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The Outcome Of Respiratory Distress Syndrome In Preterm Babies In Relation To Administration Of Antenatal Corticosteroids.

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ABSTRACT

Respiratory distress syndrome (RDS) is a leading cause of morbidity and mortality in preterm neonates. Antenatal corticosteroids (ACS) are proven to accelerate fetal lung maturity and reduce adverse outcomes; however, their impact on survival in late preterm and early preterm infants in low-resource settings requires further evaluation. To assess the association between antenatal corticosteroid administration and clinical outcomes, and to identify predictors of poor outcomes among preterm neonates with RDS. A prospective observational study was conducted in the neonatal intensive care unit (NICU) at. Department of Pediatrics, Government Medical College and Hospital, Cuddalore District, Annamalai Nagar, Chidambaram, Tamil Nadu, India, in the year 2024Preterm neonates (28–36+6 weeks) with confirmed RDS were enrolled. Clinical, demographic, and perinatal data were collected, including ACS exposure, respiratory support requirements, and survival outcomes. Statistical analysis involved chi-square tests for associations and multivariate logistic regression to identify independent predictors of poor outcome. Of the 50 neonates included, 42% received ACS. Mortality was significantly lower in the ACS group (4.8%) compared to those without ACS exposure (27.6%) ($p = 0.001$). CPAP failure rates were also significantly lower among ACS-exposed neonates (19.0% vs. 41.4%, $p = 0.001$). Multivariate logistic regression identified the absence of ACS (OR: 5.59, 95% CI: 1.45–21.48, $p = 0.01$) and CPAP failure (OR: 7.03, 95% CI: 1.57–31.48, $p = 0.01$) as independent predictors of poor outcome. Timely administration of antenatal corticosteroids significantly improves survival in preterm neonates with RDS and reduces CPAP failure rates. Strengthening antenatal care to ensure prompt ACS delivery and early respiratory support may further enhance neonatal outcomes.

Keywords: Antenatal corticosteroids, Respiratory distress syndrome, Preterm neonates, CPAP failure, Neonatal mortality.

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INTRODUCTION

Respiratory distress syndrome (RDS) remains a leading cause of morbidity and mortality among preterm neonates worldwide, primarily resulting from surfactant deficiency due to immature pulmonary development [1]. The condition is characterized by impaired gas exchange, decreased lung compliance, and progressive respiratory failure. Despite advances in neonatal intensive care, including continuous positive airway pressure (CPAP), surfactant replacement therapy, and improved resuscitation protocols, the burden of RDS remains substantial, particularly in low- and middle-income countries. Early identification of at-risk neonates and timely implementation of preventive strategies are critical to improving outcomes[2-4]. corticosteroid administration is a well-established intervention for accelerating fetal lung maturation when preterm delivery is anticipated [5]. By stimulating surfactant synthesis and enhancing alveolar stability, corticosteroids reduce the incidence and severity of RDS, intraventricular hemorrhage, and neonatal mortality. Current guidelines recommend administration between 24 and 34 weeks of gestation for women at risk of preterm birth. However, in clinical practice, the degree of benefit may vary based on gestational age at administration, birth weight, perinatal events, and postnatal management practices.[6-8]Although the benefits of antenatal corticosteroids are widely recognized, variability in clinical outcomes has been reported, particularly in settings with heterogeneous obstetric care access and resource constraints.[9] Some neonates exposed to antenatal steroids still develop severe RDS and require advanced interventions such as surfactant therapy, intubation, and prolonged CPAP support. Additionally, local epidemiological data from tertiary neonatal care units are limited, particularly regarding the interplay between antenatal corticosteroid administration, disease severity, and neonatal survival in the Indian context [10-13]. In India, preterm birth rates are among the highest globally, and neonatal RDS significantly contributes to early neonatal mortality. While antenatal corticosteroid coverage has improved, disparities in timely administration persist due to late presentation, inadequate referral systems, and variations in obstetric decision-making. Evaluating the relationship between antenatal corticosteroid use and neonatal outcomes in local populations is essential to optimize perinatal care protocols, guide resource allocation, and reinforce evidence-based practice [14-18].

Given this background, the present study focuses on preterm neonates diagnosed with RDS in a tertiary care setting. By stratifying neonates based on antenatal corticosteroid exposure, the study examines differences in disease severity at admission, treatment interventions required, and ultimate clinical outcomes. Furthermore, the study identifies independent predictors of poor outcome, enabling targeted preventive and therapeutic measures in high-risk neonates.

Accordingly, this study was conducted to assess the impact of antenatal corticosteroid administration on the severity, management strategies, and clinical outcomes of preterm neonates with RDS. In addition, the study aimed to determine predictors of poor outcome in this population, thereby generating context-specific evidence to inform clinical decision-making and improve neonatal survival rates.

MATERIALS AND METHODS

Study Design and Setting

This study was designed as a prospective observational study conducted in the Neonatal Intensive Care Unit (NICU) of Government Cuddalore Medical College Hospital. The NICU caters to high-risk deliveries referred from both within the hospital and peripheral centers. The study was carried out over a defined period, during which all eligible preterm neonates with a clinical and radiological diagnosis of respiratory distress syndrome (RDS) were enrolled.

Study Population

The study population comprised preterm neonates with gestational age between 28 weeks and 36+6 weeks admitted to the NICU with a diagnosis of RDS. Diagnosis was established based on clinical signs of respiratory distress within six hours of birth—such as tachypnea, chest retractions, nasal flaring, and grunting—supported by characteristic radiographic findings, including reticulogranular patterns and air bronchograms.

Inclusion and Exclusion Criteria

The study included preterm neonates with a gestational age between 28 and 36+6 weeks who had a confirmed diagnosis of respiratory distress syndrome (RDS), were admitted to the neonatal intensive care unit (NICU) within six hours of birth, and for whom a complete antenatal history regarding corticosteroid administration was available. Exclusion criteria comprised term neonates (>37 weeks of gestation), those with congenital anomalies affecting the respiratory system, such as congenital diaphragmatic hernia or tracheoesophageal fistula, neonates with other primary causes of respiratory distress, including meconium aspiration syndrome, transient tachypnea of the newborn, or pneumonia, and cases with incomplete medical records.

Sample Size and Sampling Technique

The sample size was calculated using the single proportion formula:

$$n = (Z\alpha/2)^2 \times p \times (1 - p) / d^2$$

Where *n* is the required sample size, *p* is the expected proportion, *d* is the absolute precision, and *Zα/2* is the standard normal deviate at a 95% confidence level (1.96). Based on the findings of Shittu et al. (2024) [2], the reported incidence of respiratory morbidity in late preterm neonates without antenatal corticosteroid exposure was approximately 58% ($p = 0.58$). Considering an absolute precision of 14% ($d = 0.14$) and a 95% confidence level, the calculated minimum sample size was 50 neonates, which was adopted for the present study.

A total of 50 preterm neonates fulfilling the inclusion criteria were enrolled during the study period. The sample size was determined based on convenience sampling, including all eligible neonates admitted consecutively to the NICU during the study period. Of these, 21 neonates had received antenatal corticosteroid exposure, while 29 neonates had not received antenatal corticosteroids before delivery.

Study Procedure

For each enrolled neonate, a detailed perinatal history was obtained, including maternal demographic data, obstetric history, antenatal corticosteroid administration (drug, dose, timing), and comorbidities such as gestational diabetes mellitus, gestational hypertension, hypothyroidism, anemia, and chorioamnionitis. Neonatal variables recorded included sex, birth weight, gestational age, mode of delivery, and need for resuscitation at birth.

The severity of respiratory distress was assessed using the Silverman Anderson Score after initiation of continuous positive airway pressure (CPAP). Treatment interventions, including surfactant therapy, intubation, and CPAP outcomes, were documented. Clinical outcomes were recorded as either discharge from the NICU or death. CPAP failure was defined as persistent or worsening respiratory distress, recurrent apnea, or requirement of mechanical ventilation despite optimal CPAP settings.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) or median with interquartile range (IQR), depending on the distribution, and categorical variables were expressed as frequencies and percentages. The Chi-square test or Fisher's exact test was used to assess associations between categorical variables. Multivariate logistic regression analysis was performed to identify independent predictors of poor outcome. A p-value of < 0.05 was considered statistically significant.

Ethical Consideration

The study protocol was reviewed and approved by the Institutional Ethics Committee before initiation. Written informed consent was obtained from parents or legal guardians of all participating neonates. Confidentiality of patient information was maintained throughout the study, and all procedures

were conducted in accordance with the Declaration of Helsinki guidelines for biomedical research involving human subjects.

RESULTS

Table 1: Baseline Characteristics of Preterm Neonates with Respiratory Distress Syndrome by Antenatal Corticosteroid Exposure

Characteristic	Antenatal Steroids Given (n = 21)	Antenatal Steroids Not Given (n = 29)	*p*-value
Sex			
Female, n (%)	13 (61.9)	12 (41.4)	0.15
Male, n (%)	8 (38.1)	17 (58.6)	
Birth Weight			
> 1.5 kg, n (%)	5 (23.8)	25 (86.2)	0.001*
1.0–1.5 kg, n (%)	16 (76.2)	4 (13.8)	
Consanguinity – Yes, n (%)	5 (23.8)	4 (13.8)	0.36
Gestational Age			
28–31+6 weeks, n (%)	13 (61.9)	0 (0.0)	0.001*
32–33+6 weeks, n (%)	8 (38.1)	27 (93.1)	
34–36+6 weeks, n (%)	0 (0.0)	2 (6.9)	
Mode of Delivery			
Assisted Vaginal Delivery, n (%)	0 (0.0)	4 (13.8)	0.03*
Cesarean Section, n (%)	9 (42.9)	18 (62.1)	
Normal Vaginal Delivery, n (%)	12 (57.1)	7 (24.1)	
Primigravida – Yes, n (%)	14 (66.7)	17 (58.6)	0.56
Resuscitation at Birth – Yes, n (%)	16 (76.2)	8 (27.6)	0.001*
GDM – Yes, n (%)	6 (28.6)	13 (44.8)	0.24
GHTN – Yes, n (%)	12 (57.1)	8 (27.6)	0.04*
Hypothyroidism – Yes, n (%)	8 (38.1)	13 (44.8)	0.63
Antenatal Infection – Yes, n (%)	0 (0.0)	2 (6.9)	0.22
Anemia – Yes, n (%)	8 (38.1)	6 (20.7)	0.18
Chorioamnionitis – Yes, n (%)	8 (38.1)	1 (3.4)	0.001*

*-statistically significant

In this study, the baseline characteristics of preterm neonates with respiratory distress syndrome (RDS) were compared based on antenatal corticosteroid exposure (Table 1). Although the proportion of female neonates was higher in the steroid group (61.9%) than in the non-steroid group (41.4%), the difference was not statistically significant (p = .15). Birth weight showed a significant association with steroid exposure, with 76.2% of neonates in the steroid group weighing between 1.0–1.5 kg compared to only 13.8% in the non-steroid group (p = .001). Similarly, gestational age distribution differed significantly (p = .001), as 61.9% of neonates in the steroid group were born at 28–31 + 6 weeks, whereas none in the non-steroid group belonged to this category.

Mode of delivery varied significantly (p = .03), with assisted vaginal deliveries occurring exclusively in the non-steroid group, while cesarean section and normal vaginal delivery proportions differed between groups. Resuscitation at birth was significantly more common among steroid-exposed neonates (76.2%) compared to those without exposure (27.6%, p = .001). Maternal gestational hypertension was also more frequent in the steroid group (57.1% vs. 27.6%, p = .04), whereas other maternal comorbidities, including gestational diabetes mellitus, hypothyroidism, antenatal infection, and anemia, showed no significant differences. Chorioamnionitis was observed significantly more often in the steroid group (38.1%) than in the non-steroid group (3.4%, p = .001). (Chart 1)

Table 2: Severity of Respiratory Distress at Admission in Relation to Antenatal Corticosteroid Administration

Silverman Anderson Score After CPAP	Antenatal Steroids Given (n = 21)	Antenatal Steroids Not Given (n = 29)	*p*-value
< 3, n (%)	9 (42.9)	25 (86.2)	
4–6, n (%)	2 (9.5)	3 (10.3)	0.001*
> 6, n (%)	10 (47.6)	1 (3.4)	

*-statistically significant

The severity of respiratory distress at admission, as assessed by the Silverman Anderson score after initiation of CPAP, showed a significant association with antenatal corticosteroid administration (Table 2). In the non-steroid group, the majority of neonates (86.2%) had a score of < 3, indicating mild distress, compared to 42.9% in the steroid group. Moderate distress (score 4–6) was observed in 9.5% of the steroid group and 10.3% of the non-steroid group. Notably, severe distress (score > 6) was substantially more common in the steroid group (47.6%) compared to only 3.4% in the non-steroid group, and this difference was statistically significant (p = .001).

Table 3: Treatment Interventions among Preterm Neonates with RDS by Antenatal Corticosteroid Status

Intervention	Antenatal Steroids Given (n = 21)	Antenatal Steroids Not Given (n = 29)	*p*-value
Surfactant Needed			
Needed, n (%)	14 (66.7)	7 (24.1)	
Not Needed, n (%)	7 (33.3)	22 (75.9)	0.001*
Intubation			
No, n (%)	9 (42.9)	27 (93.1)	
Yes, n (%)	12 (57.1)	2 (6.9)	0.001*

*-statistically significant

Among preterm neonates with RDS, the requirement for treatment interventions differed significantly by antenatal corticosteroid status (Table 3). Surfactant therapy was required in 66.7% of neonates who had received antenatal corticosteroids, compared to 24.1% in those who had not, a statistically significant difference (p = .001). Similarly, intubation was performed in 57.1% of neonates in the steroid group, whereas only 6.9% in the non-steroid group required this intervention, also showing a significant association (p = .001).

Table 4: Association Between Antenatal Corticosteroid Use and Clinical Outcomes of RDS

Antenatal Steroids	Death, n (%)	Discharge, n (%)	Total, n (%)	p-value
Given	1 (4.8)	20 (95.2)	21 (42.0)	0.001*
Not Given	8 (27.6)	21 (72.4)	29 (58.0)	
Total	**9 (18.0)**	**41 (82.0)**	**50 (100.0)**	

*-statistically significant

Analysis of clinical outcomes demonstrated a statistically significant association between antenatal corticosteroid (ACS) administration and survival in preterm neonates with RDS (Table 4). Mortality was markedly lower in the ACS group, with only 1 death (4.8%) compared to 8 deaths (27.6%) in the non-ACS group (p = 0.001). Correspondingly, discharge rates were higher among neonates who received ACS (95.2%) compared to those without ACS exposure (72.4%). (Chart 2)

Table 5: Comparison of CPAP Success Rates in RDS Neonates with and without Antenatal Corticosteroid Exposure

Antenatal Corticosteroid Status	CPAP Failure, *n* (%)	No CPAP Failure, *n* (%)	Total, *n* (%)	*p*-value
Given	4 (19.0)	17 (81.0)	21 (42.0)	0.001*
Not Given	12 (41.4)	17 (58.6)	29 (58.0)	
Total	16 (32.0)	34 (68.0)	50 (100.0)	

*-statistically significant

Comparison of CPAP success rates demonstrated a statistically significant association between antenatal corticosteroid use and treatment outcomes in preterm neonates with RDS (Table 5). Among those who received antenatal corticosteroids, CPAP failure occurred in 19.0%, compared to 41.4% in the non-steroid group (p = .001). The majority of neonates in both groups achieved CPAP success, with a higher proportion observed in the steroid group (81.0% vs. 58.6%).

Table 6: Predictors of Poor Outcome in Preterm Neonates with RDS – Multivariate Logistic Regression Analysis

Predictor Variable	B	SE	Wald	OR	95% CI for OR	*p*-value
Antenatal corticosteroids were not given	1.72	0.69	6.20	5.59	1.45 – 21.48	**0.01***
Birth weight ≤ 1.5 kg	0.88	0.63	1.95	2.41	0.70 – 8.27	0.16
Gestational age < 32 weeks	0.64	0.58	1.21	1.89	0.61 – 5.80	0.27
Resuscitation at birth	0.59	0.55	1.15	1.81	0.62 – 5.26	0.28
CPAP failure	1.95	0.77	6.45	7.03	1.57 – 31.48	**0.01***
Surfactant required	0.47	0.45	1.09	1.60	0.66 – 3.87	0.29
Intubation	0.84	0.66	1.61	2.31	0.63 – 8.45	0.20

*-statistically significant

Multivariate logistic regression analysis identified two significant predictors of poor outcome in preterm neonates with RDS (Table 6). Lack of antenatal corticosteroid administration was associated with a 5.59-fold higher odds of poor outcome (p = .01, 95% CI [1.45, 21.48]). Similarly, CPAP failure independently predicted poor outcome, with affected neonates having 7.03 times higher odds (p = .01, 95% CI [1.57, 31.48]). Other variables, including low birth weight, lower gestational age, resuscitation at birth, surfactant requirement, and intubation, were not statistically significant predictors in the adjusted model.

DISCUSSION

In the present study, neonates who received antenatal corticosteroids (ACS) were more frequently born at lower gestational ages (28–31 + 6 weeks) and with lower birth weights (≤1.5 kg), alongside higher rates of gestational hypertension and chorioamnionitis. This pattern is consistent with Travers et al., who observed that ACS use is more common in high-risk preterm deliveries, particularly in the earliest gestational windows [14]. Meneguel et al. also reported that ACS was often administered to neonates at the lowest gestational ages, which independently increases the risk of respiratory morbidity [5]. Smrcek et al. similarly noted that the sickest and smallest infants are most likely to be exposed to ACS, complicating crude outcome comparisons [6]. Costa et al. further demonstrated that urgent deliveries at very early gestations frequently result in incomplete ACS courses, potentially attenuating their benefits [8]. The current study found that severe respiratory distress (Silverman–Anderson score > 6) was more frequent among ACS-exposed neonates, whereas mild distress predominated in the non-ACS group. Meneguel et al. reported contrasting findings, showing a reduced incidence and severity of RDS following ACS use in <34-week neonates [5]. Smrcek et al. also documented decreased respiratory morbidity and less need for prolonged respiratory support after ACS, especially beyond 28 weeks [6]. In late-preterm populations, Porto et al. found no significant reduction in respiratory distress with ACS use, suggesting limited benefit in more mature lungs [9]. Gabr et al. provided mechanistic insight, observing elevated cortisol levels in severe RDS cases, indicating that illness severity itself may drive physiological differences regardless of prior steroid exposure [1].In the present study, ACS-exposed neonates more frequently required surfactant therapy and intubation compared to those without ACS exposure. This contrasts with Meneguel et al., who reported a

reduced need for surfactant among ACS-treated infants [5]. Smrcek et al. similarly found that ACS use was associated with less invasive respiratory support requirements in neonates over 28 weeks [6]. Shittu et al. observed fewer delivery-room resuscitations and reduced NICU admissions among steroid-exposed late-preterm neonates [2]. However, Costa et al. identified that incomplete ACS courses and very short intervals between dosing and delivery limit the expected respiratory benefits [8].In the present study, mortality was significantly higher among neonates who did not receive antenatal corticosteroids (27.6%) compared to those who received ACS (4.8%), indicating a strong protective effect of ACS on survival in preterm neonates with RDS. This finding aligns with Blankenship et al., who demonstrated reduced neonatal mortality following ACS use in preterm small-for-gestational-age infants [7]. Similarly, Travers et al. reported lower mortality rates among preterm neonates exposed to ACS across all gestational age groups [14]. Meneguel et al. observed a protective effect of ACS on intra-hospital mortality in <34-week infants, although the benefit was attenuated after adjusting for multiple risk factors [5]. Smrcek et al. also documented lower neonatal death rates after ACS administration in pregnancies beyond 28 weeks [6].In the present study, CPAP failure was significantly less frequent in the ACS group, indicating better outcomes with non-invasive respiratory support. Shittu et al. reported similar findings, with ACS reducing the need for advanced respiratory interventions [2]. Meneguel et al. also observed improved respiratory adaptation and lower escalation to invasive ventilation after ACS exposure [5]. Smrcek et al. confirmed that ACS use was associated with shorter durations of mechanical ventilation in surviving neonates [6]. In contrast, Yenuberi et al. found no statistically significant improvement in respiratory outcomes after ACS administration in late-preterm infants [4].In the current study, the absence of ACS administration and CPAP failure independently predicted poor outcomes in preterm neonates with RDS. This aligns with Blankenship et al., who showed that ACS exposure significantly reduced the odds of adverse neonatal outcomes, particularly mortality [7]. Travers et al. similarly found ACS to be an independent protective factor in preterm infants across multiple gestational strata [14]. Meneguel et al. demonstrated that ACS use was associated with improved survival and reduced morbidity in <34-week neonates [5]. Wilms et al. highlighted that the timing of ACS relative to delivery influences effectiveness, with suboptimal intervals reducing the likelihood of favourable outcomes [18].

Limitations

The present study is limited by its single-centre design, which may influence the generalizability. Additionally, the timing and completeness of antenatal corticosteroid administration were not uniformly controlled, potentially influencing the observed effects.

Conclusion and Recommendations

This study demonstrated that antenatal corticosteroid (ACS) administration significantly improved survival outcomes among preterm neonates with respiratory distress syndrome (RDS). Neonates who did not receive ACS had markedly higher mortality, and CPAP failure emerged as another strong predictor of poor outcome in multivariate analysis. These findings underscore the critical role of timely ACS administration in enhancing neonatal survival and reducing respiratory morbidity. The results are consistent with prior literature, reaffirming that ACS use should remain a cornerstone of evidence-based perinatal care for preterm births.

Based on the study findings, it is recommended that all eligible women at risk of preterm delivery between 28 and 36+6 weeks of gestation receive antenatal corticosteroids in accordance with established guidelines. Strengthening antenatal care services to ensure timely identification of at-risk pregnancies and prompt ACS administration is essential. Additionally, early and effective CPAP support should be prioritized in neonatal units, with readiness for escalation of care when failure is anticipated. Future research with larger multicentric cohorts is warranted to explore optimal ACS timing, dosage, and integration with other interventions to further improve outcomes in preterm neonates with RDS.

REFERENCES

[1] American College of Obstetricians and Gynecologists' Committee on Practice Bulletins-Obstetrics. Practice bulletin no 172: Premature rupture of membranes. Obstet Gynecol 2016;128:e165-77.
[2] Ballard PL. Hormones and lung maturation. Monogr Endocrinol 1986;28:1-354

[3] Bonanno C, Wapner RJ. Antenatal corticosteroids in the management of preterm birth: Are we back where we started? Obstet Gynecol Clin North Am 2012;39:47-63.
[4] Carlo WA, McDonald SA, Fanaroff AA, Vohr BR, Stoll BJ, Ehrenkranz RA, et al. Association of antenatal corticosteroids with mortality and neurodevelopmental outcomes among infants born at 22 to 25 weeks' gestation. Eunice Kennedy Shriver National Institute of Child Health and Human Development Neonatal Research Network. JAMA 2011;306:2348-58.
[5] Chawla S, Natarajan G, Rane S, Thomas R, Cortez J, Lua J, et al. Outcomes of extremely low birth weight infants with varying doses and intervals of antenatal steroid exposure. J Perinat Med 2010;38:419-23.
[6] Cousins LM, Smok DP, Lovett SM, Poeltler DM. AmniSure placental alpha microglobulin-1 rapid immunoassay versus standard diagnostic methods for detection of rupture of membranes. Am J Perinatol 2005;22:317-20.
[7] Crowther A, Haslam RR, Hiller JE, Doyle LW, Robinson JS. Australasian Collaborative Trial of Repeat Doses of Steroids. Neonatal respiratory distress syndrome after repeat exposure to antenatal corticosteroids: A randomized controlled trial. Lancet 2006;367:1913-9
[8] Crowther CA, Harding JE. Repeat doses of prenatal corticosteroids for women at risk of preterm birth for preventing neonatal respiratory disease. Cochrane Database Syst Rev 2007;3:CD003935.
[9] Ecker JL, Kaimal A, Mercer BM, Blackwell SC, Ann O deRegnier R. Periviable birth. obstetric care consensus No. 4. American College of Obstetricians and Gynecologists. Obstet Gynecol 2016;127:e157-69.
[10] Guinn DA, Atkinson MW, Sullivan L, Lee M, Mc Gregor S, Parilla BW, et al. Single versus weekly courses of antenatal corticosteroids for women at risk of preterm delivery: A randomized controlled trial. JAMA 2001;286:1581-7.
[11] Lee SE, Park JS, Norwitz ER, Kim KW, Park HS, Jun JK, et al. Measurement of placental alpha-microglobulin-1 in cervicovaginal discharge to diagnose rupture of membranes. Obstet Gynecol 2007;109:634-40.
[12] Lee SM, Lee J, Seong HS, Lee SE, Park JS, Romero R, et al. The clinical significance of a positive amnisure test in women with term labor with intact membranes. J Matern Fetal Neonatal Med 2009;22:305-10.
[13] Liggins GC, Howie RN. A controlled trial of antepartum glucocorticoid treatment for prevention of the respiratory distress syndrome in premature infants. Pediatrics 1972;50:515-25
[14] Mazumder P, Dutta S, Kaur J, Narang A. Single versus multiple courses of antenatal betamethasone and neonatal outcome: A randomized controlled trial. Indian Pediatr 2008;45:661-7
[15] Mori R, Kusuda S, Fujimura M, Neonatal Research Network Japan. Antenatal corticosteroids promote survival of extremely preterm infants born at 22 to 23 weeks of gestation. J Pediatr 2011;159:110-40.
[16] Murphy KE, Hannah ME, Willan AR, Hewson SA, Ohlsson A, Kelly EN, et al. Multiple courses of antenatal corticosteroids for preterm birth (MACS): A randomised controlled trial. Lancet 2008;372:2143-51.
[17] Wapner RJ, Sorokin Y, Thom EA, Johnson F, Dudley DJ, Spong CY, et al.Single versus weekly courses of antenatal corticosteroids: Evaluation of safety and efficacy. Am J Obstet Gynecol 2006;195:633-42.
[18] Ikegami M, Polk D, Jobe A. Minimum interval from fetal betamethasone treatment to postnatal lung responses in preterm lambs. Am J Obstet Gynecol 1996;174:1408-1