

Original article



Predictors of Success Rate in Different Initial Respiratory Supports in Very Low Birthweight Infants with Respiratory Distress

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Abstract

Background: Ideal respiratory support for very low birth weight infants (VLBW) can be selected based on demographic and clinical status at birth.

Methods: In this prospective cohort study, we included 163 VLBW neonates treated with either invasive or non-invasive respiratory support in their first 72 hours of life in the neonatal intensive care unit of Mahdihyeh hospital, Tehran, Iran. We used descriptive statistics to describe the data, and multiple logistic regression to determine the factors associated with the success rate of different strategies and the choice of strategy for primary respiratory support. All analyses were done using SPSS version 20 and STATA version 12 at a significance level of 0.05.

Results: The success rates of initial respiratory supports with nasal continuous positive airway pressure (NCPAP), noninvasive positive pressure ventilation (NIPPV), and INSURE (intubation surfactant extubation) were 63.20%, 42.10% and 61.90%, respectively. The results of multiple logistic regression analysis showed patent arterial duct (PDA) (yes vs. no: OR = 0.42) had a significant effect on initial respiratory support success ($P < 0.05$). Also, gestational age (>28 vs. ≤ 28 weeks: OR = 0.26) and 5-min APGAR (≤ 6 vs. >6 : OR = 9.69) had a significant effect on the choice of initial respiratory support in VLBW infants ($P < 0.05$).

Conclusion: The neonatal clinical condition may be a predictor of success for initial respiratory support at birth. Since the arterial duct may be open during the first hours of life, more study is needed to verify if early closure of the arterial duct may help increase the success rate of non-invasive respiratory support.

Keywords: Mechanical ventilation, Non-invasive ventilation, Respiratory distress syndrome, Surfactant, Very low birth weight infant

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Introduction

Neonatal respiratory distress syndrome (RDS) is the most common respiratory disease in infants, which can lead to respiratory failure due to lack of alveolar surfactants, and is one of the major causes of their death. Many studies have indicated the importance of using non-invasive respiratory support techniques to reduce the need for intubation, mechanical ventilation (MV) and surfactant.¹⁻⁶ With the preservation of functional residual capacity (FRC), continuous positive airway pressure (CPAP) prevents the need for an increased peak inspiratory pressure (PIP).^{1,7,8} Understanding the physiology of RDS and the importance of preserving FRC in its treatment has resulted in studies comparing the administration of early CPAP and early surfactant therapy.^{2,3,9,10} In a retrospective cohort study, Lindner et al applied a stabilization method by using

bag and mask and then placing neonates on CPAP as an alternative to instantaneous intubation. This study showed that by applying a personalized intubation strategy, even extremely low birth weight infant did not need intubation in 25% of cases.²

The use of early CPAP has been compared with early surfactant therapy in several recent randomized trials.^{3,11} A study by Van Marter et al showed the benefits of CPAP in comparison with MV in preventing chronic lung disease.⁵ Therefore, early CPAP alone or in combination with antenatal steroid helps in preventing respiratory failure in many infants with spontaneous respiration.^{6,12,13} Therefore, the present study aimed to determine the factors associated with the success rate of different strategies and also the choice of primary respiratory support strategy among VLBW infants with RDS.

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Patients and Methods

In this prospective cohort study, we investigated 163 VLBW neonates (weighing less than 1500 g) who were treated with different respiratory support strategies for RDS during a one-year period at the NICU of Mahdیه hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran. Mahdیه hospital is a level III perinatal center in Tehran, capital of Iran. At the time of this study, this center had 39 active NICU beds and 5000 live births per year.

Respiratory support strategies was selected based on clinical and paraclinical indices, according to the latest recommendations in guidelines approved by the European consensus and neonatal resuscitation program, as well as the results of valid studies after considering the respiratory conditions of each infant in different clinical conditions.

At the time of the birth of a VLBW baby, a pediatrician or neonatal specialist decided about the method of respiratory support and the need for transfer to NICU after the initial recovery procedures. The decision was based on patient's respiratory status and a predesigned protocol. Based on our protocol, all neonates under 1000 grams needing nasal continuous positive airway pressure (NCPAP) with positive end-expiratory pressure (PEEP) of about 4–6 cmH₂O were transferred to NICU, unless there was no spontaneous breathing or the patient suffered from gasping, which would necessitate intubation. In the case of infants weighing 1000 to 1500 grams, if spontaneous effective breathing was present without moderate or severe manifestations of respiratory distress (absence of retraction, FIO₂<30), the patient was transferred by a qualified nurse to NICU using a portable incubator and respiratory support equipment. In the case of moderate respiratory distress (presence of retraction, FIO₂>30), NCPAP was performed using a T-piece resuscitation machine with PEEP of 4–6 cmH₂O (with PEEP selected according to oxygen saturation based on pulse oximetry). Finally, if the neonate did not have spontaneous breathing or was suffering from severe respiratory distress (retraction, gasping) or in case of low Apgar score, the patient was transferred to NICU after intubation in the delivery room. To initiate neonatal recovery, 21%–100% oxygen was used based on SO₂; the decision for using oxygen in continuing resuscitation was based on the value of oxygen saturation in the post-birth transfer phase. In this study, the target value of blood oxygen saturation at NICU was 90%–95%. All infants who were intubated in the delivery room, after being stable in terms of vital signs, received surfactant in NICU (with the type selected based on availability).

Neonates under NCPAP were considered as CPAP failure if a PEEP of more than 6 cmH₂O or FIO₂ of over 40% was needed to maintain the target SO₂. These patients underwent noninvasive positive pressure ventilation (NIPPV) with a respiratory rate of 15–25 bpm, PIP of

12–14 cmH₂O, PEEP of 4–6 cmH₂O and FIO₂ of less than 40%. In the case of NIPPV failure (requiring FIO₂ of more than 40% or PIP of more than 14 cmH₂O or a rate of more than 25 bpm), the candidates were subjected to INSURE; in case of INSURE failure (requiring FIO₂ above 40 or MAP higher than 7) patients were intubated again and underwent MV with surfactants.

The patients were followed up until discharge. For this research, the following demographic and clinical information was collected from all neonates: gestational age, birth weight, sex, plurality, delivery, maternal disease, PROM + chorioamnionitis, 1-minute APGAR, 5-minute APGAR, and patent arterial duct (PDA). In this study, achieving a lower level of respiratory support or no need for more respiratory protection defined the success of the used strategy. These respiratory strategies were divided into two groups as follows, and the success rate of strategies used for neonates were evaluated in the first 72 hours of life. The first group (Non-Invasive group): Oxyhood [11 (13.40%) neonates], Room Air [14 (17.10%) neonates], NCPAP [19 (23.20%) neonates], and non-invasive positive pressure ventilation [NIPPV, 38 (46.30%) neonates]. The second group (invasive group): intubation surfactant-extubation [INSURE, 21 (25.92%) neonates], and MV with or without surfactant [60 (74.07%) neonates].

Quantitative and qualitative variables were summarized as mean ± SD and frequency (%), respectively. Chi-square and Fisher exact tests were used for categorical variable comparison. Then, to determine the factors associated with the success of primary respiratory support strategies and also the choice of primary respiratory support strategy, a multiple logistic regression model was used. For this purpose, variables with *P* < 0.30 were entered into the multiple logistic model. Receiver operating characteristic (ROC) curves were constructed to test the ability of demographic and clinical predictors in the multiple logistic regression model to predict the choice of primary respiratory support and also the success of different strategies of primary respiratory support in the first 72 hours after birth among VLBW infants with RDS. All analyses were performed using the IBM SPSS Statistics for Windows (version 20.0 Armonk, NY: IBM Corp) and STATA statistical software (Release 12. College Station, TX: Stata Corp LP). *P* < 0.05 was considered statistically significant.

Results

In the present study, 163 patients were included, of whom 82 (50.30%) were in the non-invasive group with a mean gestational age of 30.02 ± 2.57 weeks and 81 (49.70%) were in the Invasive group with a mean gestational age of 28.04 ± 2.15 weeks. There was a statistically significant difference in the mean gestational age of the two groups (*P* < 0.05). The mean birth weights of the non-invasive and invasive groups were 1190.30 ± 251.49 g and 1039.63

± 251.46 g, respectively, which showed a statistically significant difference between the two groups ($P < 0.05$). The results of the Chi-square test showed that the frequency distribution of neonates was significantly different between the two groups in terms of the variables of gestational age, birth weight, 1-minute APGAR, and 5-min APGAR ($P < 0.05$) (Table 1). The results of multiple logistic regression presented in Table 2 show that gestational age and 5-min APGAR had a significant effect on the choice of primary respiratory support in VLBW infants ($P < 0.05$). Thus, after adjusting the effect of other variables, the odds of choosing the invasive respiratory support approach in infants over 28 weeks of gestational age were 0.26 times that of infants less than 28 weeks of gestational age ($P < 0.05$). Similarly, after adjusting the effect of other variables, the odds of undergoing the invasive respiratory support approach in infants with 5-minute APGAR less than/equal to 6 were 9.69 times higher than those with 5-minute APGAR greater than 6 ($P < 0.05$). Other variables had no significant effect on primary respiratory support choice ($P > 0.05$). The ROC curves were constructed in order to test the ability of gestational age, birth weight, 1-minute APGAR

and 5-minute APGAR to predict the choice of the primary respiratory support method (Table 2). The AUC of the model was 0.76, which indicates an appropriate predictive power for the model (Figure 1).

Patients were followed up until discharge and the median follow-up duration was 52 days in total. The overall survival rate was 77.30% (126 cases) (63.10% for infants ≤ 1000 grams and 86.70% for infants > 1000 g and also 64.50% for infants ≤ 28 week and 88.50% for infants > 28 week). The male-to-female ratio was 58.30% to 41.70% with survival rates of 77.90% and 76.50%, respectively. The survival rate until discharge and the success rate of primary respiratory support in VLBW infants during the first 72 hours after birth are presented in Table 3. In general, the success rates of the first and second groups were 62.20% and 90.10%, respectively. Moreover, survival rates in the first and second groups were 89% and 65.40%, respectively. The success rates in the non-invasive MV group which included Room Air, Oxyhood, NCPAP and NIV (NIPPV) during the first 72 hours after birth were 12 (85.70%), 11 (100%), 12 (63.20%) and 16 (42.10%), respectively. The survival rate of the Room Air, Oxyhood,

Table 1. Comparison of VLBW Infants' Characteristics in the Two Groups (n = 163)

Characteristics	Overall	Group		P
		Non-Invasive+No Support	Invasive	
Gestational age, Mean \pm SD	29.04 \pm 2.56	30.02 \pm 2.57	28.04 \pm 2.15	
≤ 28 weeks	76 (100)	22 (28.90)	54 (71.10)	< 0.001
> 28 weeks	87 (100)	60 (69.00)	27 (31.00)	< 0.001
Birth weight, Mean \pm SD	1115.43 \pm 261.84	1190.30 \pm 251.49	1039.63 \pm 251.46	
≤ 1000 g	65 (100)	23 (35.40)	42 (64.60)	< 0.001
> 1000 g	98 (100)	59 (60.20)	39 (39.80)	0.002
Sex				
Female	68 (100)	34 (50.00)	34 (50.00)	0.947
Male	95 (100)	48 (50.50)	47 (49.50)	
Plurality				
Single	97 (100)	50 (51.50)	47 (48.50)	0.701
Multiple	66 (100)	32 (48.50)	34 (51.50)	
Delivery				
NVD	22 (100)	9 (40.90)	13 (59.10)	0.343
C/S	141 (100)	73 (51.80)	68 (48.20)	
Maternal disease				
No	113 (100)	56 (49.60)	57 (50.40)	0.774
Yes	50 (100)	26 (52.00)	24 (48.00)	
PROM+Chorioamnionitis				
No	147 (100)	73 (49.70)	74 (50.30)	0.617
Yes	16 (100)	9 (56.20)	7 (43.80)	
1-min APGAR				
> 6	102 (100)	65 (63.70)	37 (36.30)	< 0.001
≤ 6	61 (100)	17 (27.90)	44 (72.10)	
5-min APGAR				
> 6	141 (100)	81 (57.40)	60 (42.60)	< 0.001
≤ 6	22 (100)	1 (4.50)	21 (95.50)	
PDA				
No	78 (100)	42 (53.80)	36 (46.20)	0.387
Yes	85 (100)	40 (47.10)	45 (52.90)	

C/S, caesarean section; CPR, cardiopulmonary resuscitation; Maternal disease, Bleeding, diabetes and others preeclampsia, placenta previa; N, Number; NVD, natural vaginal delivery; PDA, patent ductus arteriosus.

Table 2. Factors Affecting the Choice of the Primary Respiratory Support in VLBW Infants According to the Multiple Logistic Regression Model

Characteristics (Reference)	Coef(se)	Odds Ratio (95% CI)	P
Gestational age (≤28 weeks)			
>28 weeks	-1.32 (0.41)	0.26 (0.11,0.59)	0.001
Birth weight (≤1000 g)			
>1000 g	0.13 (0.43)	1.14 (0.48,2.71)	0.752
1-min APGAR (>6)			
≤6	0.77 (0.41)	2.18 (0.97,4.89)	0.059
5-min APGAR (>6)			
≤6	2.27 (1.09)	9.69 (1.14,82.39)	0.038

Table 3. Success Rate of Primary Respiratory Support in VLBW Infants for the First 72 Hours after Birth and Survival Rate until Discharge from Hospital

Respiratory Support At birth (pt)	N	Success Rate	Survival Rate
		No. (%)	No. (%)
Non-invasive +No support group			
Room Air	14	12 (85.70)	14 (100.00)
Oxyhood	11	11 (100)	10 (90.90)
NCPAP	19	12 (63.20)	18 (94.70)
NIPPV	38	16 (42.10)	31 (81.60)
Total	82	51 (62.20)	73 (89.00)
Invasive group			
MV ± surfactant	60	60 (100)	34 (56.70)
INSURE	21	13 (61.90)	19 (90.50)
Total	81	73 (90.10)	53 (65.40)

NCPAP and NIPPV strategies until discharge from hospital were 14 (100%), 10 (90.90%), 18 (94.70%), and 31 (81.60%), respectively.

In addition, the success rates in the invasive MV group which included MV ± surfactant and INSURE during the first 72 hours after birth were 60 (100%), and 13 (61.90%), respectively. The survival rates of the MV ± surfactant and INSURE strategies until discharge from hospital were 34 (56.70%) and 19 (90.50%), respectively.

Demographic and clinical factors influencing the outcome of primary respiratory support (success vs. failure) in the first 3 days of birth are reported in Table 4. Fifty-one (62.20%) and 73 (90.10%) neonates had success in the Non-Invasive and Invasive groups, respectively ($P < 0.05$). Also, there was a significant association between the outcome of primary respiratory support and maternal disease ($P < 0.05$). However, the other variables showed no significant relationship with outcome of primary respiratory support ($P > 0.05$) (Table 4). Based on the results from the multiple logistic regression as shown in Table 5, PDA and type of strategies (Invasive vs. non-Invasive) had a significant effect on primary respiratory support success during the first 72 hours after birth in VLBW infants ($P < 0.05$). Thus, after adjusting the effect of other variables, the odds of initial respiratory support success for neonates in the invasive group were 6.18 times higher than those in

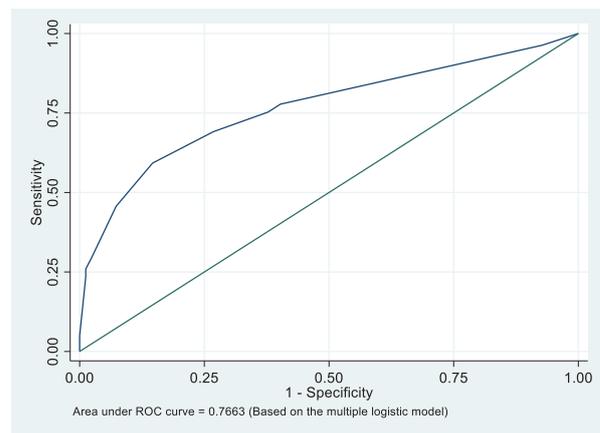


Figure 1. Receiver Operating Characteristic Curve for Gestational Age, Birth Weight, 1-minute APGAR, and 5-minute APGAR to Predict the Choice of Primary Respiratory Support Method.

the non-invasive group and this difference was statistically significant ($P > 0.05$). Furthermore, after adjusting the effects of other variables, the odds of primary respiratory support success for infants who had PDA were 0.42 times greater than those who did not have PDA ($P > 0.05$). But other variables had no significant effect on the success rate of primary respiratory support ($P > 0.05$). The ROC curves were constructed in order to test the ability of plurality, maternal disease, 1-minute APGAR, 5-minute APGAR, and PDA to predict the success of primary respiratory support in VLBW infants (presented in Table 5). The AUC of the model was 0.77, which indicates an appropriate predictive power for the model (Figure 2).

Discussion

Better understanding of the physiology of RDS and the importance of preserving FRC in its treatment have resulted in studies comparing early CPAP strategies and early surfactant therapies. Overall, the selection of the first respiratory support for VLBWs, called initial respiratory support has found special significance.^{14,15} Although many studies are about the importance of neonatal specifications, including demographic characteristics and prenatal history, as predictors of the failure or success of non-invasive ventilation, few studies have examined the predictor of success or failure of respiratory supports as the initial strategies.¹⁶ Such studies are about finding models or scores to predict early success or failure of non-invasive respiratory support strategies, which have often been retrospective.^{17,18} So, it is essential to investigate more of these challenges or problems. Therefore, we conducted a prospective study to determine the predictor of the success or failure of selected initial respiratory support at birth within the first 72 hours, based on the patient’s clinical status at birth. Due to the importance of the ability to select the best primary respiratory support method at birth, the possible factors influencing the choice of initial respiratory support were also determined in this study.

Table 4. Evaluation of Relationship between VLBW Infants' Characteristics and Outcomes of Primary Respiratory Support for the First 72 Hours after Birth (n = 163)

Characteristics	Overall	Result		P Value
		Failure	Success	
Gestational age, Mean±SD	29.04 ± 2.56	28.72 ± 2.33	29.14 ± 2.63	
≤28 weeks	76 (100)	16 (21.10)	60 (78.90)	0.375
>28 weeks	87 (100)	23 (26.40)	64 (73.60)	0.422
Birth weight, Mean ± SD	1115.43 ± 261.84	1059.10 ± 291.05	1133.15 ± 250.61	
≤1000 g	65 (100)	18 (27.70)	47 (72.30)	0.124
>1000 g	98 (100)	21 (21.40)	77 (78.60)	0.359
Sex				
Female	68 (100)	15 (22.10)	53 (77.90)	0.636
Male	95 (100)	24 (25.30)	71 (74.70)	
Plurality				
Single	97 (100)	27 (27.80)	70 (72.20)	0.156
Multiple	66 (100)	12 (18.20)	54 (81.80)	
Delivery				
NVD	22 (100)	7 (31.80)	15 (68.20)	0.351
C/S	141 (100)	32 (22.70)	109 (77.30)	
Maternal disease				
No	113 (100)	22 (19.50)	91 (80.50)	0.045
Yes	50 (100)	17 (34.00)	33 (66.00)	
PROM+Chorioamnionitis				
No	147 (100)	34 (23.10)	113 (76.90)	0.470
Yes	16 (100)	5 (31.20)	11 (68.80)	
1-min APGAR				
>6	102 (100)	29 (28.40)	73 (71.60)	0.081
≤6	61 (100)	10 (16.40)	51 (83.60)	
5-min APGAR				
>6	141 (100)	36 (25.50)	105 (74.50)	0.224
≤6	22 (100)	3 (13.60)	19 (86.40)	
PDA				
No	78 (100)	14 (17.90)	64 (82.10)	0.087
Yes	85 (100)	25 (29.40)	60 (70.60)	
Group				
Non-invasive + No Support	82 (100)	31 (37.80)	51 (62.20)	<0.001
Invasive	81 (100)	8 (9.90)	73 (90.10)	

C/S, caesarean section; CPR, cardiopulmonary resuscitation; Maternal disease, Bleeding, diabetes and others preeclampsia, placenta previa; N, Number; NVD, natural vaginal delivery; PDA, patent ductus arteriosus

Table 5. Adjusted Odds Ratios of Risk Factors for the Success of Primary Respiratory Support in VLBW Infants Based on the Multiple Logistic Regression Model

Characteristics (Reference)	Coef (se)	Odds Ratio (95% CI)	P Value
Plurality (Single)			
Multiple	0.61 (0.44)	1.84 (0.77,4.38)	0.163
Maternal disease (No)			
Yes	-0.76 (0.42)	0.46 (0.20,1.06)	0.069
1-min APGAR (>6)			
≤6	0.32 (0.54)	1.37 (0.47,3.98)	0.554
5-min APGAR (>6)			
≤6	-0.26 (0.84)	0.76 (0.14,4.01)	0.753
PDA (No)			
Yes	-0.86 (0.42)	0.42 (0.18,0.96)	0.040
Type of strategies (Non-invasive + No Support)			
Invasive	1.82 (0.51)	6.18 (2.24,17.01)	< 0.001

In a 2005 review by Ammari et al, which evaluated and compared different methods of initial respiratory support, the results showed that CPAP had a lower success rate in very low birth weight premature infants compared to premature newborns with more weight.¹⁸ In our

prospective study in the first 72 hours after birth, 71.10% of infants under 28 weeks were in the invasive group and 28.90% were in the noninvasive group ($P < 0.001$). On the other hand, 64.60% of infants weighing less than 1000 grams were in the invasive group and 35.40% were in the

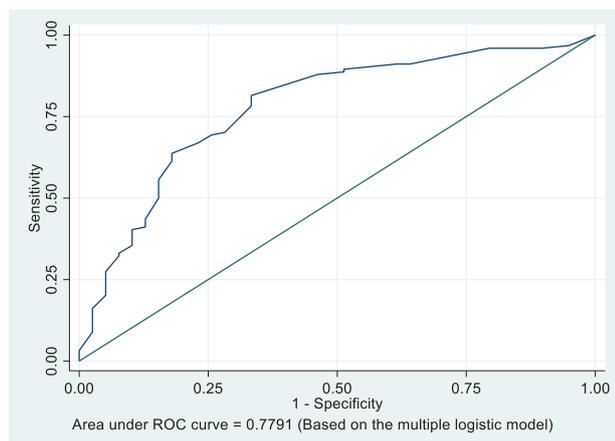


Figure 2. Receiver Operating Characteristic Curve for Plurality, Maternal Disease, 1-minute APGAR, 5-minute APGAR, PDA and Goup to Predict the Success of Primary Respiratory Support in VLBW Infants.

noninvasive group ($P = 0.002$). These results are similar to those of Ammari et al, indicating that the probability of failure of non-invasive methods increases in lower-weight neonates.¹⁸

Based on a meta analysis in 2013 in low- and middle-income countries, including 2002 neonates on bubble CPAP, reduction in MV of 30%–50% with no increase in mortality was reported.¹⁹

Although in our study CPAP as the primary respiratory support was used in fewer cases, non-invasive respiratory supports are used totally in 34.90% of all neonates with RDS, similar to this report.

CPAP success rate as the initial respiratory support is 63.20% with a mean GA of 30.02 ± 2.57 weeks, which is comparable to some other studies including Fuchs et al, Dargaville et al and CURPAP (2010) which found the use of CPAP to have success rates of 49%, 78% and 67% among neonates with the GA under 29, 32 and 25 to 28 weeks, respectively.^{20–22}

Although several studies have compared NCPAP with NIPPV for the management of RDS, few studies evaluate the predictors of NIPPV failure. The use of other non-invasive MV methods has also increased significantly in recent years. Studies conducted at various levels of NICU suggest some variations in the use of NIV (NIPPV). It is evident that the variation in NIPPV usage is to some extent linked to the heterogeneity of the ventilators and the chosen settings.^{23–25} In a study conducted in Australia and New Zealand, Tingay et al showed an increase in the use of non-invasive nasal CPAP from 16% to 43.20% in the period from 1996 to 2003.²⁶ In a study by Rugger et al, in 2012, a 30% increase (from 43% to 73.20%) was reported in the use of CPAP in Switzerland between 1996 and 2008.²⁷ In the present study, NCPAP was used as the primary respiratory strategy in 19 VLBW infants and NIPPV was used in 38 cases. Although sufficient studies on the use of non-invasive MV techniques in Iran are not

available, it seems that their use is much less common than the worldwide standard and non-invasive MV methods should be promoted.

INSURE has been compared in various studies as a hybrid strategy with non-invasive and invasive respiratory strategies. This method is used as a way for early stabilization (early INSURE), as well as treatment of RDS in later stages among infants who have effective spontaneous respiration and have been put on NCPAP (late INSURE). The results of these studies indicate a wide failure range of 9% to 50% for this method. The variation in INSURE failure rate in different studies can be attributed to factors such as variations in RDS severity, diversity in type and dosages of surfactant therapy, and different restrictions in deciding the need for intubation.¹⁴ In an RCT in 2003, Tooley et al divided 25 to 28-week-old infants into standard treatment and INSURE (extubated to the CPAP after one hour) treatment groups. The result showed that 47% of infants who were extubated at the first hour never needed re-intubation.²⁸ In the present study, INSURE success rate was 61.90%. The high survival rate of 90.50% among infants undergoing INSURE in our study compared to overall survival may be due to the selection of patients with better respiratory conditions for undergoing INSURE as the initial respiratory strategy.

A study by Kakkilaya et al evaluated the demographic factors of 189 infants with a 50% CPAP failure rate. In their study, patients with CPAP failure had lower birth weight and had received lower doses of antenatal corticosteroids, but these were not confirmed after logistic regression modeling analysis.²⁹ According to a study by Pillai et al, gestational age under 28 weeks and prolonged preterm rupture of membrane (PPROM) were independently identified as two predictors of CPAP failure.³⁰ In a study by Mehta et al, higher weight and female sex were found as two protective factors against NIPPV failure. Also, at extubation time, higher gestational age and female sex correlated with a delay of NIPPV failure.¹⁶

However, contrary to the results of Pillai et al and Mehta et al, in our study, there was no association between birth weight, gestational age, gender, or PPRM as predictors for success or failure in selecting initial respiratory support. Another difference between the present study with the mentioned studies is that after adjusting the effect of non-invasive and invasive respiratory supports, the impact of demographic and clinical factors on the success or failure of all initial respiratory support methods were evaluated. In our study based on the results from multiple logistic regression, PDA had a significant effect on primary respiratory support success during the first 72 hours after birth in VLBW infants ($P < 0.05$).

All of the studies of respiratory support strategies outcomes investigate arterial duct status, but since the arterial duct may be open physiologically during the first

72 hours of life, it cannot be used to design a predictive model for choosing the respiratory support method at birth. Therefore, more studies are needed to find out if early closure of the arterial duct may help increase the success rate of non-invasive respiratory support.

While the use of cesarean section delivery according to the NICHD report was 7% at 22 weeks and 24% at 28 weeks of gestational age in 2003–2007,³¹ in the present study, the cesarean section was the dominant method for preterm delivery although it was not significantly different between the invasive (40.90%) and noninvasive/no support groups (59.10%). Since Mahdijeh hospital is a specialized infertility center and has a high total number of twin births, the high rates of the cesarean section may be acceptably justified. The difference between invasive and non-invasive respiratory support in our study is comparable to the survey by Afje et al in 2017.³²

In conclusion, in the present study, different approaches to initial respiratory support were investigated and the predictors of success and failure rate of invasive and non-invasive MV methods were evaluated. Although the best approach to respiratory difficulties among infants is not fully recognized, this study can be considered as an initial step. More studies are needed to find out the predictors of success or failure of initial respiratory supports.

Authors' Contribution

Study concept and design: NTT, AA, MF. Analysis and interpretation of data: ARS, NTT. Drafting of the manuscript: NTT, MJ. Critical revision of the manuscript for important intellectual content: AA, MR, MF. Study supervision: NTT, AA. Collection of data in the questionnaire: FE.

Conflict of Interest Disclosures

The authors have no conflict of interest with the subject matter of this manuscript.

Ethical Statement

This study was approved by the ethics committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran and informed consent was obtained from all parents.

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