Section: Pediatrics

Original Research Article

PREDICTION OF FACTORS ASSOCIATED WITH EXTUBATION FAILURE IN CHILDREN OF AGE GROUP 1 MONTH TO 12 YEARS IN PAEDIATRIC IINTENSIVE CARE UNIT IN TERTIARY CARE CENTRE

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Abstract

Background: Extubation failure, which occurs in 3–22% of cases is linked to worse patient outcomes, including higher mortality rates, prolonged PICU (Pediatric Intensive Care) and hospital stay etc. Reducing reintubation rates necessitates the accurate identification of risk factors. So we aim to determine the factors associated with extubation failure in our setting. **Materials and Methods:** This cross-sectional study was conducted in PICU tertiary care hospital in South India in children between the age group of 30 days to 12 years who were mechanically ventilated from April 2023 to March 2024. The patient's demographic data, PRISM (Pediatric Risk of Mortality Score) at admission, nutrition status, sedation duration, blood gas values were collected. The study population was classified into Extubation failure (EF) and successful extubation (SE) groups and the differences in patient characteristics and possible risk factors between the ES and EF groups were studied. **Result:** Among 96 children included in this study, 14 (14.6%) failed extubation. The majority of EF occurred within the first three days of extubation (78%). There were significant differences between the EF and SE groups in the duration of mechanical ventilation (P <0.0099) and PRISM score at admission (P < 0.02). **Conclusion:** The study found that prolonged duration of mechanical ventilation and higher PRISM scores at admission were significant risk factors. We have also found that the use of HFNC support during post-extubation had better outcomes compared to NIV. Careful assessment of readiness for weaning and structured post-extubation strategies, including the use of HFNC, can reduce reintubation risks.

INTRODUCTION

The proportion of children requiring mechanical ventilation in our PICU (Pediatric Intensive Care) ranges from 5-10 per cent of all admissions. The primary indicator for assisted ventilation is respiratory failure, as a result of primary airway anomaly or lung disease or secondary to multi-organ failure.

Extubation, defined as the removal of the endotracheal tube, can fail when reintubation is needed within hours or days due to factors like the inability to maintain oxygenation, ventilation, airway patency, or secretion management.[1] Extubation failure, which occurs in 3–22% of cases, regardless of the initial illness severity, is linked to worse patient outcomes, including higher mortality rates, prolonged PICU and hospital stay, higher cost and greater need for tracheostomy.[2]

Reducing reintubation rates necessitates the accurate identification of risk factors. Studies have highlighted various factors contributing to reintubation, including age, mechanical ventilation duration, etc.[3]

So we aim to determine the factors associated with reintubation in our PICU.

MATERIALS AND METHODS

This cross-sectional study was conducted at the PICU of tertiary care hospital in South India. All children between the age group of 30 days to 12 years who

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were mechanically ventilated in our PICU from April 2023 to March 2024 were recruited. Children who expired before extubation, referred to another hospital with an endotracheal tube (ETT) or those need tracheostomy were excluded. Only the first planned extubation attempt for each patient was assessed for this study. Extubation failure (EF) was defined as the need for reintubation within seven days of a planned extubation.[4,5] The patients' details were reviewed and specific predefined clinical variables including patient's demographic data, PRISM(Pediatric Risk Mortality Score) III at admission, nutrition status, sedation duration, requirement of fluid boluses, dual inotropes, pre-intubation and post-extubation blood gas values and other risk factors of EF were collected.

All infants were ventilated using Macquet ventilators. The primary ventilation mode was pressure control ventilation. Infants were extubated once they were on minimal ventilatory parameters, had normal blood gases and were decided by the PICU team (established spontaneous breathing, hemodynamically stable).

Post-extubation interventions included a high-flow nasal cannula(HFNC)/NIV(Non invasive ventilation) for oxygenation. The study population was classified into two groups: EF and successful extubation(SE). Descriptive statistics included mean ± standard deviation (SD) or median and interquartile range (IQR) for continuous variables and counts and percentages for categorical variables. The differences in patient characteristics and possible risk factors between the ES and EF groups were tested using the Chi-squared test for categorical variables. Statistical Package for the Social Sciences (SPSS), Version 23.0 (IBM Corp., Chicago, Illinois, USA) was used for data analysis. A P value of ≤ 0.05 was considered statistically significant. Ethical approval was obtained through the institution's Medical Research Ethics Committee IEC-CMC approval/19/2022 dated 30.3.2023.

RESULTS

A total of 96 children were included in this study, out of which 14 (14.6%) failed extubation [Figure 1]. Most of the EF children belong to the age group of 1 month to 1 year (79%). The most common reasons for reintubation were increased work of breathing (60%) followed by desaturation and bradycardia (20%) and upper airway obstruction (13.8%) [Figure 2]. MV was most frequently indicated for hypoxemic respiratory failure (49%), followed by apnea (13.5%) and status epilepticus (14.6%) [Figure 2]. The majority of extubation failures occurred within the first three days of extubation (78%). There were significant differences between the EF and SE groups for the following two parameters: duration of mechanical ventilation (P <0.0099) [Figure 4], and PRISM score at admission (P < 0.02). There were no significant differences in other clinical variables (nutrition status, indication for mechanical ventilation, sedation duration, fluid boluses, onotropes) and blood gas results [Table 1].

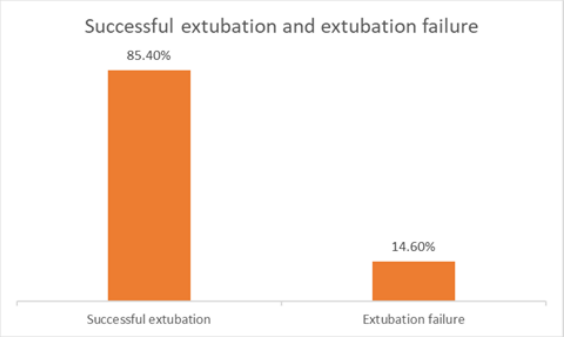

Figure 1: Showing comparison of successful and failed extubation

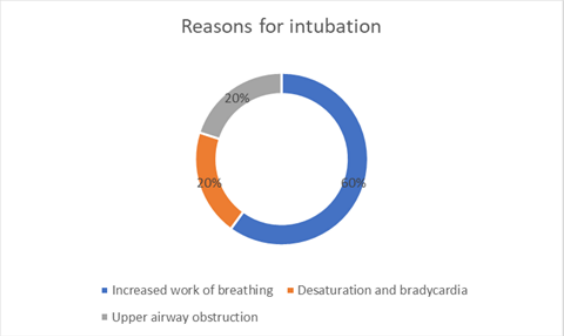

Figure 2: Depicting reasons for re-intubation in our study

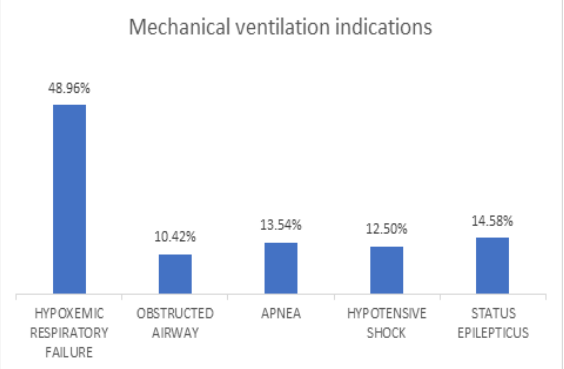

Figure 3: Showing indications for mechanical ventilation.

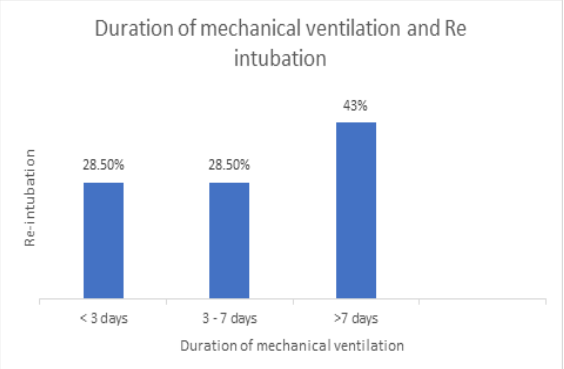

Figure 4: Association between re-intubation and duration of mechanical ventilation

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Table 1: Characteristics of successful extubation (SE) and failed extubation (EF).

Variable		SE(n=82)	EF(n=14)	P value
Age (years) n(%)	1month to 1 year	39(48%)	11(79%)	0.09
	1 year to 5 years	35(43%)	2(14%)	
	5 years to 12 years	8(9%)	1(7%)	
Male n(%)		47(57%)	11(79%)	0.133
MV (>7 days) n(%)		8(9%)	6(43%)	0.009
Indication for MV	Hypoxemic respiratory failure	38(46%)	9(64%)	0.562
	Obstructed airway	9(11%)	1(7%)	
	Apnea	13(16%)	0	
	Hypotensive shock	10(12%)	2(14%)	
	Status epilepticus	12(15%)	2(14%)	
PRISM score(median IQR)		6(5-7)	18(14-22)	0.02
Duration of sedation >72 hours		13(16%)	1(0.07%)	0.393
Malnourished		33(40%)	2(0.14%)	0.228
Presence of Comorbidity		60(73%)	12(86%)	0.316
Higher fluid bolus requirement[>60ml/hr]		33(40%)	8(57%)	0.099
Dual inotropes requirement		28(34%)	8(57%)	0.24
Respiratory acidosis	Before intubation	24(29%)	4(29%)	0.534
	After extubation	4(29%)	1(7%)	0.554

SE-successful extubation; EF-Extubation failure; MV-Mechanical ventilation; PRISM-Pediatric Risk Of Mortality

P<0.05 is considered significant

DISCUSSION

This study determined the re-intubation rates rate (and associated risk factors) among intubated children in a

tertiary care PICU in south India. The extubation failure rate was found to be 14.6% compared to other studies 4-19%. The following factors were associated with extubation failure in our study: duration of mechanical ventilation and higher PRISM scores.

The study investigated the association between the duration of mechanical ventilation (MV) and the need for reintubation, with significant findings (p = 0.0099). Badruddin et al,[7] 2020 found that prolonged mechanical ventilation(MV) was associated with an increased risk of ventilator-associated complications and reintubation. The median MV duration was 5.5 days, and high-flow nasal cannula support post-extubation showed a lower prevalence of reintubation. Awasthi et al,[8] 2013 study identified that prolonged MV (>4 days) was a strong risk factor for VAP and reintubation in pediatric ICU settings, emphasizing the importance of vigilant monitoring and timely extubation. From these findings, we emphasize that strategies should be followed to reduce the duration of MV thereby preventing morbidities of EF.

A significant proportion of participants(EF) (76%) had an elevated PRISM score[18 (14-22)]at admission, indicating higher severity of illness or greater risk of mortality. Additionally, chronic comorbidities were present in 86% of participants, suggesting that many patients had underlying health conditions that could influence their clinical outcomes Trachsel et al,[9] 2005 showed that the PRISM score, used within the first 12 hours of mechanical ventilation, independently predicts mortality and ventilation duration, which are critical factors influencing reintubation rates. Vijayaraghavan et al,[10] 2019] confirmed the predictive accuracy of the PRISM III score in estimating mortality risk, which can indirectly inform reintubation strategies in pediatric ICUs. These findings signifies the fact higher the PRISM score, Higher the re-intubation rates thereby specified criteria should be followed in all intensive care settings for the extubation.

In our study, the most common used ventilation modes were high-flow nasal oxygen (HFNC, 36.5%) and non-rebreather mask (NRM, 32.3%), with 25% of participants receiving non-invasive ventilation (NIV) after extubation. A significant majority (81.3%) of NIV cases required reintubation. Rosenberg,[11] 2020 study assessed HFNC's effectiveness compared to NIV for preventing extubation failure. HFNC showed better patient comfort and reduced the risk of reintubation compared to NIV in pediatric patients with high-risk conditions. Ramnarayan et al,[12] 2022 randomized trial compared HFNC and CPAP for post-extubation respiratory support in critically ill children. HFNC was non-inferior to CPAP in reducing the time to respiratory support liberation but had a higher mortality rate at day 180. HFNC had a lower reintubation rate and shorter ICU stays than NIV, suggesting it was a feasible post-extubation option.

Our study showed that 37% had malnutrition and found that there was no significant association between nutrition and reintubation. Fontela et al,[13] 2005 explored risk factors for extubation failure, including age, ventilation duration, and comorbidities like malnutrition, providing insights for managing pediatric ICU patients. It suggests that malnutrition and inadequate nutritional support can contribute to extubation failure, necessitating reintubation though our study finding did not support that.

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The association between sedation duration and the need for reintubation was analyzed, showing no statistically significant relationship (p = 0.393). Among patients who received sedation for less than 72 hours, 15.9% required reintubation, while 84.1% did not. In contrast, only 7.1% of those who were sedated for more than 72 hours needed reintubation, with the majority (92.9%) avoiding it. Schultheis et al,[14] 2017 found no statistically significant difference in extubation failure rates between deeply sedated and non-deeply sedated groups. However, deep sedation was associated with longer durations of ventilation and increased odds of extubation challenges. Ishak et al,[15] 2022 identified sedation duration as a significant factor in extubation failure. Prolonged sedation was linked to extubation difficulties, particularly in younger children.

Our study has certain limitations as well. It was a single-centre study restricted to children admitted over a specific period. Since extubation was based on clinical judgement by pediatric ICU consultants, results would have been affected.

CONCLUSION

The study found that pediatric ventilated patients will fail extubation if they have longer duration of mechanical ventilation and higher PRISM scores at admission. We have also found that the use of HFNC support during post-extubation had better outcomes compared to NIV. Careful assessment of readiness for weaning and structured post-extubation strategies, including the use of HFNC, can reduce reintubation risks. The standardised scoring system for extubation should be studied and validated in further studies to prevent extubation failure.

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