

Tracheostomy in pediatric intensive care: A comprehensive overview of indications, clinical outcomes, and the role of palliative care

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ABSTRACT

Objective: Tracheostomy is frequently required in pediatric intensive care units (PICUs), particularly for children with complex neurological or respiratory conditions. This study aimed to evaluate the indications, outcomes, and the role of pediatric palliative care (PPC) services in the post-tracheostomy management of pediatric patients.

Materials and Methods: This retrospective, single-center study included 42 pediatric patients (0–18 years) who underwent their first tracheostomy in the PICU between January 2020 and November 2024. Demographics, clinical indications, complication rates, palliative care utilization, and discharge outcomes were analyzed descriptively.

Results: The median age was 2 (0–11.25) years, with 66.7% male patients. Prolonged intubation was the most common indication (66.7%), followed by subglottic stenosis and neuromuscular causes. Tracheostomy-related complications occurred in 40.4% of patients. Remarkably, 95.2% were transferred to the PPC unit, where they stayed for a median of 21 days. Discharge to home was achieved in 88.1% of patients, and overall mortality was 11.9%, with no deaths directly attributable to tracheostomy. Among discharged patients, 60.5% required home mechanical ventilation.

Conclusion: This study highlights the critical role of PPC services in facilitating safe discharge and optimizing outcomes for children undergoing tracheostomy. The high home discharge rate and low mortality underscore the benefits of a structured, multidisciplinary care model. Integration of PPC services should be considered standard in the post-tracheostomy management of children with complex comorbidities.

Keywords: Artificial, intensive care units, pediatric, palliative care, respiration, tracheostomy

Introduction

Tracheostomy is a surgical procedure increasingly utilized in pediatric intensive care units (PICUs), particularly in patients requiring prolonged mechanical ventilation, with upper airway obstruction, or with neuromuscular disorders (1). The frequency of tracheostomy in pediatric populations has increased significantly in recent years, parallel to advances in medical care that have extended the survival of children with chronic conditions (2). Tracheostomy improves airway management in ventilated patients, facilitates secretion clearance, and reduces airway-related complications. Furthermore, it enables earlier weaning from mechanical ventilation and discharge, improving the quality of life for both patients and families (3).

Due to advancements in technology and the expansion of neonatal and pediatric intensive care services, the indications for tracheostomy have evolved considerably. Although indications and durations for prolonged ventilation are better defined in adult populations, such data in children remain limited (4,5). There are also regional and ethnic differences in both the indications for tracheostomy and management approaches, underscoring the need for population-specific protocols (6). The decision to perform a tracheostomy in children is complex, requiring multidisciplinary evaluation, and marks the beginning of a long-term care process rather than merely a surgical intervention (7).

Post-tracheostomy care necessitates specialized approaches due to the risk of complications, increased

caregiving demands, and the social impact on families (8). Pediatric palliative care services offer critical support, not only during end-of-life care but throughout the management of life-limiting conditions that lead to significant functional impairments (9). These services provide multidisciplinary, patient-centered care, assisting in clinical management, caregiver education, and discharge planning for tracheostomized children (10.)

In this study, we retrospectively evaluated the clinical and demographic characteristics of pediatric patients who underwent tracheostomy for the first time in a tertiary care PICU. In addition, the impact of pediatric palliative care services on mortality and discharge home rates were analyzed in the light of the existing literature. This topic was selected due to the growing prevalence of pediatric tracheostomy procedures and the critical need for comprehensive understanding of outcomes and optimal care strategies, particularly regarding the knowledge gap in pediatric tracheostomy management and palliative care integration.

Materials and Methods

This retrospective, cross-sectional study was conducted at the Pediatric Intensive Care Unit (PICU) of Kayseri City Hospital between January 2020 and November 2024. The study population consisted of pediatric patients aged 0-18 years who underwent their first tracheostomy procedure during hospitalization in the PICU. All patients who met the inclusion criteria during the study period were enrolled.

Inclusion criteria were pediatric patients aged 0-18 years, first-time tracheostomy performed during PICU hospitalization, and complete medical records available. Exclusion criteria included patients who underwent tracheostomy at another facility, patients admitted only for routine tracheostomy tube changes, and patients with incomplete medical data.

Patient data were retrospectively collected from electronic medical records. The following variables were recorded: age, sex, nationality, primary admission diagnosis, tracheostomy indication, duration of intubation prior to tracheostomy, requirement for home mechanical ventilation (HMV), length of stay in the pediatric palliative care unit, discharge status, mortality outcomes, and cause of death when applicable.

Statistical analysis

Data analysis was performed using TURCOSA Analytics software (Turcosa Analytics Ltd. Co., Kayseri, Türkiye; accessed in 2025). Descriptive statistics were expressed as frequencies and percentages, means and standard deviation, and medians (minimum and maximum). Quantitative data were summarized based on their distribution. The study was designed for descriptive purposes only; therefore, no inferential statistical tests were applied.

Results

A total of 42 pediatric patients were included. The mean age was 5.05 ± 5.87 years (range: 0–16 years), and the median age was 2 years. Males constituted 66.7% (n=28) of the cohort, while 33.3% (n=14) were female. Nationality distribution included 69.0% Turkish (n=29); 28.6% Syrian (n=12) and 2.4% Afghan (n=1). At discharge, 88.1% (n=37) of patients were successfully sent home, while mortality was recorded in 11.9% (n=5). Tracheostomy-related complications occurred in 40.4% (n=17), the most common being cannula occlusion (9.5%, n=4); cuff rupture (7.1%, n=3); cannula fracture (2.4%, n=1); and pneumothorax (9.5%, n=4). Additional complications included skin infections (7.1%, n=3), subcutaneous emphysema (2.4%, n=1); and tracheal fistula (2.4%, n=1). No complications occurred in 59.6% (n=25) of patients. Causes of death included respiratory arrest secondary to acute respiratory failure (60%, n=3) and septic shock (40%, n=2) (Table I).

Table I: Demographic characteristics of patients and study data

Variable	n (%)
Male	
Female	14 (33.3)
Male	28 (66.7)
Nationality	
Republic of Türkiye	29 (69.0)
Syria	12 (28.6)
Afghanistan	1 (2.4)
Discharge status	
Discharged	37 (88.1)
Deceased	5 (11.9)
Post-procedure complications	
Complications observed	17 (40.4)
No complications	25 (59.6)
Observed complications	
Cannula-related problems	8 (19.0)
Pneumothorax	4 (9.52)
Cannula site skin infection	3 (7.14)
Subcutaneous emphysema	1 (2.38)
Tracheal fistula	1 (2.38)
Cause of death	
Acute respiratory failure*	3 (7.14)
Septic shock	2 (4.76)

**: Respiratory arrest was considered secondary to acute respiratory failure according to the clinical findings.*

Table II: Data on length of stay and patient age

Variable (n=42)	Median (IQR)
Age (years)	2 (0–11.25)
Pre-procedure MV duration (days)	25 (17–36)
Palliative care duration (days)	21 (15–34)

***MV:** mechanical ventilator, Data are presented as median (25th–75th percentile)*

The median duration of intubation prior to tracheostomy was 25 days (IQR: 17–36). Of the cohort, 95.23% (n=40) were transferred to the pediatric palliative care unit, where they stayed for a median duration of 21 days (IQR: 15–34) (Table II).

Only 7.1% (n=3) of the patients had no comorbidities. The most prevalent comorbidities were cerebral palsy (35.7%, n=15); epilepsy (33.3%, n=14); metabolic disorders (14.3%, n=6); and laryngomalacia (11.9%, n=5). Other significant conditions included SMA, Down syndrome, diffuse axonal injury, chronic lung disease, hypothyroidism, immunodeficiencies, genetic muscle and mitochondrial diseases, scoliosis, congenital heart disease, and global developmental delay (Table III).

Table III: Comorbidity profile of the patient group

Variable	n (%)
Group	
With comorbidities	39 (92.9)
Without comorbidities	3 (7.1)
Comorbidity Details	
Cerebral palsy	15 (35.7)
Epilepsy	14 (33.3)
Non-mitochondrial metabolic disease	6 (14.4)
Laryngomalacia	5 (11.9)
Diffuse axonal injury (post trauma)	4 (9.5)
Hypothyroidism	4 (9.5)
HIE sequelae	3(7.1)
Hypotonia*	3 (7.1)
SMA	3 (7.1)
Immunodeficiency	2 (4.8)
Scoliosis	2 (4.8)
Earthquake victim (Crush syndrome)	2 (4.8)
Down syndrome	2 (4.8)
Growth retardation / malnutrition	2 (4.8)
Chronic renal failure	2 (4.8)
Chronic lung disease	2 (4.8)
Hydrocephalus	1 (2.4)
Lissencephaly	1 (2.4)
Syringomyelia	1 (2.4)
Neurological sequelae (caused by kernicterus)	1 (2.4)
Intellectual disability	1 (2.4)
Achondroplasia	1 (2.4)
Alexander disease	1 (2.4)
Hypertrophic cardiomyopathy	1 (2.4)
Presence of patent ductus arteriosus	1 (2.4)
Known history of supraventricular tachycardia	1 (2.4)
Duchenne muscular dystrophy	1 (2.4)
Genetic disease (with muscle weakness)	1 (2.4)
Mitochondrial disease	1 (2.4)
Congenital cataract	1 (2.4)
Vocal cord paralysis	1 (2.4)

Patients may have more than one comorbidity. ***HIE:*** *hypoxic ischemic encephalopathy,* ***SMA:*** *spinal muscular atrophy *Hypotonia was considered a clinical manifestation associated with underlying neurological or neuromuscular disorders rather than an independent diagnosis.*

Table IV: Hospitalization and tracheostomy indications and discharge clinic

	n (%)
Diagnosis of hospitalization	
Pneumonia	17 (40.47)
Respiratory distress	5 (11.90)
Status epilepticus	5 (11.90)
Acute bronchiolitis	3 (7.14)
Post-cardiac arrest	4 (9.52)
Traffic accident	3 (7.14)
Earthquake - trauma	3 (7.14)
Meningitis	1 (2.38)
Acute gastroenteritis	1 (2.38)
Indications for tracheostomy	
Prolonged intubation	28 (66.66)
Subglottic stenosis	5 (11.90)
Diffuse axonal injury	3 (7.14)
Respiratory muscle weakness	3 (7.14)
Laryngomalacia	2 (4.76)
Vocal cord paralysis	1 (2.38)
Need for home MV at discharge	
Required	23 (62.16)
Not required	14 (37.83)

Primary PICU admission diagnoses were pneumonia/bronchopneumonia (40.5%), respiratory distress (11.9%), and status epilepticus (11.9%). The leading indication for tracheostomy was prolonged intubation (66.7%, n=28); followed by subglottic stenosis (11.9%, n=5); diffuse axonal injury (7.14%, n=3); respiratory muscle weakness (7.14%, n=3); laryngomalacia (4.76%, n=2); and vocal cord paralysis (2.4%, n=1). While 62.16% (n=23) of the patients needed HMV at discharge, 37.83% (n=14) were discharged without the need for HMV (Table IV).

Discussion

In this study, the demographic characteristics, clinical indications, home mechanical ventilation (MV) requirements at discharge, palliative care processes, and discharge outcomes of 42 patients who underwent tracheostomy in our pediatric intensive care unit were evaluated. The majority of patients (95.23%, n=40) who were anticipated to be discharged after tracheostomy were transferred to the pediatric palliative care service; individualized care plans were created, family education was provided, and home care support was organized. Our findings are noteworthy for a low mortality rate (11.9%) and a high home discharge rate (88.1%). In our study, the most common indication for tracheostomy was prolonged intubation (66.7%). Among these patients, 24% and 60% of those with subglottic stenosis were discharged without the need for home MV. These findings suggest that tracheostomy performed in a timely manner and with appropriate indications in the suitable patient group increases the rate of discharge from intensive care to home, and that management of the post-tracheostomy process with a multidisciplinary approach and palliative care services positively influences patient outcomes.

To the best of our knowledge, this represents one of the few studies specifically examining the role of pediatric palliative care services in tracheostomy outcomes among children with complex neurological and respiratory conditions. The strength of this study lies in its comprehensive evaluation of patients with diverse underlying conditions including cerebral palsy, epilepsy, spinal muscular atrophy, metabolic disorders, and diffuse axonal injury, reflecting the real-world complexity of pediatric intensive care populations. The systematic approach to palliative care integration, with a median 21 days in the palliative care unit, allowed for thorough preparation of both patients and families for home discharge. Pediatric palliative care is a multidisciplinary approach aimed at providing symptom control, improving quality of life, and supporting families of children with life-threatening or life-limiting conditions (9). In our center, patients who underwent tracheostomy were transferred to the pediatric palliative care unit following the intensive care period as part of a standardized care model. During the palliative care process, families received education on tracheostomy and ventilator management, including cannula care and secretion management; respiratory physiotherapy was provided, and enteral nutrition planning and preparation for home care were organized. This process was carried out by a multidisciplinary team consisting of pediatric intensive care specialists, pediatric neurologists, respiratory therapists, nutrition support teams, and psychosocial support units. This

study addresses a significant gap in the literature regarding the clinical benefits of palliative care services beyond end-of-life care, demonstrating their crucial role in improving discharge readiness and long-term outcomes.

In the literature, prolonged intubation has been reported as an indication for tracheostomy at rates ranging from 50–90% (6,11–14.) The rate in our study (66.7%) is consistent with these data. Additionally, indications such as diffuse axonal injury, subglottic stenosis, laryngomalacia, and neuromuscular insufficiency support findings from other studies in which neurological causes were prominent (14–16). The median MV duration before tracheostomy in our study was 25 days, which is longer than the 7–21 days reported in the literature (17–18). This difference may be attributed to several factors (12). First, a substantial proportion of our patients had complex neurological or neuromuscular conditions, which often require prolonged attempts at weaning and repeated extubation trials before a decision for tracheostomy is made. Second, socioeconomic and cultural characteristics of families may influence the timing of tracheostomy, as caregivers often require additional time to understand the long-term implications of tracheostomy and home ventilator care. Finally, variability in the informed consent process and the need for detailed family counseling may prolong the decision-making period. These factors together may explain the relatively longer duration of mechanical ventilation prior to tracheostomy observed in our cohort. Our findings underscore that pediatric intensive care units serve a wide spectrum of patients with neurologic and respiratory failure, and tracheostomy remains a frequent necessity for this patient population.

The need for MV after tracheostomy varies from 41–89% in the literature and is generally related to the indication for the procedure (14,16,17,19). Similarly, decannulation rates have been reported to be 74% in patients with airway obstruction and 52% in those with prolonged intubation (20). However, studies assessing indication-specific MV dependence are limited. In our study, 60.52% of patients discharged home required home MV support. Twenty-four percent of patients who underwent tracheostomy due to prolonged intubation, 60% of those with subglottic stenosis, and all patients with respiratory muscle weakness were discharged without the need for home MV. These findings show that, in our clinic, post-tracheostomy planning includes effective use of home ventilation to shorten the intensive care period on a patient-specific basis. However, the low weaning rate from MV among patients receiving long-term ventilatory support highlights ongoing challenges in managing this patient group.

Early discharge from the intensive care unit is important for preventing nosocomial infections and MV-related complications, as well as reducing healthcare costs (3,10). Although the literature has not yet reached a consensus on the effects of early versus late tracheostomy on mortality and morbidity, the high MV requirement following prolonged intubation suggests the need for further studies focusing on the timing of tracheostomy, particularly with consideration of comorbidities (14,21–23).

In our study, a substantial number of patients had severe neurologic or neuromuscular comorbidities, including cerebral palsy, epilepsy, spinal muscular atrophy (SMA), mitochondrial diseases, and metabolic disorders. Literature suggests that most pediatric patients undergoing tracheostomy have such comorbid neurodevelopmental or chronic systemic diseases, which increases both the need for tracheostomy and the complexity of post-discharge care (14–16).

During the post-tracheostomy period, a multidisciplinary approach and palliative care services are essential to facilitate safe discharge by managing infection risk, secretion control, and home care processes (6,10). At least one parent must be adequately trained in post-tracheostomy care and emergency procedures (24). Pediatric palliative care services offer significant advantages by reducing infection risk, educating families, and ensuring individualized care planning (25,26). In our study, 95.23% (n = 40) of the patients expected to be discharged were transferred to the pediatric palliative care service, where they were followed for a median of 2 days. During this period, comprehensive care plans were implemented, families were trained, and home care support was arranged. Given that discharge rates from intensive care units in the literature range between 32–77%, our study's high home discharge rate (88.1%) and low mortality rate (11.9%) are remarkable (3,14,16).

All observed deaths were associated with critical conditions such as respiratory arrest secondary to acute respiratory failure and septic shock; no mortality directly attributable to tracheostomy was reported. Our mortality rate was lower than the 14–40% reported in the literature and consistent with findings that associate mortality primarily with sepsis and underlying disease rather than the tracheostomy procedure itself (11,14,20,27). These favorable outcomes may reflect the active involvement of the palliative care team, structured planning of respiratory support, and the inclusion of families in care processes.

Tracheostomy carries certain risks of complications. In our study, the tracheostomy-related complication rate was 40.4%, which aligns with reported rates in the literature (approximately 25–42%) (6,11,15). Differences between centers may be explained by variations in how complications are defined and recorded. In our study, not only major surgical complications but also minor and manageable events occurring during the follow-up period—such as cannula occlusion, cannula cuff rupture, and local skin infection at the cannula site—were systematically documented. In contrast, some studies report only major or early postoperative complications, which may result in lower reported complication rates. In addition, no complications resulting in permanent sequelae or intraoperative adverse events were observed in our cohort. Pneumothorax (9.52%) was among the common complications noted, consistent with literature in patients managed with MV (28). Problems such as cannula occlusion, cannula cuff rupture and skin infection at the cannula site are preventable conditions seen in patients preparing for discharge after the procedure and once again reveal the importance of family education and palliative care support.

Limitations

Several limitations should be acknowledged in this study. The retrospective design limits the ability to establish

causal relationships between palliative care intervention and improved outcomes. The relatively small sample size and single-center design may limit the generalizability of findings to other pediatric intensive care settings. Additionally, long-term follow-up data regarding home care outcomes, quality of life measures, and re-hospitalization rates were not available for analysis

Conclusion

This study demonstrates that pediatric palliative care services play a crucial role in optimizing outcomes for children undergoing tracheostomy, extending well beyond traditional end-of-life care paradigms. The integration of palliative care services resulted in exceptional home discharge rates and low mortality, particularly in patients with complex neurological conditions such as cerebral palsy, epilepsy, and neuromuscular disorders. The indication-specific variations in home mechanical ventilation requirements provide valuable prognostic information for clinical decision-making and family counseling. Future research should focus on prospective multicenter studies examining long-term outcomes, quality of life measures, and cost-effectiveness of palliative care integration in pediatric tracheostomy management. These findings support the routine involvement of pediatric palliative care teams in the management of children requiring tracheostomy, particularly those with complex underlying conditions.

Ethics committee approval

This study was conducted in accordance with the Helsinki Declaration Principles. The study was approved by Kayseri City Training and Research Hospital (24.12.2024, reference number: 277).

Contribution of the authors

Study conception and design: MOD, MAD; data collection: MOD, MAD, TD, AS; analysis and interpretation of results: MOD, MAD, TD, AS; draft manuscript preparation: MOD. All authors reviewed the results and approved the final version of the article

Presented

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Conflict of interest

The authors declare that there is no conflict of interest.

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