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Effect of Surfactants on Respiratory Distress Syndrome in Newborns Admitted in NICU of Secondary Care unit, Islamabad

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Abstract

Preterm neonates frequently suffer from respiratory distress syndrome (RDS) because of their underdeveloped lungs and inadequate surfactant production. In this study, surfactant therapy's efficacy and clinical outcomes are assessed in neonates suffering from RDS symptoms who have been admitted to the NICU at Polyclinic Hospital in Islamabad. A randomized survey was conducted regarding surfactant therapy on 20 neonates suffering from RDS with an average of 1.57 kg birth weight and an average of 34.8 weeks gestational age. Data collection was done by a structured questionnaire to study the effectiveness of therapy and the associated factors. For data analysis, Python 3.10. was used. The study found that surfactant therapy significantly improves respiratory outcomes in neonates with RDS, with a p-value of 0.012 and an F-value of 4.52. Despite high overall effectiveness, variability in outcomes and a non-linear distribution of complications signifies the need for tailored clinical approaches and continuous evaluation. Larger, multi-center studies should be the main focus of future research to confirm these results and investigate the underlying causes of gender-specific therapy responses.

Keywords: Surfactant; Rds; Neonates; Nicu; Surfactant Therapy; Mechanical Ventilation; Respiratory Health

Introduction

Babies born before 34 weeks of gestation face significant challenges due to their underdeveloped lungs and insufficient surfactant production, which can lead to respiratory distress syndrome (RDS) [1]. These preterm infants, often weighing ≤ 1000 grams, struggle with breathing problems expressed by symptoms such as retractions, tachypnea, grunting, and cyanosis [1,2]. Surfactant, a vital fluid helping to keep the lungs expanded, is crucial for these babies. Without adequate surfactant, their lungs cannot function properly, leading to severe complications or even death within a few days if untreated [3]. Potential complications include hemorrhages, lung collapse, infections, and organ failures, underscoring the determination of effective intervention [1].

Surfactant replacement therapy is a basis for managing RDS, especially in newborns exhibiting radiographic and clinical indications or requiring mechanical ventilation due to respiratory failure. Commonly used surfactants like Beractant (Survanta), Poractant alfa (Curosurf), and Lucinactant (Surfaxin) have been pivotal in treating affected neonates. This mode of treatment significantly improves the chances of survival, reducing the need for positive pressure breathing, and minimizing the risk of pulmonary air leaks [3,4].

In Pakistan, the prevalence of preterm births and associated RDS poses a significant challenge due to limited healthcare resources and access to advanced neonatal care. The implementation of surfactant replacement therapy is not as widespread, often hindered by a lack of specialized medical facilities and financial constraints. Efforts are being made for improving neonatal care through training healthcare professionals and increasing the availability of essential treatments. Despite these efforts, there remains a critical need for enhanced infrastructure and resource allocation to effectively manage RDS in Pakistan. So, we aim to evaluate the efficacy of surfactant therapy in the NICU, assess the impact of maternal demographics on RDS development, and identify factors influencing neonatal responsiveness to treatment in the secondary care unit in Islamabad, Pakistan.

Methodology

Study Design: A cross-sectional observational study was conducted to measure the knowledge and attitude of healthcare providers regarding surfactant therapy in the NICU and to investigate the efficacy of surfactant therapy in neonates with RDS with the help of a structured questionnaire from January 2024 to March 2024.

Study Site: The study was carried out at the NICU of Polyclinic Hospital in Islamabad, Pakistan. Ethical approval was obtained, and parents of neonates with less than 37 weeks gestational age who were diagnosed with symptoms of RDS and treated with surfactant provided written consent.

Inclusion Criteria: The study included patients with gestational age less than 37 weeks and symptoms of RDS (grunting, tachypnea, and intercostal retraction) either at delivery or within 48 hours of the birth of the baby.

Exclusion Criteria: Patients with congenital defects (abnormalities of the airway, malformation of cardiothoracic or craniofacial), neonates with asphyxia, and those with air-leak syndrome were excluded from this study.

Data Collection Tool: Data collection was gathered through a questionnaire with four sections. The first section explored the demographic information of the participants, filled out from patient files. The second section collected demographic data of mothers of neonates using patient files and interviews with mothers. The third section assessed the efficacy and clinical outcomes of surfactant therapy in neonates suffering from RDS. The fourth section explored the attitude and knowledge of physicians regarding surfactant therapy in neonates with RDS (attached as supplementary file I).

Data Analysis: The responses were analyzed using Python 3.10. Descriptive statistics and ANOVA tests were used in evaluating the results, and a post-hoc test was used to make multiple comparisons among responses. A p-value of ≤ 0.05 was considered significant.

Results

This study comprised a total of 20 neonates (11 males, 9 females) with an average of 34.8 weeks gestational age, an average of 1.57 kg birth weight, and an average of 12.42105 days of hospital stay. Surfactant dose per kilogram was given to all infants exhibiting radiographic and clinical indications of RDS. The scatter plot between the birth weight of neonates and the surfactant shows a linear relation as the doses (in milligrams) were given per kilogram of body weight of neonates Figure 1.

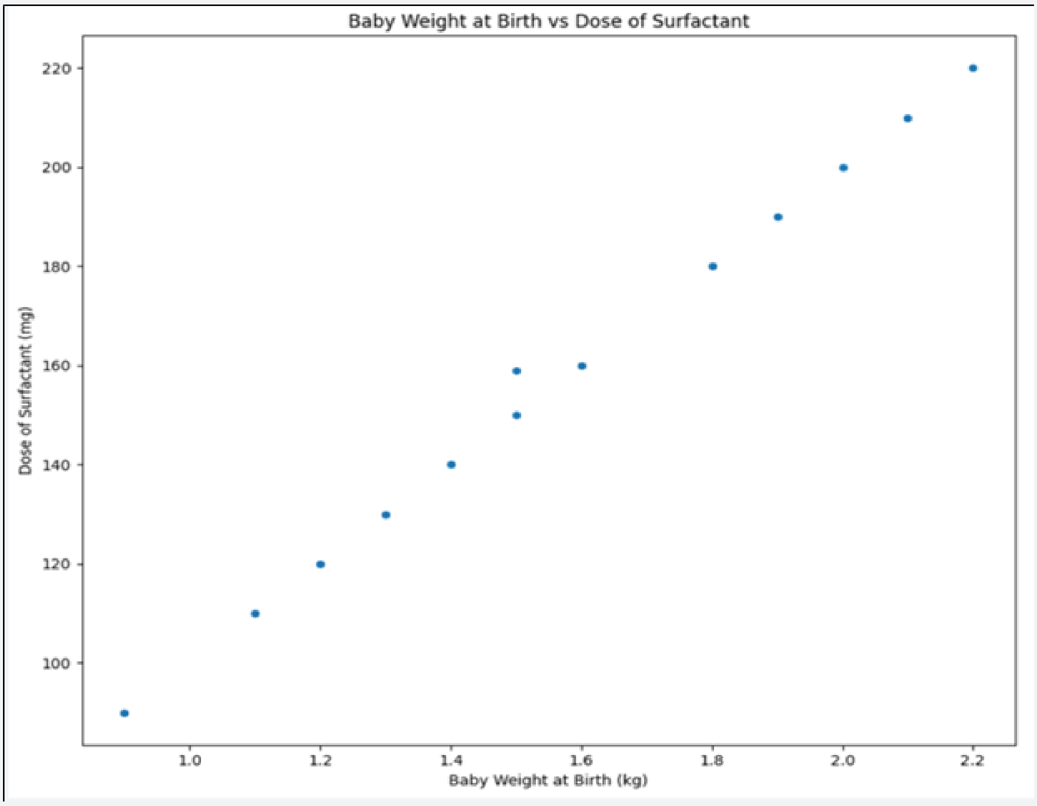

Figure 1: Variation in complications after surfactant.

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This clinical study indicates that females exhibit higher rates of side effects following surfactant treatment compared to males. The vertical bar plot Figure 2 illustrates the variation in complications observed after surfactant treatment by gender, with specific colors representing distinct side effects whereas the horizontal bar plot Figure 3 shows the frequency of occurrence of complications or side effects observed after surfactant treatment showing edema as the highest.

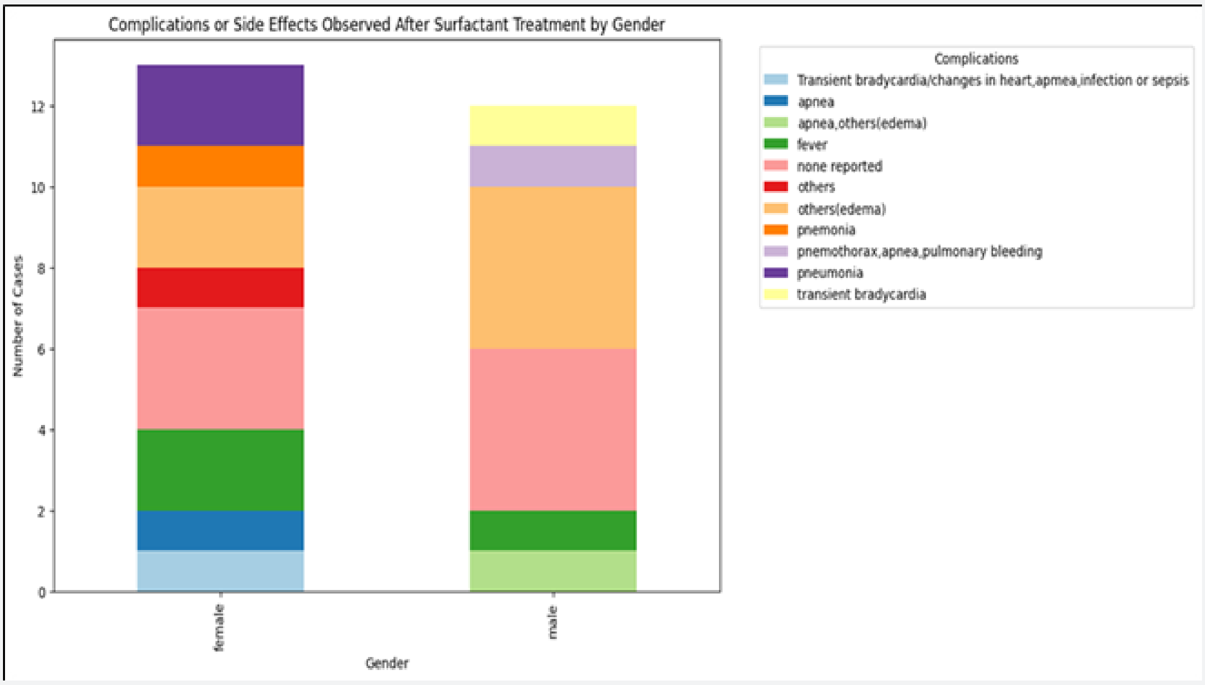

Figure 2: Complications after surfactant administration in neonates by gender.

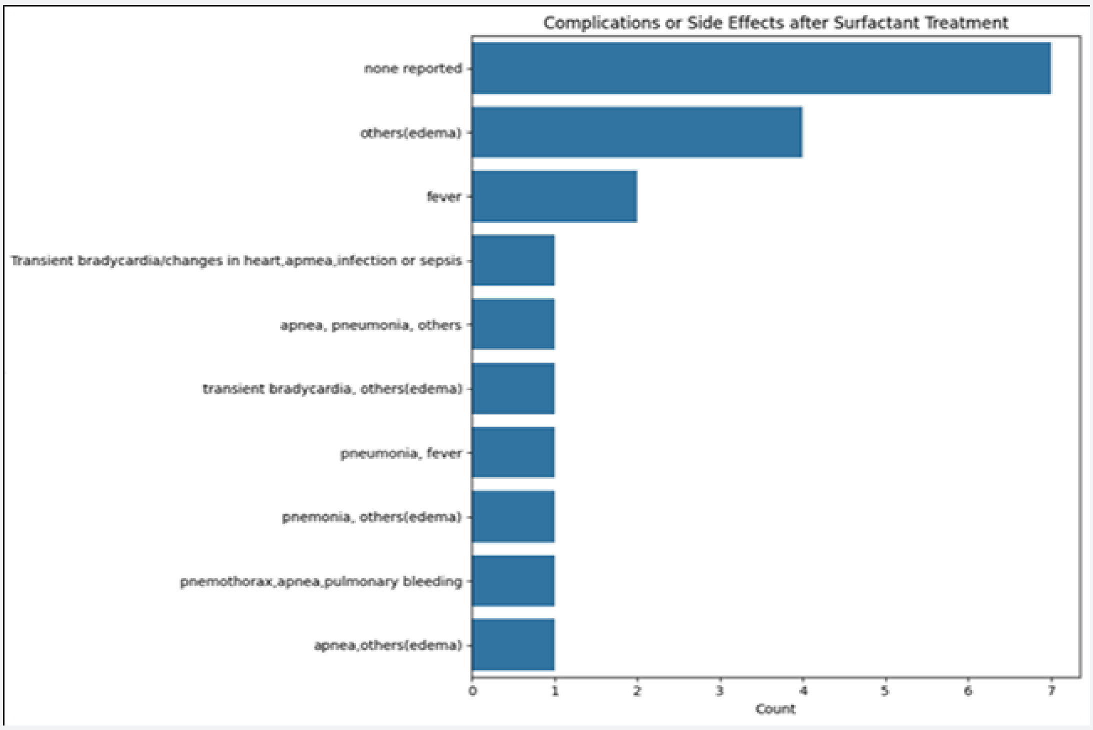

Figure 3: Complications/side effects after surfactant therapy.

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The 3D scatter plot Figure 4 depicts the relationship between gestational age, surfactant dose, and complications, with marker size representing the baby's weight. The graph revealed a linear relationship between gestational age, surfactant dose, and body weight, whereas complications demonstrated a non-linear distribution.

Figure 4 3D Scatter plot between gestational age, dose of surfactant, complications, and baby's weight at birth. The 2D scatter plot illustrates the relationship between maternal education level and the number of children, with prenatal care received as markers, indicating no statistically significant correlation between the number of children and maternal education level, nor with the prenatal care received Figure 5. The majority of mothers of neonates received prenatal care, as they were all housewives who visited the hospital during pregnancy.

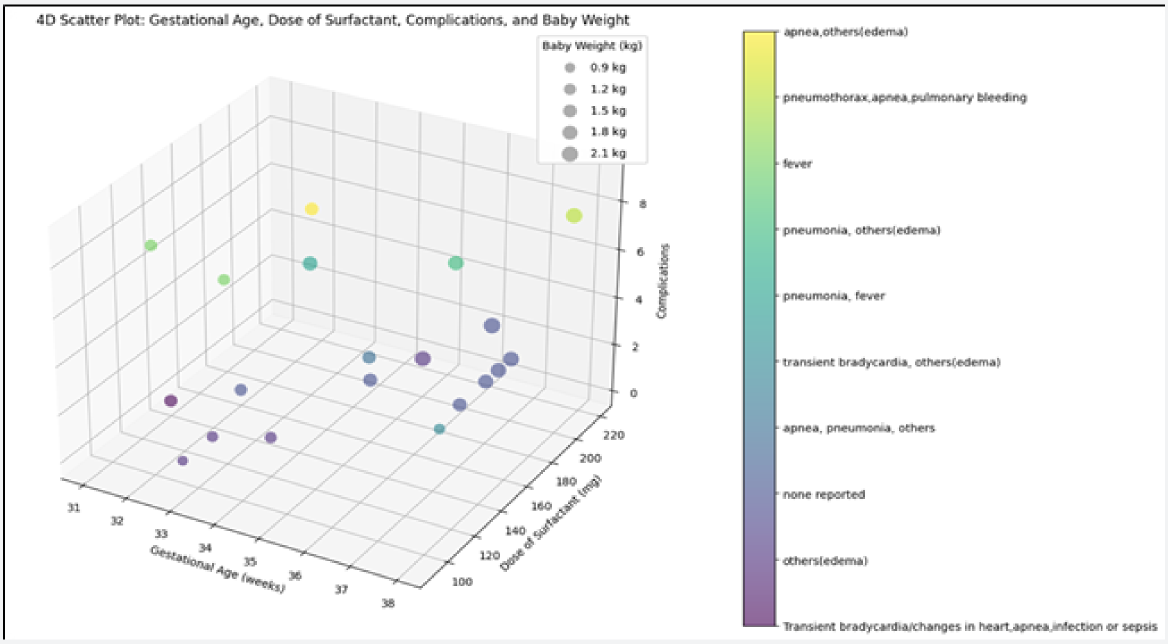

Figure 4: 3D Scatter plot between gestational age, dose of surfactant, complications, and baby's weight at birth.

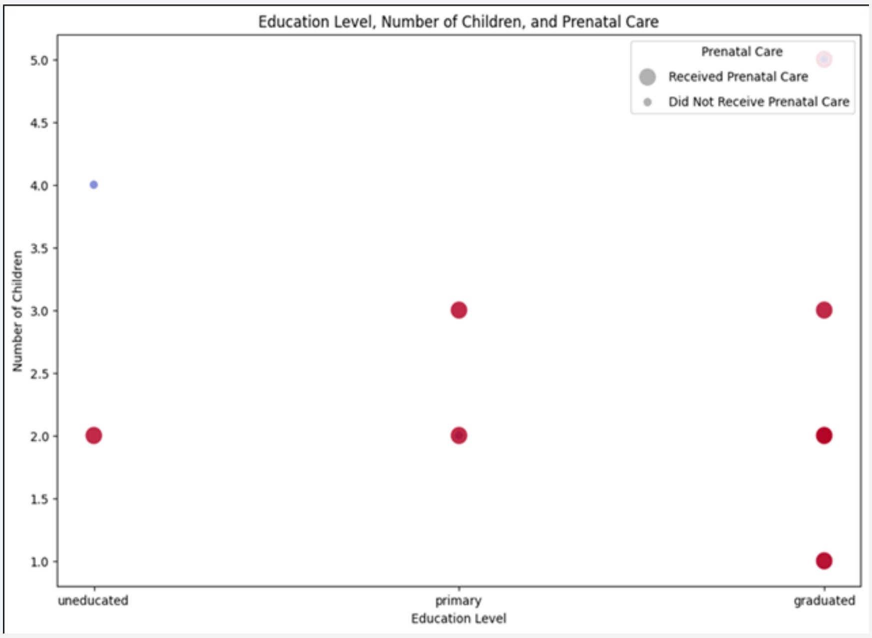

Figure 5: 2D plot between a mother's education level and number of children, with prenatal care received as markers.

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The distribution of physician perception of surfactant effectiveness ratings revealed that the most frequent rating is 4, occurring with the highest frequency. It was also observed that a rating of 1 (least effective) was given three times, corresponding to cases where neonatal death occurred. The impact of independent factors (surfactant and gestational age) on the dependent variable (surfactant effectiveness) was assessed using a one-way analysis of variance (ANOVA). Since the p-value (0.012) is less than the significance level (0.05), the alternative hypothesis, which asserts that surfactants impact RDS in neonates, is accepted, while the null hypothesis, which asserts that surfactants do not affect RDS in neonates, is rejected. Also, the F-value (4.52) from the ANOVA exceeds the critical F-value of 4.41. Consequently, the alternative hypothesis—that surfactants have an impact on RDS in neonates—is accepted, and the null hypothesis—that surfactants have no impact on RDS in neonates—is rejected.

Discussion

The effectiveness of surfactant therapy in neonates with RDS is critical for improving neonatal outcomes, particularly in preterm infants. This study aimed to evaluate the impact of surfactant administration on neonatal health, investigating various factors such as surfactant dose, gestational age, and the occurrence of complications. The findings provide significant insights into the clinical efficacy of surfactants and the influence of independent variables on treatment outcomes.

Complications and their non-linear distribution: The 3D scatter plot illustrating the revealed a linear relationship between gestational age, surfactant dose, and body weight. However, complications exhibited a non-linear distribution, suggesting that factors other than gestational age and surfactant dose significantly influence the occurrence of adverse outcomes. This complexity underscores the multifaceted nature of neonatal care, where multiple variables, including genetic factors, prenatal care quality, and immediate postnatal interventions, interact to determine health outcomes [5].

Maternal education and prenatal care: Interestingly, the 2D scatter plot assessed the relationship between maternal education level and some children, indicating no statistically significant correlation. This finding suggests that while maternal education level may not directly influence the number of children or prenatal care received, other socio-economic and cultural factors play a crucial role [6]. Ensuring that all expecting mothers receive adequate prenatal care, regardless of level of education, remains a public health priority [7].

Association of surfactants and gestational age: The impact of administering a surfactant and gestational age on its effectiveness provided statistically significant results in parallel to existing literature highlighting the critical role of surfactant therapy in managing RDS in preterm infants [8]. Surfactants, by reducing surface tension in the lungs, enhance alveolar stability and improve respiratory function, which is particularly vital in neonates with immature lungs [9]. The significant impact of gestational age on treatment outcomes also highlights the necessity for timely intervention, as earlier gestational ages are associated with higher risks of respiratory complications and may require more intensive therapeutic strategies.

Physician Effectiveness Ratings: The distribution of physician effectiveness ratings revealed that the most frequent rating was 4, suggesting a generally high perceived effectiveness of surfactant therapy to 1 (indicating the least effectiveness) corresponding to cases where neonatal deaths occurred highlighting the variability in treatment outcomes and underscores the necessity for continuous monitoring and evaluation of clinical practices as by previous literature [10].

Conclusion

Surfactants have proved to be effective in enhancing the clinical status of neonates with RDS admitted at NICU as there is considerable improvement in oxygen concentration and the distinctive symptoms. The statistically significant impact of surfactants on improving respiratory outcomes highlights their critical role in NICU. However, the variability in treatment effectiveness and the non-linear distribution of complications point toward a holistic approach, considering multiple factors, which is necessary for optimizing neonatal health outcomes. Continuous evaluation and adaptation of clinical practices, alongside targeted interventions to address identified risk factors, are crucial for improving the survival and health of preterm infants with RDS.

Limitations and future prospects

Subsequent studies need to enroll more recruitments and centers to substantiate the mentioned tendencies and investigate genetic, environmental, and hormonal mediators of the surfactant therapy's effect. Examining outcomes beyond an initial NICU stay and other possible add-on therapies may help enhance the management of neonates with RDS. These results should be implemented in clinical practice considering quality improvement for the better management of RDS in neonates.

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