Original article

Factors associated with failed extubation in extremely low birth premature newborn: A retrospective observation study

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Abstract. *Background and aim:* Most of the extremely low birth weights (*ELBW)* are intubated in the delivery room or soon after. Achieving successful extubation is one of the most critical milestones in managing these newborns. This study aimed to evaluate the extubation patterns of ELBW newborns (23 and 27 gestation weeks). *Methods:* This population-based retrospective study was conducted at a tertiary neonatal intensive care unit (NICU) in Qatar for 30 months. Data was collected from electronic medical records. *Results:* The study comprised 73 ELBW newborns who were successfully extubated and 55 had to be re-intubated, resulting in a failure rate of 42% (55/128). Logistic regression analysis revealed that weight at extubation was significant (AUC = 0.693), birth weight (AUC = 0.702), gestational age (AUC = 0.707), and age at initial extubation are significant predictors of extubation outcome ($p < 0.0001$). Active patent ductus arteriosus and extubation within < 24 hours after birth caused extubation failure. The administration of two doses of prenatal steroids and one dosage of surfactant exhibited a significant difference between the two groups (P = 0.027 and 0.001, respectively). Neonatal infection was the primary reason for re-intubation after 14 days of life. *Conclusions*: The most common risk factors for failed extubation were gestational age of 23–25 weeks, active patent ductus arteriosus, extubation occurring in less than 24 hours after birth, and birth weight under 800 grams. The 7–14-day observation window was the most optimal time frame for reporting the reintubation rate. (www.actabiomedica.it)

Key words: extubation, extremely low birth weight (ELBW) newborns, bronchopulmonary dysplasia, premature, re-intubation, ventilation

Introduction

Preterm newborns weighing under 1000 grams may necessitate artificial ventilation due to respiratory immaturity. Intubation in the delivery room has been standard practice for many years. In recent years, neonatologists worldwide have increased their awareness of the risks associated with intubation, the potential short- and long-term harm from the endotracheal tube, and the dangers of mechanical ventilation (1). Extubation of a preterm newborn is considered a significant milestone; however, reintubation represents a considerable setback. The greatest concern for neonatologists is encountering an extremely low birth weight newborn in the delivery room following a challenging intubation. Reports indicate that 86% of attending neonatologists achieve success on the first intubation attempt, in contrast to 76% of experienced fellows and fewer than 25% of residents (2). Additionally, studies indicate that newborns intubated in the delivery room face an increased risk of mortality and/or significant brain injury compared to those intubated in the NICU. Newborns who experience failed intubation or require multiple attempts are at an increased risk of developing bronchopulmonary dysplasia, mortality, or significant neurological deficits (3–5). It became increasingly recognized that prolonged intubation and mechanical ventilation are an ideal recipe for the development of significant neurodevelopmental abnormalities and a high risk of death (6). In recent years, there has been an increased awareness that the extent of neonatal resuscitation significantly influences the outcomes of ELBW newborns. There has been a significant push among carers of preterm newborns to avoid intubation, particularly in the delivery room. Since the advent of early, successful noninvasive ventilation and doctors' comprehension of changes in the newborn's heart rate and oxygen saturation levels during resuscitation, the number of babies requiring intubation in the delivery room has considerably decreased (7–9). Although up to 70% of ELBW newborns remain intubated in the delivery room or shortly after admission to the NICU, ascertaining the appropriate timing for extubation is not only a pivotal inquiry but also the most significant milestone in the management of this vulnerable population. Extubation must not be a gamble or a trial-and-error procedure; it should be a meticulously calculated approach that employs all available methodologies in the literature to minimize failure. The literature characterizes successful extubation as "survival without the necessity for respiratory support via an endotracheal tube after extubation during an observation period. The literature defines extubation failure as a reintubation occurring within a specified observation period following the initial elective extubation (10). Failed extubation and recurring intubation are considered significant risk factors for the onset of bronchopulmonary dysplasia, with an uncertain risk of mortality. Longer hospitalizations, home oxygen discharges, and extended invasive and noninvasive ventilation are significant outcomes (11). This observational study aims to document our experience with extubating ELBW newborns and to analyze the reintubation patterns, seeking a more definitive observation window that accurately reflects the reintubation rate in any NICU unit.

Patients and Methods

Study design

This Retrospective study collected data on preterm neonates under 28 weeks gestation who were admitted to the NICU at the Women's Wellness and Research Centre (WWRC) between January 2021 and mid-2023 and were intubated during the first week of life and were then extubated. The Women's Wellness and Research Centre is the largest tertiary women's hospital in the country, with an average of 16000 to 18000 deliveries annually.

Definitions and describing the research

The NICU-WWRC is the primary unit that cares for newborn newborns under 30 weeks gestation. The delivery room applies golden hour arrangements to all newborns born before 30 weeks gestation. Before having to intubate the newborn, we typically attempt noninvasive ventilation, such as CPAP or nasal positive pressure ventilation. Less invasive surfactant installation (LISA) is the primary choice before intubation. An attending neonatologist, NICU nurse, respiratory therapist, and neonatal fellow who have all received Neonatal Resuscitation Program certification attends all high-risk deliveries. As a routine initial ventilation procedure, the NICU typically uses assisted control intermittent positive pressure ventilation with volume guarantee. The initial ventilator's starting settings are PIP/PEEP = 16-22/5-7, volume guarantee = 4.5-6 ml/kg, inspiratory time is 0.35, and at a rate of 40 breaths per minute. The unit follows an extubation bundle that tells it what settings to use before removing the tube. These include a volume guarantee of 4.5 ml/kg, a PIP/PEEP of 16/5, mean airway pressure less than 8 Cm H_2O, FIO_2 of 30% or less, an oxygen saturation range of 90-95%, a PCO_2 below 45, and a pH level above 7.25.

Population

The newborn should pass a spontaneous breathing test (SBT) at least once before the extubation process, loading dose of caffeine, and the PDA should be hemodynamically stable. Upon meeting these criteria, a multidisciplinary team often conducts a thorough assessment of the newborn's extubation readiness, considering all aspects of the newborn's health. Continuous monitoring post-extubation is crucial to promptly address any respiratory distress or complications that may arise. Birth weight, age of extubation, gestational age, and/or inactive patent ductus arteriosus status are not standard criteria for making an extubation decision. Newborns who died before extubation, those transferred to another hospital during intubation for surgery, and those with significant congenital defects were among the exclusion criteria. Currently, there is no observation window defined in our unit. A total of 326 preterm newborns less than 30 weeks gestation were admitted to the NICU and intubated endotracheally with ventilatory support. A total of 198 preterms were excluded from the study for the following reasons: 135 preterms were older than 27+6 weeks GA, 58 ELBW died before extubation, and 4 ELBW were transferred to another hospital for surgical intervention. Finally, 128 ELBW ≤ 27+6 GA satisfied the inclusion criteria for the study as shown in Figure 1.

Data collection

We obtained the patient data retrospectively from the patient's electronic file (CERNER)®.

We then transferred the data from Microsoft Excel to the SPSS-26 program. The study's primary focus was data on gestational age, age at extubation, birth weight, weight at extubation, antenatal steroid, surfactant therapy, chorioamnionitis, Apgar score, intubation in the delivery room versus NICU, resuscitation at birth, pre-extubation ventilation parameters, and pre-extubation blood gas.

Additionally, we analyzed the correlation between these variables and the overall outcomes of the patients to identify potential predictors of successful extubation. This comprehensive analysis aimed to enhance our understanding of the factors influencing the outcome of the extubation process.

Statistical analysis

We present the data as the standard deviation, frequency distribution, percentage, mean, or median, and interquartile range of continuous variables for the basic characteristics of ELBW newborns. We examined the frequencies using the chi-square test. We utilized an independent T-test for continuous variables. We utilize it to determine whether there are substantial differences between the fundamental attribute data, respiratory parameters, and clinical parameters. We generated and presented the sensitivity and specificity values for the receiver operating characteristic

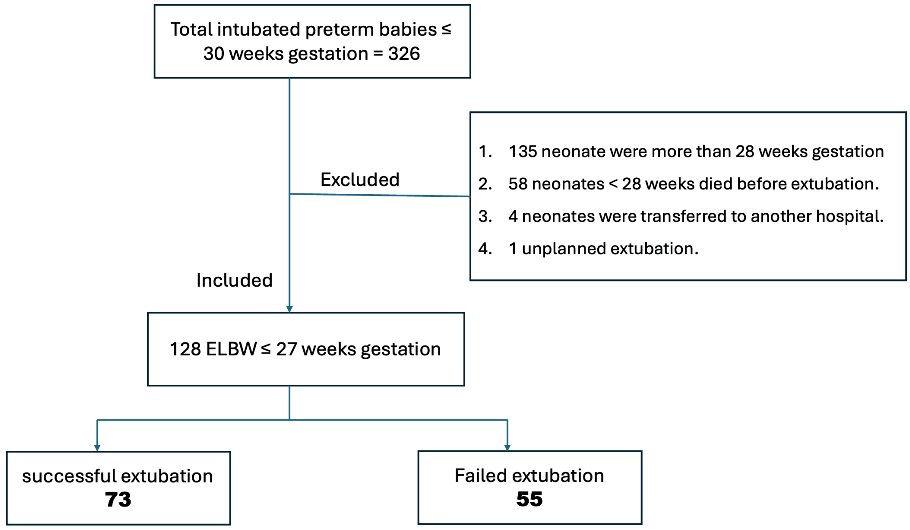

Figure 1. Flow diagram of the neonate's enrollment.

curve (ROC) analysis using all clinical cut-off metrics to assess the diagnostic performance of various predictors.

This approach allowed us to identify key indicators that significantly affect the outcomes of ELBW preterm newborns, ultimately guiding clinical decision-making and improving patient management strategies. We used multivariate logistic regression to obtain the odds ratio of the predicted parameters for extubation success. $P < 0.05$ were considered statistically significant. We structured the data in Excel and ran the statistical analysis with SPSS 26 software.

Ethical considerations

This study was approved by the Women's Wellness and Research Center, Hamad Medical Corporation, Doha-Qatar, with protocol number MRC-01-22-807, Jan 2023. The main ethical concern in this type of research is respecting the confidentiality and privacy of potential participants.

Results

We evaluated the extubation patterns of ELBW newborns (23 and 27 gestation weeks). There were 73 ELBW preterm with first attempt successful extubation and 55 ELBW preterm with failed first attempt extubation with a rate of 42% (55/128). The demographics, prenatal characteristics, and medication use of the ELBW newborns included are described in Table 1.

The gestational age of preterm newborns was between 23^{+0} to 27^{+6} weeks, with a mean of 26.11 (±1.03) and 25.25 (±1.18) weeks in the success and failure groups, respectively (P = 0.0001). Birth weight ranged from 490 grams to 1350 grams, and the success and failure groups weighed 933 grams (±191) and 803 grams (±162.5) respectively (P = 0.0001). The weight at first extubation was 932 grams (±185) vs 830 grams (± 152) (P = 0.0001).

Our study displayed the non-significant risk factors (Table 2), such as anemia, hypercarbia, and the ability to pass spontaneous breathing tests, and found

Table 1. Significant Demographic: neonatal, maternal, and ventilation-associated data for EF and ES groups.

Variable	Extubation failure (EF) n=55	Extubation success (ES) n=73	P =
Maternal and prenatal characteristics			
No of antenatal steroid dose* Non One dose, n (%) Two doses, n (%)	 3 (5.5%) 8 (14.5%) 44 (80%)	 11 (15.0%) 23 (31.5%) 39 (53.4%)	 0.001
Neonatal characteristics			
Gestational age, weeks, mean (SD)	25.25(±1.18)	26.11(±1.03)	0.0001*
Birth weight, grams, mean (SD)	803.681(162.5)	933.82(191)	0.0001*
Number of Surfactant doses, n (%)			
No Surfactant	2(3.6%)	---	0.001
One dose of surfactant	17(30.9%)	43(58.9%)	
≥ 2 doses of surfactant	33(60%)	30(41.1%)	
PDA, n (%)	36(65.4%)	20(27.39%)	0.0001*
Ventilation associated data			
Weight at first extubation	830(±152)	932.43(±162)	0.0001*

Abbreviations: ANS= Antenatal steroid; missing ANS treatment against single dose ANS = P = 0.75 -OR=0.8, Missing ANS treatment against 2 doses = P = 0.04 - OR=0.2, and Missing ANS+One dose ANS treatment against 2 doses = P = 0.001- OR=3.4. PDA; Patent ductus arteriosus.

Table 2. Non-significant Demographic, neonatal, maternal, and ventilation-associated data for EF and ES groups

Variable	Extubation failure (EF) n=55 (%)	Extubation success (ES) n=73 (%)	P =
Maternal and prenatal characteristics			
Cord PH	7.3 (0.09)	7.27 (0.115)	0.091
Antenatal steroid	52 (94.5%)	66 (90.4%)	0.3
Chorioamnionitis, n (%)	7 (12.7%)	9 (12.3%)	0.9
PROM, n (%)	25 (45.45%)	29 (39.7%)	0.5
Maternal PP+, n (%)	6 (10.9%)	9 (12.3%)	0.8
Mode of delivery, n (%)			
VD, n (%) Cs, n (%)	21 (38.18%) 34 (61.8%)	32 (43.8%) 41 (56.1%)	0.5
Neonatal characteristics			
Apgar score at 5 min, median (IQR)	8 (2-10)	8 (2-10)	0.9
PPHN, n (%)	4 (1.7%)	6 (8.2%)	0.6
Intubation in the delivery room	45 (81.8%)	60 (82%)	0.95
Ventilation associated data			
Age at first intubation (hours)	6.073 ± 6.04	8.18 ± 7.8	0.86
Age at first extubation (days)	9.2 ± 10.96)	7.16 ± 9.2	0.3
Sepsis, n (%)	11 (20%)	9 (12.3%)	0.2
FIO2 at extubation (%)	28.6 (0.066)	28.97 (0.083)	0.781
PH at extubation	7.36 ± 0.055	7.31 ± 0.358	0.27
PCO2 at extubation	42.925 (10.35)	42.45 (10.23)	0.8
Hemoglobin at extubation	13.6 ± 2.8	14.3 ± 2.6	0.18
SBT before extubation, n (%)	35 (63.6%)	52 (87.6%)	0.362
Pass SBT, n (%)	34 (61.8%)	49 (67.1%)	0.5
Pre-extubation steroid	7 (12.7%)	10 (13.6%)	0.8
Sedation, n (%)	6 (10.9%)	4 (5.4%)	0.257
Duration of mechanical ventilation (days)	15.08 (11.5)	15.01 (12.4)	0.9
Caffeine, n (%)	54 (94.5%)	72 (98.6%)	0.8

Abbreviations: PROM; Premature rupture of membranes, PP; pulse pressure, VD; vaginal delivery, CS; cesarean section, PPHN; Persistent pulmonary hypertension of the newborn, FIO2; fraction of inspired oxygen, PCO2; partial pressure of carbon dioxide, SBT; Spontaneous breathing trial.

no statistical difference. Newborns who did not receive ANS had no significant difference from those who received a single dose of ANS (P = 0.75), but those who did not receive, or had an incomplete course were significantly more at risk than those who received the whole course (P = 0.001).

The presence of PDA showed a significant difference between the failed group (n=36/55:65%) and the success group (n=20/73:27%) respectively (P = 0.0001). Missing or incomplete course of antenatal steroids was more common among the successful extubation group (20% vs 46%). Missing ANS was not of significance compared with a single dose of ANS (P = 0.75 & OR= 0.8) but missing ANS plus those received incomplete course (20%) compared to those receiving full course (34%) was significant (P = 0.001). There

Table 3. Multivariate logistic regression analysis for GA, WT at extubation, age categories at extubation, and duration of IPPV

Successful Extubation		SE n (%)	FE n (%)	P	OR	95% confidence interval for exp (b)	
						Lower bound	Upper bound
GA	Ga 23-24+	9 (7%)	24 (18.8%)	*0.003**	0.15	0.043	0.528
	Ga 25+	14 (10.9%)	12 (9.4%)	0.080	0.334	0.098	1.142
	Ga 26+	27 (21.1%)	11(8.6%)	0.635	0.767	0.256	2.294
	Ga 27+	23 (18%)	8 (6.3%)	----	-----	-----	-----
Weight at extubation	500-700	3 (2.3%)	13 (10.2%)	0.029	0.274	0.060	1.253
	701-800	15 (11.7%)	10 (7.8%)	0.228	1.582	0.561	4.463
	>800	55 (43%)	32 (25%)	------	------	-------	--------
Age categories at extubation	<24 hrs	30 (23.4%)	17 (13.3%)	0.975	.985	0.367	2.640
	>24-48 hrs	7 (5.5%)	4 (3.1%)	0.815	1.197	0.264	5.416
	>48 hrs-1 weeks	12 (9.4%)	12 (9.4%)	0.738	1.216	0.387	3.826
	>7days	24 (18.8%)	22 (17.2%)	------	-----	------	---------
Duration of MV	≤24 hrs	61 (47.7%)	44 (34.4%)	*0.0001***	7.5	2.43	2.30
	25-72 hrs	11 (8.6%)	11 (8.6%)	*0.0001***	7.1	7.13	7.13
	3-7 days	1 (0.8%)	0	------	------	------	--------

Abbreviations: GA; gestational age, MV; mechanical ventilation, IPPV; Intermittent Positive Pressure Ventilation, SE; Successful extubation, FE; Failed Extubation.

were no significant differences in the prenatal characteristics, mode of delivery, Apgar score, intubation in the delivery room, Medications, including caffeine, and measured respiratory parameters before extubation between the two groups. In the multivariate logistic regression analysis model the gestational age and the duration of MV were significantly associated with successful extubation, as the odds of extubation success decreased by 85% among GA 23-24+ group compared to those with GA over 24 weeks (OR=0.15, 95% CI=0.04-0.528, P = 0.003), also the odds of extubation success is the same for both groups whose duration of MV less than 72 hours group compared to those who were intubated more than 3 days (OR=7.4 and 95% CI=2.43-2.30, P = 0.0001*) and (OR=7.13, 95%CI=7.13-7.13 P = 0.0001) (Table 3 - Figure 2).

The predictive parameters for the factors affecting the duration of extubation were further analyzed, age at first extubation, GA, duration of mechanical ventilation, birth weight, weight at first intubation and proven sepsis all showed significant differences, as the age at first extubation increased one unit the odds of extubation duration less than 24 hours increases 19% (OR=1.19, CI=1.056-1.344, P = 0.005, while the odds increase 45% for the neonates' duration of extubation between 49-72 hours (OR=1.5, CI= 1.2-1.8, P = 0.0001), and 10 times for the 5-7 days group (OR=10.05, 95%CI=7.842-12.88, P = 0.0001). Also, one unit increase in GA increases the odds of duration of extubation less than 24 hours 3 times (OR=3.343, 95%CI=1.28-9.2, P = 0.014), compared to more than 7 days duration of extubation. Accordingly, the odds of an increase in the duration of extubation to more than 7 days are 7 times higher for neonates with sepsis (OR=7.08, CI=1.246-40.217, P = 0.027) (Table 4).

Other factors that did not influence extubation outcome in our study; were maternal chorioamnionitis, Apgar score, and intubation in the delivery room. Although the age at extubation was significant in logistic regression, the AUC on the ROC curve was low (Figure 3).

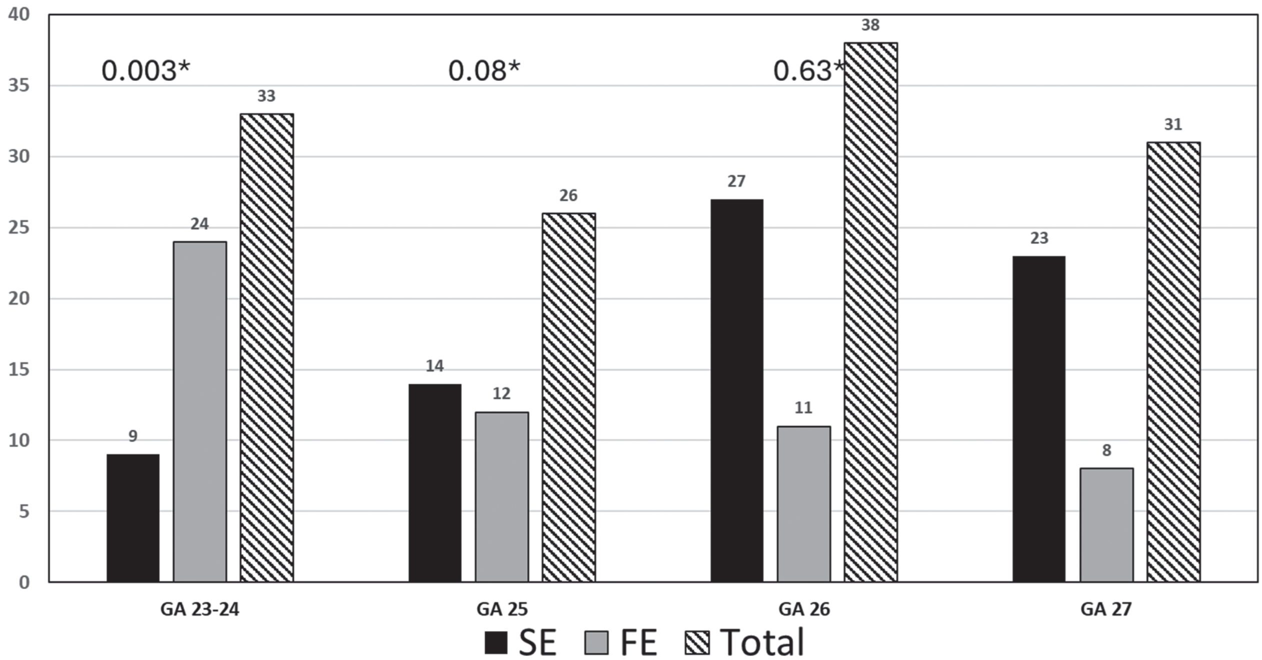

Figure 2. Successful extubation compared to failed extubation by gestational age (Comparing different gestation ages against 27 weeks' gestation with *P values. The odds ratios are 0.15, 0.33, and 0.77 for 23 and 24 weeks, 25 weeks, and 26 weeks, respectively).

Table 4. Multivariate logistic regression analysis for the factors significantly associated with extubation duration

Variable	Duration of extubation	AOR	(95% CI for OR)	P
Age at first extubation	<24 hrs	1.191	1.056-1.344	0.005*
	49-72 hrs	1.495	1.2-1.86	0.0001*
	5-7 days	10.052	7.842-12.88	0.0001*
GA	<24 hrs	3.3437	1.28-9.2	0.014*
Duration of IPPV	25-48 hrs	1.128	1.003-1.128	0.044*
sepsis	more than 7 days	7.079	1.246-40.217	0.027*

Abbreviations: GA; gestational age, MV; mechanical ventilation, IPPV; Intermittent Positive Pressure Ventilation.

Analysis of re-intubation timing revealed that 40% of such events transpired within 24 hours post-extubation. This phenomenon can be attributed to several factors: expedited extubation based exclusively on blood gas and ventilation parameters, premature extubation within the initial 24-48 hours of life (with 34% of failed extubation cases occurring within the first 24 hours), or an elevated threshold for re-intubation among the attending physician on duty (Figures 4 and 5). Figure 6 shows the primary cause of re-intubation is immaturity.

Discussion

Any NICU treats the expected arrival of an ELBW newborn as an emergency, especially when expectations are unknown and based on potentially incomplete forecasts. The pre-delivery scenario is defined by the interactions between the obstetrics and NICU team, the attending physician and the respiratory therapist, the nursing staff, and, most importantly, the attending physician and the parents. In the last ten years, the strategy of deferring or avoiding intubation in the delivery room for newborns weighing less than 1500 grams has become an important component of resuscitation. Neonatologists are investigating whether intubation in the delivery room causes more damage to the preterm lung than intubation later in the NICU (7,11–13). Harm may arise from the use of a laryngoscope by an untrained individual, excessive

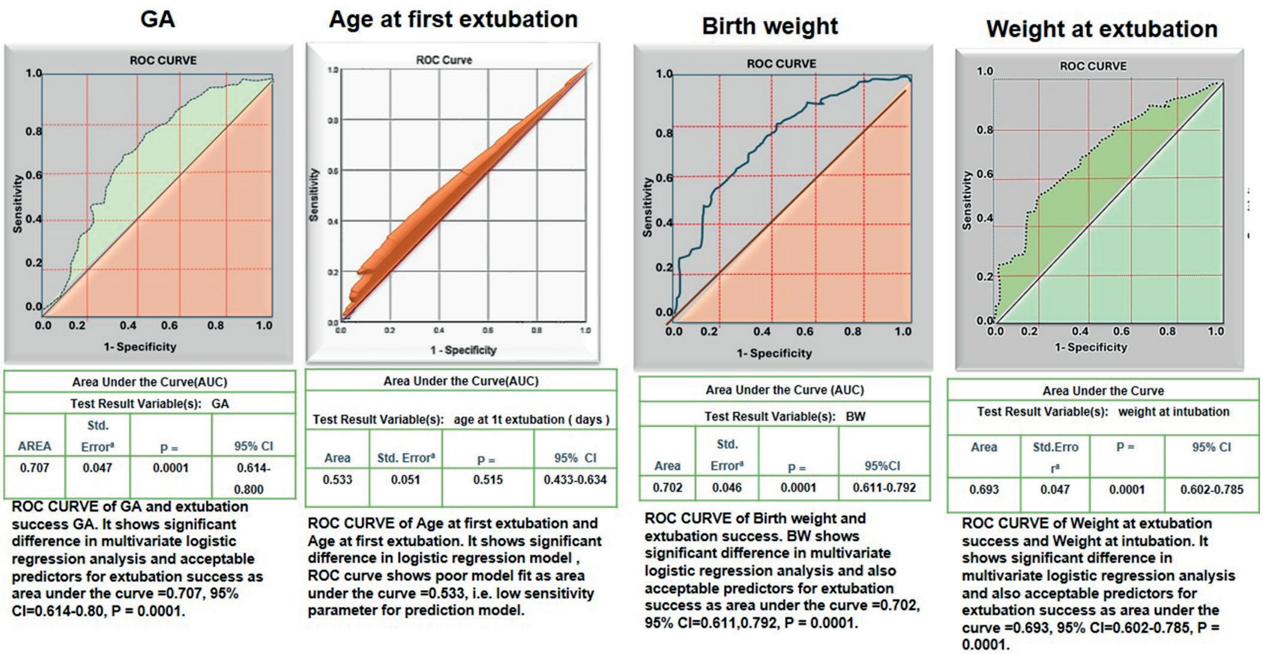

Figure 3. Receiver operating characteristic (ROC curve). AUC: Area under the curve for age at first extubation, Gestation age, Birth weight, and weight at extubation.

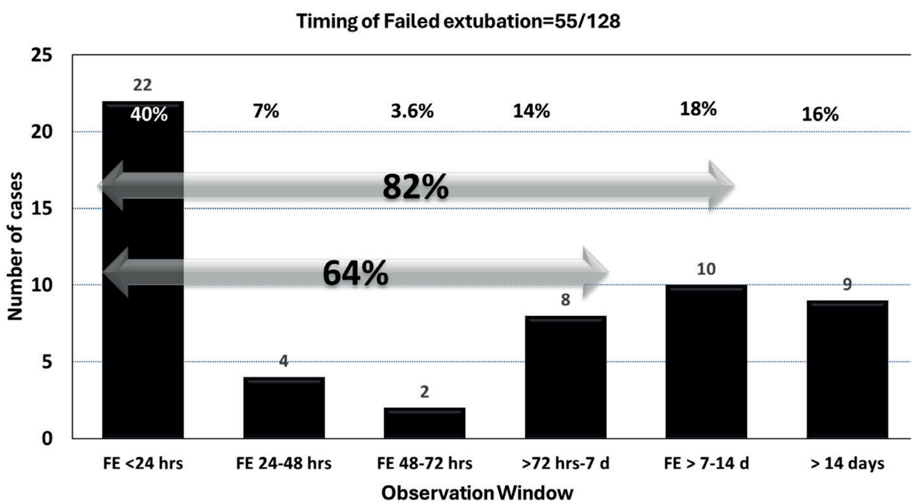

Figure 4. Timing of re-intubation (55/128%) and the most conclusive observation window.

manipulation of the oropharyngeal cavity, prolonged intubation efforts, or repeated attempts, all of which might alter cerebrovascular hemodynamics and potentially result in significant brain injury. A robust association exists between the frequency of failed intubation attempts and the occurrence of intraventricular hemorrhage in extremely low birth weight patients (3). Furthermore, a recent study found a link between the place of intubation, the frequency of tracheal intubation attempts, and the risk of death or serious neurological disability (3,14). These disturbing studies obliged those caring for ELBW newborns to avoid

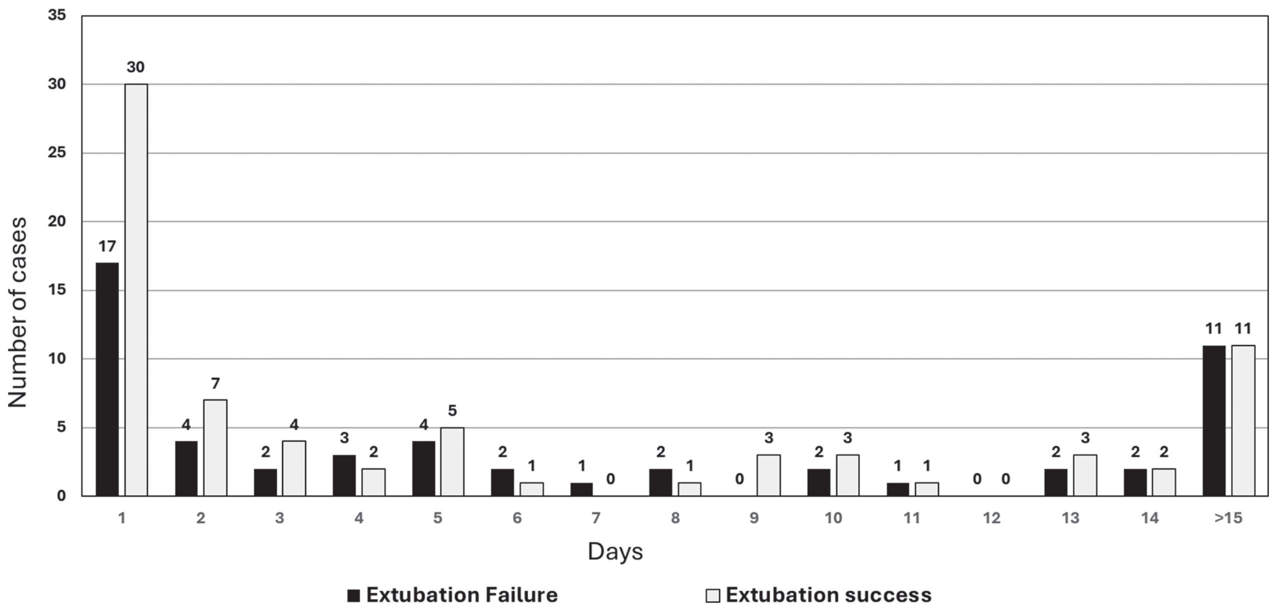

Figure 5. Extubation pattern per post-natal age of the infant.

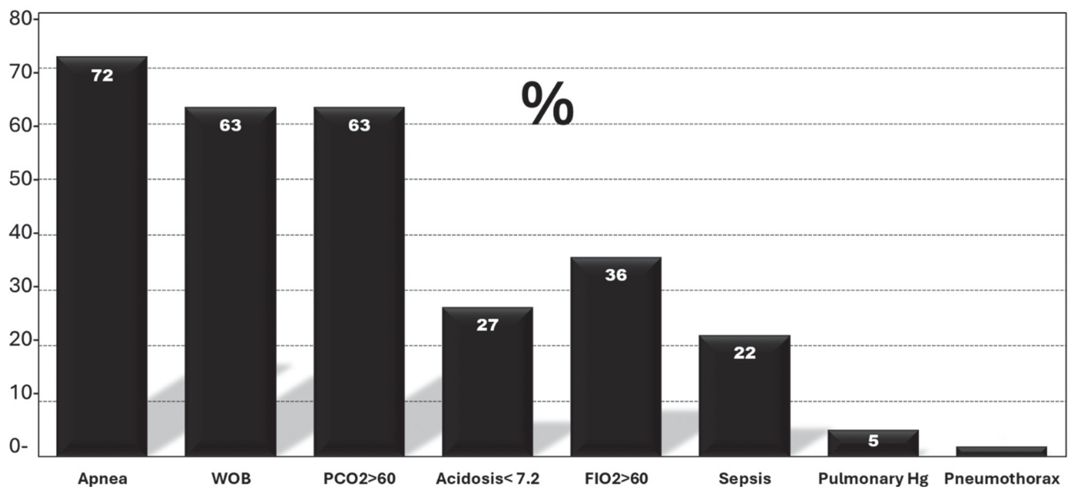

Figure 6. The clinical deterioration required re-intubation among the 55 ELBW newborns.

intubation whenever possible as well as to swiftly determine extubation plans soon after the implantation of the newly inserted endotracheal tube. The decision to extubate an ELBW newborn is a big milestone in his life as well as a celebrating event for his parents; such a decision should not be based solely on speculation, but rather on a combination of scientific evidence and anecdotal professional experience. Before extubation, it is critical to undertake a thorough evaluation of all elements that contribute to successful extubation, assess the newborn's clinical and chemical preparedness, establish the best time for extubation, and plan the post-extubation ventilation strategy. In this cohort of 128 ELBW newborns, we found a robust link between lower gestational age, birth weight upon extubation, and the existence of hemodynamically significant PDA with failed extubation. In the logistic regression model, the age at first extubation was significantly different. However, the ROC curve shows poor model fit with an area under the curve of 0.533, which means the prediction model has a low sensitivity parameter. Figures 4 and 5 reveal that newborns who underwent extubation within the first 24 hours of life experienced most re-intubation episodes. This is consistent with earlier investigations that found the same result (15). For newborns older than 14 days, non-respiratory reasons such as documented infections accounted for most reintubation episodes (22%).

Observation window

Our extubation bundle does not dictate a time range for observation. However, in our analysis, the observation window of one week or 168 hours post-extubation identified only 66% of all occurrences of unsuccessful extubation, whereas the 2-week window identified 80% of all incidents. Documented sepsis was primarily responsible for the increased rate of reintubation after two weeks in this research. In a comprehensive assessment, Giaccone and Schmidt proposed in an elegant review that a 2-week period is more representative of most extubation failures (16). The first 72-hour observation window did capture 66% of newborns weighing more than 1000 g and 60% of those weighing less than 1000 g. The 7-day observation window captures 88% of newborns weighing more than 1000 g and 95% of those weighing less than 1000 g. Shalish et al. explicitly elaborated on the same analysis, revealing that the most reflective window of observation for respiratory causes is 14 days, whereas it stays open for non-respiratory causes (17).

Clinical indications for reintubation

The primary cause of re-intubation is immaturity, evidenced by recurrent apnea episodes, increased respiratory effort, deteriorating blood gas levels, and an elevated requirement for oxygen. Increased tolerance to these clinical signs leads to further lung decruitment, potentially causing varying degrees of respiratory failure upon reintubation. Gupta and Greenberg established in a cohort of reintubated preterm newborns that a minimum of 3 to 7 days is required to restore pre-extubation respiratory function (18).

The dangers of re-intubation

Studies have found that early extubation lowers mortality, and bronchopulmonary dysplasia, and improves the neurodevelopmental outcome of ELBW newborns. However, reintubation as well can result in greater chances of developing chronic lung disease, longer hospital stays, more days of ventilation, ventilator-induced pneumonia, necrotizing enterocolitis, IVH, and PVL (15–17).

Reporting the re-intubation rate

Two published investigations from our NICU over the past five years have presented three distinct rates dependent on gestational age. The lowest rate recorded was 8% in newborns older than 30 weeks gestation; however, another study indicated a rate of 35% in newborns aged 24 to 28 weeks gestation. This current study reveals a re-intubation rate of 42% (19,20). The incidence of failed extubation and/or re-intubation serves as a critical quality metric in all NICUs. To accurately reflect and report these figures, the NICU care provider must deliver five components: gestational age, observation window, the proper utilization of post-extubation resources (ex: CPAP vs IPPV), extubation criteria, and re-intubation criteria for each specific NICU independently. The five components collectively elucidate the reasons for the variability in re-intubation rates across NICUs and in various published studies. Giaccone et al, reviewed much-published research to conclude wide variation of observation windows will skew any targeted report. A survey conducted across 163 NICU facilities in four countries revealed that merely only 5% employed re-intubation criteria, while 31% utilized extubation guidelines. Fewer than 50% of patients undergo spontaneous breathing tests before extubation. A significant proportion of units, approximately 40%, will extubate ELBW newborns before 48 hours of age. In contrast, 86% to 98% of units base their extubation decisions on the main 3 parameters: ventilatory settings, blood gas analysis, and clinical stability. Most units do not utilize an observation window exceeding 72 hours, falsely inflating the extubation success rate (16,21). Our findings showed that very early extubation (within the first 48 hours) was related to failed extubation, especially in newborns under the Gestation age of 25 weeks and weighing less than 750 grams at the time of extubation.

Limitations of the study

There are several limitations to the study. The primary limitation lies in the retrospective nature of the study. One center (WWRC) cared for all newborns included in the analysis; no independent cohort across multiple sites validated the prediction model, and we did not assess longer-term outcomes beyond hospital discharge. The sample size is relatively small, and only 3 cases of ELBW born at 23 weeks' gestation provide a realistic analysis.

Conclusion

In this study, failed extubation can be multifactorial in units following clear extubation guidelines, primarily due to the following risk factors: gestation age less than 25 weeks, birth weight less than 800 grams, weight at extubation less than 750 grams, age at extubation less than 48 hours, need for more than one dose of surfactant, active PDA, and lack of antenatal steroid. The results indicate that ELBW neonates may require additional respiratory support or alternative approaches post-extubation to improve outcomes. Also, these findings underscore the multifactorial nature of extubation failure, suggesting that even with established guidelines, individualized assessment may be necessary for high-risk infants. Further studies are warranted to explore interventions that focus on the development of individualized extubation readiness assessments, potentially incorporating biomarkers or predictive algorithms, which may improve extubation outcomes in neonates with multiple risk factors.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement, etc.) that might pose a conflict of interest in connection with the submitted article.

Authors Contribution: H.S.; the research supervisor, and owner of the idea. He also supervised the proposal preparation, analyzed data, and wrote the manuscript. L.I.; fellow neonatology, writing proposal, submitting proposal to the research center. She also supervised other authors during data collection and shared in data collection and writing the manuscript. W.B., L.D., and M.Y. collected all the data.

Declaration on the Use of AI: we declare that the chatbot was not used.

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