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Original Research

Rescue Antenatal Corticosteroids in Late Preterm Birth after Completion of the Initial Cycle of Antenatal Corticosteroids during the Early Preterm Period

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Abstract

Background: Late preterm birth is associated with increased risks of adverse neonatal outcomes, including respiratory distress syndrome (RDS) and hypoglycemia. The use of antenatal corticosteroids (ACS) has been shown to reduce these risks in early preterm infants. However, the efficacy of rescue ACS in late preterm infants remains uncertain. This study aimed to assess the effectiveness of rescue ACS in reducing the incidence of RDS and hypoglycemia in late preterm infants. **Methods**: A retrospective cohort study was conducted on women who delivered singleton late preterm infants (34 + 0 to 36 + 6 weeks of gestation) at a tertiary hospital. The inclusion criteria were completion of the initial cycle of ACS in the early preterm period (before 34 + 0 weeks of gestation). Data on maternal baseline characteristics, ACS administration, and neonatal outcomes were collected from medical records. Statistical analyses, including logistic regression and multivariate modeling, were performed to assess the association between rescue ACS and neonatal outcomes. **Results**: A total of 155 singleton late preterm infants were included in the study. Among them, 27.8% (43/155) received rescue ACS after 34 weeks of gestation, while 72.2% (112/155) did not. Neonates who did not receive rescue ACS had a significantly higher incidence of RDS compared to those who did (10.7% *vs.* 0%, $p = 0.038$). However, the results were not statistically significant in the multivariate analysis (odds ratio (OR), 0.07; 95% confidence interval (CI), 0.00–1.48; $p = 0.087$). Additionally, there were no significant differences in the frequencies of hypoglycemia (glucose level $\leq$40 mg/dL) (8.0% *vs.* 9.3%, $p = 0.755$) and hypoglycemia (glucose level $\leq$60 mg/dL) (52.7% *vs.* 37.2%, $p = 0.106$) between the two groups. **Conclusions**: Rescue ACS administration in late preterm infants was not associated with a reduced risk of RDS. Additionally, there was no significant difference in the incidence of hypoglycemia. Further studies with larger sample sizes are needed to confirm these results and assess potential long-term implications.

Keywords: late preterm delivery; antenatal corticosteroid; rescue corticosteroid; betamethasone; respiratory distress syndrome; hypoglycemia

1. Introduction

Late preterm birth is defined as delivery between 34 + 0/7 weeks and 36 + 6/7 weeks of gestational age [1]. The incidence of late preterm birth among live singleton births ranges from 3.0% to 5.0%. The rate of late preterm birth out of preterm birth is as high as 65%–75% and is on the rise, especially in high-income countries [2,3]. Newborns born during the late preterm period face more neonatal complications than those born at term, including transient tachypnea of the newborn (TTN), respiratory distress syndrome (RDS), persistent pulmonary hypertension, and apnea [1–5].

Antenatal corticosteroid (ACS) administration prior to 34 + 0/7 weeks of gestation is known to reduce neonatal RDS, TTN, neonatal intensive care unit admission, and hospital stay [6–8]. Recently, studies on the efficacy of ACS administration have been actively conducted on late preterm infants, and the ALPS (Antenatal Betamethasone for Women at Risk for Late Preterm Delivery) trial has shown that late preterm ACS administration significantly reduces severe respiratory complications, such as TTN and the composite of RDS, bronchopulmonary dysplasia, and apnea [9]. Conversely, late preterm ACS administration has several adverse effects, including neonatal hypoglycemia, impaired growth, and long-term risk [7,10,11]. While the results are controversial, based on the ALPS trial, both the American College of Obstetricians and Gynecologists and the Society for Maternal-Fetal Medicine recommend a single course of ACS for pregnant women between 34 + 0/7 and 36 + 6/7 weeks of gestation who are at an imminent risk of preterm delivery within the next 7 days or prior to reaching 37 + 0/7 weeks of gestational age [6,12].

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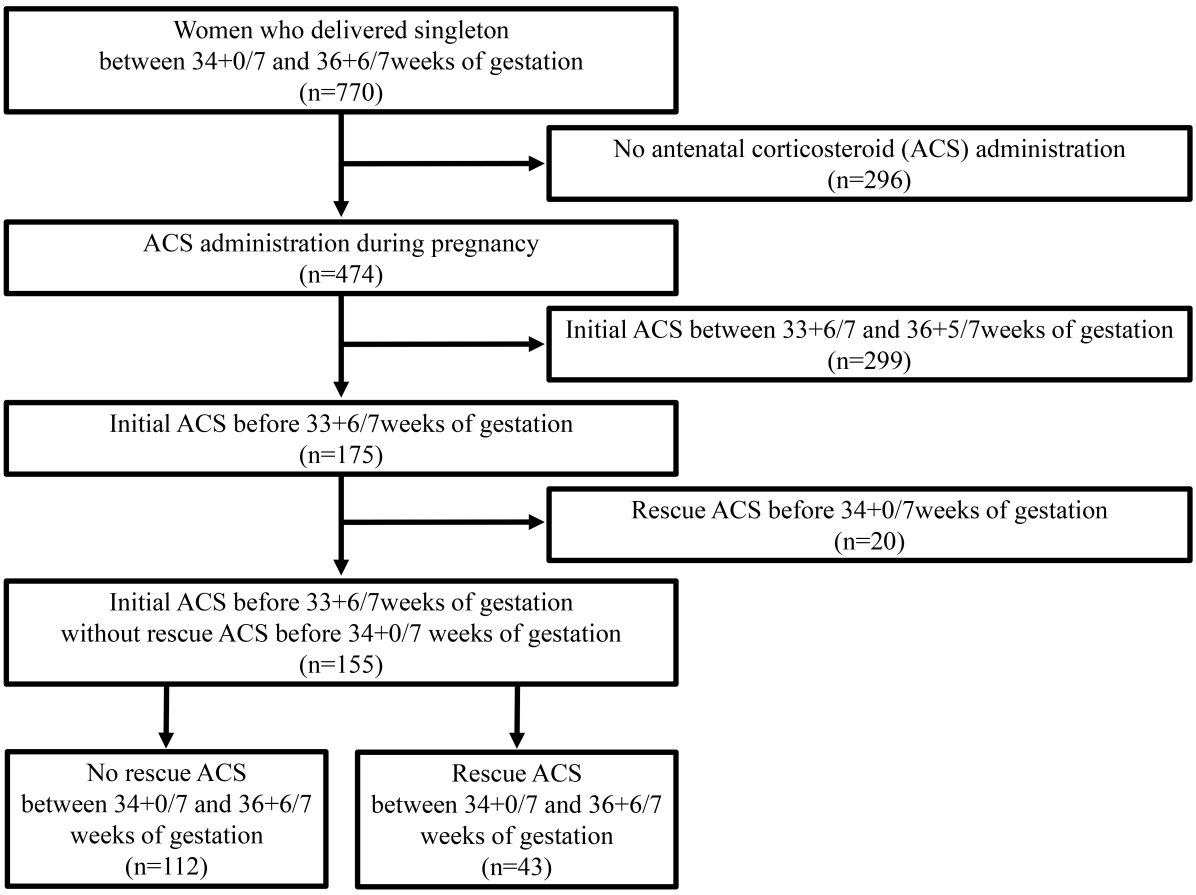

Fig. 1. Flow chart of the study.

In a multicenter, randomized, placebo-controlled trial on rescue ACS, patients who had singleton or twin pregnancies before 33 weeks of gestation and completed a single course of ACS before 30 weeks of gestation were randomly chosen to receive a rescue course of ACS or placebo at least 14 days apart from the initial single course of ACS [13]. This trial reported that rescue ACS significantly reduced neonatal morbidity at <34 weeks, incidence of RDS, need for ventilator support, and surfactant use. Currently, it is advised to consider a single repeat course of ACS for women at a risk of preterm delivery within 7 days or before 34 + 0/7 weeks of gestation, especially if their prior dose of ACS was administered more than 14 days ago. Depending on the clinical scenario, rescue ACS could be administered as soon as 7 days from the last dose [6,8]. Nonetheless, the efficacy of rescue ACS between 34 + 0/7 and 36 + 6/7 weeks of gestation has not been well studied, and there is insufficient evidence to make recommendations for or against it [6,8].

The present study aimed to evaluate the efficacy of rescue ACS between 34 + 0/7 and 36 + 6/7 weeks of gestation in patients who completed an initial course of ACS before 34 + 0/7 weeks of gestation.

2. Materials and Methods

2.1 Study Design and Participants

This was a retrospective cohort study conducted on women who delivered singleton late preterm infants (34 + 0 to 36 + 6 weeks of gestation) at Seoul National University Bundang Hospital from May 2016 to October 2021 (Fig. 1). The inclusion criteria were as follows: completion of the initial cycle of ACS in the early preterm period (before 34 + 0 weeks of gestation). The exclusion criteria were as follows: (1) patients who were not exposed to ACS during pregnancy; (2) patients who were provided with initial ACS during the late preterm period (33 + 6/7–36 + 5/7 weeks of gestation); (3) patients who received rescue ACS for more than one cycle; and (4) patients who received both initial and rescue ACS during the early preterm period (before 34 + 0/7 weeks of gestation).

Data on maternal baseline characteristics, such as age, parity, mode of delivery, gestational age at delivery, gestational age at initial ACS, and gestational age at rescue ACS, were obtained from medical records. Data regarding the presence or absence of pregnancy-related complications and risk factors, such as hypertensive disorder of pregnancy, gestational diabetes, and indication for initial ACS, were also collected. The study protocol was approved by

Table 1. Clinical characteristics of the study population according to rescue steroid administration after a gestational age of 34 weeks.

	Rescue steroid administration		*p*-value
	Absent (n = 112)	Present (n = 43)	
Maternal age (years)	34.0 (31.0–36.0)	35.0 (31.0–37.0)	0.468
Nulliparity	56.3% (63)	62.8% (27)	0.460
Hypertensive disorder of pregnancy	34.8% (39)	44.2% (19)	0.281
Gestational diabetes	12.5% (14)	23.3% (10)	0.135
Gestational age at initial ACS administration (weeks)	32.6 (31.3–33.3)	31.4 (29.5–32.5)	<0.001
Interval initial ACS administration to delivery (days)	16 (8–26)	25 (18–44)	<0.001
Indication for initial ACS administration			
Spontaneous preterm birth	48.2% (54)	53.5% (23)	0.557
Medically indicated preterm birth	51.8% (58)	46.5% (20)	
Gestational age at delivery (weeks)	34.4 (34.1–35.4)	35.1 (34.5–35.3)	0.011
Vaginal delivery	33.9% (38)	37.2% (16)	0.701
Sex (male)	59.8% (67)	60.5% (26)	0.942
Birthweight (grams)	2260 (2023–2630)	2280 (2035–2520)	0.875
1-min Apgar score <7	22.3% (25)	20.9% (9)	0.851
5-min Apgar score <7	5.4% (6)	2.3% (1)	0.674
Respiratory distress syndrome	10.7% (12)	0% (0)	0.038
Transient tachypnea of the newborn	42.0% (42/100)	25.6% (11/43)	0.062
Hypoglycemia, glucose level ≤40 mg/dL	10.7% (12)	9.3% (4)	>0.999
Hypoglycemia, glucose level ≤60 mg/dL	62.5% (70)	53.5% (23)	0.305
Histologic chorioamnionitis	25.0% (28)	18.6% (8)	0.399
Neonatal sepsis	1.8% (2)	0% (0)	>0.999

Data are presented as median (interquartile range) or as % (n). ACS, antenatal corticosteroid.

the Institutional Review Board of Seoul National University Bundang Hospital (B-1905-540-005). The need for obtaining informed consent from the study participants was waived due to the retrospective nature of this study.

2.2 Rescue ACS in the Late Preterm

Based on the ALPS trial, we administered a course of ACS to patients in the late preterm period (34 + 0/7–36 + 6/7 weeks in gestation) who were at risk of delivery within 7 days or before 37 weeks of gestation in our institution since May 2016 [9]. In some cases, rescue ACS was also administered to late preterm infants based on the physician's decision, although it is not recommended by guidelines [6,8]. For this study, rescue ACS in the late preterm period was defined as the administration of at least one of two doses of 12 mg (3 mL) betamethasone, which is sodium phosphate 5.2 mg (betamethasone 4.0 mg) in 1 ample (1 mL), produced by Dawon Parm (Seoul, Korea), intramuscularly every 24 h between 34 + 0/7 and 36 + 6/7 weeks of gestation.

2.3 Neonatal Outcomes

The primary outcomes assessed were RDS and neonatal hypoglycemia. RDS, typically caused by surfactant deficiency, was diagnosed clinically if the neonate exhibited respiratory distress requiring surfactant replacement at least once [14,15]. Neonatal hypoglycemia was defined as a glucose level ≤40 mg/dL within the first 24 h of life, based on consultation with the neonatologists at our institution [16,17]. Our secondary outcomes included neonatal hypoglycemia, defined as a glucose level ≤60 mg/dL within the first 24 h of life; birth weight; 1-min Apgar score less than 7; 5-min Apgar score less than 7; and TTN [16–19]. Serum glucose tests were routinely conducted for all neonates within 24 h of birth. TTN, resulting from delayed resorption and clearance of fetal alveolar fluid, typically resolves spontaneously or with supportive care [15]. We diagnosed TTN clinically if the neonate exhibited respiratory distress requiring respiratory support but not surfactant administration.

2.4 Statistical Analysis

Continuous variables were compared using the Mann–Whitney U test, and categorical variables were assessed using the Chi-square test. Fisher's exact test was used in cases where the frequency was less than 5 or when the sample size of any variable was below 20% of the total sample size. Multivariate logistic regression was used to determine the factors associated with neonatal outcomes. Multivariate modeling with inclusion of the following factors was applied: variables with $p < 0.2$ in the univariate analysis and with exclusion of variables showing multicollinearity. Statistical significance was set at $p < 0.05$. Statistical analysis was performed using SPSS version 25 (IBM SPSS Inc., Armonk, NY, USA).

Table 2. Clinical characteristics of the study population according to respiratory distress syndrome.

	Respiratory distress syndrome		*p*-value
	Absent (n = 143)	Present (n = 12)	
Maternal age (years)	34.0 (31.0–36.0)	35.0 (31.0–36.0)	0.480
Nulliparity	58.7% (84)	50.0% (6)	0.556
Hypertensive disorder of pregnancy	39.2% (56)	16.7% (2)	0.213
Gestational diabetes	15.4% (22)	16.7% (2)	1.000
Gestational age at initial ACS administration (weeks)	32.4 (31.0–33.2)	31.0 (30.3–32.9)	0.118
Indication for initial ACS administration			
Spontaneous preterm birth	50.3% (72)	41.7% (5)	0.563
Medically indicated preterm birth	49.7% (71)	58.3% (7)	
Rescue steroid administration	30.1% (43)	0% (0)	0.038
Gestational age at delivery (weeks)	34.6 (34.1–35.4)	35.2 (34.2–35.3)	0.605
Vaginal delivery	36.4% (52)	16.7% (2)	0.218
Sex (male)	60.8% (87)	50.0% (6)	0.462
Birthweight (grams)	2260 (2025–2600)	2413 (2214–2820)	0.099
1-min Apgar score <7	20.3% (29)	41.7% (5)	0.085
5-min Apgar score <7	3.5% (5)	16.7% (2)	0.093
Hypoglycemia, glucose level ≤40 mg/dL	7.7% (11)	16.7% (2)	0.265
Hypoglycemia, glucose level ≤60 mg/dL	49.0% (70)	41.7% (5)	0.628
Histologic chorioamnionitis	24.5% (35)	8.3% (1)	0.297
Neonatal sepsis	0.7% (1)	8.3% (1)	0.149

Data are presented as median (interquartile range) or as % (n). ACS, antenatal corticosteroid.

3. Results

During the study period, a total of 155 singleton late preterm neonates were exposed to ACS in the early preterm period (before 34 + 0 weeks of gestation) (Fig. 1). Clinical characteristics were compared based on rescue ACS administration after a gestational age of 34 weeks, and the results are summarized in Table 1.

In total, 155 singleton late preterm neonates were administered ACS in the early preterm period due to expected birth but did not actually deliver (before 34 + 0 weeks of gestation). Among these, 27.8% (43/155) received rescue ACS after 34 weeks of gestation, while the remaining 72.2% (112/155) did not receive further rescues ACS. Neonates who did not receive further late preterm rescue ACS had a significantly higher frequently of RDS than those who did (0% with late preterm ACS *vs*. 10.7% without late preterm ACS, $p = 0.038$). There were no significant differences between the two groups in the frequencies of TTN (25.6% *vs*. 42.0%, $p = 0.089$), hypoglycemia (glucose level ≤40 mg/dL) (9.3% *vs*. 8.0%, $p = 0.755$), and hypoglycemia (glucose level ≤60 mg/dL) (37.2% *vs*. 52.7%, $p = 0.106$) (Table 1).

Patients were divided into two groups according to whether they experienced RDS: 143 patients did not experience RDS, whereas 12 did (Table 2). The gestational age at initial ACS administration and the gestational age at delivery was not different between the two groups ($p = 0.118$ for 32.4 weeks *vs*. 31.0 weeks and = 0.605 for 34.6 weeks *vs*. 35.2 weeks). The rate of rescue steroid administration was significantly lower in neonates with RDS than in those without RDS (0% [0/12] *vs*. 30.1% [43/143], $p = 0.038$). Other outcomes such as gestational age at delivery were not different between the two groups.

When the patients were classified according to whether they experienced hypoglycemia (glucose level ≤40 mg/dL), no significant differences in pregnancy outcomes were observed between the two groups, except for the vaginal delivery rate ($p = 0.035$) (Table 3).

As shown in Table 4, we conducted a logistic regression analysis of risk factors for RDS and performed multivariate modeling. Variables with $p < 0.2$ in the univariate analysis were included, while variables showing multicollinearity were excluded. In the multivariate modeling, rescue ACS administration did not show statistical significance (odds ratio [OR], 0.07; 95% confidence interval [CI], 0.00–1.48; $p = 0.087$). Similarly, other factors such as gestational age at initial ACS, gestational age at delivery, birth weight, and neonatal hypoglycemia (both glucose levels ≤40 mg/dL and ≤60 mg/dL) were not statistically significant.

4. Discussion

4.1 Principal Findings

In this study, neonates who received late preterm rescue ACS had a lower occurrence of RDS. Other neonatal outcomes, including TTN of the newborn and hypoglycemia (glucose level ≤40 mg/dL and ≤60 mg/dL), demonstrated no differences between the two groups. However, in the multivariate modeling of the risk factors for RDS, late preterm rescue ACS tended to reduce neonatal

Table 3. Clinical characteristics of the study population according to hypoglycemia (glucose level ≤40 mg/dL).

	Hypoglycemia (glucose level ≤40 mg/dL)		*p*-value
	Absent (n = 142)	Present (n = 13)	
Maternal age (years)	34.0 (31.0–36.0)	33.0 (30.0–36.5)	0.648
Nulliparity	58.5% (83)	53.8% (7)	0.747
Hypertensive disorder of pregnancy	38.7% (55)	23.1% (3)	0.373
Gestational diabetes	16.2% (23)	7.7% (1)	0.693
Gestational age at initial ACS administration (weeks)	32.4 (31.0–33.2)	32.5 (29.5–33.2)	0.730
Indication for initial ACS administration			
Spontaneous preterm birth	49.3% (70)	53.8% (7)	0.753
Medically indicated preterm birth	50.7% (72)	46.2% (6)	
Rescue steroid administration	27.5% (39)	30.8% (4)	0.755
Gestational age at delivery (weeks)	34.8 (34.1–35.4)	35.0 (34.1–35.3)	0.671
Vaginal delivery	37.3% (53)	7.7% (1)	0.035
Sex (male)	60.6% (86)	53.8% (7)	0.636
Birthweight (grams)	2273 (2034–2635)	2260 (2070–2383)	0.633
1-min Apgar score <7	22.5% (32)	15.4% (2)	0.735
5-min Apgar score <7	4.2% (6)	7.7% (1)	0.465
Respiratory distress syndrome	7.0% (10)	15.4% (2)	0.265
Transient tachypnea of the newborn	36.4% (48/132)	45.5% (5/11)	0.549
Histologic chorioamnionitis	25.4% (36)	0% (0)	0.040
Neonatal sepsis	0.7% (1)	7.7% (1)	0.161

Data are presented as median (interquartile range) or as % (n). ACS, antenatal corticosteroid.

RDS, but the difference was not statistically significant. Hypoglycemia (glucose level ≤40 mg/dL and ≤60 mg/dL) also did not show an association in the multivariate modeling.

4.2 Late Preterm ACS and Hypoglycemia

ACS administration may cause temporary maternal hyperglycemia, leading to fetal hyperinsulinemia and subsequent hypoglycemia [20].

In the ALPS trial, hypoglycemia (glucose level ≤40 mg/dL) was more frequent in neonates exposed to late preterm ACS than in those in the control group (24.0% *vs*. 15.0%, $p < 0.001$) [9]. In a prospective cohort study, Ramadan *et al*. [21] reported that neonates born to mothers receiving ACS (two doses of 12 mg of betamethasone administered intramuscularly 24 h apart) in late preterm showed a higher incidence of hypoglycemia (glucose level ≤40 mg/dL) within 1 h of life (20.3% *vs*. 10.9%; OR, 2.09; 95% CI, 1.03–4.24; $p = 0.039$). Similarly, Dude *et al*. [10] performed a retrospective cohort study comparing the neonatal outcomes of late preterm infants by dividing them before and after the APLS trial into mothers with pre-gestational diabetes and mothers with gestational diabetes. They reported that the post-protocol group exposed to ACS experienced hypoglycemia (glucose level ≤60 mg/dL) more frequently than the pre-protocol group (59.7% *vs*. 79.6%; OR, 2.82; 95% CI, 1.19–6.72; $p = 0.03$) [10].

Gyamfi-Bannerman *et al*. [22] re-analyzed the data of infants enrolled in the ALPS trial and reported no significant difference in the incidence of neonatal hypoglycemia between the betamethasone and placebo groups (29.3% *vs*. 17.3%; relative risk (RR), 1.69; 95% CI, 1.46–1.96). In addition, most cases of neonatal hypoglycemia resolved spontaneously within 24 h in both groups, and the time to resolution was shorter in the betamethasone group than that for the placebo group (2.80 h [interquartile range: 2.03–7.03] *vs*. 3.74 h [interquartile range: 2.15–15.08]; $p = 0.002$) [13].

In our study, late preterm rescue ACS was not associated with hypoglycemia (glucose level ≤40 mg/dL) or hypoglycemia (glucose level ≤60 mg/dL).

4.3 Late Preterm ACS and RDS

ACS administration accelerates alveolization by promoting normal thinning of the double capillary loops, forming thin gas-exchanging walls of alveoli, and inducing lung maturation by promoting pneumocyte II maturation and pulmonary surfactant generation [23,24].

The efficacy of ACS in late preterm infants remains controversial, and there are few studies on rescue ACS in late preterm infants. According to the ALPS trial, ACS in late preterm infants reduces the risk of composite RDS, TT of the newborn, or apnea (13.9% *vs*. 17.8%; RR, 0.78; 95% CI, 0.66–0.93; $p = 0.004$) [9]. Mansouri *et al*. [25] reported that the incidence of neonatal RDS was significantly lower in the group administered betamethasone (12 mg/kg/BW twice every 24 h) at 35–36 weeks compared to in the untreated group in a double-blind randomized controlled trial (8% *vs*. 20%, $p < 0.01$).

Shanks *et al*. [26] conducted a randomized controlled study that compared the surfactant-to-albumin ratio (TDx-

Table 4. Firth-corrected logistic regression analysis of risk factors for respiratory distress syndrome after a gestational age of 34 weeks.

	Univariate		Multivariate	
	OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
Maternal age (years)	0.99 (0.85–1.16)	0.898		
Nulliparity	0.78 (0.36–4.59)	0.698		
Hypertensive disorder of pregnancy	0.35 (0.07–1.68)	0.189	0.99 (0.21–4.66)	0.978
Gestational diabetes	0.53 (0.06–4.31)	0.550		
Gestational age at initial ACS administration (weeks)	0.88 (0.69–1.12)	0.303		
Indication for initial ACS administration	0.83 (0.24–2.85)	0.772		
Rescue steroid administration	0.10 (0.01–1.76)	0.116	0.07 (0.00–1.48)	0.087
Gestational age at delivery (weeks)	1.06 (0.50–2.26)	0.874		
Vaginal delivery	0.39 (0.08–1.89)	0.244		
Sex (male)	0.53 (0.15–1.82)	0.313		
Birthweight (grams)	1.00 (1.00–1.00)	0.077	1.00 (1.00–1.00)	0.063
1-min Apgar score <7	3.30 (0.94–11.59)	0.062	3.21 (0.73–14.12)	0.123
5-min Apgar score <7	6.18 (1.05–36.38)	0.044	2.36 (0.26–21.58)	0.448
Hypoglycemia, glucose level ≤40 mg/dL	0.86 (0.10–7.19)	0.889		
Hypoglycemia, glucose level ≤60 mg/dL	0.35 (0.10–1.26)	0.109	0.35 (0.10–1.31)	0.119
Interval initial ACS administration to delivery (days)	1.01 (0.98–1.05)	0.382		

OR, odds ratio; 95% CI, 95% confidence interval; Multivariate modeling with inclusion of the following factors was applied: variables with $p < 0.2$ in the univariate analysis, with exclusion of variables showing multicollinearity.

FLM-II), a laboratory marker that is useful for determining fetal lung maturity, depending on ACS administration in pregnant women at 34 + 0/7–36 + 6/7 weeks. They showed that the surfactant-to-albumin ratio (TDx-FLM-II) significantly increased in the group exposed to ACS after 34 weeks (28.37 mg/g *vs*. 9.76 mg/g, $p < 0.002$) [26]. In a randomized controlled trial, Ontela *et al*. [27] argued that late preterm ACS was not associated with composite respiratory morbidity (RR, 0.91; 95% CI, 0.7–1.2; $p = 0.49$). Additionally, Ramadan *et al.* [21] reported that late preterm ACS did not increase the incidence of RDS in neonates (8.1% *vs*. 6.8%; OR, 1.21; 95% CI, 0.452–3.25; $p = 0.702$) (hypoglycemia, no RDS).

In our study, we found that late preterm ACS might be associated with a reduced risk of RDS; however, the results were not statistically significant in the multivariate analysis (OR, 0.07; 95% CI, 0.00–1.48; $p = 0.087$). It is presumed that the small sample size was insufficient to obtain statistical significance. Through this study, we were not able to definitively prove whether mothers who have already received steroids once during the early preterm period, when labor is predicted, can definitely have reduced RDS or TTN by receiving rescue steroids when labor is predicted in the late preterm period. Additionally, we could not establish a correlation of late preterm ACS with increased neonatal hypoglycemia. Therefore, we believe that future large-scale studies are needed to investigate the efficacy or potential adverse effects of administering rescue steroids in women with singleton pregnancies.

4.4 Strength and Limitations

Although studies on the efficacy of late preterm ACS have been actively conducted before and after the ALPS trial, there have been few studies on the efficacy of rescue ACS in late preterm infants. The major strength of our study is being the first to evaluate the benefits and side effects of rescue ACS in late preterm infants. Our findings may shed some light on rescue ACS use in late preterm infants.

However, this study had a few limitations. First, as this was a retrospective hospital-based cohort study, the number of patients who were exposed to rescue ACS in late preterm was insufficient to reach statistical significance. Further studies with a larger number of pregnant women are needed to verify the efficacy of late preterm rescue for ACS. A second potential limitation is that we only collected data from neonates within 24 h of birth. Potential long-term outcomes, such as neurodevelopmental outcomes, need to be evaluated in future studies. Third, residual disturbances due to other factors or interventions, such as fetal anomalies and antibiotic treatment, and maternal factors of gestational diabetes or pregestational diabetes were not addressed but cannot be excluded.

5. Conclusions

Administering rescue ACS in the late preterm stage may not reduce the risk of RDS among women at risk of late preterm birth who initially received ACS before 34 weeks of gestation. Additionally, it does not appear to increase the risk of neonatal hypoglycemia within the first 24 hours after birth. There has been no prior research on the use of rescue

steroids in the late preterm period following the ALPS trial. Although this is a limited study, further research is needed on mothers who receive rescue ACS, specifically those who initially received ACS in the early preterm period, and more than a week has elapsed since. Further studies with larger sample sizes are needed to confirm these results and assess potential long-term implications.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

DEJ: Conceptualization, Data curation, Manuscript writing; JYL: Data curation; EJO: Data curation; KNL: Conceptualization, Data curation, Investigation, Project development, Manuscript writing, Review & editing; HK: Conceptualization, Data curation, Investigation; HJK: Conceptualization, Formal analysis, Manuscript writing; JYP, YHJ: Methodology, Formal analysis, Validation, Review & editing; KJO: Methodology, Project development, Review & editing; CWC: Validation, Review & editing. All authors contributed to editorial changes in the manuscript. All authors approved the final manuscript.

Ethics Approval and Consent to Participate

The study protocol was approved by the Institutional Review Board of Seoul National University Bundang Hospital (B-1905-540-005). The requirement for the acquisition of informed consent from the study participants was waived owing to the retrospective nature of this study.

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Conflict of Interest

The authors declare no conflict of interest.

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