Research Article

URF PUBLISHERS
connect with research world

American Journal of Pediatrics and Neonatology

https://urfpublishers.com/journal/pediatrics-and-neonatology

Vol: 1 & Iss: 2

Outcomes in Preterm Infants with BPD and Tracheostomy: A Single-Center Study

Naisha B Chokshi[1]*, Hannah Pulido[2], Roces Velasco[2] and Indira Chandrasekar[1]

[1]Department of Neonatology, Valley Children's Hospital, Madera, California, USA

[2]Department of Pediatrics, Valley Children's Hospital, Madera, California, USA

Citation: Chokshi NB, Pulido H, Velasco R, Chandrasekar I. Outcomes in Preterm Infants with BPD and Tracheostomy: A Single-Center Study. *American J Pedia Neonat* 2025;1(2): 68-72.

Received: 30 July, 2025; **Accepted:** 04 August, 2025; **Published:** 06 August, 2025

***Corresponding author:** Naisha B. Chokshi, Department of Neonatology, Valley Children's Hospital, Madera, California, USA, E-mail: nchokshi@valleychildrens.org

A B S T R A C T

Objective: Tracheostomy is required in cases of severe Bronchopulmonary Dysplasia (BPD) in preterm babies who need prolonged mechanical ventilation. There are no guidelines and consensus on the timing of placement of tracheostomy tube as well as timing for decannulation. The objective of our study is to identify the risk factors in the patients with the BPD which might contribute to prolonged tracheostomy tube need or delays decannulation.

Method: A retrospective chart review of extreme low birth weight infants with severe BPD who had tracheostomy tube placed during their neonatal intensive care unit stay. Important variables prior to tracheostomy tube placement as well as after discharge from hospital were recorded.

Results: A total of 18 patients were included. There was a predominance of male infants (66.6%) who required tracheostomy placement. tube. Male newborns (66.6%) who had a poor growth during NICU stay and Small for Gestational Age (SGA) on weight percentile at one and two years of age, required longer time/duration on tracheostomy. SGA was defined as weight less than 10th percentile on Fenton preemie growth curve. Babies who had pulmonary hypertension also required longer time of tracheostomy in situ.

Conclusion: Poor growth trajectory especially in a male newborn and evidence of pulmonary hypertension in the BPD patients showed need of longer duration on tracheostomy prior to decannulation. Further studies with multicenter large sample size are recommended.

Keywords: Preterm infants, Tracheostomy, Poor growth, Newborn, Decannulation

Abbrevations: SGA: Small for Gestational Age; BPD: Bronchopulmonary Dysplasia; PHT: Pulmonary Hypertension; TS: Tracheostomy: REDCap: Research Electronic Data Capture; PMA: Post Menstrual Age; HFV: High Frequency Ventilation

1. Introduction

Bronchopulmonary Dysplasia (BPD) is a common morbidity associated with prematurity, significantly impacting growth and neurodevelopmental outcomes[1,2]. In infants with severe BPD requiring prolonged mechanical ventilation, tracheostomy is often considered to facilitate respiratory support and improve quality of life. The incidence of tracheostomy placement in

NICUs has been reported to range from 0.1% to 2.7%, with an upward trend over recent years[3,4]. Between 2011 and 2017, Donda et al. [5] noted an increase in tracheostomy rates from 1.9 to 3.5 per 100,000 live births, contributing to a substantial rise in healthcare expenditures. A 36% increase in tracheostomy placement among extremely preterm infants from 2006 to 2012 has also been documented[6]. More recent data indicate a tracheostomy rate of approximately 12% in infants with severe BPD at tertiary NICUs[7,8], while the BPD Collaborative Registry reports that 23% of patients with severe BPD undergo tracheostomy placement[9].

Advancements in neonatal critical care and increasing caregiver acceptance have contributed to the growing prevalence of tracheostomy in preterm infants with BPD[5,10,11]. This population represents a unique subset of tracheostomy-dependent patients who, as lung function improves, may be able to wean off mechanical ventilation and ultimately undergo decannulation[12]. A recent clinical database study reported low mortality rates post-tracheostomy in premature infants with BPD, indicating a growing cohort of survivors who continue to require longitudinal follow-up[13]. Essential outcomes in this population include survival rates, ventilator liberation, tracheostomy decannulation, growth trajectories and neurodevelopmental progress.

The objective of this study is to evaluate the risk factors associated with tracheostomy placement in infants with BPD and to identify factors contributing to prolonged ventilator dependence and delayed decannulation. Understanding these variables may help optimize clinical decision-making, improve patient outcomes and guide future research in managing tracheostomy-dependent infants with BPD.

2. Material and Methods

This retrospective observational study was conducted at an 80-bed regional level IV NICU from June 1, 2018, to May 31, 2023. The study included all newborn infants with a gestational age of ≤ 32 weeks at birth and with a diagnosis of BPD who required tracheostomy prior to discharge from NICU. The inclusion criteria were as follows: ≤ 32 weeks at birth, diagnosis of BPD by definition based on Jensen criteria and newborn who had a tracheostomy placement prior to discharge from VCH NICU. Patients were excluded if they underwent tracheostomy prior to transfer to our institution; tracheostomy for reasons other than BPD.

Data collection was done using REDCap (Research Electronic Data Capture), a secure and standardized web-based platform, utilized for structured data collection. Study data was abstracted directly from the medical record. Variables collected included gestational age at birth, race, gender, surfactant administration, duration of invasive ventilation, maternal complications, duration of rupture of membranes, antenatal steroids, necrotizing enterocolitis, PDA, intraventricular hemorrhage, early and late onset sepsis, pneumonia, death before or after discharge from the NICU. At 36 weeks PMA the grade of BPD, respiratory support including first intention jet ventilation, concentration of oxygen, IM vitamin A use, postnatal corticosteroids use (defined as parenteral administration of dexamethasone or hydrocortisone for more than five consecutive days), chest x-ray along with echo findings were collected. Anthropology parameters at birth, 1 and 2 years of age with percentiles were collected. We recorded age at the time of tracheostomy placement, airway surgeries, bronchoscopy findings, respiratory support at the time of discharge, presence or absence of pulmonary hypertension, time at oxygen discontinuation, room air challenge and time of tracheostomy decannulation on follow-up visits.

IRB approval- HSC2533 obtained from Valley Children's Hospital. The study was approved in accordance with regulations found at 45CFR46.110(5) – Research involving materials (data, documents, records or specimens) that have been collected or will be collected solely for nonresearch purposes and Subpart D 45CFR46.404.

The request for a waiver of consent was approved in accordance with regulations at 45CFR46.116(f)(1).

Statistics: Demographic and clinical data were summarized with standard descriptive statistics.

3. Results

Our Cohort had male predominance 12/18 (67%), Female 6/18 (33%). Post Menstrual Age (PMA) at the time of tracheostomy placement ranged from 38-64 weeks with mean 45.1 weeks.

Survival: Out of total 18 patients, 5 patients died giving the mortality rate of 27.7%. 3 (16.6%) patients died during the initial hospital admission and while in the NICU, prior to discharge. Two patients died at home due to respiratory cause and 1 of them was tested positive for COVID. Approximate age of death was 9.5 months with range of 8-12 months. Survival at 1 year of age was 14/18 (77%) and survival at 2 years 13/18 (72%). Of the initial 18 patients, 5 died and 13 survived. Therefore, outcomes such as long-term ventilator dependency and decannulation were reported based on the survivors (Figure 1).

At 36 weeks PMA, 8 patients (44.5%) were on non-invasive ventilator support. 10/18(55.5%) were on invasive ventilator support. Of the infants on invasive support, 5/10 (50%) on conventional ventilation, 2/10 (20%) on High-Frequency Ventilation (HFV), 3/10 (30%) on Volumetric Diffusive Respirator VDR4.

Respiratory support at discharge: 10/15 (66.6%) were discharged on home ventilator, 2/15(13.3%) on oxygen, 3/15 (20%) patients with tracheostomy were discharged from hospital on room air.

Of 13 patients who are alive- one patient is ventilator dependent at 58 months of age. Of the rest 12 patients, the average duration of mechanical ventilation was 27 months (range 5–50 months) with median age of 24.5 months. 7/13 (53%) survivors have been decannulated at an average age of 38 months from birth (range 24 months to 59 months) and median age of 36 months. 5 of 13 (38%) survived patients needed tracheal reconstruction surgery.

Steroid Use: Majority of the patients 15/18 (83%) received steroids during NICU stay. 5/18 (33.3%) received dexamethasone, 15/18 (83%) received hydrocortisone and 3/18 (16.6%) received prednisone. 3/18 (16.6%) did not receive any steroids.

Patent ductus arteriosus was present in 12/18 patients, of which 11 received medical management: 7/12 acetaminophen, 6/12 –ibuprofen, 1/12 - required device closure, 3/12 required PDA ligation. 6/18 (33.3%) patients did not require any intervention for PDA.

Pulmonary Hypertension: 7 infants out of 18 (38%) had documented pulmonary hypertension (PHT) based on ECHO findings. Of the 7 with PHT, 3 died and 2 were ventilator dependent with a tracheostomy. 5/7(71%) infants with PHT had adverse outcome with mortality or prolonged ventilator dependence. Of the 2 decannulated patients, ventilator need was 23 and 26 months, decannulation done at 24 and 32 months (Figure 2).

Of the 13 alive infants, 9 (69%) were SGA at 1 year and 5(38%) were SGA at 2years of chronological age. At 1 year, 2/2 (100%) SGA females and 1/6 (16%) SGA male came off ventilator support. At 2 years 4/6 (66.6%) males continued to require ventilator support. Of the three patients who were SGA at birth, one patient died at 13 months of age and one patient is still ventilator dependent at 5 years of age.

When 42 weeks PMA was used as cutoff to define early vs late tracheostomy, there were 6 infants in early and 12 in late tracheostomy group. In the early TS group of 6, 1 died, 4 decannulated and 1 still has tracheostomy. In the late group of 12, 4 died, 3 decannulated and 5 still have tracheostomy.

Of the 18 preterm infants with BPD, one had associated trisomy 21 with AVSD, another with unknown genetic defect and third patient had Noonan's syndrome with congenital pulmonary valve stenosis.

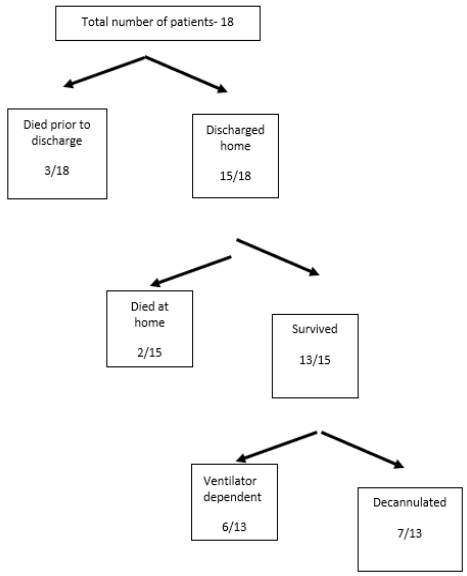

Figure 1: Survival and decannulation of Tracheostomy in BPD patients.

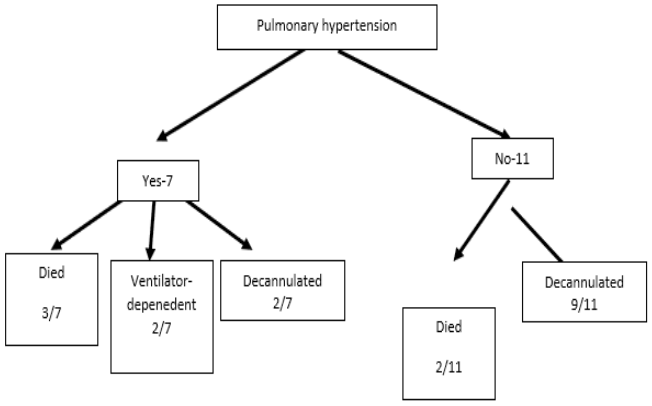

Figure 2: Outcome of BPD patients with or without pulmonary hypertension.

4. Discussion

Currently there is no consensus on the optimal timing for tracheostomy placement and most single center studies have reported a range from 42 to 51 weeks Post Menstrual Age (PMA)[14-16]. At our center, PPMA at the time of tracheostomy placement ranged from 38-64 weeks with a mean 45.1 weeks.

The average GA at birth was 28.5 weeks for infants requiring tracheostomy in one retrospective study with 145 patients over a 15-year period[17]. Mean GA of our population was 26.1 weeks, indicating an increasing number of preterm infants are being resuscitated and an increasing number of preterm infants survive longer to need tracheostomy.

Tracheostomy placement in infants requiring prolonged mechanical ventilation has advantages and disadvantages. Multiple studies have shown that early tracheostomy placement leads to less unplanned extubation, reduces the risk of subglottic stenosis, decreases the need for sedation, improves mobility and parental bonding, promotes neurodevelopment and physical growth by facilitating the transition to homecare[4,18-21]. The severity of illness or other factors may influence an earlier placement of tracheostomy[9]. Tracheostomy placement is associated with high mortality, postoperative complications, high readmission rates, neurodevelopmental impairment and significant caregiver burden, making it a highly complex and challenging decision. A case series by Gaudet et al. found some type of complication in one-third of pediatric patients who had tracheostomies[22]. With more standardization and improvement in BPD care of preterm infants, the recommendation is to avoid tracheostomy as much as possible, to reduce further complications of respiratory infection and tracheal injury[19]. In one study disproportionately more patients born at a more premature gestational age were in the late tracheostomy placement groups and it did not significantly affect the time for mechanical ventilation or decannulation[11]. Our study shows that the early tracheostomy group patients had an improved outcome in terms of early decannulation. However, 4 of the patients in that group are between 34 to 36 months of age at the time of completion of the study.

Mortality after tracheostomy may occur in the early postoperative period. Retrospective nationwide data suggest that 8% of pediatric tracheostomy patients will die during their index admission[23]. Neonatal cohort study from 2001 to 2013 identified a 26.3% mortality at a median age of 1.4 years with 11.4% dying before hospital discharge[10]. Our study demonstrated a pre-discharge mortality rate of 16% (3/18), compared to published rates ranging from 8% to 11.4%. Previous studies did not show significant gender difference[10]. In our study, predominantly male (66.6% male vs 33.3% female) infants with BPD required tracheostomy placement.

Multiple studies have showed a range of 15-21% mortality rate after hospital discharge[16,24]. Akangire, et al. [24] reported that of the 21% of their patients who died by four years of age, the median age of death occurred at 27 months, while Sillers et al. found a median age of death to be 17 months[10]. Our data showed a similar mortality rate (13.3%) after hospital discharge.

Salley et al.[25] reported that in their study the median time for decannulation of pediatric tracheostomies less than 3 years, was 2.5 years. Among premature tracheostomy patients with BPD, the majority of decannulation occurs by the 3 years post-

tracheostomy with less likelihood after 6 years[16]. In our study, decannulation time from tracheostomy is similar with an average of 38 months from birth (range 24 months to 59 months) and median of 36 months.

Several studies have indicated that nutrition is a key component of lung growth, particularly for infants with severe BPD who require tracheostomy and home ventilation. These infants have high-energy needs and energy consumption, manifested by increased work of breathing in an effort to mitigate ongoing lung inflammation and sustain continuous lung repair. Even the babies who are born appropriate for gestational age (AGA) develop severe growth failure by the time of tracheostomy[26-28]. SGA status at birth and postnatal undernutrition is associated with delayed alveolar development, abnormal lung healing and reduced lung function[29]. Patients with adequate weight gain and linear growth have been shown to wean from ventilator support and have improved pulmonary function testing in childhood[30-32]. In our study, we did not find that SGA at birth as a significant risk factor, but poor growth at one and two years of corrected age, particularly in male infants was associated with adverse outcome. This was not seen in female infants with poor growth, even though the number was too small for any meaningful speculation. We observed that male infants with poor growth were at risk of increased mortality or prolonged ventilator support in our study population.

PHT is associated with higher morbidity and mortality in BPD infants, especially in the first 6 months after the initial diagnosis[33]. Hence, it is important to diagnose and treat appropriately for improved outcomes[34]. Our study showed that the presence of PHT is a risk factor for mortality or prolonged mechanical ventilator support via tracheostomy.

The major limitation of our study is its small number of cases and retrospective nature, which presents inherent issues related to data collection and interpretation. However similar to many articles, findings in our study confirm the importance of gender, growth and co-morbidities like PHT can affect the outcomes in these vulnerable population of preterm infants with tracheostomy. In addition, our study shows the importance of growth even after discharge to be an important factor for survival and decreasing ventilator dependence.

5. Conclusion

In conclusion, our study shows that male sex and poor growth even after discharge is associated with worse outcome in patients with tracheostomy for BPD. The presence of PHT delays liberation from ventilator and decannulation.

6. Acknowledgement

The study adhered to STROBE guidelines to ensure comprehensive reporting of observational data, enhancing the reliability and reproducibility of findings.

7. References

1. Stoll BJ, Hansen NI, Bell EF, et al. Neonatal outcomes of extremely preterm infants from the NICHD Neonatal Research Network. Pediatrics. 2010;126(3): 443-456.
2. Dani C, Poggi C. Nutrition and bronchopulmonary dysplasia. J Matern Fetal Neonatal Med. 2012;25(3): 37-40.
3. Lee JH, Smith PB, Quek MB, et al. Risk Factors and In-Hospital Outcomes following Tracheostomy in Infants. J Pediatr. 2016;173: 39-44.
4. Overman AE, Liu M, Kurachek SC, et al. Tracheostomy for infants requiring prolonged mechanical ventilation: 10 years' experience. Pediatrics. 2013;131(5): 1491-1496.
5. Donda K, Agyemang CO, Adjetey NA, et al. Tracheostomy trends in preterm infants with bronchopulmonary dysplasia in the United States: 2008-2017. Pediatr Pulmonol. 2021;56(5): 1008-1017.
6. Wang CS, Kou YF, Shah GB, et al. Tracheostomy in Extremely Preterm Neonates in the United States: A Cross-Sectional Analysis. Laryngoscope. 2020;130(8): 2056-2062.
7. Grover TR, Brozanski BS, Barry J, et al. High surgical burden for infants with severe chronic lung disease (sCLD). J Pediatr Surg. 2014;49(8): 1202-1205.
8. Guaman MC, Gien J, Baker CD, et al. Point Prevalence, Clinical Characteristics and Treatment Variation for Infants with Severe Bronchopulmonary Dysplasia. Am J Perinatol. 2015;32(10): 960-967.
9. Miller AN, Shepherd EG, Manning A, et al. Tracheostomy in Severe Bronchopulmonary Dysplasia-How to Decide in the Absence of Evidence. Biomedicines. 2023;11(9).
10. Sillers L, Lioy J, Moran K, et al. Survival and decannulation across indications for infant tracheostomy: a twelve-year single-center cohort study. J Perinatol. 2022;42(1): 72-78.
11. Cheng J, Lioy J, Sobol S. Effect of tracheostomy timing in premature infants. Int J Pediatr Otorhinolaryngol. 2013;77(11): 1873-1876.
12. Yallapragada S, Savani RC, Mūnoz-Blanco S, et al. Qualitative indications for tracheostomy and chronic mechanical ventilation in patients with severe bronchopulmonary dysplasia. J Perinatol. 2021;41(11): 2651-2657.
13. Smith MA, Steurer MA, Mahendra M, et al. Sociodemographic factors associated with tracheostomy and mortality in bronchopulmonary dysplasia. Pediatr Pulmonol. 2023;58(4): 1237-1246.
14. Mandy G, Malkar M, Welty SE, et al. Tracheostomy placement in infants with bronchopulmonary dysplasia: safety and outcomes. Pediatr Pulmonol. 2013;48(3): 245-249.
15. Upadhyay K, Vallarino DA, Talati AJ. Outcomes of neonates with tracheostomy secondary to bronchopulmonary dysplasia. BMC Pediatr. 2020;20(1): 414.
16. Cristea AI, Carroll AE, Davis SD, et al. Outcomes of children with severe bronchopulmonary dysplasia who were ventilator dependent at home. Pediatrics. 2013;132(3): 727-734.
17. Lloyd AM, Behzadpour HK, Rana MS, et al. Factors associated with tracheostomy decannulation in infants with bronchopulmonary dysplasia. Int J Pediatr Otorhinolaryngol. 2023;175: 111754.
18. Wright MFA, Wallis C. Investigation and management of the long-term ventilated premature infant. Early Hum Dev. 2018;126: 10-17.
19. Zenk J, Fyrmpas G, Zimmermann T, et al. Tracheostomy in young patients: indications and long-term outcome. Eur Arch Otorhinolaryngol. 2009;266(5): 705-711.
20. DeMauro SB, D'Agostino JA, Bann C, et al. Developmental outcomes of very preterm infants with tracheostomies. J Pediatr. 2014;164(6): 1303-1310.
21. Sidman JD, Jaguan A, Couser RJ. Tracheotomy and decannulation rates in a level 3 neonatal intensive care unit: a 12-year study. Laryngoscope. 2006;116(1): 136-139.
22. Gaudet PT, Peerless A, Sasaki CT, et al. Pediatric tracheostomy and associated complications. Laryngoscope. 1978;88(10):1633-1641.

23. Muller RG, Mamidala MP, Smith SH, et al. Incidence, Epidemiology and Outcomes of Pediatric Tracheostomy in the United States from 2000 to 2012. Otolaryngol Head Neck Surg. 2019;160(2): 332-338.

24. Akangire G, Manimtim W. Tracheostomy in infants with severe bronchopulmonary dysplasia: A review. Front Pediatr. 2022;10: 1066367.

25. Salley J, Kou YF, Shah GB, et al. Survival analysis and decannulation outcomes of infants with tracheotomies. Laryngoscope. 2020;130(10): 2319-2324.

26. Rocha G, Guimarães H, Pereira-da-Silva L. The Role of Nutrition in the Prevention and Management of Bronchopulmonary Dysplasia: A Literature Review and Clinical Approach. Int J Environ Res Public Health. 2021;18(12).

27. Jung YH, Park Y, Kim BI, et al. Length at birth z-score is inversely associated with an increased risk of bronchopulmonary dysplasia or death in preterm infants born before 32 gestational weeks: A nationwide cohort study. PLoS One. 2019;14(5): 0217739.

28. Bauer SE, Vanderpool CPB, Ren C, et al. Nutrition and growth in infants with established bronchopulmonary dysplasia. Pediatr Pulmonol. 2021;56(11): 3557-3562.

29. Ma L, Zhou P, Neu J, et al. Potential Nutrients for Preventing or Treating Bronchopulmonary Dysplasia. Paediatr Respir Rev. 2017;22: 83-88.

30. Miller AN, Moise AA, Cottrell L, et al. Linear growth is associated with successful respiratory support weaning in infants with bronchopulmonary dysplasia. J Perinatol. 2022;42(4): 544-545.

31. Filbrun AG, Popova AP, Linn MJ, et al. Longitudinal measures of lung function in infants with bronchopulmonary dysplasia. Pediatr Pulmonol. 2011;46(4): 369-375.

32. Sanchez-Solis M, Perez-Fernandez V, Bosch-Gimenez V, et al. Lung function gain in preterm infants with and without bronchopulmonary dysplasia. Pediatr Pulmonol. 2016;51(9): 936-942.

33. Koroglu OA, Yalaz M, Levent E, et al. Cardiovascular consequences of bronchopulmonary dysplasia in prematurely born preschool children. Neonatology. 2013;104(4): 283-289.

34. Abman SH. The dysmorphic pulmonary circulation in bronchopulmonary dysplasia: a growing story. Am J Respir Crit Care Med. 2008;178(2): 114-115.