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Assessment of Delivery Room Resuscitation with Different Levels and Its Related Factors in Preterm Neonates

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ABSTRACT

Background: There are many known risk factors related to maternal or neonatal problems which can predict the need for resuscitation. In this study, we evaluated the resuscitation process of preterm neonates and analyzed the impact of different risk factors on the level of resuscitation required in the patients.

Methods: This cross-sectional descriptive study was conducted on inborn preterm infants with a birth weight of < 1500 g during one year. Moreover, the present study evaluated the resuscitation process of the delivery room and analyzed the association of maternal-neonatal risk factors and requirement for different levels of resuscitation.

Results: In the present study, 193 preterm neonates were evaluated. In addition, 82 (42.5%) and 110 (57%) patients were female and male, respectively. The mean values of gestational age and birth weight of the patients were 29.9±2.4 weeks and 1191.6±265.2 g, respectively. The mode of delivery in 159 (82.4%) patients was cesarean section.

In the assessment of different levels of resuscitation, 84 (43.5%), 35 (18.1%), 54 (28%), 10 (5.2%), 10 (5.2%), and 9 (4.7%) neonates needed initial steps, free flow of oxygen, positive pressure ventilation, endotracheal intubation, chest compression, and drug administration, respectively. The rate of neonatal mortality was 23.8% (n=46), and hypoxic-ischemic encephalopathy was recorded in 10 (21.7%) subjects. In the evaluation of mothers, 117 (60.6%) subjects had medical problems during pregnancy. The most common problem was preeclampsia in 44 (22.8%) mothers. The lower birth weight (P<0.001), gestational age (P<0.001), Apgar score (P<0.001), and longer duration of resuscitation had a significant effect on the needed level of resuscitation in neonates.

Conclusion: According to the obtained results, it was shown that premature neonates needed more advanced resuscitation. Therefore, improving the quality of care for mothers and neonates is necessary to obtain better outcomes. Regarding the need for noninvasive positive pressure ventilation was the second most frequent intervention, the proper use of equipment is necessary for the prevention of advanced resuscitation.

Keywords: Neonate, Neonatal resuscitation program guideline, Preterm, Resuscitation

Introduction

Neonatal mortalities happening in the first month of life consist of 70% of all mortalities below the age of one year (1). Due to providing standard delivery room care for neonates and high quality of care, the rate of mortality in the first few minutes of delivery is rare; however, the most frequent neonatal mortalities occur after leaving the delivery room in the first 24 h of delivery (2). Prematurity is the most important cause of death in the first month of life, and about 75% of neonatal mortalities are related to preterm babies (3).

In general, preterm delivery is a significant risk factor for early death in the early days or weeks of life (4). Proper resuscitation in the delivery room and after that in neonatal intensive care units (NICUs) conducted by the skilled team for sophisticated interventions, such as intubation or umbilical cord catheterization, and good facilities can prevent a significant number of mortalities (5). Overall, in 90% of deliveries, there is no need for resuscitation; nevertheless, in 10% of live births,

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some interventions are required to begin breathing, and in 1% of live births progressive resuscitation is necessary (6). Regarding the underdeveloped organs of premature babies, the need for advanced resuscitation is more anticipated than that reported for term neonates (7, 8).

The American Heart Association (AHA) has developed treatment guidelines based on the International Liaison on Resuscitation science review, and the Neonatal Resuscitation Program (NRP) has translated the AHA guidelines into an educational curriculum (9). The neonatal resuscitation program (NRP) was initiated in 1987 and is revised every 4 years (10). Based on this guideline, the levels of resuscitation are classified as the first and basic intervention, positive pressure ventilation (PPV), chest compression, and drug administration (11). The PPV can be performed by bag ventilation and in unresponsive cases, endotracheal intubation must be considered. The resuscitation policy of all NICUs in Iran similar to other global centers is based on the most recent NRP (12).

There are many known risk factors related to maternal or fetal problems which can predict the need for resuscitation (13). Maternal diseases, such as multiple pregnancies, preeclampsia, diabetes, infections, polyhydramnios or oligohydramnios, and meconium staining amniotic fluid, and neonatal risk factors, such as prematurity, congenital anomalies, and fetal distress, increase the need for all levels of resuscitation (14). In this study, we evaluated the resuscitation process of preterm neonates delivered in Mahdieh Medical Center affiliated to Shahid Beheshti University of Medical Sciences in Tehran, Iran, and analyzed the impact of different risk factors on the required level of resuscitation in the patients.

Methods

We conducted a retrospective cross-sectional descriptive study in preterm infants delivered in 2016 in Mahdieh Medical Center affiliated to Shahid Beheshti University of Medical Sciences in Tehran, Iran, with 4000-5000 deliveries annually and rate of preterm delivery in 4-7% of pregnancies. The inclusion criteria were all live-born preterm babies with a birth weight of < 1500 g and gestational age of <32 weeks in the delivery room.

The exclusion criteria were the neonates with multiple anomalies or stillbirth. The resuscitation of high-risk neonates, particularly preterm babies, was performed by a skilled qualified pediatrician or neonatal-perinatal fellow trained in this maternity hospital. The resuscitation process was conducted based on the most recent guideline of the NRP and recorded in the medical sheets of the neonates.

As previously mentioned, different levels of resuscitation were classified as the initial and basic intervention, PPV, chest compression, and drug administration. The intubation was conducted in cases with no appropriate response to PPV by bag ventilation. Obviously, all the patients needed chest compression were intubated with an endotracheal tube before the initiation of the cardiac massage because intubation establishes reliable ventilation while the coordination between ventilation and chest compression becomes better established. Post-resuscitation care was performed in the NICU after the stabilization of neonates in the delivery room. In this study, we collected the recorded reports of the resuscitation process of preterm neonates who were born in our hospital.

The variables, such as birth weight, gestational age, mode of delivery, gender, multiple pregnancy, Apgar score, duration of resuscitation and hospital stay, maternal diseases (e.g., preeclampsia, chorioamnionitis, diabetes, and other chronic pregnancy-induced diseases), neonatal complications (e.g., respiratory distress syndrome [RDS], intraventricular hemorrhage [IVH], seizure, and sepsis), and other complications related to resuscitation were analyzed. Moreover, the level of needed resuscitation based on the maternal and neonatal disorders were statistically analyzed in this study.

Descriptive analysis, including mean±standard deviation for the quantitative variables and frequency (percentage) for the categorical variables, was performed in this study. In addition, the association of variables was tested by the Fisher's exact test. The statistical SPSS software (version 16.0) was used for statistical analysis, and p-values of ≤ 0.05 were considered statistically significant.

Results

This study evaluated the resuscitation process of 193 preterm neonates in the delivery room of Mahdieh Hospital. In this study, 82 (42.5%) and 110 (57%) patients were female and male, respectively. Moreover, one case had ambiguous genitalia. The mean gestational age of the patients was 29.9±2.4 weeks (range: 25-37 weeks), and the mean birth weight of them was 1191.6±265.2 g (range: 400-1500 g). The birth weight of 45 (23.3%) neonates was < 1000 g (i.e., extremely low birth weight [ELBW]), and the birth weight of 148 (76.7%) newborns was within 1000-1500 g

(i.e., very low birth weight [VLBW]). The mean values of the gestational age of the ELBW and VLBW neonates were 27.5±1.8 (range: 25-33 weeks) and 30.6±2.1 (range: 25-37 weeks) weeks, respectively, with a statistically significant difference (P<0.001).

The modes of delivery in 34 (17.6%) and 159 (82.4%) neonates were normal vaginal delivery (NVD) and cesarean section (C/S), respectively. Out of all patients, 94 (48.7%) neonates were delivered through multiple pregnancies, and 24 (12.4%) newborns had a history of fetal distress before delivery. In rating the level of resuscitation, 84 (43.5%), 35 (18.1%), 54 (28%), 10 (5.2%), and 10 (5.2%) neonates needed the initial steps of resuscitation, free flow of oxygen, PPV by bag and mask, endotracheal intubation, and chest compression, respectively. The administration of epinephrine was required in 9 (4.7%) patients. The frequency of different levels of resuscitation was shown in Diagram 1.

The duration values of resuscitation in 183 (94.8%) and 10 (5.2%) neonates were lower than 3 and nearly 30 min, respectively. All the neonates were transferred to our NICU after resuscitation and stabilization. The relationships of patients' demographic data and levels of resuscitation were shown in Table 1. As we showed, birth weight,

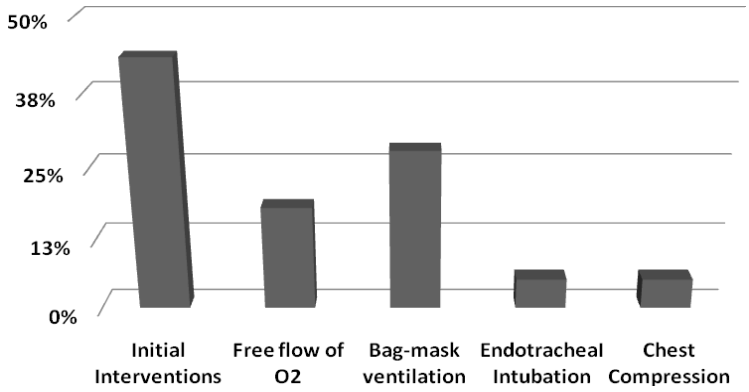

Diagram 1. Frequency of different levels of resuscitation

Table 1. Association of demographic data and different levels of resuscitation

Demographic data	Basic intervention (n=84)	Free flow of O_2 (n=35)	Positive pressure ventilation (n=54)	Intubation (n=10)	Chest compression (n=10)	P-value
Birth weight (g)	1293±180.2	1210±246.1	1119.6±287.5	809±245.7	1044±330.1	<0.001
Gestational age (week)	30.6±2.3	30.4±2.4	29.2±2.2	27.3±1.8	27.2±2	<0.001
Duration of admission (day)	30.8±17.7	25.5±18.4	33.2±25.3	31.1±44.4	19.6±29.2	0.059
Multiple pregnancy	42 (50%)	20 (57.1%)	26 (48.1%)	5 (50%)	1 (10%)	0.133
Delivery mode						
NVD	15 (17.9%)	6 (17.1%)	9 (16.7%)	1 (10%)	3 (30%)	0.824
C/S	69 (82.1%)	29 (82.9%)	45 (83.3%)	9 (90%)	7 (70%)	
Gender						
Female	40 (47.6%)	14 (40%)	22 (40.7%)	3 (30%)	3 (33.3%)	0.009
Male	44 (52.4%)	21 (60%)	32 (59.3%)	7 (70%)	6 (66.7%)	
Birth weight						
ELBW	7 (8.3%)	5 (14.3%)	21 (38.9%)	8 (80%)	4 (40%)	<0.001
VLBW	77 (91.7%)	30 (85.7%)	33 (61.1%)	2 (20%)	6 (60%)	
Mean of Apgar score						
First minute	8±1.2	7.5±1.3	5.7±1.5	4.4±1.4	2.7±0.7	<0.001
Fifth minute	9.2±0.9	8.8±1	7.7±1.2	6.4±1.4	5.3±1.6	<0.001
Duration of resuscitation						
<3 min	84 (100%)	35 (100%)	54 (100%)	0 (0%)	0 (0%)	<0.001
>3 min	0 (0%)	0 (0%)	0 (0%)	10 (0%)	10 (100%)	

NVD: Normal vaginal delivery
C/S: Cesarean section
ELBW: Extremely low birth weight
VLBW: Very low birth weight

gestational age, Apgar score, and duration of resuscitation had significantly different effects on the needed level of resuscitation in neonates (Table 1).

In the evaluation of mothers, 117 (60.6%) subjects had medical problems during pregnancy. The association of maternal diseases and different levels of resuscitation were shown in Table 2. As we showed, the most prevalent problem was preeclampsia in 44 (22.8%) subjects. The features of amniotic fluid in 165 (85.5%), 16 (8.3%), and 12 (6.2%) cases were clear, meconium-stained, and bloody, respectively. In the follow-up of the patients, 99 (51.3%) and 127 (65.8%) neonates needed mechanical ventilation within 24 h of life and surfactant administration via endotracheal intubation, respectively. We did not use the less invasive surfactant administration method for the instillation of surfactant.

Neonatal complications related to delivery room resuscitation were shown in Table 3. Table 3 shows that the level of resuscitation has a significant effect on the rate of neonatal mortality (P<0.001), and mortality due to hypoxic-ischemic encephalopathy (HIE) has a statistical difference in higher levels of resuscitation. The rate of neonatal mortality in our population was 23.8% (n=46), and HIE was recorded in 21.7% (n=10) of dead neonates. The mean duration of hospital stay in neonates was 29.9+22.7 days (range: 1-112 days).

One of the risk factors for air leak syndrome and pneumothorax in neonates is PPV during resuscitation. In the present study, the rate of pneumothorax was significantly different in higher levels of resuscitation (P=0.004). Our analysis showed that the need for mechanical ventilation and surfactant therapy was significantly higher in neonates with advanced levels of resuscitation (P<0.001). Maternal

Table 2. Association of maternal disease and levels of resuscitation

	Basic intervention	Free flow of O_2	Positive pressure ventilation	Intubation	Chest compression	P-value
Pregnancy-related disease	54 (64.3%)	24 (68.6%)	28 (51.9%)	5 (50%)	6 (60%)	0.461
Addiction	1 (1.2%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	-
Chorioamnionitis	0 (0%)	1 (2.9%)	2 (3.7%)	0 (0%)	2 (20%)	0.005
Preeclampsia	21 (25%)	7 (20%)	12 (22.2%)	3 (30%)	1 (10%)	0.805
PROM	12 (14.3%)	7 (20%)	3 (5.6%)	0 (0%)	1 (10%)	0.192
Placenta previa	8 (9.5%)	3 (8.6%)	5 (9.3%)	0 (0%)	3 (30%)	0.218
History of infertility	26 (31%)	13 (37.1%)	14 (25.9%)	4 (40%)	1 (10%)	0.450
Prolonged delivery	8 (9.5%)	4 (11.4%)	2 (3.7%)	0 (0%)	1 (10%)	0.530
Diabetes	5 (6%)	1 (2.9%)	1 (1.9%)	0 (0%)	(0%)	0.627
Amniotic fluid characteristics						
Clear	78 (92.9%)	25 (71.4%)	45 (83.3%)	10 (100%)	7 (70%)	0.007
Meconium	1 (1.1%)	8 (22.9%)	6 (11.1%)	0 (0%)	1 (10%)	
Bloody	5 (6%)	2 (5.7%)	3 (5.6%)	0 (0%)	2 (20%)	

PROM: Prolonged rupture of membranes

Table 3. Association of neonatal complications and different levels of resuscitation

Neonatal complications	Basic intervention	Free flow of oxygen	Positive pressure ventilation	Intubation	Chest compression	P-value
Need for mechanical ventilation	26 (31%)	14 (40%)	41 (75.9%)	10 (100%)	80 (80%)	<0.001
Surfactant therapy	44 (52.4%)	25 (71.4%)	44 (81.5%)	8 (80%)	6 (60%)	0.007
Seizure	5 (6%)	4 (11.4%)	6 (11.1%)	2 (20%)	2 (20%)	0.412
IVH	12 (14.3%)	2 (5.7%)	11 (20.4%)	3 (30%)	3 (30%)	0.159
Apnea	51 (60.7%)	22 (62.9%)	32 (59.3%)	6 (60%)	6 (60%)	0.998
Pneumothorax	5 (6%)	2 (5.7%)	3 (5.6%)	4 (40%)	1 (10%)	0.004
Pulmonary hemorrhage	4 (4.8%)	7 (20%)	10 (18.5%)	3 (30%)	0 (0%)	0.014
Gastrointestinal bleeding	0 (0%)	2 (5.7%)	2 (3.7%)	1 (10%)	0 (0%)	0.178
Infection	0 (0%)	1 (2.9%)	2 (3.7%)	0 (0%)	0 (0%)	0.454
Hypoglycemia	28 (33.3%)	8 (22.9%)	13 (12.4%)	5 (50%)	1 (10%)	0.201
Hypocalcemia	4 (4.8%)	1 (2.9%)	3 (5.6%)	3 (30%)	0 (0%)	0.016
Hyponatremia	11 (13.1%)	9 (25.7%)	15 (27.8%)	4 (40%)	2 (20%)	0.124
Metabolic acidosis	13 (15.5%)	7 (20%)	12 (2.22%)	5 (50%)	5 (50%)	0.023
Renal failure	2 (2.4%)	1 (2.9%)	13 (24.1%)	2 (20%)	0 (0%)	<0.001
Mortality rate	5 (6%)	3 (9.22%)	19 (35.2%)	7 (70%)	7 (70%)	<0.001
Death due to HIE	0 (0%)	0 (0%)	1 (5.3%)	3 (42.9%)	6 (85.7%)	<0.001

HIE: Hypoxic-ischemic encephalopathy
IVH: Intraventricular hemorrhage

diseases and states can be effective in the cardiorespiratory state of neonates. In the current study, maternal chorioamnionitis had a significant effect on the level of resuscitation of the neonates (P=0.005).

Neonatal complications, such as RDS, need for mechanical ventilation (P<0.001) and endotracheal surfactant installation (P=0.007), pneumothorax (P=0.004), pulmonary hemorrhage (P=0.014), and metabolic disorders, such as hypocalcemia (P=0.016), metabolic acidosis (P=0.023), and renal failure (P=0.001), were significantly different in neonates with different levels of resuscitation. Other complications, such as IVH, seizure, infection, hyponatremia, hypocalcemia, and hypoglycemia, were similar in all different levels of resuscitation.

Discussion

In this study, we evaluated the stepwise levels of delivery room resuscitation in a maternity hospital and analyzed the impact of maternal or fetal problems on the need for different levels of resuscitation, neonatal outcome, and survival. Considering the global advances in neonatal intensive care, the rate of premature neonate's mortality has declined (15). The mortality rate of neonates in our population was 23.8% (n=46), and HIE as a consequence of unsuccessful resuscitation was detected in 21.7% (n=10) of the patients.

In the current study, the rate of mortality was significantly different in neonates based on the level of resuscitation (P<0.001). A cohort study was carried out by Sara Handly on 13,758 neonates on the outcome of premature babies after delivery room resuscitation within 2005-2011. In the aforementioned study, it was concluded that premature infants with delivery room resuscitation had worse outcomes and more mortality and IVH. In our patients, the incidence of IVH was similar in all the neonates with different levels of resuscitation (P=0.159) (16).

Regarding gender differences in the neonatal outcomes of preterm babies, males had worse outcomes (17). The results of the present study showed that in all the levels of resuscitation, the number of male patients was more than female ones. In addition, statistically significant differences in the need for different levels of resuscitation were detected in this regard (P=0.009).

There is conflicting evidence about the influence of delivery mode on neonatal outcomes. In this regard, the findings of a retrospective study conducted by Holze showed that preterm neonates delivered through C/S had better outcomes than the patients with NVD in 1,320 singleton preterm deliveries. In the aforementioned study, the rate of C/S was reported as 73.5% (18). On the contrary, in a study carried out by NR Blue, preterm neonates delivered through NVD had better outcomes (19). The rate of C/S in our population was 82.4% with no statistically significant difference in the resuscitation process and need for different levels of assistance (P=0.824)

Although the initial and basic intervention was the most frequent level (43.5%) of resuscitation in our population, the need for noninvasive positive pressure ventilation was observed in 28% (n=54) of the subjects. This result is much higher than that reported for term babies. Since the population of the present study were preterm babies of less than 32 weeks of gestation, the higher percentage of ventilation problems in the delivery room and need for PPV was justified.

Fortunately, with the implication of t-peace resuscitator for PPV and early continuous positive airway pressure (CPAP) in our delivery room, the endotracheal tube was inserted just in 5.2% (n=10) of the neonates. In a study conducted by Monika Bajaj et al. on 7,014 preterm infants with a gestational age of 29-33 weeks, they showed that there was no need for resuscitation in 24% (n=1,684) of the neonates, and routine care was efficient in these patients.

The need for oxygen or CPAP, bag and mask ventilation, endotracheal tube insertion, and chest compression was reported in 32.5%, 26.1%, 14.7%, and 2.7% of the subjects, respectively (20). This significant difference in the intubation of neonates in the delivery room between the present study and Monika study (5.2% vs. 14.7%) is related to the significant different sample sizes of the two studies (7,014 vs. 189). Similar to our study, in the aforementioned study, the higher rate of mortality was associated with a higher intensity of resuscitation.

Maternal pregnancy-induced medical problems (e.g., preeclampsia, diabetes, addiction, prolonged rupture of membranes (PROM), and chorioamnionitis) and history of infertility or chronic diseases increased the need for advanced resuscitation in preterm deliveries, and the presence of a skilled resuscitation team before delivery is necessary. Fortunately, in the current study, just the chorioamnionitis and bloody or meconium-stained amniotic fluid had a statistically significant difference in the level of resuscitation (P=0.005 and 0.007, respectively).

In a study carried out by Costa Al on 222 neonates, prematurity (in 55.5% of the subjects) and intrapartum infection (in 41.8% of the subjects) were the most common complications with the need for resuscitation and NICU admission. In the aforementioned study, the authors stated that mothers with hypertensive disease and PROM should receive special attention in prenatal care due to their strong association with the requirement for advanced resuscitation (21). One of the known risk factors for RDS, surfactant deficiency, and need for mechanical ventilation in the neonatal period or after that is intrapartum hypoxia. In our population, the aforementioned factors were significantly different in all levels of resuscitation (P=0.001 and P=0.007).

As we showed in our data, neonatal complications, such as RDS, need for mechanical ventilation, endotracheal surfactant installation, and metabolic disorders (e.g., hypocalcemia, metabolic acidosis, and renal failure) were more frequently detected in cases with advanced resuscitation. These results emphasized the significance of a good quality resuscitation process with a trained resuscitation team and right equipment in neonatal outcomes. In a study conducted by Cristina Helena Ferreira, pulmonary hemorrhage was associated with delivery room intubation (OR=7.6). Similar to that in the present study, the rate of pulmonary hemorrhage was similar in all levels of resuscitation (P=0.014) (22).

The limitation of the current study was the low sample size and retrospective pattern of the method. However, the strength of the study was the analysis of all different levels of resuscitation in detail. Moreover, to date, there have been a limited number of published studies about the association of the different levels of resuscitation based on the NRP

Conclusion

In this analytical study, in different levels of resuscitation, we found that regarding the high rate of mortality and need for more advanced resuscitation in premature babies, improving the quality of care for mothers and neonates is necessary to obtain better outcomes among these high-risk neonates. According to our results, the mode of delivery did not affect the different levels of resuscitation. Since noninvasive positive pressure ventilation after the initial support was the most frequent intervention, the proper use of equipment is necessary for the prevention of advanced resuscitation.

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Conflicts of interest

The authors declare that there is no relevant financial interest or financial conflict.

Ethical Considerations

The study protocol was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences, and written consent was obtained from the mothers.

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