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Estimating probability of early onset sepsis in late Preterms on the basis of maternal risk factors

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Abstract

Background: Late preterm neonates are at increased risk of early-onset sepsis (EOS) because of physiological and immunological immaturity. Early identification is challenging because clinical manifestations may be nonspecific and maternal risk factors may vary in their predictive value.

Objective: To estimate the probability of early-onset sepsis in late preterm neonates based on maternal risk factors and to assess the association of clinical and laboratory parameters with EOS.

Methods: A prospective observational study was conducted in the Neonatal Intensive Care Unit, Department of Paediatrics, Karnataka Medical College and Research Institute, Hubballi, Karnataka, from May 2023 to December 2024. Ninety-five late preterm neonates with two or more predefined risk factors for sepsis were enrolled. Maternal risk factors, neonatal clinical features, and laboratory parameters including total leukocyte count, absolute Neutrophil count, micro-ESR, immature-to-total Neutrophil ratio, CRP and blood culture were assessed. Neonates were followed during hospitalisation and immediate outcomes were recorded. Data were analysed using SPSS version 17.0. Chi-square/Fisher's exact test and multivariable logistic regression were used, with $p<0.05$ considered statistically significant.

Results: Among 95 neonates, 48 (50.5%) developed EOS, and 47 (49.5%) did not. Of the septic neonates, 21 (43.7%) had proven sepsis, 19 (39.5%) probable sepsis

and 8 (16.7%) possible sepsis. Frequent per-vaginal examination (84.2%) and low birth weight (83.2%) were the most common risk factors, followed by PROM (45.3%). None of the maternal risk factors showed a statistically significant independent association with EOS on multivariable analysis. Respiratory distress (p=0.018), tachycardia, abdominal distension and apnea (p<0.001) were significantly associated with EOS. TLC, ANC, micro-ESR, I/T ratio and CRP at birth, 12–24 hours and 48 hours were significantly associated with sepsis (p<0.001). Mortality was 12.5% among septic neonates compared with 0% among non-septic neonates (p=0.012).

Conclusion: EOS was common among the selected high-risk late preterm neonates. Although maternal risk factors were frequent, none independently predicted sepsis in multivariable analysis. Serial clinical assessment and laboratory evaluation, supported by blood culture, are important for early identification and management of EOS in late preterm neonates.

Keywords: Late Preterm Neonate, Early-Onset Sepsis, Maternal Risk Factors, CRP, Blood Culture, Neonatal Sepsis.

Introduction

Late preterm neonates are infants born at 34^0/7 to 36^6/7 weeks of gestation. Although they are considerably more mature than very preterm infants, late preterm neonates remain physiologically immature and have a higher risk of respiratory morbidity, feeding difficulties, temperature instability, hypoglycemia, hyperbilirubinaemia and infection compared with term neonates.[1,2]

Early-onset sepsis (EOS) is a serious neonatal infection that generally becomes clinically apparent within the first 72 hours of life. It is predominantly acquired through vertical transmission of microorganisms from the maternal genital tract before or during delivery. Prematurity is an important risk factor for EOS, and the risk is influenced by both gestational age and perinatal circumstances [3,4].

The diagnosis of EOS remains difficult because clinical manifestations are frequently nonspecific. Respiratory distress, tachycardia, poor feeding, apnea, abdominal distension and neurological abnormalities may occur in neonates with sepsis, but similar findings can also result from non-infectious complications of prematurity. Therefore, clinical findings need to be interpreted in the context of maternal risk factors and laboratory investigations [3,5].

Several maternal and intra partum factors have been associated with an increased risk of EOS. These include prolonged rupture of membranes, maternal intrapartum fever or intra-amniotic infection, prematurity, maternal urinary or genital tract infection and repeated vaginal examinations. A recent meta-analysis demonstrated significant associations between EOS and premature rupture of membranes, maternal urinary or reproductive tract infection, perinatal fever, lower gestational age, very low birth weight and vaginal examinations performed three or more times [6].

Blood culture remains the diagnostic standard for culture-confirmed EOS. However, its yield may be affected by the small volume of blood obtained from neonates and previous exposure to antimicrobial agents. Haematological parameters such as total leukocyte count (TLC), absolute Neutrophil count (ANC) and immature-to-total Neutrophil (I/T) ratio are frequently used as adjunctive investigations. Nevertheless, these parameters have limited sensitivity and specificity when used

individually and should not be considered diagnostic of EOS in isolation [7,8].

C-reactive protein (CRP) is another commonly used inflammatory biomarker. Its concentration generally increases several hours after the onset of an inflammatory response, resulting in relatively low sensitivity when measured immediately after birth. Serial measurements may therefore provide more useful information than a single measurement obtained at birth. However, current evidence indicates that CRP and other laboratory tests should complement, rather than replace, clinical assessment and blood culture [7,8].

Accurate identification of neonates at increased risk of EOS is important because both delayed treatment of genuine infection and unnecessary antibiotic exposure can have adverse consequences. Contemporary approaches Emphasise integration of maternal risk factors, gestational age, neonatal clinical condition and serial assessment rather than relying on a single risk factor or laboratory test [8,9].

Late preterm neonates represent a clinically important population in this context because they have increased susceptibility to infection while also having clinical manifestations that may overlap with common complications of prematurity. Assessment of the contribution of maternal risk factors in this population may therefore assist in identifying neonates who require closer monitoring and early investigation.

The present study was undertaken to estimate the probability of early-onset sepsis in late preterm neonates based on maternal risk factors. The study also evaluated the association of selected clinical and laboratory parameters with EOS and assessed immediate neonatal outcomes.

Materials And Methods

Study Design and Setting

The present study was conducted as a prospective observational study in the Neonatal Intensive Care Unit (NICU), Department of Paediatrics, Karnataka Medical College and Research Institute (KMCRI), Hubballi, Karnataka, from May 2023 to December 2024.

Study Population

The study population comprised late preterm neonates born at KMCRI during the study period. A total of 95 neonates fulfilling the predefined eligibility criteria were included in the study.

Eligibility Criteria

Late preterm neonates born between 34 and 36 completed weeks of gestation with two or more risk factors for sepsis were included. The risk factors considered were premature rupture of membranes (PROM) >18 hours, prolonged labour>24 hours, peripartum maternal febrile illness, low birth weight (<2.5 kg), foul-smelling liquor, spontaneous prematurity, maternal urinary tract infection, and frequent per-vaginal examinations during labour (>3 times).

Neonates enrolled in the ACTION-III trial evaluating Betamethasone and Dexamethasone for prevention of respiratory distress syndrome in late preterm neonates, babies born to HIV-positive mothers, neonates with major external congenital anomalies, and those whose parents or guardians declined consent were excluded.

Sample Size

The sample size was calculated based on a previously reported incidence of early-onset sepsis of 13.6% among late preterm neonates. Using the formula:

$\mathbf{N = Z^2_{1-\alpha/2} \times p(1-p) / d^2}$ where Z = 1.96 at a 5% level of significance, p = 13.6%, and d = 7% absolute

precision, the required sample size was calculated to be 95 neonates.

Ethical Considerations

The study was initiated after obtaining approval from the Institutional Ethics Committee of KMCRI, Hubballi. Written informed consent was obtained from the parents or legal guardians before enrolment.

Data Collection

Late preterm neonates born at KMCRI were identified by the attending paediatrician. Gestational age was determined from the last menstrual period and/or antenatal ultrasonography and was confirmed using the Ballard scoring system when required. Maternal demographic, antenatal and obstetric details were obtained from antenatal and delivery records. Detailed information regarding maternal risk factors for neonatal sepsis was recorded.

Each enrolled neonate underwent detailed clinical examination at birth and was reassessed at 12–24 hours, 48 hours, and during the hospital stay. Clinical features suggestive of neonatal sepsis and immediate neonatal outcomes were documented.

Laboratory Investigations

Laboratory evaluation included blood culture, complete haemogram, total leukocyte count (TLC), absolute Neutrophil count (ANC), peripheral blood smear, immature-to-total Neutrophil (I/T) ratio, C-reactive protein (CRP), and micro-erythrocyte sedimentation rate (micro-ESR).

Blood culture, complete haemogram with peripheral smear, micro-ESR, and I/T Neutrophil ratio were assessed at birth. CRP was measured at the time of blood culture collection and subsequently at 12–24 hours and 48 hours.

The following values were considered abnormal:

- I/T Neutrophil ratio >0.20
- Micro-ESR >15 mm in the first hour
- CRP >1 mg/dL
- TLC <5,000/mm³
- ANC <1,800/mm³

Blood Culture

Approximately 1 mL of peripheral venous blood was collected under strict aseptic precautions. The venepuncture site was disinfected using 70% isopropyl alcohol and povidone-iodine alternately three times. The collected blood was inoculated into a BACT/ALERT blood culture bottle and transported promptly to the microbiology laboratory for bacterial culture and identification.

Definition of Early-Onset Sepsis

Early-onset sepsis was categorised based on clinical, laboratory, and microbiological findings.

- **Proven sepsis:** Positive blood culture in the presence of clinical signs and symptoms of infection.
- **Probable sepsis:** Presence of clinical signs and symptoms of infection with at least two abnormal laboratory parameters and a negative blood culture.
- **Possible sepsis:** Presence of clinical signs and symptoms of infection with raised CRP and a negative blood culture.

The neonates were followed throughout their hospital stay, and immediate outcomes were documented.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using SPSS version 17.0. Categorical variables were expressed as frequencies and percentages. The incidence of early-onset sepsis was presented as a percentage with 95% confidence intervals.

The association between maternal/neonatal risk factors and early-onset sepsis was assessed using the Chi-square

test or Fisher's exact test, wherever appropriate. Multivariable logistic regression analysis was performed to identify independent risk factors associated with early-onset sepsis. Odds ratios (ORs) with 95% confidence intervals (CIs) were reported. A p-value <0.05 was considered statistically significant. Bar diagrams and pie charts were used for graphical representation of the findings.

Results and Observations

During the study period, a total of 9,663 newborns were delivered at Karnataka Medical College and Research Institute, Hubballi. Among them, 7,649 were term neonates and 2,014 were preterm neonates. Of the preterm neonates, 680 were early preterm and 1,334 were late preterm. After applying the exclusion criteria, 95 late preterm neonates fulfilling the study eligibility criteria were enrolled. Among the 95 enrolled neonates, 48 (50.5%) developed early-onset sepsis, while 47 (49.5%) did not.

Table 1: Distribution of newborns according to gestational maturity and study enrolment

Category	Number
Total newborns delivered	9,663
Term neonates	7,649
Preterm neonates	2,014
Early preterm neonates	680
Late preterm neonates	1,334
ACTION-III trial	352
Major congenital anomalies	6
Born to HIV-positive mothers	9
Late preterm neonates included in study	95

Table 2: Distribution of mothers according to age

Maternal age (years)	Number	Percentage (%)
<20	2	2.1
20–30	80	84.2
>30	13	13.7
Total	95	100.0

The mean maternal age was 26.0 ± 4.5 years, with a minimum age of 19 years and maximum age of 43 years. The majority of mothers (84.2%) belonged to the 20–30-year age group, followed by those aged >30 years (13.7%).

Table 3: Distribution of neonates according to gender

Gender	Number	Percentage (%)
Male	54	56.8
Female	41	43.2
Total	95	100.0

Male neonates constituted 56.8% of the study population, while female neonates constituted 43.2%, giving a male-to-female ratio of approximately 1.3:1.

Table 4: Distribution of neonates according to birth weight

Birth weight (kg)	Number	Percentage (%)
<1.0	0	0.0
1.0–1.5	11	11.6
1.5–2.5	68	71.6
≥2.5	16	16.8
Total	95	100.0

Most neonates (71.6%) had a birth weight between 1.5 and 2.5 kg. A further 11.6% had a birth weight between 1.0 and 1.5 kg, while 16.8% weighed ≥2.5 kg. None of the neonates had a birth weight below 1 kg.

Table 5: Occurrence and classification of early-onset sepsis

Early-onset sepsis status	Number	Percentage (%)
Sepsis present	48	50.5
Sepsis absent	47	49.5
Total	95	100.0

Classification among neonates with sepsis (n=48)

Type of sepsis	Number	Percentage (%)
Proven sepsis	21	43.7
Probable sepsis	19	39.5
Possible sepsis	8	16.7
Total	48	100.0

The occurrence of early-onset sepsis was 50.5% (95% CI: 40.1–60.9). Among the 48 neonates with sepsis, proven sepsis was the most common category (43.7%), followed by probable sepsis (39.5%) and possible sepsis (16.7%).

Table 6: Distribution of maternal and neonatal risk factors

Risk factor	Number	Percentage (%)
Frequent per-vaginal examination (>3 times)	80	84.2
Low birth weight	79	83.2
PROM >18 hours	43	45.3
Spontaneous prematurity	29	30.5
Prolonged labour>24 hours	11	11.6
Peripartum febrile illness	9	9.5
Maternal UTI	3	3.2
Foul-smelling liquor	1	1.1

Frequent per-vaginal examination was the most commonly observed risk factor (84.2%), followed by low birth weight (83.2%). PROM >18 hours was present in 45.3% and spontaneous prematurity in 30.5% of neonates. Prolonged labour, peripartum febrile illness, maternal UTI and foul-smelling liquor were less frequently observed.

Table 7: Multivariable logistic regression analysis of risk factors associated with early-onset sepsis

Risk factor	Sepsis Yes n (%)	Sepsis No n (%)	Odds ratio (95% CI)	p-value
PROM	21 (48.8)	22 (51.2)	0.71 (0.21–2.30)	0.58
Peripartum febrile illness	6 (66.7)	3 (33.3)	1.50 (0.24–8.80)	0.68
Spontaneous prematurity	13 (44.8)	16 (55.2)	0.55 (0.12–2.60)	0.45
Frequent per-vaginal examination	41 (51.3)	39 (48.8)	0.85 (0.20–3.70)	0.83
Low birth weight	40 (50.6)	39 (49.4)	1.10 (0.22–10.20)	0.68
Maternal UTI	3 (100.0)	0 (0.0)	Not estimable	0.08
Foul-smelling liquor	1 (100.0)	0 (0.0)	Not estimable	0.32

Multivariable logistic regression showed that none of the evaluated risk factors had a statistically significant independent association with early-onset sepsis. Peripartum febrile illness and low birth weight showed higher odds of sepsis, but the associations were not statistically significant. Maternal UTI and foul-smelling liquor occurred exclusively in the sepsis group, preventing reliable estimation of the odds ratio.

Table 8: Association of clinical features with early-onset sepsis**

Clinical feature	Sepsis Yes n (%)	Sepsis No n (%)	p-value
Respiratory distress			
Present	40 (58.0)	29 (42.0)	0.018
Absent	8 (30.8)	18 (69.2)	
Poor feeding			
Present	7 (77.8)	2 (22.2)	0.086
Absent	41 (47.7)	45 (52.3)	
Tachycardia			
Present	22 (100.0)	0 (0.0)	<0.001
Absent	26 (35.6)	47 (64.4)	
Abdominal distension			
Present	13 (100.0)	0 (0.0)	<0.001
Absent	35 (42.7)	47 (57.3)	
Apnea			
Present	12 (100.0)	0 (0.0)	<0.001
Absent	36 (43.4)	47 (56.6)	
Convulsions			
Present	11 (68.8)	5 (31.3)	0.110
Absent	37 (46.8)	42 (53.2)	

Respiratory distress was significantly associated with early-onset sepsis (p=0.018). Tachycardia, abdominal distension and apnea showed highly significant associations with sepsis (p<0.001). Poor feeding and convulsions did not show statistically significant associations.

Table 9: Association of laboratory parameters with early-onset sepsis

Laboratory parameter	Sepsis Yes n (%)	Sepsis No n (%)	p-value
TLC<5,000/mm³	23 (47.9)	0 (0.0)	<0.001
TLC ≥5,000/mm³	25 (52.1)	47(100.0)	
ANC<1,800/mm³	36 (75.0)	0 (0.0)	<0.001
ANC≥1,800/mm³	12 (25.0)	47(100.0)	
Micro-ESR >15 mm/hour	20 (41.7)	1 (2.1)	<0.001
Micro-ESR ≤15 mm/hour	28 (58.3)	46 (97.9)	
I/T ratio >0.20	17 (35.4)	0 (0.0)	<0.001
I/T ratio ≤0.20	31 (64.6)	47(100.0)	
CRP abnormal at birth	36 (75.0)	6 (12.8)	<0.001
CRP normal at birth	12 (25.0)	41 (87.2)	
CRP abnormal at 12–24 h	47 (97.9)	5 (10.6)	<0.001
CRP normal at 12–24 h	1 (2.1)	42 (89.4)	
CRP abnormal at 48 h	48 (100.0)	5 (10.6)	<0.001
CRP normal at 48 h	0 (0.0)	42 (89.4)	

All laboratory parameters demonstrated statistically significant associations with early-onset sepsis. Low TLC, low ANC, elevated micro-ESR, elevated I/T ratio and abnormal CRP were significantly more frequent among neonates with sepsis (p<0.001). The proportion of neonates with abnormal CRP increased progressively from 75.0% at birth to 97.9% at 12–24 hours and 100% at 48 hours among septic neonates.

Table 10: Association between early-onset sepsis and neonatal outcome

Sepsis status	Discharged n (%)	Died n (%)	Total n (%)

Sepsis present	42 (87.5)	6 (12.5)	48 (100.0)
Sepsis absent	47 (100.0)	0 (0.0)	47 (100.0)
Total	89 (93.7)	6 (6.3)	95 (100.0)

Discussion

The present prospective observational study evaluated early-onset sepsis among 95 late preterm neonates with two or more predefined risk factors for sepsis. Of the 95 neonates included, 48 (50.5%) developed EOS, whereas 47 (49.5%) did not. This relatively high proportion should be interpreted in relation to the study population, which was specifically composed of late preterm neonates already considered to be at increased risk because of the presence of at least two predefined risk factors. Therefore, the observed proportion should not be interpreted as the prevalence of EOS among all late preterm neonates.

Late preterm infants are more vulnerable to infection because of developmental immaturity of immune and other physiological systems. In addition, respiratory distress and feeding problems are common in this age group and may overlap with clinical manifestations of infection[1,2]. This makes early recognition of EOS particularly challenging and supports the importance of systematic clinical surveillance.

Among the 48 neonates classified as having EOS, 21 (43.7%) had proven sepsis, 19 (39.5%) had probable sepsis and 8 (16.7%) had possible sepsis. Proven sepsis was therefore the largest category. Blood culture remains the reference standard for confirming neonatal bacterial sepsis, although culture sensitivity may be affected by factors such as the volume of blood collected and previous antibiotic exposure[7,8]. The presence of probable and possible sepsis in the study also reflects the practical difficulty of diagnosing neonatal infection solely through microbiological confirmation.

In the present study, the majority of mothers were aged 20–30 years (84.2%), with a mean maternal age of 26.0 ± 4.5 years. Male neonates constituted 56.8% of the study population, giving a male-to-female ratio of 1.3:1. Regarding birth weight, 71.6% of neonates weighed between 1.5 and 2.5 kg, while 11.6% weighed between 1.0 and 1.5 kg. These findings reflect the expected predominance of low birth weight among a population of late preterm neonates.

The most frequently observed risk factor in the present study was frequent per-vaginal examination (>3 times), reported in 84.2%, followed by low birth weight in 83.2% and PROM >18 hours in 45.3%. Spontaneous prematurity was observed in 30.5%, while prolonged labour, Peripartum febrile illness, maternal UTI and foul-smelling liquor were less common. These findings are clinically relevant because several of these factors have been associated with increased risk of EOS in previous observational studies and meta-analyses [6].

The high frequency of repeated vaginal examinations in the present cohort is particularly noteworthy. A recent meta-analysis reported that vaginal examination three or more times was associated with increased odds of EOS [6]. Repeated examinations may theoretically increase exposure of the ascending genital tract to micro organisms, particularly when the membranes have already ruptured. However, the present study cannot establish a causal relationship because the frequency of examinations may also be related to prolonged labour, membrane rupture and other obstetric circumstances.

Despite the high prevalence of individual risk factors, multivariable logistic regression did not identify any maternal risk factor as an independent statistically significant predictor of EOS. PROM had an OR of 0.71 (95% CI: 0.21–2.30; p=0.58), spontaneous prematurity

had an OR of 0.55 (95% CI: 0.12–2.60; p=0.45), and frequent per-vaginal examination had an OR of 0.85 (95% CI: 0.20–3.70; p=0.83). Peripartum febrile illness showed an OR of 1.50 (95% CI: 0.24–8.80; p=0.68), while low birth weight showed an OR of 1.10 (95% CI: 0.22–10.20; p=0.68).

The absence of statistical significance should be interpreted cautiously. The study population was relatively small and was already enriched with multiple risk factors. In addition, several exposures were uncommon. These factors reduce the statistical power to demonstrate independent effects and result in wide confidence intervals. Therefore, the findings indicate that no individual maternal risk factor demonstrated an independent statistically significant association in this particular cohort, rather than demonstrating that these factors have no relationship with EOS.

Maternal UTI and foul-smelling liquor were present exclusively among neonates with sepsis. However, because no neonate in the non-sepsis group had these risk factors, odds ratios could not be estimated reliably. The findings may indicate a potential association, but the very small numbers preclude a definitive statistical conclusion. Larger studies with adequate numbers of exposed neonates would be required to determine their independent predictive value.

Clinical manifestations showed stronger associations with EOS in the present study. Respiratory distress was significantly associated with sepsis (p=0.018), while tachycardia, abdominal distension and apnea were highly significantly associated with sepsis (p<0.001). Poor feeding and convulsions were more common among septic neonates but did not reach statistical significance.

These observations are consistent with the recognised clinical presentation of neonatal sepsis, in which respiratory and systemic abnormalities may be early manifestations[3,5]. However, respiratory distress is particularly difficult to interpret in late preterm infants because respiratory immaturity and non-infectious respiratory disorders may produce similar findings. Therefore, respiratory distress should be interpreted together with the overall clinical condition and maternal risk profile rather than being considered diagnostic of EOS on its own [8].

The particularly strong associations observed for tachycardia, abdominal distension and apnea are noteworthy. In the present dataset, all neonates with tachycardia, abdominal distension or apnea belonged to the sepsis group. Nevertheless, these findings should be interpreted with caution because of the relatively small sample size and observational design. The findings demonstrate an association within the study cohort but do not establish that these clinical features independently predict EOS.

The haematological parameters assessed in the present study also showed significant associations with EOS. TLC <5,000/mm³ was present in 47.9% of septic neonates but in none of the non-septic neonates. Similarly, ANC <1,800/mm³ was observed in 75.0% of septic neonates compared with none of the non-septic neonates. These findings suggest that marked abnormalities in leukocyte and Neutrophil counts may provide useful supportive evidence in a clinically suspected case of EOS.

However, contemporary evidence indicates that TLC, ANC and I/T ratio have limited sensitivity and specificity when used as isolated diagnostic tests. The American Academy of Paediatrics notes that leukocyte indices are affected by gestational age and several perinatal factors, and that extreme abnormalities may be

associated with EOS but generally have low sensitivity [7,8]. Therefore, the significant associations observed in the present study should be regarded as supportive rather than diagnostic findings.

An elevated micro-ESR (>15 mm/hour) was present in 41.7% of septic neonates compared with only 2.1% of non-septic neonates. Similarly, an I/T ratio >0.20 was observed in 35.4% of septic neonates and in none of the non-septic neonates. The I/T ratio can increase in response to infection because of increased release of immature neutrophils. Nevertheless, its value is influenced by gestational age and timing of sampling, and an elevated I/T ratio may also occur in non-infectious conditions [7,8].

CRP demonstrated a particularly notable temporal pattern. Among septic neonates, 75.0% had abnormal CRP at birth, 97.9% at 12–24 hours and 100% at 48 hours. In contrast, abnormal CRP was observed in 12.8%, 10.6% and 10.6% of non-septic neonates at the corresponding time points. Thus, the proportion of septic neonates with an abnormal CRP increased progressively after birth.

This pattern is consistent with the known kinetics of CRP. CRP has relatively low sensitivity immediately after birth because an inflammatory response needs time to develop. Its sensitivity improves when measured several hours after birth [7]. The findings of the present study therefore support the potential value of serial rather than single CRP measurements as an adjunct in the evaluation of suspected EOS. However, an abnormal CRP should not independently establish the diagnosis, because CRP can also increase in response to non-infectious inflammatory conditions [8].

The outcome analysis showed a significant relationship between EOS and mortality. Among neonates with sepsis, 42 (87.5%) were discharged, and 6 (12.5%) died, whereas all 47 neonates without sepsis were discharged. The overall mortality was 6.3%, and all deaths occurred in the sepsis group. The association between sepsis status and outcome was statistically significant (p= 0.012). This finding underscores the clinical importance of EOS in late-preterm neonates and reinforces the need for timely recognition and appropriate management.

An important overall observation from the present study is that maternal risk factors were common but did not demonstrate statistically significant independent associations in the multivariable model, whereas several neonatal clinical and laboratory findings showed strong associations with EOS. This supports current approaches that use a combination of maternal risk assessment and serial newborn examination rather than depending on a single maternal risk factor [8,9].

The results also have implications for antimicrobial stewardship. Treating all neonates with risk factors may expose many uninfected infants to unnecessary antibiotics, whereas failure to recognise a deteriorating neonate can result in delayed treatment of genuine infection. Current guidance therefore supports integration of clinical condition, gestational age and maternal risk factors, with blood culture remaining the diagnostic standard and laboratory markers being used as adjuncts [8,9].

Conclusion

The present study demonstrated a high occurrence of early-onset sepsis (50.5%) among late preterm neonates with multiple maternal risk factors. Although frequent per-vaginal examination, low birth weight and PROM were common, none of the maternal risk factors showed a statistically significant independent association with sepsis on multivariable analysis. Respiratory distress,

tachycardia, abdominal distension and apnea were significantly associated with sepsis, while haematological parameters and serial CRP showed significant abnormalities among septic neonates. Mortality was significantly higher among neonates with sepsis. A combination of maternal risk assessment, serial clinical examination, laboratory evaluation and blood culture is therefore essential for early recognition and appropriate management of EOS in late preterm neonates.

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