

## Original Research

# Antenatal corticosteroids in the late preterm period: A prospective cohort study

Mohammad K. Ramadan<sup>a</sup>, Ghina Hussein<sup>a</sup>, Walid Saheb<sup>a</sup>, Mariam Rajab<sup>b</sup> and Fadi G. Mirza<sup>c,d,\*</sup>

<sup>a</sup>*Makassed General Hospital, Department of Obstetrics and Gynecology, Division of Maternal Fetal Medicine, Beirut, Lebanon*

<sup>b</sup>*Makassed General Hospital, Department of Pediatrics, Division of Neonatology, Beirut, Lebanon*

<sup>c</sup>*American University of Beirut Medical Center, Department of Obstetrics and Gynecology, Division of Maternal Fetal Medicine, Beirut, Lebanon*

<sup>d</sup>*Columbia University College of Physicians and Surgeons, Department of Obstetrics and Gynecology, Division of Maternal Fetal Medicine, New York, NY, USA*

Received 10 August 2015

Revised 15 October 2015

Accepted 28 December 2015

### Abstract.

**OBJECTIVE:** The study objective was to examine the effect of antenatal corticosteroids on the incidence of short-term neonatal morbidities in singletons born during the late preterm period.

**STUDY DESIGN:** This was a prospective cohort study of singleton gestations at risk of imminent delivery between 34<sup>0/7</sup> and 36<sup>6/7</sup> weeks. Short-term neonatal morbidities were compared between the corticosteroid exposed and non-exposed groups. The rates of Neonatal Morbidity Composite and Any Adverse Neonatal Morbidity were then compared between the two groups.

**RESULTS:** During the two-year study period, a total of 295 subjects were included. Of those, 74 were exposed to antenatal corticosteroids, while 221 cases constituted the non-exposed group. There was no statistically significant difference in the rate of Any Adverse Neonatal Morbidity (47.3% vs. 40.7%,  $p=0.32$ ) or the rate of Neonatal Morbidity Composite (34.4% vs. 37.8%,  $p=0.59$ ) between the two groups. Additionally, there was no statistically significant difference in the rates of neonatal intensive care unit admission, respiratory distress syndrome, transient tachypnea of the newborn, hypothermia, and need for phototherapy.

**CONCLUSION:** Administration of antenatal corticosteroids to parturients at risk of imminent delivery during the late preterm period does not appear to reduce short-term neonatal morbidities.

Keywords: Antenatal corticosteroids, late preterm, neonatal morbidity, prematurity, respiratory morbidity

### Abbreviations

NICU Neonatal intensive care unit  
ACS Antenatal corticosteroids

LPP late preterm period  
NICHD National Institute of Child Health and Human Development  
RDS respiratory distress syndrome  
TTN transient tachypnea of the newborn  
SD standard deviation  
SPSS Statistical Package for the Social Sciences

\*Address for correspondence: Fadi G. Mirza, M.D., Columbia University Medical Center 622W, 168th Street, New York, NY, 10032, USA. Tel.: +1 212 305 6293; Fax: +1 212 305 3717; E-mail: fgm2107@columbia.edu.

OR	odds ratio
CI	confidence interval
IVH	intraventricular hemorrhage
CPAP	continuous positive airway pressure
PPROM	preterm premature rupture of membranes
ALPS	Antenatal Late Preterm Steroids

## 1. Introduction

Preterm birth represents a major public health concern worldwide and is associated with increased neonatal morbidity and mortality [1, 2]. Late preterm births between 34<sup>0/7</sup> and 36<sup>6/7</sup> weeks account for approximately 75% of all preterm births, and they represent the fastest growing subset of premature neonates [3]. Fortunately, this increase in prevalence of LPP has stalled in recent years with an estimated prevalence of 8.0% in 2013 [4]. Late preterm infants populate the neonatal intensive care unit (NICU), as they have higher frequencies of respiratory as well as non-respiratory morbidities compared to their term counterparts 5–7. Primary and secondary prevention strategies to ameliorate preterm birth, including late preterm birth, have been difficult to implement globally and might not be possible in many regions depending on resources. Alternatively, many efforts have focused on tertiary prevention, which aim at improving long-term neonatal outcomes [8]. One of these efforts has been the administration of antenatal corticosteroids (ACS) to pregnant women at increased risk of preterm birth.

Administration of ACS to parturients who are less than 34 weeks of gestation and at risk of preterm delivery currently represents standard of care [9]. However, there is no substantial data to support ACS administration in the late preterm period (LPP), and further research was suggested by members of the National Institute of Child Health and Human Development (NICHD) workshop in 2011 that focused on efforts to reduce preterm birth and neonatal morbidity [10–12]. The objective of our study was to examine the effect of ACS administered between 34<sup>0/7</sup> and 36<sup>6/7</sup> weeks to women at risk of imminent delivery on the incidence of short-term neonatal morbidities.

## 2. Material and methods

This was a prospective cohort study conducted over a period of 30 months from July 1, 2009 to December 31, 2011 at Makassed General Hospital, a tertiary care

teaching facility located in Beirut, Lebanon and affiliated with the American University of Beirut. At this institution, obstetric providers fall into two groups, one that administers antenatal corticosteroids beyond 34 weeks to pregnant women at risk of preterm delivery and a second that refrains from this practice, in accordance with the current standard of care. In the case of the former, two doses of 12 mg of betamethasone are administered intramuscularly 24 hours apart.

Approval of the Institutional Review Board was secured for this observational study. Parturients with a singleton gestation at 34<sup>0/7</sup> to 36<sup>6/7</sup> weeks at imminent risk of delivery were eligible; exclusion criteria included fetal demise, major congenital anomalies, and chromosomal abnormalities. The decision to administer ACS was at the discretion of the managing obstetrician. Gestational age determination was based on the last menstrual period confirmed by ultrasonography during the first half of pregnancy.

Demographic variables collected for the purpose of this study included maternal age, parity, gestational age, newborn weight, gender, mode of delivery, presence of labor at presentation and the primary indication for delivery. Antenatal bleeding included cases of abruptio placentae or placenta previa. Fetal compromise included oligohydramnios, abnormal antenatal testing and severe fetal growth restriction, defined as an estimated fetal weight less than the 3rd percentile for gestational age. Hypertensive disorders of pregnancy included both gestational hypertension and preeclampsia.

Indications for NICU admission at our institution included any of the following: birth weight less than 1,800 g, respiratory morbidity, persistent hypoglycemia, suspected sepsis, poor feeding, decreased oxygen saturation or requirement for close observation as assessed by the neonatologist. Hypoglycemia was defined as a blood glucose level of less than 40 mg/dl within 1 hour of life. Hypothermia was defined as a newborn core body temperature of less than 36.0°C within 1 hour of life.

Seven neonatal outcome variables were compared between the two groups, namely admission to NICU, respiratory distress syndrome (RDS), transient tachypnea of the newborn (TTN), suspected sepsis, jaundice with the need for phototherapy, hypoglycemia, and hypothermia. The incidence of Any Adverse Neonatal Morbidity (primary outcome variable) was calculated and compared between the two groups. A Neonatal Morbidity Composite that includes all seven morbidities was also calculated and compared.

### 2.1. Statistical analysis

Data were reported as number of cases (percent-age) or mean  $\pm$  standard deviation (SD). Independent samples T-test for continuous variables and Chi-square test for discrete variables were used to assess any significant difference between the two groups. A *P*-value of  $<0.05$  was considered significant. Statistical Package for the Social Sciences (SPSS) version 19 was used to execute the statistical analysis (SPSS Inc., Chicago, IL). Any Adverse Neonatal Morbidity was considered the primary outcome. Based on previously published studies by Melamed et al and Bastek et al, and the risk of developing Any Adverse Neonatal Morbidity during the LPP would be in the range of 30–39% [13, 14]. In addition, the results of a previous pilot study conducted at our institution were consistent, with this risk reported to be 36.8%. During this pilot study, a 1:3 ratio was noted for the exposed to an-exposed patients. Accordingly, sample size was calculated using PS version 3.0.43, considering a beta of 80% and an alpha of 0.05% and expected Any Adverse Neonatal Morbidity at the rate of 35% and a desired 50% decline in this rate. It was estimated that 72 exposed and 216 controls were needed. Based on the annual number of deliveries of 1000 and a rate of late preterm birth of 10% at our unit, a 30-month duration was estimated for completion of the study.

### 3. Results

During the study period, 2910 deliveries took place at our institution. Of those, 328 cases occurred

between 34<sup>0/7</sup> and 36<sup>6/7</sup> weeks. After 33 subjects were excluded due to fetal demise, 295 were enrolled in the study. Study subjects were divided into two groups: the study group (*n* = 74 patients) consisting of subjects who received ACS and the control group (*n* = 221) consisting of patients who did not receive the treatment.

The demographic characteristics of the two groups are shown in Table 1. Of note, a statistically significant difference was noted in three demographic characteristics. The use of ACS was found to be highest in the 34<sup>0/7</sup> to 34<sup>6/7</sup> week category (58.1% vs. 41.9%, *p* < 0.0001) and lowest in the 36<sup>0/7</sup> to 36<sup>6/7</sup> week category (81.7% vs. 18.3%, *p* < 0.0001). This resulted in a lower mean birth weight in the study group (2748 g vs. 2620 g; *p* 0.043). Concerning the rate of ACS administration as a function of gestational age in this study, more patients at 34 weeks received steroids than those at 36 weeks (58.1% vs. 18.3%, *p* < 0.0001). The most frequent indication for delivery was preterm labor (50.0%), followed by premature preterm rupture of membranes (21.0%), hypertensive disorders of pregnancy (10.0%), antepartum bleeding (4.0%), fetal compromise (7.4%), and elective (6.4%).

There was no statistically significant difference in the rate of the primary outcome variable as well the individual variables studied between the exposed and unexposed groups, except for higher rates of suspected sepsis (10.8% vs. 3.6%, *p* 0.018; odds ratio (OR) 3.22, 95% confidence interval (CI) 1.17–8.93) and hypoglycemia (20.3% vs. 10.9%, *p* 0.039; OR 2.09, CI 1.03–4.24) in infants born to mothers exposed to ACS (Table 2). The effect of ACS

Table 1  
Demographic characteristics

	NO ACS ( <i>n</i> = 221)	ACS ( <i>n</i> = 74)	<i>P</i> value
Mean maternal age (years)	28.5 $\pm$ 6.5	29.7 $\pm$ 6.6	0.160
Mean birth weight (g)	2748.6 $\pm$ 438.9	2620.5 $\pm$ 552.5	0.043
Primiparity	65 (29.4%)	26 (35.1%)	0.356
Male gender	117 (52.9%)	45 (60.8%)	0.239
Cesarean delivery	121 (54.8%)	41 (55.4%)	0.922
Diabetes mellitus	12 (5.4%)	7 (9.5%)	0.222
Preterm labor	112 (50.7%)	33 (44.6%)	0.365
Preterm premature rupture of membranes	44 (19.9%)	18 (24.3%)	0.420
Hypertension	20 (9.0%)	10 (13.5%)	0.272
Antenatal hemorrhage	9 (4.1%)	3 (4.1%)	0.994
Fetal compromise	15 (6.8%)	7 (9.5%)	0.449
Elective	18 (8.1%)	1 (1.4%)	0.039
Gestational age (34 <sup>0/7</sup> - 34 <sup>6/7</sup> )	13 (41.9%)	18 (58.1%)	<0.0001
Gestational age (35 <sup>0/7</sup> - 35 <sup>6/7</sup> )	52 (71.2%)	21 (28.8%)	0.403
Gestational age (36 <sup>0/7</sup> - 36 <sup>6/7</sup> )	156 (81.7%)	35 (18.3%)	<0.0001

Data presented as numbers (percent) or means  $\pm$  standard deviation.

Table 2  
Short-term neonatal outcomes following ACS administration

Outcome	No ACS (221 cases)	ACS (74 cases)	P-value	OR	95% CI
Any neonatal morbidity	90 (40.7%)	35 (47.3%)	0.322	1.306	0.769–2.218
NICU admissions	42 (19.0%)	20 (27.0%)	0.143	1.578	0.855–2.915
Neonatal death	2 (1%)	0 (0%)	–	–	–
Mean NICU stay (Days)*	8.14 ± 4.8	9.60 ± 6.0	0.315	–	–
Suspected sepsis	8 (3.6%)	8 (10.8%)	0.018	3.227	1.166–8.933
Composite respiratory morbidity	34 (15.4%)	13 (17.6%)	0.657	1.172	0.581–2.364
RDS	15 (6.8%)	6 (8.1%)	0.702	1.212	0.452–3.247
TTN	15 (6.8%)	6 (8.1%)	0.702	1.212	0.452–3.247
Ventilator	14 (6.3%)	5 (6.8%)	0.898	1.071	0.372–3.083
Oxygen supply	19 (8.6%)	7 (9.5%)	0.821	1.111	0.447–2.758
Composite metabolic morbidity	76 (34.4%)	28 (37.8%)	0.591	1.161	0.673–2.004
Phototherapy	54 (24.4%)	20 (27.0%)	0.656	1.145	0.630–2.082
Hypothermia	21 (9.5%)	8 (10.8%)	0.743	1.154	0.488–2.729
Hypoglycemia	24 (10.9%)	15 (20.3%)	0.039	2.087	1.028–4.235

Data presented as numbers (percent) or mean ± standard deviation\*.

Table 3  
Neonatal outcomes following exposure to ACS according to gestational age

Outcome		LPP (295 cases)	34 weeks (31 cases)	35 weeks (73 cases)	36 weeks (191 cases)
Any neonatal morbidity	No ACS	90/221 (40.7%)	10/13 (76.9%)	25/52 (48.1%)	55/156 (35.3%)
	ACS	35/74 (47.3%)	12/18 (66.7%)	11/21 (52.4%)	12/35 (34.3%)
	P value	0.322	0.535	0.739	0.913
Respiratory morbidity	No ACS	34/221 (15.4%)	7/13 (53.8%)	10/52 (19.2%)	17/156 (10.9%)
	ACS	13/74 (17.6%)	6/18 (33.3%)	4/21 (19.0%)	3/35 (8.6%)
	P value	0.657	0.253	0.986	0.685
Metabolic morbidity	No ACS	76/221 (34.4%)	9/13 (69.2%)	23/52 (44.2%)	44/156 (28.4%)
	ACS	28/74 (37.8%)	9/18 (50.0%)	7/21 (33.3%)	12/35 (34.3%)
	P value	0.591	0.284	0.392	0.475
Suspected sepsis	No ACS	8/221 (3.6%)	0/13 (0.0%)	2/52 (3.8%)	6/156 (3.8%)
	ACS	8/74 (10.8%)	3/18 (16.7%)	4/21 (19.0%)	1/35 (2.9%)
	P value	0.018	0.121	0.032	0.778
NICU	No ACS	42/221 (19.0%)	8/13 (61.5%)	13/52 (25.0%)	21/156 (13.5%)
	ACS	20/74 (27.0%)	9/18 (50.0%)	8/21 (38.1%)	3/35 (8.6%)
	P value	0.143	0.524	0.263	0.430

was also studied with respect to gestational age. No statistically significant difference was identified for any morbidities, except for higher rate of sepsis in the ACS group at 35 weeks' gestation (19.0% vs. 3.8%,  $p$  0.032, OR 5.88, CI 0.99–35.03), as illustrated in Table 3.

The mean interval from steroid administration to delivery was 12.9 hours (range 1–168). In order to examine the effect of the duration of ACS exposure, those who received ACS were stratified into three groups, namely those who were delivered: less than 8 hours, between 8 and 12 hours and more than 12 hours after receiving the first dose of ACS. Longer exposures were found to be associated with higher rates of morbidities. This was of statistical significance in Any Adverse Neonatal Morbidity and Composite Metabolic Morbidity (37.0 vs. 50.0%, 75.0%,  $p$  0.037

and 34.8% vs. 16.7% vs. 62.5%,  $p$  value 0.037 respectively).

#### 4. Discussion

A major goal for contemporary obstetrics is to minimize prematurity-related neonatal morbidity and mortality. Undoubtedly, one of the most important antenatal interventions is corticosteroid administration to parturients less than 34 weeks of gestation who are at risk of preterm delivery. Recent reports have suggested a potential role for corticosteroids when administered during the LPP, which spans from 34 to 37 weeks. However, the few studies that aimed at answering this research question have reported conflicting results; hence, the use of ACS during the

LPP has not been endorsed by any professional society to date. The present study demonstrated that the administration of ACS to women at risk of imminent delivery during the LPP did not diminish the risk of neonatal morbidity.

The association between the use of ACS and improved neonatal outcome dates back to the late 1960s. At that time, Graham Liggins was investigating factors involved in the initiation of labor in a sheep model when he incidentally noted that preterm lambs exposed to corticosteroids had more structurally mature lungs than expected on post-mortem analyses [15]. Steroid-exposed animals were also viable at an earlier gestational age and had less severe respiratory distress at birth. Liggins and Howie realized the potential of this therapy for improving lung function in premature infants, and their preliminary work led to a landmark randomized clinical trial that supported the role of a potent glucocorticoid, namely betamethasone given to mothers expected to deliver prematurely in improving the respiratory status of preterm neonates [16]. The use of ACS in cases of threatened preterm delivery, however, did not gain popularity until a consensus meeting was held by the NICHD in 1994 [17]. This meeting concluded that their use significantly reduces RDS, intraventricular hemorrhage (IVH), and neonatal mortality with no proven risks to the infant. The panel recommended that ACS be administered to all women at 24 to 34 weeks and at risk of preterm delivery. This recommendation was ultimately endorsed by the American College of Obstetricians and Gynecologists and American Academy of Pediatrics [18].

In contrast to the management of parturients at risk of preterm birth prior to 34 weeks, the administration of antenatal corticosteroids to their late preterm counterparts does not represent standard obstetric care. However, the late preterm infants and parturients at risk of preterm birth during the LPP have recently attracted the attention of researchers and professional societies. This population is not only the largest portion of preterm infants, comprising nearly 75% of all preterm births, but they also represent the fastest growing preterm period, increasing by about 50% between 1981 and 2006 [3]. Late preterm infants populate the neonatal intensive care unit, and this is not surprising given the predisposition of those infants to a number of neonatal morbidities. A retrospective study summarized a single center's 18-year experience and examined seven morbidities that were all significantly increased in late preterm compared to term infants [10]. These included culture-proven

sepsis, necrotizing enterocolitis, grade one and two IVH, and need for phototherapy and ventilator use. Another retrospective study looked specifically at short-term respiratory morbidities in late preterm births [5]. In this study, the incidence of respiratory distress syndrome was 10.5% at 34 weeks compared to only 0.3% at 38 weeks with an adjusted odds ratio of 40.

Late preterm infants are particularly inclined to experience respiratory morbidity. While only few studies have investigated the effects of ACS administration after 34 weeks with regards to this outcome, several have studied the effects of ACS administration prior to 34 weeks on neonates born during the LPP. Ventolini et al. compared the outcome of late preterm infants born between 34 and 36 weeks of gestation who had received antenatal steroids prior to 34 weeks to those who had not [24]. The incidence of RDS and the need for ventilation and for continuous positive airway pressure (CPAP) and oxygen were significantly less in the former group. In this study, only 24% of steroid-exposed infants required admission to the NICU compared to 81% of their unexposed counterparts. Subsequently, Eriksson et al. showed that late preterm infants exposed to ACS prior to 34 weeks had reduced risks of respiratory distress syndrome [25]. In turn, several studies demonstrate that ACS administration prior to 34 weeks had no benefit in reducing morbidity if neonates were born in the LPP [26–29].

Among the few studies that evaluated ACS administration beyond 34 weeks, the following results were demonstrated. Shanks et al. enrolled women with immature fetal lung maturity profile on amniocentesis in a small, randomized controlled trial that was concluded early due to difficult recruitment [30]. Subjects were randomized to 1 of 2 groups, a treatment group that received antenatal steroids or a control group that received no treatment. Both groups underwent repeat testing of amniotic fluid 7 days later, and the lung maturity profile was more likely to be mature in the treatment group (50% vs. 27%). In turn, a randomized controlled trial conducted by Porto et al. showed between parturients who received antenatal 2 doses of betamethasone between 34<sup>0/7</sup> and 36<sup>6/7</sup> weeks of gestation compared to their counterparts who received placebo [31]. They concluded that ACS was not effective in decreasing respiratory disorders, NICU admission rates and other morbidities except for jaundice. Most recently, Yinon et al. conducted a retrospective cohort study of women who underwent amniocentesis to determine fetal lung maturity

from 34–37 weeks of gestation [32]. Patients with negative results were categorized into 2 groups: study group treated with betamethasone ( $n=83$  women) and control group in which patients did not receive betamethasone therapy ( $n=84$  women). Antenatal steroid administration after 34 weeks of gestation was associated with improved neonatal outcome and should be considered when fetal lung immaturity is documented.

Given the natural surge of endogenous corticosteroids in the late preterm and term period, some authors have raised concerns regarding the long-term neurodevelopmental outcomes of exogenous corticosteroids that are administered during these periods and that may have an additive, undesired effect. Stutchfield P et al. assessed the use of ACS for planned cesarean delivery at term and reported a reduction in respiratory morbidity for those who had a single course of ACS and delivered between 37<sup>0/7</sup> and 38<sup>6/7</sup> weeks of gestation [33]. Of particular importance, the investigators completed a follow-up study amongst children aged 8–15 years old, using parent questionnaires as well as standardized test scores and school assessments of child's quartile ability [34]. This study demonstrated there were no differences in the children's behavioral outcomes or their long-term health issues such as the likelihood of developing asthma. There was however, a higher probability that schools would rank children in the lower quartile of academic ability if they had received ACS compared to those who had not ( $p=0.03$ ). Another study, the MACS-5 study (Multiple Courses of Antenatal Corticosteroids for Preterm Birth Study: Outcomes in Children at 5 Years of Age) examined women at risk for preterm birth (between 25–32 weeks' gestation) and randomized them to receiving either a single course of ACS or multiple courses to be administered every 14 days until either delivery or 32 weeks' of gestation had been achieved [35]. In the five-year follow-up of this study, children who had received multiple courses of ACS preterm, but then ultimately went on to deliver at term, were at increased risk for the primary outcome of either death or survival with a neurodevelopmental disability in at least one domain (OR 1.69, 95% CI 1.04–2.77,  $p=0.04$ ). This group of children was also at an increased risk of neurosensory disability (OR 3.70, 95% CI 1.57–8.75,  $p=0.004$ ) with no evidence of a dose response relationship. While this data may not be applicable to neonates and children exposed to a single course of ACS in the LPP, it still highlights the fact that some concern

exists regarding long-term complications related to antenatal exposure to corticosteroids amongst newborns that deliver later in pregnancy. These concerns are further substantiated by the biologic plausibility that relate to the endogenous corticosteroid surge occurring at the same time of corticosteroids administration.

In our study, antenatal corticosteroids did not appear to reduce the probability of developing adverse neonatal morbidity when administered to women at imminent risk of preterm delivery during the LPP. The main indications for delivery in our population were preterm labor and preterm premature rupture of membranes (PPROM), which together constitute 71% of the causes. These rates were similar to those reported by McIntire et al, where preterm labor was responsible in 45% of cases, PPRM for 35%, and together amount to 80% of all late preterm deliveries [10]. In our cohort, a small portion of deliveries occurred electively and all fell within one or two days from term. This resulted from scheduling deliveries based on erroneous menstrual calculations [19].

Concerning the rate of ACS administration as a function of gestational age in this study, more patients at 34 weeks received steroids than those at 36 weeks. This pattern is similar to that reported in the population studied by Joseph et al, who demonstrated that prenatal steroid use decreases with increasing gestational age [11]. Chien et al. also described the same pattern of ACS use, being highest between 25 and 31 weeks of gestation and decreasing gradually with lower and higher gestational ages [17]. We also found that hypoglycemia and sepsis were significantly increased among late preterm newborn infants exposed to ACS, which is consistent with the study by Kamath-Raney et al that reported similar results [20].

Response of cases delivered at LPP due to preterm labor and PPRM to ACS was analyzed separately and once more ACS was not associated with any change in the rate of major morbidities, with the exception of increased risks for suspected sepsis in cases admitted with PPRM. We studied the effect of ACS on morbidities in relation to gestational age. Again no statistically significant improvement was seen in most morbidities upon the use of ACS with the exception of higher rate of suspected sepsis at 35 weeks among cases who received ACS. Porto et al analyzed only respiratory morbidity across the 3 weeks and reported no change after the use of ACS at any gestational age group [31]. With respect to the

duration of ACS exposure, significant difference was observed in the rate of Any Adverse Neonatal Morbidity and Composite Metabolic Morbidity, which were higher among those who were delivered beyond 12 hours after ACS, when compared to those who were delivered before 12 hours. Costa et al reported that incomplete ACS did not show any difference in the morbidity of infants born between 32 and 34 weeks [21]. In our study, most cases were presenting with imminent delivery; hence, the chance of receiving the complete ACS dose was low. This is similar to the results by Chien et al who reported that only 30% of the patients received the complete course of ACS [17]. Nevertheless, in our study, a real-life scenario was presented since it was not possible to delay delivery just to provide the complete ACS dose. The European consensus on issues in perinatal practice released in 2008, has recommended “all women at high risk of preterm delivery should start a course of ACS unless delivery is imminent (less than one hour) even if only one dose is anticipated” [22]. In fact, complete course can only be assured before elective deliveries, which in our cohort constituted only 6%.

The present study was conducted given the conflicting data on the role of antenatal corticosteroids during the later preterm period, and it falls among those that do not support a beneficial role for such practice. Our study has a number of limitations. Similar to most studies that have tackled this research question, the sample size was small, which deprived us the opportunity to study individual morbidities as well as composite respiratory morbidity. Another limitation relates to the fact that not all patients received two doses of corticosteroids and/or delivered after 48 hours.

In conclusion, antenatal corticosteroids did not appear to reduce neonatal morbidity in this study. In fact, the rates of suspected sepsis and hypoglycemia were increased in neonates of steroid-exposed mothers. As such, this practice should generally be limited to experimental studies especially if absence of any benefit together with a tendency towards more complications were confirmed by other studies. An ongoing large randomized controlled trial, Antenatal Late Preterm Steroids (ALPS), may help answer this controversy and establish a universal practice for women at risk of preterm birth during the LPP.

#### Disclosure statement

The authors report no conflicts of interest.

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