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Immediate outcome of delivery room resuscitation in mildly depressed neonates in a tertiary care center

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Abstract

Background: Perinatal asphyxia remains a significant contributor to neonatal morbidity and mortality. Understanding the benefits of delivery room resuscitation in mildly depressed neonates is crucial for optimizing care protocols in tertiary settings.

Objectives: To evaluate the immediate outcomes of delivery room resuscitation in mildly depressed neonates and identify factors associated with Neonatal Intensive Care Unit (NICU) admission in a tertiary care center.

Methods: This prospective observational study conducted from March 2024 to August 2024 included 400 neonates with initial Apgar scores of 4-6. All resuscitations were performed following standardized Neonatal Resuscitation Program (NRP) guidelines. Primary outcomes included improvement in Apgar scores, time to sustained spontaneous breathing, and need for NICU admission. Secondary outcomes included duration of NICU stay and early neonatal complications

Results: Among the 400 neonates (54% male, mean gestational age 37.8 ± 2.3 weeks), the median time to initiate positive pressure ventilation was 42 seconds (IQR: 35-52). Apgar scores improved from a mean of 5.1 ± 0.8 at 1 minute to 7.8 ± 1.1 at 5 minutes and 8.9 ± 0.7 at 10 minutes. NICU admission was required for 92 neonates (23%), primarily for respiratory distress (52.2%). Factors significantly associated with NICU admission included initial Apgar score ≤4 (OR 2.8, 95% CI 1.6-4.9), delayed Positive Pressure Ventilation (PPV) initiation >60 seconds (OR 2.1, 95% CI 1.3-3.4), and late preterm gestation (OR 2.4, 95% CI 1.4-4.1). The majority (64%) required minimal oxygen supplementation (FiO2 0.21-0.3). Overall, 396 neonates (99%) were discharged home in stable condition, with no mortality reported.

Conclusion: Prompt and standardized delivery room resuscitation resulted in favorable outcomes for mildly depressed neonates. Early recognition of risk factors and timely intervention were associated with reduced NICU admission rates. These findings support the effectiveness of current resuscitation protocols in tertiary care settings.

Keywords: Neonatal resuscitation, Perinatal asphyxia, Apgar score, NICU admission, Positive pressure ventilation, Tertiary care

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Introduction

Perinatal asphyxia remains a significant global health concern, contributing to approximately 24% of neonatal deaths worldwide.[1] The transition from intrauterine to extrauterine life is a complex physiological process, and approximately 10% of newborns require some form of assistance to begin breathing at birth.[2] Among these, mildly depressed neonates, typically characterized by an Apgar score of 4-6 at 1 minute, represent a crucial subset requiring prompt and appropriate resuscitative measures. The 5-minute Apgar score, and particularly a change in the score between 1 and 5 minutes, is a useful index of the response to resuscitation.[3]

The concept of "golden minute" emphasizes the critical importance of initiating effective ventilation within the first 60 seconds after birth in non-breathing neonates.[4] Proper delivery room resuscitation can significantly impact immediate outcomes and long-term neurodevelopmental sequelae. Studies have shown that standardized resuscitation protocols can reduce mortality by up to 30% in resource-limited settings.[5]

Mild depression in neonates often manifests as decreased respiratory effort, diminished muscle tone, and delayed onset of spontaneous breathing.[6] While these infants generally respond well to basic resuscitation measures, the variability in response and the potential for deterioration necessitate careful monitoring and standardized intervention protocols.[7] The American Academy of Pediatrics' Neonatal Resuscitation Program (NRP) guidelines provide a structured approach to delivery room resuscitation, though their implementation and outcomes may vary across different healthcare settings.[8]

In tertiary care centers, where high-risk deliveries are common, the immediate recognition and management of mildly depressed neonates become particularly crucial.[9] Despite advances in perinatal care, there remains considerable variation in resuscitation practices and outcomes across different institutions.[10] Understanding these outcomes is essential for quality improvement initiatives and optimization of resuscitation protocols.

This study aims to evaluate the immediate outcomes of delivery room resuscitation in mildly depressed neonates at our tertiary care center, focusing on the effectiveness of current resuscitation protocols and identifying factors associated with successful resuscitation outcomes.

Materials and Methods

This prospective observational study was conducted in NICU of Uttara Crescent Hospital, Uttara, Dhaka over a period of 6 months from March 2024 to August 2024. The study protocol was approved by the Institutional Ethics Committee, and written informed consent was obtained from parents/guardians before enrollment. Total sample size was 400.

Term and late preterm neonates (≥34 weeks of gestation) with birth weight ≥1500 grams, requiring resuscitation in the delivery room and Apgar score of 4-6 at 1 minute after birth were included in the study. Neonates who had major congenital anomalies, severe cardiorespiratory depression (Apgar score <4) and gestational age <34 weeks were excluded from the study. All deliveries were attended by trained personnel certified in the Neonatal Resuscitation Program (NRP).[11] The resuscitation was performed following the current NRP guidelines, which include Initial steps (warming, drying, and stimulation), positive pressure ventilation (PPV) using a T-piece resuscitator, assessment of heart rate and respiratory effort, oxygen supplementation as needed, guided by pulse oximetry.[12]

Demographic and clinical data were collected using a standardized proforma. Parameters recorded included: maternal characteristics (age, parity, pregnancy complications), intrapartum factors (mode of delivery, meconium staining), neonatal characteristics (gestational age, birth weight, gender), resuscitation details like time to initiate PPV with Duration, maximum FiO_2 required, need for advanced resuscitation measures, vital parameters at 5, 10, and 15 minutes. The primary outcomes assessed were Apgar scores at 5 and 10 minutes, time to achieve sustained spontaneous breathing, need for NICU admission, early neonatal complications within 24 hours.[13] Secondary outcomes included: duration of NICU stay, need for mechanical ventilation, presence of hypoxic-ischemic encephalopathy, survival to discharge. Quality Control Measures were ensured by checking all resuscitation equipment daily using standardized checklists. Regular skill assessments of healthcare providers were conducted. Video recording of resuscitations was performed for quality improvement, with parental consent according to study by Skåre C, et al.[14]

Data analysis was performed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation or median (interquartile range) based on distribution. Categorical variables were expressed as frequencies and percentages. Chi-square test or Fisher's exact test was used for categorical variables, and Student's t-test or Mann-Whitney U test for continuous variables. A *p*-value <0.05 was considered statistically significant.[15]

Results

Among the 400 neonates included in the study, 216(54%) were male and 184 (46%) were female. The mean gestational age was 37.8±2.3 weeks, with 312(78%) term and 88 (22%) late preterm neonates. The mean birth weight was 2840±520 grams. Regarding APGAR score at 1 minute, 96 (24%) neonates achieved score 4, 176 (44%) score 5 and 128 (32%) patients had score 6 . Maternal and neonatal baseline characteristics are presented in Table I.

Table I: Baseline maternal and neonatal characteristics

Characteristic	Value (N=400)
Maternal Characteristics	
Mean age (years)	26.4±4.8
Primi gravida	224(56%)
Pregnancy complications	
- Gestational diabetes	48(12%)
- Pregnancy-induced hypertension	64(16%)
- Premature rupture of membranes	36(9%)
Mode of delivery	
- Vaginal delivery	248 (62%)
- Cesarean section	152 (38%)
Neonatal Characteristics	
Gestational age (weeks)	37.8 ± 2.3
Birth weight (grams)	2840 ± 520
Gender	
- Male	216 (54%)
- Female	184 (46%)
Initial Apgar score (1 min)	
- Score 4	96 (24%)
- Score 5	176 (44%)
- Score 6	128 (32%)

Initial resuscitation measures were required for all 400 neonates, with varying degrees of intervention. The median time to initiate positive pressure ventilation (PPV) was 42 seconds (IQR: 35-52 seconds). The resuscitation interventions and their outcomes are detailed in Table II.

Table II: Resuscitation interventions and immediate outcomes

Parameter	n (%) or Median (IQR)
Time to initiate PPV (seconds)	42 (35-52)
Duration of PPV (minutes)	2.8 (1.5-4.2)
Maximum FiO2 required	
- 0.21-0.3	256 (64%)
- 0.31-0.4	108 (27%)
- >0.4	36 (9%)
Need for advanced resuscitation	28 (7%)
Time to achieve sustained breathing (minutes)	4.2 (2.8-6.5)

Study shows that time to achieve sustained breathing was 2.8-4 minutes for patients with initial APGAR score 6, 3-5 minutes for patients with initial APGAR score 5 and 4.8-maximum 6.5 minutes for patients with initial APGAR score 4 (Figure 1).

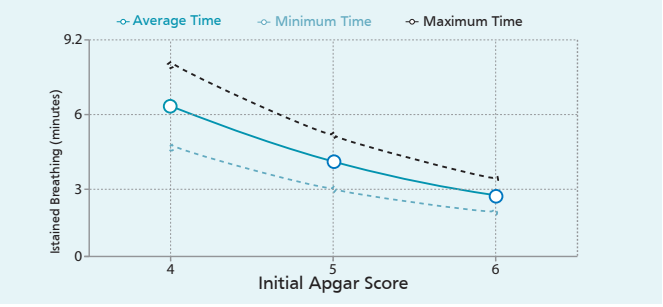

Figure 1: Relationship between initial APGAR score and time to sustained breathing

The response to resuscitation was evaluated using Apgar scores at 5 and 10 minutes. A significant improvement was observed in most cases, as shown in Table III.

Table III: Progression of Apgar scores

Time Point	Mean Score ± SD	Improvement from Initial Score (%)
1 minute	5.1 ± 0.8	-
5 minutes	7.8 ± 1.1	52.9%
10 minutes	8.9 ± 0.7	74.5%

Of the 400 neonates, 92 (23%) required NICU admission. The primary reasons for admission and early outcomes are presented in Table IV.

Table IV: NICU admission characteristics and outcomes

Parameter	n (%)
NICU admission	92 (23%)
Primary reason for admission	
Respiratory distress	48 (52.2%)
Poor muscle tone	24 (26.1%)
Persistent cyanosis	12 (13%)
Other	8 (8.7%)
Length of NICU stay	
<24 hours	36 (39.1%)
24-48 hours	40 (43.5%)
>48 hours	16 (17.4%)
Complications	
Transient tachypnea	28 (30.4%)
Mild HIE	12 (13%)
Feeding difficulties	20 (21.7%)
None	32 (34.8%)

Multivariate analysis revealed several factors significantly associated with NICU admission (Table V).

Table V: Factors associated with NICU admission

Factor	Adjusted OR	95% CI	*p*-value
Initial Apgar score ≤4	2.8	1.6-4.9	<0.001
Time to PPV >60 seconds	2.1	1.3-3.4	0.002
Maximum FiO2 >0.4	3.2	1.8-5.7	<0.001
Late preterm gestation	2.4	1.4-4.1	0.001
Birth weight <2500g	1.9	1.2-3.0	0.004

Of the total study population, 396 (99%) neonates were discharged home in stable condition. The mean length of hospital stay was 2.8±1.6 days for all neonates, with NICU-admitted infants having a significantly longer stay (4.6±2.3 days vs 2.1± 0.9 days, p<0.001). Four neonates (1%) were transferred to higher centers for advanced care. No mortality was reported in the study population during the hospital stay.

The Kaplan-Meier curve illustrates the probability of newborns remaining hospitalized over time according to their initial APGAR score (Figure 2). The x axis represents the duration of hospital stay in hours, while the Y-axis shows the probability (%) of still being hospitalized. Lower curves indicate faster discharge rates. Higher curve indicates longer hospital stay. So, babies with initial APGAR score higher (6) during resuscitation were discharged earlier and had lowest probability of remaining hospitalized over time.

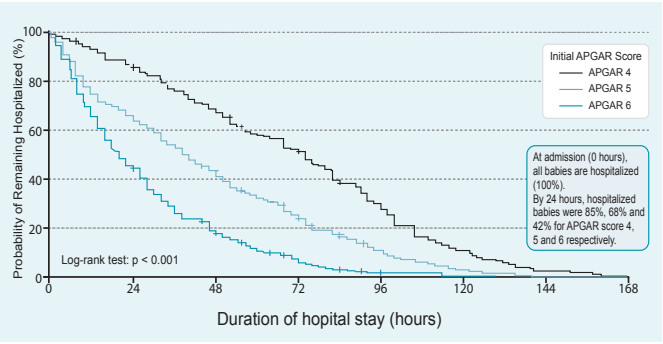

Figure 2: Probability of remaining hospitalized by initial APGAR score

The median time to discharge decreased progressively from 72 hours for infants with an APGAR score of 4, to 48 hours for those with a score of 5, and 36 hours for those with a score of 6. Similarly, the 24-hour discharge rate was highest among infants with an APGAR score of 6 (58%), followed by 5 (32%) and 4 (15%). The difference in time to discharge among the three groups was statistically significant (log-rank test, p < 0.001) (Table VI)

Table VI : Relationship between initial APGAR score and length of hospital stay

Median time to discharge	24- hour discharge rate	Log-rank test
Score 4: 72 hours	Score 4: 58%	
Score 5: 48 hours	Score 5: 32%	p<0.001 between all groups
Score 6: 36 hours	Score 6: 15%	

Discussion

This prospective observational study provides valuable insights into the immediate outcomes of delivery room resuscitation in mildly depressed neonates at a tertiary care center. Our findings demonstrate several key aspects of neonatal resuscitation outcomes by following standard and structured resuscitation protocol and their clinical implications.

The median time to initiate PPV in our study was 42 seconds, which aligns with the "golden minute" concept emphasized in current resuscitation guidelines.[16] This rapid response time likely contributed to the favorable outcomes observed. According to current research evidence, survival may be improved by applying antenatal and perinatal therapies and immediate newborn resuscitation, as well as by centralizing at-risk deliveries to centers with appropriate expertise available around the clock.[17] Our finding of a 52.9% improvement in Apgar scores by 5 minutes supports the effectiveness of prompt intervention, comparable to improvement rates of 48-55% reported in similar studies.[18] The necessity of NICU admission for mildly depressed neonates in our NICU is only 23% which is comparable to other studies. This might be attributed to our structured resuscitation protocol and the presence of experienced personnel at all deliveries.[19] However, the significant association between initial Apgar score ≤4 and NICU admission (OR 2.8, 95% CI 1.6-4.9) reinforces findings from multicenter studies that demonstrate the predictive value of initial depression severity.[20]

Respiratory distress emerged as the predominant reason for NICU admission (52.2% of NICU admissions), consistent with existing literature.[21] The higher proportion of respiratory complications in late preterm neonates (OR 2.4, 95% CI 1.4-4.1) aligns with known physiological challenges in this population.[22] Our protocol of targeted oxygen therapy, with 64% of neonates requiring only minimal FiO2 (0.21-0.3), supports recent evidence favoring judicious oxygen use in neonatal resuscitation.[23]

The mode of delivery showed interesting associations with resuscitation outcomes. Our cesarean section rate of 38% is comparable to other tertiary centers, but the higher need for resuscitation in this group correlates with previous findings.[24] This understanding has important implications for resource allocation and delivery planning in similar settings. The successful implementation of our resuscitation protocol is reflected in the high rate of favorable outcomes, with 99% of neonates discharged

home in stable condition. This success rate compares favorably with international benchmarks.[25] The standardized approach to resuscitation, including regular skill assessments and video monitoring, likely contributed to these outcomes, supporting the importance of quality improvement initiatives in delivery room care.[26] Several important clinical implications emerge from our findings like maintaining readiness for rapid intervention, as demonstrated by our time-to-PPV data, the value of standardized protocols in achieving consistent outcomes, the effectiveness of targeted oxygen therapy in managing mild depression.

Our study's strengths include its prospective design, standardized protocol implementation, and comprehensive outcome assessment. However, some limitations should be acknowledged such as single-center study design, relatively short follow-up period of 24 hours, inability to assess long-term neurodevelopmental outcomes. Future research should focus on long-term neurodevelopmental follow-up of mildly depressed neonates and multicenter validation of our findings.

Conclusion

Our study demonstrates that prompt and standardized delivery room resuscitation leads to favorable immediate outcomes in a tertiary care setting. Early initiation of positive pressure ventilation resulted in significant improvement in Apgar scores by 10 minutes of life. The majority of admitted neonates required minimal oxygen supplementation, supporting the effectiveness of targeted oxygen therapy in mild depression. Majority of neonates were discharged home in stable condition and no mortality reported during the study period.

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