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Clinical Features of Respiratory Distress Syndrome in Preterm Neonates

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Abstract

Respiratory distress syndrome (RDS) is one of the most common and severe disorders of the early neonatal period in preterm infants.

***Objective**: to investigate the clinical features of respiratory distress syndrome in preterm neonates according to gestational age.*

***Materials and Methods**: The study included 60 neonates with RDS. Their gestational age ranged from 26 to 37 weeks. A general clinical examination was performed. The clinical severity of respiratory distress was assessed using the Silverman/Downes score.*

***Results**: The incidence of severe birth asphyxia was two- to threefold higher among preterm neonates born at 26-28 weeks of gestation than among those born at 29-37 weeks. Assessment using the Silverman score showed that 94.7% of preterm neonates born at 26-28 weeks had extremely severe RDS, a substantially higher proportion than in the groups born at 29-37 weeks. In preterm neonates born at 33-37 weeks, RDS was predominantly mild.*

Keywords: **Neonate, prematurity, respiratory distress syndrome, asphyxia, Silverman score**.

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1. Introduction

Neonatal respiratory distress syndrome (RDS) remains one of the most significant problems in modern neonatology and a leading cause of respiratory failure in preterm infants. Despite major advances in perinatal care, the widespread use of antenatal corticosteroid prophylaxis, exogenous surfactant replacement therapy, and modern noninvasive respiratory support, RDS continues to contribute substantially to early neonatal morbidity and mortality, particularly among very and extremely preterm neonates [1, 2]. Current guidelines emphasize that the principal goal in managing a preterm infant with RDS is not only to ensure adequate oxygenation and ventilation, but also to minimize injury to immature lung tissue, which may subsequently contribute to the development of bronchopulmonary dysplasia [1].

RDS is caused by the morphofunctional immaturity of lung tissue and a primary deficiency of pulmonary surfactant,

which lead to reduced lung compliance, alveolar instability, and alveolar collapse at end-expiration. The resulting atelectasis, reduced functional residual capacity, and ventilation-perfusion mismatch cause hypoxemia, hypercapnia, and increased work of breathing [2-4]. The incidence and severity of the disease are strongly inversely related to gestational age. According to M. Tana et al., RDS develops in approximately 80% of infants born at 28 weeks of gestation and may affect up to 90% of neonates born at approximately 24 weeks [2]. Thus, the degree of morphofunctional lung maturity at birth is one of the main factors determining the clinical course of the disease.

Clinical manifestations of RDS usually occur immediately after birth or during the first hours of life. Typical signs include tachypnea, expiratory grunting, nasal flaring, retraction of the compliant areas of the chest, use of accessory respiratory muscles, episodes of desaturation, and a progressively increasing need for supplemental oxygen and respiratory support [1-3]. In very preterm neonates, immaturity of the central respiratory control mechanisms may also result in irregular breathing and episodes of apnea. In severe cases, worsening hypoxemia, hypercapnia, and mixed respiratory-metabolic disturbances increase the likelihood that invasive mechanical ventilation will be required [2, 5].

The severity of respiratory distress is determined not only by gestational age and birth weight, but also by a combination of antenatal, intrapartum, and postnatal factors. According to O.V. Zavyalov et al., the severity and progression of RDS in very preterm infants are closely associated with gestational age, extremely low birth weight, perinatal hypoxia, and intrauterine infection [5]. Late-preterm neonates also warrant particular attention. A multicenter study by A.V. Mostovoy et al. demonstrated that the need for respiratory therapy remains relatively high among infants born at 34-36 weeks of gestation who develop RDS; more than half of the observed infants with RDS required exogenous surfactant [6]. These data indicate that clinically significant RDS is not confined to very preterm neonates and may follow a severe course even at a relatively advanced gestational age.

Current management strategies for preterm infants focus on the early initiation of noninvasive respiratory support, primarily continuous positive airway pressure (CPAP), judicious oxygen use, and timely administration of exogenous surfactant when respiratory failure progresses [1, 3]. Sh.I. Navruzova and G.G. Yuldasheva reported improved gas-exchange parameters in preterm neonates with RDS following surfactant replacement therapy, confirming its important role in the comprehensive intensive care of this patient population [7]. However, treatment effectiveness largely depends on the timely assessment of respiratory-distress severity and identification of infants at high risk of progressive respiratory failure.

In recent years, lung ultrasonography has assumed an increasingly important role alongside the traditional clinical assessment of respiratory-distress severity. F. Raimondi et al. demonstrated that changes in the lung ultrasound score in preterm infants with RDS depend on gestational age, correlate with oxygenation parameters, and may be used to monitor disease severity and predict bronchopulmonary dysplasia [8]. Nevertheless, despite advances in instrumental diagnostics, clinical signs and their serial assessment remain essential for determining an infant's clinical severity and selecting the appropriate level of respiratory therapy.

Studies seeking clinical and laboratory criteria for an unfavorable course of RDS are of particular interest. G.N. Chistyakova et al. found that preterm neonates with RDS had lower Apgar scores, acid-base disturbances with a tendency toward hypercapnia and acidosis, and longer durations of mechanical ventilation [9]. Taken together, these findings confirm the heterogeneity of the clinical course of RDS and the need for a differentiated approach to assessing preterm infants that accounts for the degree of prematurity, perinatal history, severity of respiratory failure, and need for different types of respiratory support.

Thus, despite substantial advances in modern neonatology, the clinical course of respiratory distress syndrome in preterm infants remains highly variable and is largely determined by gestational age and the degree of morphofunctional maturity of the neonate. Studying the presentation, severity, and evolution of respiratory disturbances in different groups of preterm infants is important for the early identification of high-risk patients, timely selection of optimal respiratory therapy, and prevention of adverse outcomes.

Objective: to investigate the clinical features of respiratory distress syndrome in preterm neonates according to gestational age.

2. Methods

To address the study objectives, investigations were conducted from 2018 to 2020 in the neonatal intensive care

units of the Republican Perinatal Center and the City Perinatal Center. The study included 60 neonates with respiratory distress syndrome and 20 preterm neonates without RDS. Gestational age ranged from 26 to 37 weeks. Among the neonates with RDS, 19 (32%) were born at 26-28 weeks, 28 (46%) at 29-32 weeks, and 13 (22%) at 33-37 weeks of gestation.

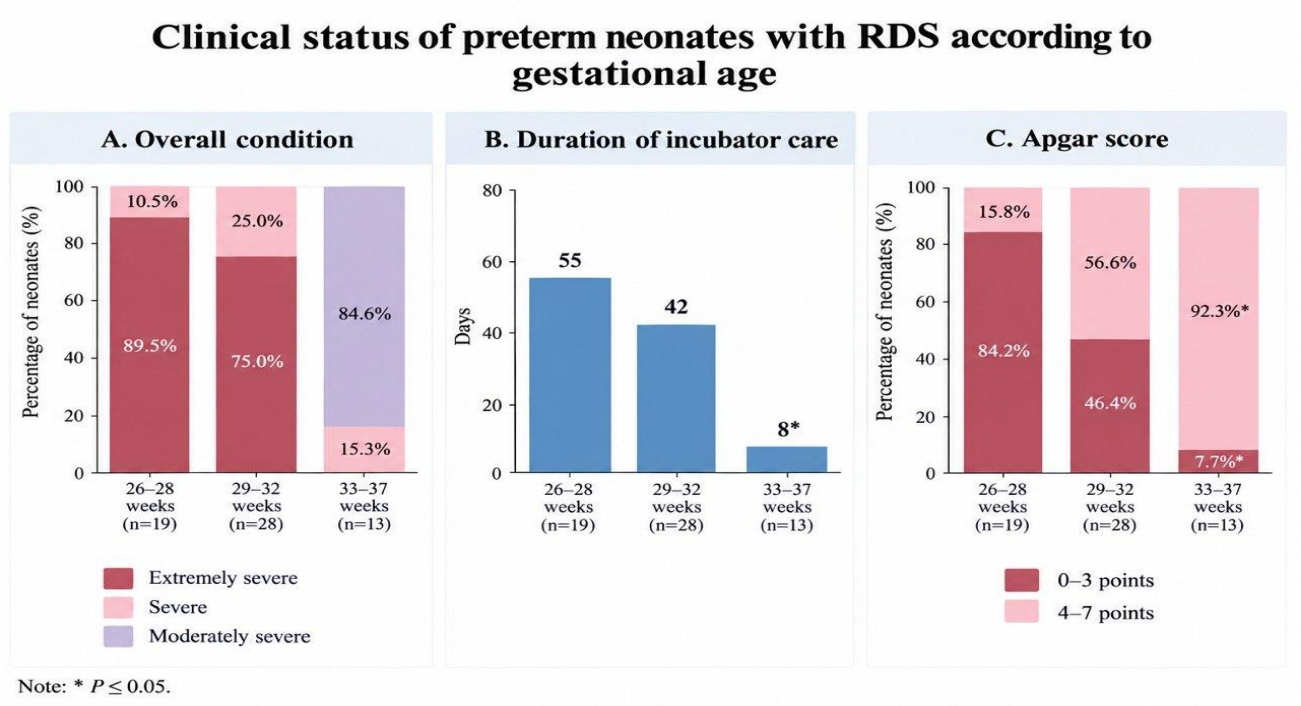
A general clinical examination of all organs and systems was performed. The Silverman/Downes score (1956) was used to diagnose and assess the severity of respiratory distress in neonates. The data were statistically analyzed using Microsoft Excel software and its statistical functions, including Student's t-test, with calculation of the probability of error (P). Differences were considered statistically significant at $p<0.05$.

3. Results and Discussion

The study examined the clinical features of respiratory distress syndrome in preterm neonates according to gestational age.

We analyzed the clinical status of preterm neonates with RDS according to gestational age (Table 1).

Table 1.



Among infants born at 26-28 weeks, the condition at birth was assessed as extremely severe in 89.5% and severe in 10.5% (Table 1). In the 29-32-week group, the condition at birth was also extremely severe in most neonates (75.0%) and severe in 25.0%. In both groups, severity was attributable to grade II-III respiratory failure and neurological signs (central nervous system depression) in the setting of prematurity and morphofunctional immaturity. Among infants born at 34-37 weeks, the condition at birth was moderately severe in 84.6% and severe in 15.3%.

Because of immature thermoregulatory mechanisms, a substantial proportion of neonates required incubator care, and its duration depended considerably on the degree of prematurity. Among neonates born at 26-28 weeks, the duration of incubator care ranged from 45 to 90 days, with a mean of 60 days (Table 1).

The mean duration of incubator care for infants born at 29-32 weeks was 41 days and ranged from 17 to 56 days. Infants born at 33-37 weeks required incubator care much less often, and its mean duration was 8 days.

Thus, infants born at 26-28 weeks were twice as likely to be born in an extremely severe condition and required longer incubator care than more mature neonates born at 29-37 weeks.

Because of the immaturity of the anatomical structures of the lungs, most preterm infants are born with asphyxia. Birth asphyxia is known to be a risk factor for respiratory distress syndrome [13].

We analyzed Apgar scores (Figure 1).

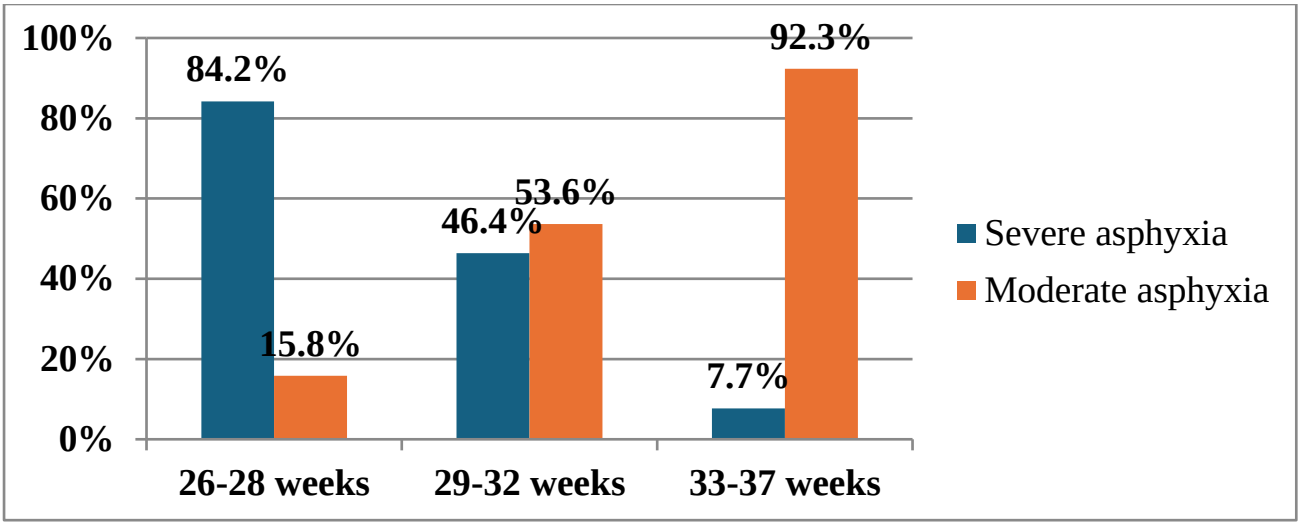


Figure 1. Analysis of Apgar scores

In the analyzed group of neonates born at 26-28 weeks, severe asphyxia with an Apgar score of 0-3 points was observed in almost all infants (84.2%), requiring more extensive initial resuscitation, including airway suctioning, tactile stimulation, assisted ventilation, and mechanical ventilation. After initial resuscitation was completed, these infants were transferred from the delivery room to the neonatal intensive care unit for preterm infants. In this group, moderate asphyxia with an Apgar score of 4-6 points occurred in 15.8% of cases.

Among preterm infants born at 29-32 weeks, severe asphyxia occurred in 46.4%, whereas moderate asphyxia was observed in 53.6%.

Among most preterm infants born at 33-37 weeks (92.3%), moderate asphyxia with an Apgar score of 4-7 points was observed; only 7.7% of infants in this group had severe asphyxia.

Our findings showed that severe birth asphyxia was two- to threefold more common among preterm infants born at 26-28 weeks than among those born at 29-37 weeks.

These findings indicate that profound prematurity and the immaturity of neonatal body structures contribute to severe birth asphyxia.

The effectiveness of spontaneous breathing was assessed among the clinical signs present at birth. Spontaneous breathing was absent in 5 (8.3%) neonates; irregular spontaneous breathing with episodes of apnea was recorded in 18 (30.0%); and irregular spontaneous breathing accompanied by gasping was observed in 11 (18.3%). In the remaining cases, spontaneous breathing was ineffective, with retraction of the compliant areas of the chest and persistent generalized cyanosis. Gestational age and birth weight did not appear to influence these findings, because apnea and low Apgar scores occurred in infants across different gestational ages and birth weights.

Clinical signs of RDS were present in all infants from birth and progressed during the first 1-5 hours of life as respiratory failure worsened: respiratory rate rose to 90 breaths per minute, cyanosis intensified, and diffuse crepitations were heard over the lungs against a background of unevenly diminished breath sounds.

The severity of respiratory distress in preterm infants was assessed using the Silverman score.

The Silverman score results showed that 73.8% of preterm neonates born at 33-37 weeks scored up to 5 points and had mild RDS, whereas 26.2% scored 6-9 points, corresponding to moderately severe RDS.

In the 29-32-week group, 85.7% of neonates had moderately severe RDS, whereas 14.3% had extremely severe RDS, corresponding to a Silverman score of 10 points.

Among preterm neonates born at 26-28 weeks, 94.7% had extremely severe RDS, corresponding to a score of 10 points. Only one infant (5.3%) had moderately severe RDS.

Because of impaired surfactant synthesis and release, many preterm infants require surfactant administration and respiratory support immediately after birth (Table 2).

Our findings showed that 45.9% of preterm neonates born at 26-28 weeks and 15.8% of those born at 29-32 weeks received endotracheal surfactant (Curosurf) during the first hours of life; in two infants, it was administered before the first breath using the INSURE technique (Intubation, SURfactant administration, and Extubation).

Table 2.

Comparative analysis of respiratory support in preterm neonates according to gestational age

	26-28 weeks n-19	**29-32 weeks n-28**	**33-37 weeks n-13**
Administration of exogenous surfactant	45.9%	15.8%	-
Mechanical ventilation	48.9%		-
CPAP	34.0%		73.8%
Oxygen mask	17.0%		38.5%
Mean duration of mechanical ventilation	22 days	9 days	

Respiratory support in the form of mechanical ventilation is a component of neonatal intensive care. Among infants born at 26-32 weeks, 5 (10.6%) were placed on mechanical ventilation within the first minutes after birth, 10 (21.3%) during the first 2 hours of life, and 8 (17.0%) at 3-12 hours of life. Overall, 23 (48.9%) neonates required mechanical ventilation. Supplemental oxygen with positive end-expiratory pressure during stable spontaneous breathing (CPAP) was provided to 16 (34.0%) infants, and 8 (17.0%) received oxygen through a face mask. In the 33-37-week group, only 3 (23.1%) infants received supplemental oxygen via CPAP, and 5 (38.5%) received it through a face mask.

The duration of ventilation ranged from 1 to 38 days and differed between groups: the mean duration of mechanical ventilation was 22 days among infants born at 26-28 weeks and 9 days among those born at 29-32 weeks. During the first days of mechanical ventilation, most infants received moderate ventilator settings (fraction of inspired oxygen [FiO2] >0.4; peak inspiratory pressure [PIP] >20).

4. Conclusions

Thus, infants born at 26-28 weeks were twice as likely to be born in an extremely severe condition and required longer incubator care than more mature neonates born at 29-37 weeks. The severity of their condition due to birth asphyxia and respiratory failure was directly correlated with gestational age. Severe birth asphyxia was two- to threefold more common among preterm infants born at 26-28 weeks than among those born at 29-37 weeks. The Silverman score results showed that 94.7% of preterm neonates born at 26-28 weeks had extremely severe RDS, a substantially higher proportion than in the groups born at 29-37 weeks. In the 33-37-week group, RDS was predominantly mild.

With standard treatment and preventive measures, infants born at an early gestational age (before 28 weeks) required mechanical ventilation more often and for longer periods and therefore had a higher risk of bronchopulmonary dysplasia. This finding indicates the need for a more differentiated approach to preventing bronchopulmonary

dysplasia in very preterm infants.

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