

# Incidence and Risk Factors of Early-Onset Neonatal Sepsis Among Neonates Admitted to a Neonatal Intensive Care Unit in a Tertiary Care Hospital: A Prospective Observational Study

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## Abstract-

**Introduction-** Early-onset neonatal sepsis (EONS) is a major cause of neonatal morbidity and mortality, particularly in developing countries. Its incidence remains high due to multiple maternal and neonatal risk factors. This study aims to determine the incidence and identify risk factors associated with EONS among neonates admitted to a tertiary care Neonatal intensive care unit (NICU).

**Material and Method-** This prospective observational study was conducted over 6 months in a tertiary care NICU, including 270 neonates admitted within 72 hours. Clinical and laboratory evaluation identified EONS cases. Maternal and neonatal risk factors were recorded. Data were analyzed using appropriate statistical tests, and multivariate logistic regression identified independent predictors, with  $p < 0.05$  considered significant.

**Result-** Among 270 neonates, 54 (20%) developed EONS. Prematurity, low birth weight, PROM >18 hours, and maternal fever were significant independent risk factors. Gram-negative organisms predominated, with 55.6% culture positivity. Most cases recovered (77.8%), while mortality was 11.1%. EONS was significantly associated with adverse perinatal factors and prolonged hospital stay.

**Conclusion-** EONS showed a 20% incidence, with PROM, prematurity, low birth weight, and maternal fever as key risk factors. Gram-negative organisms predominated. Despite good recovery, mortality remained 11.1%, highlighting the need for early risk identification, improved intrapartum care, and strengthened neonatal infection control practices.

**Keywords-** Early-onset neonatal sepsis, NICU, Maternal, Risk factors, Neonates etc.

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## Introduction-

Neonatal sepsis remains a major global health concern and is a leading cause of neonatal morbidity and mortality, particularly in low- and middle-income countries. It is estimated to contribute substantially to neonatal deaths worldwide, with a disproportionately higher burden in developing regions [1,2]. Early-onset neonatal sepsis (EONS), typically defined as sepsis occurring within the first 72 hours of life, is primarily acquired through vertical transmission of pathogens from the maternal genital tract during labor or delivery [3,4]. Despite advances in perinatal care and infection control practices, EONS continues to pose significant diagnostic and therapeutic challenges. The incidence of

EONS varies widely across different geographical settings, ranging from approximately 1–2 cases per 1000 live births in developed countries to significantly higher rates in resource-limited settings [5]. In India, the burden is particularly alarming, with reported incidence rates much higher than global averages, reflecting variations in maternal health, intrapartum practices, and neonatal care facilities [6]. Recent studies have reported incidence as high as 20% among hospitalized neonates, highlighting the persistent magnitude of the problem in tertiary care settings [7].

Multiple maternal and neonatal risk factors have been implicated in the development of EONS. These include prematurity, low birth weight, prolonged rupture of

## **Incidence and Risk Factors of Early-Onset Neonatal Sepsis Among Neonates Admitted to a Neonatal Intensive Care Unit in a Tertiary Care Hospital: A Prospective Observational Study**

membranes, maternal infections such as chorioamnionitis, intrapartum fever, and repeated vaginal examinations during labor [7,8]. Additionally, invasive obstetric interventions and inadequate aseptic practices further increase the risk of neonatal infection. The predominant causative organisms include Group B Streptococcus and Escherichia coli, with variations depending on regional microbial patterns [5,9]. Preterm infants are particularly vulnerable due to their immature immune systems and increased exposure to invasive procedures [5]. Despite ongoing research, early diagnosis of EONS remains difficult due to nonspecific clinical presentation and limitations of laboratory diagnostics. This often leads to empirical antibiotic use, contributing to antimicrobial resistance and increased healthcare burden [3,9]. Furthermore, variations in incidence and risk factor profiles across different institutions necessitate region-specific data for effective prevention strategies. There is a paucity of prospective data from tertiary care hospitals in developing countries, particularly in the Indian context, regarding the incidence and determinants of early-onset neonatal sepsis. Identification of modifiable risk factors is crucial for developing targeted interventions to reduce neonatal morbidity and mortality. Therefore, the present study aims to determine the incidence and associated risk factors of EONS among neonates admitted to a neonatal intensive care unit in a tertiary care hospital.

### **Material and Method-**

This prospective observational study was conducted in the Neonatal Intensive Care Unit (NICU) of GMC and Super Facility Hospital Azamgarh over a period of 6 months from September 2025 to February 2026. The study aimed to determine the incidence and identify risk factors associated with early-onset neonatal sepsis (EONS) among admitted neonates. Ethical clearance was obtained from the Institutional Ethics Committee prior to commencement of the study, and informed consent was obtained from parents or guardians of all enrolled neonates. All neonates admitted to the NICU within the first 72 hours of life were screened for inclusion. Neonates presenting with clinical features suggestive of sepsis such as respiratory distress, temperature instability, lethargy, poor feeding, apnea, or hemodynamic instability were enrolled. Both inborn and outborn neonates were included. Neonates with congenital anomalies, those admitted after 72 hours of life, or those who had received prior antibiotic therapy for more than 48 hours before admission were excluded

from the study. The sample size was calculated based on an anticipated incidence of early-onset neonatal sepsis of 20% from previous studies, with a 95% confidence level and 5% absolute precision. Using the standard formula for proportion estimation, the minimum sample size was estimated to be 246 neonates. Considering possible dropouts and incomplete data, a total of 270 neonates were included in the study using consecutive sampling.

A detailed maternal and neonatal history was recorded for each case, including maternal age, parity, antenatal complications, history of fever, prolonged rupture of membranes (>18 hours), mode of delivery, and intrapartum events. Neonatal parameters such as gestational age, birth weight, sex, Apgar score, and need for resuscitation were also documented. All suspected cases underwent laboratory evaluation including complete blood count, C-reactive protein (CRP), blood culture, and other relevant investigations as per clinical indication. EONS was diagnosed based on a combination of clinical features and laboratory parameters, with blood culture positivity considered confirmatory. Data were entered into a structured proforma and analyzed using appropriate statistical software. Incidence of EONS was calculated as the proportion of confirmed cases among total NICU admissions within 72 hours of life. Risk factors were analyzed using chi-square test for categorical variables and independent t-test for continuous variables. Multivariate logistic regression analysis was performed to identify independent predictors of EONS. A p-value of <0.05 was considered statistically significant.

### **Result-**

A total of 270 neonates admitted to the NICU within the first 72 hours of life were included in the study. As seen in Table 1, among them, males constituted a higher proportion with 154 (57.0%) cases, while females accounted for 116 (43.0%). In terms of gestational age, the majority of neonates were born at term, comprising 172 (63.7%), whereas 98 (36.3%) were preterm. With respect to birth weight, 112 (41.5%) neonates had low birth weight (<2500 g), while 158 (58.5%) had a birth weight of  $\geq 2500$  g. The duration of hospital stay was almost equally distributed, with 136 (50.4%) neonates staying for  $\leq 7$  days and 134 (49.6%) staying for >7 days. Regarding the mode of delivery, 168 (62.2%) neonates were delivered vaginally, while 102 (37.8%) were delivered via cesarean section. Maternal antibiotic use was reported in 90 (33.3%) cases, while 180

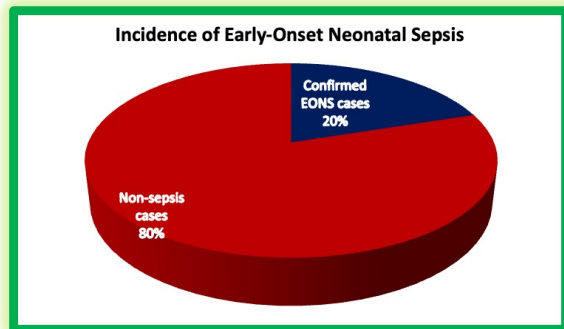
## Incidence and Risk Factors of Early-Onset Neonatal Sepsis Among Neonates Admitted to a Neonatal Intensive Care Unit in a Tertiary Care Hospital: A Prospective Observational Study

(66.7%) did not receive antibiotics during the peripartum period.

**Table 1- Baseline characteristics of study population (n = 270)**

Variable		n (%)
<b>Total NICU admissions (≤72 hrs)</b>		270 (100%)
<b>Sex</b>	Male	154 (57.0%)
	Female	116 (43.0%)
<b>Gestational age</b>	Preterm (<37 weeks)	98 (36.3%)
	Term (≥37 weeks)	172 (63.7%)
<b>Birth weight</b>	<2500 g	112 (41.5%)
	≥2500 g	158 (58.5%)
<b>Duration of hospital Stay</b>	≤7 days	136 (50.4%)
	>7 days	134 (49.6%)
<b>Mode of delivery</b>	Vaginal Delivery	168 (62.2%)
	Cesarean Section	102 (37.8%)
<b>Maternal antibiotic use</b>	Yes	90 (33.3%)
	No	180 (66.7%)

Figure 1 shows that out of the total 270 neonates admitted to the NICU, 54 (20.0%) were diagnosed with early-onset neonatal sepsis (EONS), while the remaining 216 (80.0%) did not develop sepsis. This indicates that one-fifth of the study population was affected by EONS during the early neonatal period.



**Figure 1- Incidence of Early-Onset Neonatal Sepsis**

Table 2 illustrates that, among the 54 neonates diagnosed with early-onset neonatal sepsis, the majority demonstrated positive sepsis screening parameters. C-reactive protein (CRP) was elevated in 40 (74.1%) cases, while abnormal total leukocyte count (TLC) was observed in 36 (66.7%) neonates. Thrombocytopenia was present in 28 (51.9%) cases. Notably, 44 (81.5%) neonates exhibited two or more abnormal sepsis screening parameters, indicating a high burden of laboratory abnormalities among suspected cases. Blood

culture positivity was noted in 30 (55.6%) cases. Among the culture-positive isolates, *Escherichia coli* was the most common organism, accounting for 12 (40.0%) cases, followed by *Klebsiella pneumoniae* in 8 (26.7%), *Staphylococcus aureus* in 6 (20.0%), and Group B *Streptococcus* in 4 (13.3%) cases.

**Table 2- Sepsis screening parameters among EONS cases (n = 54)**

Parameter		n (%)
<b>Positive CRP</b>		40 (74.1%)
<b>Abnormal TLC</b>		36 (66.7%)
<b>Thrombocytopenia</b>		28 (51.9%)
<b>≥2 abnormal parameters</b>		44 (81.5%)
<b>Positive blood culture</b>		30 (55.6%)
<b>Microbiological profile of blood culture positive cases (n = 30)</b>	<i>Escherichia coli</i>	12 (40.0%)
	<i>Klebsiella pneumoniae</i>	8 (26.7%)
	<i>Staphylococcus aureus</i>	6 (20.0%)
	Group B <i>Streptococcus</i>	4 (13.3%)

The distribution of early-onset neonatal sepsis (EONS) according to various maternal and neonatal factors is presented in Table 3. The occurrence of EONS was higher among male neonates (22.1%) compared to females (17.2%); however, this difference was not statistically significant ( $p = 0.21$ ). A significantly higher proportion of EONS was observed among preterm neonates (32.7%) compared to term neonates (12.8%) ( $p < 0.001$ ). Similarly, low birth weight neonates (<2500 g) had a significantly higher incidence of EONS (30.4%) compared to those with birth weight ≥2500 g (12.7%) ( $p = 0.001$ ). Regarding duration of hospital stay, a greater proportion of EONS cases had a stay of more than 7 days (70.4%) compared to those with shorter hospital stay (29.6%), and this association was statistically significant ( $p = 0.002$ ). No significant association was found between mode of delivery and EONS, although a slightly higher proportion was observed in vaginally delivered neonates (21.4%) compared to cesarean section (17.6%) ( $p = 0.45$ ). Additionally, maternal antibiotic use was significantly associated with EONS, with a higher proportion observed among neonates whose mothers did not receive antibiotics (77.8%) compared to those who did (22.2%) ( $p = 0.04$ ).

## Incidence and Risk Factors of Early- Onset Neonatal Sepsis Among Neonates Admitted to a Neonatal Intensive Care Unit in a Tertiary Care Hospital: A Prospective Observational Study

**Table 3- Distribution of EONS according to different maternal and neonatal factors**

Variable		EONS Present n (%)	EONS Absent n (%)	p-value
Sex	Male	34 (22.1%)	120 (77.9%)	0.21
	Female	20 (17.2%)	96 (82.8%)	
Gestational Age	Preterm	32 (32.7%)	66 (67.3%)	<0.001
	Term	22 (12.8%)	150 (87.2%)	
Birth Weight	<2500 g	34 (30.4%)	78 (69.6%)	0.001
	≥2500 g	20 (12.7%)	138 (87.3%)	
Duration of hospital Stay	≤7 days	16 (29.6%)	120 (55.6%)	0.002
	>7 days	38 (70.4%)	96 (44.4%)	
Mode of delivery	Vaginal	36 (21.4%)	132 (78.6%)	0.45
	Cesarean	18 (17.6%)	84 (82.4%)	
Maternal antibiotic use	Yes	12 (22.2%)	78 (36.1%)	0.04
	No	42 (77.8%)	138 (63.9%)	

Table 4 depicts the maternal and neonatal risk factors associated with early-onset neonatal sepsis (EONS). Among the maternal factors, prolonged rupture of membranes (PROM >18 hours) was significantly associated with EONS, being present in 51.9% of cases compared to 19.4% in the non-sepsis group ( $p < 0.001$ ). Maternal fever was also significantly higher among EONS cases (40.7%) compared to those without sepsis (17.6%) ( $p = 0.001$ ). Similarly, chorioamnionitis showed a significant association, observed in 25.9% of EONS cases versus 8.3% in non-sepsis neonates ( $p = 0.002$ ). A higher number of vaginal examinations ( $\geq 3$ ) was significantly associated with EONS, seen in 48.1% of affected neonates compared to 27.8% in those without sepsis ( $p = 0.006$ ). Although meconium-stained liquor was more frequent among EONS cases (33.3%) compared to non-sepsis cases (21.3%), the association was not statistically significant ( $p = 0.08$ ). Among neonatal factors, prematurity was strongly associated

with EONS, occurring in 59.3% of cases compared to 30.6% in the non-sepsis group ( $p < 0.001$ ). Low birth weight (<2500 g) was also significantly associated, observed in 63.0% of EONS cases versus 36.1% of non-sepsis cases ( $p = 0.001$ ). Birth asphyxia was significantly more common among EONS cases (37.0%) compared to non-sepsis neonates (18.5%) ( $p = 0.007$ ). Additionally, the need for resuscitation at birth was significantly higher in neonates with EONS (44.4%) compared to those without sepsis (24.1%) ( $p = 0.005$ ).

**Table 4- Risk factors associated with EONS**

Risk Factor		EONS Present n (%)	EONS Absent n (%)	p-value
Maternal risk factors	PROM >18 hrs	28 (51.9%)	42 (19.4%)	<0.001
	Maternal fever	22 (40.7%)	38 (17.6%)	0.001
	Chorioamnionitis	14 (25.9%)	18 (8.3%)	0.002
	≥3 Vaginal examinations	26 (48.1%)	60 (27.8%)	0.006
	Meconium-stained liquor	18 (33.3%)	46 (21.3%)	0.08
Neonatal risk factors	Prematurity	32 (59.3%)	66 (30.6%)	<0.001
	Low birth weight (<2500 g)	34 (63.0%)	78 (36.1%)	0.001
	Birth asphyxia	20 (37.0%)	40 (18.5%)	0.007
	Need for resuscitation	24 (44.4%)	52 (24.1%)	0.005

Multivariate logistic regression analysis was performed to identify independent risk factors associated with early-onset neonatal sepsis (EONS). Prolonged rupture of membranes (>18 hours) emerged as the strongest

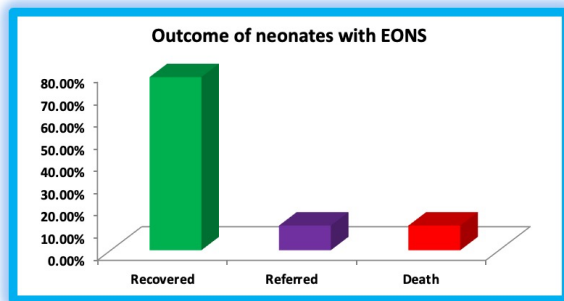
## Incidence and Risk Factors of Early-Onset Neonatal Sepsis Among Neonates Admitted to a Neonatal Intensive Care Unit in a Tertiary Care Hospital: A Prospective Observational Study

independent predictor, with neonates having a 3.2-fold higher risk of developing EONS (AOR: 3.2; 95% CI: 1.6–6.4;  $p = 0.001$ ). Prematurity was also significantly associated with EONS, with preterm neonates having 2.8 times higher odds of developing sepsis compared to term neonates (AOR: 2.8; 95% CI: 1.4–5.5;  $p = 0.003$ ). Similarly, low birth weight (<2500 g) was identified as an independent risk factor, increasing the risk by 2.5 times (AOR: 2.5; 95% CI: 1.3–4.9;  $p = 0.005$ ). Maternal fever was also found to be a significant independent predictor, with a 2.1-fold increased risk of EONS (AOR: 2.1; 95% CI: 1.1–4.2;  $p = 0.02$ ).

**Table 5- Multivariate logistic regression analysis of independent risk factors for EONS**

Variable	AOR (95% CI)	p-value
<b>PROM &gt;18 hrs</b>	3.2 (1.6–6.4)	<b>0.001</b>
<b>Prematurity</b>	2.8 (1.4–5.5)	<b>0.003</b>
<b>Low birth weight</b>	2.5 (1.3–4.9)	<b>0.005</b>
<b>Maternal fever</b>	2.1 (1.1–4.2)	<b>0.02</b>

The outcomes of neonates diagnosed with early-onset neonatal sepsis are illustrated in Figure 2. The majority of neonates recovered, accounting for 42 (77.8%) cases. A smaller proportion, 6 (11.1%), required referral to higher centers for further management. The mortality rate among EONS cases was 11.1%, with 6 neonates succumbing to the illness.



**Figure 2- Outcome of neonates with EONS**

### Discussion-

Early-onset neonatal sepsis (EONS) remains a major contributor to neonatal morbidity and mortality, particularly in resource-limited settings. In the present study, the incidence of EONS was 20%, which is comparable to findings reported by Lemma et al. [7] and Singh et al. [11] in similar tertiary care settings. However, this incidence remains higher than that observed in developed countries, where effective antenatal screening and intrapartum antibiotic prophylaxis have significantly reduced the burden of

EONS [4,5]. A higher proportion of EONS was observed among male neonates, although the association was not statistically significant. This trend is consistent with the findings of van der Hoeven et al. [12], who suggested a possible role of sex-related immunological differences. However, the lack of statistical significance and inconsistent findings across studies indicate that sex may not be an independent risk factor [13]. Prematurity and low birth weight were identified as significant risk factors in this study. These findings are in agreement with Kumar et al. [6] and Guo et al. [14], who demonstrated that preterm and low birth weight neonates are more susceptible to infections due to immature immune defenses. Similar observations have been reported by Manandhar et al. [15] and Getabelew et al. [16], although some studies suggest that the impact of these factors may be influenced by maternal and environmental conditions [13].

Among maternal factors, prolonged rupture of membranes (PROM >18 hours), maternal fever, chorioamnionitis, and multiple vaginal examinations showed significant associations with EONS. These findings are supported by Lemma et al. [7], Schrag et al. [5], and Shrestha et al. [17], all of whom emphasized the role of ascending infections in the pathogenesis of neonatal sepsis. PROM emerged as the strongest independent predictor in the present study, consistent with the findings of Birgisdottir et al. [18]. In contrast, meconium-stained liquor did not show a significant association, unlike some reports where it has been identified as a risk factor [14]. Neonatal factors such as birth asphyxia and the need for resuscitation were also significantly associated with EONS. These findings are supported by studies suggesting that perinatal hypoxia may impair neonatal immune function, increasing vulnerability to infections [15,16]. Additionally, outborn neonates had a higher incidence of EONS, which aligns with previous studies attributing this to delayed referral, suboptimal delivery conditions, and increased exposure to infections [6,19]. The microbiological profile in this study revealed a predominance of Gram-negative organisms, particularly *Escherichia coli* and *Klebsiella pneumoniae*. This is consistent with findings from developing countries, as reported by Stoll et al. [9] and Getabelew et al. [16]. In contrast, Group B *Streptococcus* is more commonly reported in developed settings due to routine maternal screening and prophylaxis [5]. The mortality rate of 11.1% observed in this study is comparable to previously reported rates in

## Incidence and Risk Factors of Early-Onset Neonatal Sepsis Among Neonates Admitted to a Neonatal Intensive Care Unit in a Tertiary Care Hospital: A Prospective Observational Study

similar settings [2,11]. Despite improvements in neonatal care, EONS continues to pose a significant risk to neonatal survival. Overall, the findings underscore the importance of early identification and management of maternal and neonatal risk factors. Strengthening antenatal care, timely management of PROM, minimizing unnecessary vaginal examinations, and improving neonatal resuscitation and infection control practices are essential to reduce the burden of EONS.

### Conclusion-

The present prospective observational study highlights that early-onset neonatal sepsis (EONS) remains a significant clinical concern, with an incidence of 20% among neonates admitted to the NICU. The study identifies key maternal and neonatal determinants contributing to the development of EONS. Among these, prolonged rupture of membranes, prematurity, low birth weight, and maternal fever emerged as significant independent risk factors. Additionally, factors such as chorioamnionitis, multiple vaginal examinations, birth asphyxia, and need for resuscitation were also found to be significantly associated with increased risk. The predominance of Gram-negative organisms, particularly *Escherichia coli* and *Klebsiella pneumoniae*, underscores the need for region-specific antimicrobial policies. Although the majority of neonates recovered, the observed mortality rate of 11.1% indicates that EONS continues to contribute substantially to adverse neonatal outcomes. The findings of this study have important clinical implications. Early identification of high-risk pregnancies, strict intrapartum monitoring, timely management of maternal infections, and judicious use of antibiotics can play a crucial role in reducing the incidence of EONS. Furthermore, strengthening neonatal resuscitation practices and infection control measures in NICUs is essential. Implementation of targeted preventive strategies and evidence-based clinical protocols can significantly improve neonatal survival and reduce the burden of early-onset sepsis in tertiary care settings.

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### Conflict of interest- None

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