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Best Strategies against Respiratory Problems in Extremely Low Birth Weight Infants

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Abstract

Background

Neonatology has evolved with respect to the needs of premature infants for special care. One of the major problems in premature infants is that their lungs are not developed adequately to fulfill newborns' needs. There is a broad spectrum of strategies for management of respiratory problems in premature infants. In this study, we aimed to determine the best Strategies against Respiratory Problems in Extremely Low Birth Weight Infants.

Materials and Methods

In this analytical, prospective study, we recruited 79 newborns with birth weight of less than 1000 g, who were born in Mahdieh Hospital in Tehran- Iran, during September 2011-March 2013. The newborns were divided into three groups of Supportive care (n=10), the INSURE strategy (n=17), and Mechanical ventilation (n=52) based on their needs. Survival rate and complications were evaluated among these groups.

Results

Gestational age ranged between 23 and 34 weeks, and birth weight ranged between 420g and 1000 g. Survival rates in the supportive care, INSURE, mechanical ventilation groups were 90%, 47.1%, and 17.3%, respectively. Gestational age and birth weight in the three groups were significantly different ($P<0.05$). Complications were not significantly different between the groups except for pulmonary hemorrhage, which was significantly higher in the mechanical ventilation group, compared to the other groups ($P<0.05$).

Conclusion

However weight and gestational age are significantly different in all three groups, but only pulmonary hemorrhage as biomedical variable was higher in mechanical ventilation group. The best strategy according to different conditions for challenging babies is intervention only when it would be necessary and not rushing in INSURE and mechanical ventilation.

Key Words: Extremely low birth weight, Infants, Mechanical ventilations.

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1- INTRODUCTION

Prematurity is the main leading cause of infant mortality and it is one of the major causes of morbidity in pediatric population (1,2). Approximately 50% of developmental delays in children can be attributed to immaturity (3). With the advancement of neonatal intensive care, survival rates in extremely preterm or very low birth weight (VLBW) neonates, with gestational age (GA) <28 weeks or birth weight <1000g have expanded (4-6). These groups of infants are at higher risk than term-born (≥37 weeks of gestation), normal birth weight (NBW, ≥2,500g) newborns for developmental problems including neurosensory disorders, global intellectual disability, impaired cognition and learning, and behavioral disorders (7, 8). Lower than estimated GA is found to be associated with increased risk of mortality in low birth weight (LBW) infants (9), in whom different body systems, especially the pulmonary system fail to function (10). LBW can lead to complications such as pneumothorax and bronchopulmonary dysplasia (11-13).

Respiratory failure secondary to surfactant deficiency is a major cause of morbidity and mortality in preterm infants. Respiratory distress syndrome (RDS), resulting from deficiency of pulmonary surfactant, is the most frequent clinical respiratory disorder in preterm infants (14-17). Surfactant therapy substantially reduces mortality and respiratory morbidities in premature neonates (18). A multitude of studies exhibited that surfactant therapy could effectively lower mortality rate in preterm infants (19, 20). Intratracheal exogenous surfactant replacement therapy also reduces air leaks and need for respiratory support in mechanically ventilated premature infants, with early surfactant therapy being superior to late rescue therapy in lowering the rates of mortality and respiratory morbidity. There are various strategies using surfactant in preterm infants, but some neonatal health centers use surfactant as a prophylactic. In neonatology, surfactant is well-established as the first-line treatment after occurrence of RDS symptoms (21, 22). Intubation-surfactant-Administration–Rapid Exudation (INSURE) strategy is widely used throughout the world. In randomized, clinical trials performed prior to 2008, the INSURE approach, compared to rescue surfactant administration in infants with RDS, was associated with significantly reduced need for mechanical ventilation and oxygen at 28 days (23).

Brief description of the existing methods for the treatment of LBW and premature newborns demonstrates that despite the variety of methods that can be adopted, there is no decisive indication to select a definitive one in neonates. Given that a great portion of mortality and morbidities is result of the respiratory complications among low birth weight newborns, finding the best approach is of great importance. In the present study, we aimed to evaluate the efficiency of the three methods of supportive care, INSURE, and surfactant administration with mechanical ventilation in diminishing respiratory problems among extremely low birth weight (ELBW) infants, who were admitted to Madieh Hospital, Tehran-Iran, during September 2011-March 2013.

2- MATERIALS AND METHODS

2-1. Patients

This analytical, prospective study was performed on infants with birth weight below 1000g, who were admitted to Mahdieh Hospital, in Tehran-Iran, during September 2011 and March 2013. The study population included all the consecutive infants (n=79) admitted to the neonatal intensive care unit (NICU) of Mahdieh Hospital. The inclusion criteria were live birth, Respiratory distress and birth weight less than 1000g. All infants without respiratory distress were excluded.

2-2. Methods

We divided all the infants into the three groups of supportive care, INSURE, and mechanical ventilation considering their clinical condition. Thereafter, using patient charts, the therapeutic interventions and incidence of complications were recorded based on time of event in the checklist. The therapeutic interventions were classified into three categories, according to respiratory distress intensity, as follows:
1) Supportive care group: the infants who received only conservative treatments such as fluid therapy as well as intravenous antibiotics and oxygen administration, but they were only considered in terms of respiratory problems to find out evidence of the need for therapeutic intervention for respiratory problems;

2) INSURE group: in addition to conventional treatments such as fluid therapy and antibiotics administration, the infants who were treated with surfactant using INSURE method (the infants were intubated and then surfactant was injected; after immediate removal of the tracheal tube, the infant was monitored for reoccurrence of need for intervention); and
3) Mechanical ventilation group: the infants who received mechanical ventilation and surfactant. In case any of the infants in group one faced to severe signs and required an intervention, they were assigned to either group two or three for INSURE or mechanical ventilation.

2-3. Statistical analysis

To analyze the data, descriptive statistics were performed for each variable and Chi-square, ANOVA, t-test, and Mann-Whitney U tests were run using SPSS-16 with P-value less than 0.05.

2-4. Ethical considerations

All the information of infants and their mothers remained confidential, and written consent was obtained from the parents; all the infants received the routine care. Moreover, none of the infants was deprived of the required interventions. Also, the study protocol was reviewed and approved by Ethics Committees of Shahid Beheshti University of Medical Sciences (ID number: 248).

3- RESULTS

3-1. Demographic data

In general, 79 infants were enrolled in the study, 26 (32.9%) of whom survived. Minimum and maximum gestational ages were 23 and 34 weeks, respectively, and their mean age was 27.3±2.24 weeks. Minimum gestational age and weight of the survived infants were 25 weeks and 730 g, respectively. Moreover, 18 (22.8%) infants were delivered through natural vaginal delivery and 61 (77.2%) were born through caesarean section.

3-2. Clinical variables

Minimum and maximum lengths of hospital stay were one day and 110 days, respectively, and mean length of hospital stay was 27.8±7.12 days. In addition, minimum and maximum durations of hospital stay in the survived infants were 35 days and 110 days, respectively, and mean duration of hospital stay was 63.7±3.54 days.

3-3. Intervention

Supportive care was provided for 10 (12.7%) infants. INSURE strategy was administered on 17 (21.5%) cases, and the remaining 52 (65.8%) infants received mechanical ventilation and surfactant (**Tables 1, 2**). The shortest duration of hospital stay was recorded for the supportive care group (50.8 days), while the longest pertained to the mechanical ventilation group (73.3 days). There was a significant relationship between the applied strategy and duration of hospital stay (P=0.01) (**Table.1**). Minimum and maximum durations of intubation were one day and 138 days with the mean of 16.5±5.71 days. No significant difference was observed between the three groups regarding mean duration of intubation (P=0.9) (**Table.1**).

There was a significant relationship between survival and place of birth (P=0.01), whereby the survival rate of infants, who were out-born was higher (100%) than inborn (27.8%) ones. Mean GA was 30 weeks for the supportive care group, 26.9 weeks for the INSURE group, and 26.9 weeks for the mechanical ventilation group; mean gestational age was significantly different between the treatment groups (P=0.01). GA was significantly associated with survival rate (P=0.01), that is, mean gestational age of survived infants was 28.7± 1.79 weeks and mean gestational age of the expired ones was 26.6± 2.24 weeks. Fifth minute Apgar score was significantly related to survival rate (P=0.02), so that mean Apgar score of the survived neonates was 7.6, while this score was 6.6 for those who died (P<0.01), and the highest survival rate (90%) belonged to the supportive care group and the lowest rate (17.3%) was pertinent to the mechanical ventilation group. Surfactant administration was significantly related to survival rate of newborns (P<0.01) the need for frequent administration of surfactant increased with lower survival rate (**Figure.1**).

Pulmonary hemorrhage was associated statistically significant with selective treatment strategy (P = 0.02). The highest rate of pulmonary hemorrhage was 44.2% for strategy 3 and the the lowest was 0% for strategy 1; and the lowest (0%) was to supportive care. On the whole, 53 infants expired during the study period as follows: 2(3.8%) cases due to asphyxia, 29 (54.7%) respiratory failure, 19(35.8%) sepsis, 1(1.9%) intraventricular hemorrhage, and 2(3.8%) cases necrotizing enterocolitis (**Table.2**).

Table1: Comparison of variables between the supportive, INSURE, and mechanical ventilation +surfactant (MV+Surf.) groups

Variables		Groups				P-value
		Supportive	INSURE	MV+Surf.	Total	
Gestational Age	N	10(12.7%)	17(21.5%)	52(65.8%)	79(100%)	0.01
	Mean	30.00	26.94	26.92	27.32	
	SD	2.708	2.249	1.792	2.245	
	Min.	26	23	24	23	
	Max.	34	33	32	34	
Fifth minute Apgar score	N	10(12.7%)	17(21.5%)	52(65.8%)	79(100%)	0.02
	Mean	7.50	7.41	6.63	6.91	
	SD	1.650	1.661	1.837	1.799	
	Min.	6	3	3	3	
	Max.	10	9	10	10	
Outcome	Survived	9	8	9	26(32.9%)	-
	Expired	1	9	43	53(67.1)	
Duration of hospitalization	No.	10(12.7%)	17(21.5%)	52(65.8%)	79(100%)	0.01
	Mean	50.78	67.50	73.33	63.73	
	SD	10.721	13.005	21.243	18.074	
	Min.	35	51	48	35	
	Max.	66	83	110	110	

Duration of intubation	No.	10(12.7%)	17(21.5%)	52(65.8%)	79(100%)	0.9
	Mean	27.33	31.63	34.44	31.12	
	SD	21.383	16.151	41.219	27.790	
	Min.	1	9	5	1	
	Max.	60	50	138	138	

Table 2: Complications in different studied groups

Groups		One	Two	Three
Type of delivery	Vaginal	30%	29%	19%
	Caesarian	70%	71%	81%
Prenatal complication	Yes	60%	70%	50%
	No	40%	30%	50%
Gender	Female	20%	24%	62%
	Male	80%	76%	38%
Multiple pregnancies		60%	82%	46%
Intrauterine growth restriction	SGA	90%	58%	52%
	AGA	10%	35%	40%
	LGA	0%	7%	8%
Cardiopulmonary resuscitation (CPR)	Primary CPR	50%	47%	30%
Survival	STD	90%	47%	17%

SGA: Small for gestational age; AGA: Appropriate for gestational age; LGA: Large for gestational age.

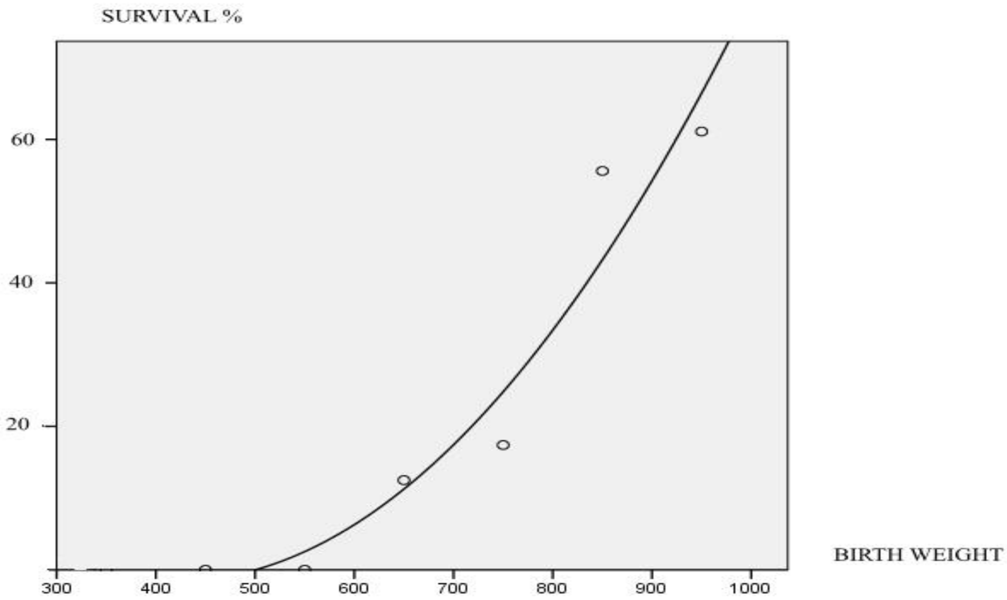

Fig.1: The relationship between survival rate and birth weight in newborns

4- DISCUSSION

Findings of the current study, quite in line with those of Dani (2011), reflected that higher need for surfactant administration was associated with reduced survival rate (24); given the pathophysiology of disease, these infants might show more severe pulmonary complications, which promote the need for interventions and decrease rate of survival. Also, Dani et al. (2010) in another study showed that INSURE strategy in infants under 750g may fail to render successful results, which is in alignment with the current outcomes (25). Kugelman (2011) concluded that the best treatment for ELBW infants is application of multiple procedures or interventions with a comprehensive insight into the pathophysiology, treatment, and complications of RDS to gain the best therapeutic results and increased survival rates (26). Accordingly, we used three methods to determine the most efficient approach for treating this condition, and we showed that newborns' needs are not fixed during the treatment procedure and they require diverse interventions.

Sandri et al. (2010) exhibited that prophylactic surfactant was not superior, as surfactant therapy was associated with continuous positive airway pressure (CPAP) (27); this finding is consistent with the current findings as administration of surfactant and mechanical ventilation increased the rate of survival. This finding is also in alignment with those of Miller et al. (2010) as to the use of proper strategies based on patients' needs and taking precaution for mechanical ventilation (28). Rojas et al. (2009) preferred CPAP and surfactant to mechanical ventilation, and they generalized it to all VLBW infants (29); this is not consistent with the findings of our study, whereby use of surfactant without mechanical ventilation increased survival. In addition, our findings indicated that some ELBW infants did not need surfactant, and lack of administration of surfactant increased the survival rate. Aly (2005) and Linder (1999) separately evaluated intubation and therapeutic intervention, and their findings were in line with our results (30, 31). In both of these studies, intubation and immediate treatment strategies were rejected in the delivery room. The current data revealed high rate of survival in groups receiving less interventions. Kirsten et al. (2012) showed that approximately 70% of VLBW infants solely needed CPAP (32); this finding is congruent with our results. However, we took a step further and evaluated treatment without the use of CPAP, which showed that in some cases, ELBW infants did not need CPAP. However, in the second group, CPAP was used after removal of the tube. In conclusion, our findings indicated that ELBW neonates show very good prognosis if minimum of intervention is carried out until moderate to severe respiratory symptoms present and arterial blood gases are acceptable. In the supportive care strategy, despite desirable start, infants required respiratory intervention in 60% of the cases. Thus, in dealing with ELBW infants, in case immediate intervention is not required based on clinical symptoms, the success of this process would be about 40%.

Based on the present findings, in ELBW infants with no evidence of need for intervention, CPAP is the best treatment of choice; if not possible, conservative treatments should be administered. Supportive care yielded the most favorable outcomes, which indicates that performing interventions based on pre-determined protocols is not viable.

5. CONCLUSION

However weight and gestational age are significantly different in all three groups, but only pulmonary hemorrhage as biomedical variable was higher in mechanical ventilation group. The best strategy according to different conditions for challenging babies is intervention only when it would be necessary and not rushing in INSURE and mechanical ventilation.

6- CONFLICT OF INTEREST: None.

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