

Treatment Outcome and Associated Factors of Neonatal Sepsis Among Neonates Admitted to Neonatal Intensive Care Unit of Degehabur General Hospital, Degehabur, Eastern Ethiopia

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Abstract

Background

Newborns are particularly susceptible to infections due to their immature immune systems, and the likelihood of contracting severe infections, including neonatal sepsis, is considerable, with a higher probability of unfavorable outcomes. Although there has been a global decline, neonatal mortality rates remain high, particularly in Sub-Saharan Africa, where neonatal sepsis continues to be a significant contributing factor and a higher probability of unfavorable outcomes.

Objectives

To assess treatment outcome and associated factors of neonatal sepsis among neonates admitted to the Neonatal Intensive Care Unit of Degehabur General Hospital Degehabur Town, Eastern Ethiopia.

Methods

Institutional based cross-sectional study was conducted on 227 neonates admitted to Neonatal Intensive Care Unit of Degehabur General Hospital. Data were collected using a structured checklist by reviewing medical cards and electronic data collection software (ODK). The sampling frame consisted of all recorded neonatal sepsis admissions over the past five years. Data were exported to STATA version 17 for analysis. Bi-variable and multivariable binary logistic regression analyses were used to identify the factors associated with poor treatment outcomes. Model fitness was checked using the Hosmer-Lemeshow goodness-of-fit test. Adjusted odds ratio at 95% confidence interval and p-values < 0.05 were used to declare significant association.

Results

A total of 227 neonates with neonatal sepsis were included in the study. Out of this, 66 (29.1%) had poor treatment outcome with 95% CI (23.2–35.4). Admission weight < 2500 grams (AOR = 2.12; 95% C.I: 1.07–5.78), length of hospital stay 1–7 days (AOR = 2.16; 95% C.I: 1.09–6.37) and presence of comorbidity (AOR = 2.09; 95% C.I: 1.04–4.12) were significantly associated with poor treatment outcome of neonatal sepsis.

Conclusions

The magnitude of poor treatment outcome of neonatal sepsis among neonates in the study area was high. Admission weight < 2500 grams, Presence of comorbidity, and Length of hospital stay < 7 days were significantly associated with poor treatment outcome. Healthcare professionals should monitor

low-weight neonates with comorbidities, ensure complete antibiotic courses, and regional health bureaus focus on the prevention of risk factors.

Introduction

Neonates are more vulnerable to infections due to their underdeveloped immune systems, and the risk of acquiring a severe infection such as neonatal sepsis is considerable, with a higher possibility of an unfavorable outcome (1). Neonatal sepsis is an infection involving the bloodstream in neonates; It remains a leading cause of morbidity and mortality among neonates, particularly in middle and low-income countries (2).

Neonatal sepsis can be classified into two main types: Early-onset neonatal sepsis (EONS) and Late-onset neonatal sepsis (LONS); EONS occurs in the first seven days of life and is caused by microorganisms from the maternal genital tract; LONS occurs after the seventh day of life and can be either a nosocomial (hospital-acquired) or community-acquired infection (3, 4). The common pathogens include *Streptococcus agalactiae* and *Escherichia coli*, with *Listeria Monocytogenes* and other gram-negative enteric bacilli being less common (5).

Blood culture is the gold standard diagnostic for neonatal sepsis, but its results can take 48–72 hours, causing treatment delays. Rapid diagnostic tests like platelet parameters, sepsis screen parameters, and PCT levels have shown promise (6–9). Neonatal sepsis symptoms include body temperature changes, breathing problems, reduced movements, seizures, slow or fast heart rate, vomiting and yellow tint of skin and scleras of eyes (jaundice) (10, 11).

The World Health Organization recommends treating neonatal sepsis with a combination of ampicillin (or penicillin) and gentamicin, with third generation cephalosporin as second- line treatment, with hospitalization for suspected cases; It recommends ten or more days of parenteral therapy and switching to a different antibiotic if the condition doesn't improve within two to three days (12).

As reported by UNICEF, an estimated 61 countries will be unable to achieve the SDG3 target of decreasing neonatal mortality to 12 or fewer deaths per 1,000 live births by 2030, despite the fact that around 75% of neonatal mortality in low and middle-income countries, including Sub-Saharan African countries, can be preventable (13). Furthermore, about one-third of all neonate deaths occur on the first day of life, with almost three-quarters occurring during the first week (14).

Globally, in 2020, an estimated 5 million under-five age children died, and approximately half (2.4 million) of these occur within the first 28 days of life(15). Developing countries like Sub-Saharan Africa and Central and Southern Asia the rate was high, about 27 deaths per 1000 live births in Sub-Saharan Africa, covering 43% of global newborn deaths, which shows that the neonates in the region were 10 times more likely to die than the neonates in developed countries (16).

Since 1990, significant progress has been made in ensuring the survival of children across the world. As a result, the rate of newborn mortality decreased by 54%, from 37 in 1990 to 17 per 1000 live births in 2020. However, this dropping rate was slower than the under-five mortality rate, which dropped by 61% (17). Neonatal mortality account for approximately 42% of all under-5 mortality in Ethiopia (18). According to the Ethiopia Mini Demographic and Health Surveys (EMDHS), newborn mortality rates decreased from 39 in 2005 to 29 deaths per 1000 people in 2016. In contrast to 2019, the mortality rate climbed slightly to 33 per 1000 live births (19).

Despite the recognition of sepsis as a top healthcare priority, many developing countries, including Ethiopia, face challenges in treatment outcome of neonatal sepsis and associated factors among neonates (20, 21). Even with early empirical treatment using antibiotics, neonatal sepsis with poor treatment outcomes may lead to severe clinical deterioration, resulting in complications such as disseminated intravascular coagulation, pulmonary hypertension, congestive heart failure, and shock, which can contribute to long-term negative outcomes (22). Survivors of neonatal sepsis face long-term outcomes, including neurocognitive impairment, poor cognitive, psychological, and physical health, increased risks of secondary infections, and mortality after hospital discharge (23).

Several approaches have been proposed to address the treatment outcome of neonatal sepsis globally, including early recognition and aggressive therapy, strengthening healthcare systems, development of context-specific treatment guidelines, and the establishment of specialized units such as neonatal intensive care units (NICUs) (24–26). However, challenges still exist in defining, diagnosing, and treating neonatal sepsis, as well as in differentiating it from other noninfectious diseases with similar pathophysiological results (27). Furthermore, a hospital-based cross-sectional study conducted in the Somali region's public hospitals including Degehabur general hospital showed that the overall prevalence of neonatal sepsis was 45.8% which is high (28).

Different literatures have shown that neonatal sepsis and quality of care in developing countries have a proportional impact on neonatal sepsis treatment outcomes in both the long and short term. Treatment outcomes of neonatal sepsis vary in different hospitals with different setups. Early diagnosis and treatment are necessary to save the life of our upcoming generation. Therefore, the aim of this study is to assess the treatment outcome and associated factors of neonatal sepsis among neonates admitted to the Neonatal Intensive Care Unit of Degehabur General Hospital, Degehabur, Eastern Ethiopia, 2024.

Methods and Materials

Study Area and Period

The study was conducted in Degehabur town, which is located in the Somali Regional State of Eastern Ethiopia. Degehabur town is situated approximately 175 km east of Jigjig City and 780 km from Addis Ababa. According to the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), the total population of this woreda is 115,555. Among them, 65,081 are men and 50,474 are women. The population distribution indicates that 25.99% (30,027) are urban inhabitants, while 39.65% (45,818) are

pastoralists. The town has one general hospital, one health center, and five health posts, with many private clinics serving the people of Degehabur town and the Jarar zone of the Somali regional state. To provide geographical coordinates, Degehabur is situated between latitude 8.22035 and longitude 43.55848 (29).

Data was collected from March 15 to April 15, 2024.

Study Design

Institution based cross-sectional study was conducted.

Population

Source population

All neonates admitted to NICU of DGH with a diagnosis of neonatal sepsis.

Study Population

All randomly selected neonates admitted to NICU of DGH with the diagnosis of neonatal sepsis during the study period.

Inclusion and Exclusion Criteria

Inclusion

All medical charts of neonates admitted to NICU of DGH with the diagnosis of neonatal sepsis during the study period.

Exclusion

All medical charts of neonates with incomplete information on the variables were excluded.

Sample Size Determination

For the first objective, sample size was calculated using a single population proportion formula by considering the following assumptions:

P: Prevalence of poor treatment outcome of neonatal sepsis from previous study: 24.4% (24).

d: Margin of error tolerated: 5% (0.05)

Z $\alpha/2$ Confidence level at: 95% CI: (1.96)

n: Sample Size

$$n = \frac{(Z_{\alpha/2})^2 p(1-p)}{(d)^2}$$

$$n = \frac{(1.96)^2 \times (0.244)(1-0.244)}{(0.05)^2} = 283.45$$

Since the total population is less than 10,000, a correction formula was used.

$$N_c = \frac{N}{1 + \frac{N}{PT}}$$

Whereas:

N_c = the corrected sample size

N = the original sample size

PT = the total population size

$$N_c = \frac{283}{1 + 283/1143} = 227$$

Therefore, the final sample for this study is 227.

Sampling Technique and Procedure

According to the information obtained from the DGH Health Management Information System office, the total number of admissions for neonatal sepsis over the past five years, from January 1, 2019, to January 1, 2024, was used. To select participants for the study, a simple random sampling method was employed, using the number of medical charts as a sample frame and then using computer generated random numbers using OpenEpi online.

Data collection tools and techniques

Data were collected by using a checklist adapted from different literature ((24, 30-32)) and modified according to the Ethiopian context, then organized according to the objectives of the study, and available information on the medical charts was observed. The checklist was prepared in the English language. The tool contained socio-demographic characteristics of neonates and mothers, Obstetric characteristics of mothers, Neonatal characteristics and predisposing factors, Clinical Presentation of neonates at admission and antibiotic use and treatment outcome related questions.

Data Collection procedures

A pilot test of the checklist was done on 11 medical charts ahead of the actual data collection, and appropriate modifications were made. Data were collected by two BSc midwifery and two BSc nursing professionals who were not working in the study area and had relevant data collection expertise from previous studies. Members were given a two-day orientation and training on collecting and storing data. In addition to the data collectors, there was one assigned supervisor. Data collection was conducted by reviewing the medical charts of neonates who were admitted to DGH with diagnosis of sepsis from January 1, 2019 to January 1, 2024. The chart numbers of neonates were listed in the neonatal intensive care unit registration book. Then, using a computer-generated random number using OpenEpi online software, 227 neonatal charts were randomly chosen. Those selected charts' medical registration numbers were given to the responsible body in the card room. After that, data collection was carried out. Supervision was carried out on a daily basis throughout the data collection period.

Study Variables

Dependent variable

Treatment outcome of neonatal sepsis: Poor/Good

Independent variables

Socio-demographic characteristics of neonates and mothers: Maternal Age, Neonatal Age, Sex, Resident.

Obstetric characteristics of mothers: Parity, ANC Follow-up, Place of delivery, Mode of delivery, Onset of labour, Duration of labour, Pregnancy induced hypertension, Maternal History of Infections (PROM, Duration of PROM, Chorioamnionitis, STI, UTI, Meconium stained amniotic fluid), History of fever, and History of foul smelling vaginal discharge.

Neonatal characteristics and predisposing factors for sepsis: Gestational age, Admission weight, APGAR score, (Resuscitated at birth, Inserted to urinary catheter, Fetal distress, Meconium aspiration syndrome, Inborn error of metabolism, Congenital malformations) Type of feeding, Grunting, Length of hospital stay, Presence of comorbidity.

Clinical Presentation and Antibiotic Use of Neonate at admission: fast breathing, abnormally slow breathing, Fever, Chest recession, Nasal flaring, Vomiting, Hypothermia, tachycardia, bradycardia, Lethargic, Abnormal body movement, Abdominal distention, Jaundice, Onset of sepsis. Gentamycin, Ampicillin, Cloxacillin, Cefotaxime, Vancomycin, Metronidazole, Meropeme, Cefepime, Ceftriaxone

Data quality control

Data quality was ensured before actual collection. The necessary modifications and corrections were made to standardize and ensure its validity. Before starting the actual work, two-day training and orientation were given to chart reviewers on the purpose of the study, the data collection tool (checklist),

data collection methods, and ethical concerns during data collection. The supervisor was monitoring the data collection process of the data collectors. The principal investigator and supervisor were spot-checking and reviewing the complete checklist by the data collectors to ensure the completeness and consistency of the collected information. Consistency was examined through a random selection of charts by the principal investigator.

Operational definitions

Treatment outcomes: Neonates discharged with treatment success (Improved), leave against medical advice (LAMA), deteriorated, referred and death (24).

Good Outcome: if the neonate is discharged after completion of treatment with the symptom Free State or improved as determined by the physician (31).

Poor Outcome: if the neonate was not in a symptom-free state after treatment completion or presented with other complications, referred to other facility, leave against medical advice, or died during or after treatment (31).

Neonatal Sepsis: refers to a condition diagnosed either clinically or with laboratory-confirmation by healthcare professionals or attending physicians during admission of the neonates.

Maternal Risk/History of Infection: if the mother presented one of the following conditions during pregnancy: premature rupture of membrane, chorioaminonites, history of STI, history of UTI, and meconium-stained amniotic fluid.

A symptom-free state is when a neonate is not experiencing any noticeable signs and symptoms of a medical condition.

Fetal Distress: Signs of compromised oxygenation, such as abnormal fetal heart rate or meconium-stained amniotic fluid, increasing neonatal sepsis risk due to hypoxic-ischemic injury.

Resuscitation at Birth: Emergency interventions (e.g., ventilation, chest compressions) that may increase infection risk due to breaks in sterility.

Meconium Aspiration Syndrome: Respiratory compromise from inhalation of meconium and amniotic fluid, leading to secondary infections.

Congenital Malformations: Structural anomalies altering physiology or enabling bacterial colonization, heightening infection risks.

Data Processing and Analysis

Data were collected using electronic data collection software (ODK). Any errors identified at this time were corrected. After the completion of data collection, the data was downloaded and exported to

STATA software version 17 for further statistical analysis. Descriptive statistical analysis was carried out to compute frequency, percentage, and mean for independent variables, and the data was presented using frequency tables, figures, and graphs. Bi-variable regression analysis was done, and variables with a p-value ≤ 0.25 in the bi-variable analysis were included in the final model of multivariable binary logistic regression analysis to control all confounding variables. Multicollinearity was also checked to see the linear correlation among the independent variables, and the variance inflation factor (VIF) was computed. All variables had a VIFi value of less than 10. The direction and strength of statistical association were measured by the odds ratio (AOR) along with the 95% CI. Hosmer and Lemeshow goodness-of-fit test model coefficients were considered to assess model fitness in order to run the regression analysis and the P-value of 0.3815 indicates that the model was fit for the data. Finally, in multivariable regression, variables with a P-value <0.05 were considered statistically significant.

Results

Socio-demographic characteristics of neonates and mothers

A total of 227 neonatal medical charts with sepsis were reviewed. Out of the 227 neonates, more than half, 130 (57.3%) were male, and their medium age was 1 days (IQR ± 7). Regarding the maternal age, the mothers ages were between 16–43 years, with 146 (64.3%) of them being between the ages of 25–34 years; the mean age and standard deviation of the mothers were 26.9 (SD ± 4.92) years (Table 1).

Table 1
Socio-demographic Characteristics of Mothers and Neonates
Admitted to NICU, of Degehabur General Hospital, Degehabur,
Eastern Ethiopia, 2024.

Variable	Category	Frequency	Percentage (%)
Mother’s age	15–24	67	29.5
	25–34	146	64.3
	≥ 35	14	6.2
Age of Neonate	0–7 days	167	73.6
	8–28 days	60	26.4
Sex	Male	130	57.3
	Female	97	42.7
Residence	Urban	173	76.2
	Rural	54	23.8

Obstetric characteristics of mothers

Out of the total number of mothers, 129 (56.8%) had antenatal care follow-up. Regarding the parity of the mothers, 165 (72.7%) were multiparous. About the place of delivery, the majority of mothers, 205 (90.3%) gave birth in a health institution. The mode of delivery for the majority of mothers was 180 (79.3%) spontaneous vaginal delivery. Regarding the duration of labour, nearly half of the mothers 111 (48.9%) had spent 8–18 hours in labour followed by 86 (37.9%) had a labour duration of less than 8 hours (Table 2).

Table 2

Obstetrics characteristic of mothers of Neonates admitted to NICU, of Degehabur General Hospital, Degehabur, Eastern Ethiopia, 2024.

Variable	Category	Frequency	Percentage (%)
Parity	Primipara	62	27.3
	Multipara	165	72.7
ANC Follow-up	Yes	129	56.8
	No	98	43.2
Place of delivery	Home	22	9.7
	Health Institutions	205	90.3
Mode of delivery	Spontaneous Vaginal delivery	180	79.3
	Instrumental delivery	24	10.6
	Caesarean section	23	10.1
Onset of labour	Spontaneous	195	85.9
	Induced	32	14.1
Duration of labour	< 8	86	37.9
	8–18	111	48.9
	18–24	19	8.4
	>24	11	4.8
Pregnancy induced hypertension	Yes	60	26.43
	No	167	73.57
Maternal Hx of Infections	Yes	176	77.5
	No	51	22.5
PROM (n = 176)	Yes	80	45.4
	No	96	55.6
Duration of PROM (n = 80)	< 12 hours	52	65.0
	≥ 12 hours	28	35.0
Chorioamnionitis (n = 176)	Yes	17	9.7
PROM: Premature rupture of membrane, STI: Sexually transmitted infections Hx: History			

Variable	Category	Frequency	Percentage (%)
	No	159	90.3
STI (n = 176)	Yes	15	8.5
	No	161	91.5
UTI(n = 176)	Yes	63	35.8
	No	113	64.2
Meconium stained amniotic fluid (n = 176)	Yes	39	22.2
	No	137	77.8
History of fever	Yes	123	54.2
	No	104	45.8
Hx of foul smelling vaginal discharge	Yes	26	11.4
	No	201	89.6
PROM: Premature rupture of membrane, STI: Sexually transmitted infections Hx: History			

Neonatal characteristics and predisposing factors for sepsis

The mean and standard deviation of the admission weight of the neonates were 2998.7 (SD $\pm$ 746) grams, and around three-fourths of the neonates 164 (72.2%) were $\geq$ 2500 grams. The majority of neonates 187 (82.4%), were $\geq$ 37 weeks' gestational age with a median of 38 (IQR $\pm$ 1). More than three-quarters 182 (80.2%) of the neonates had predisposing factors of neonatal sepsis. Concerning type of feeding, two-thirds 150 (66.1%) of the neonates were exclusively breastfed. The mean duration of length of hospital stay was 5.19 (SD $\pm$ 2.79) days, and the majority 181 (79.7%) of neonates, had stayed less than 7 days. About 78 (34.3%) neonates had presented with comorbidity (Table 3).

Table 3

Neonatal characteristic and predisposing factors for sepsis of Neonates admitted to NICU, of Degehabur General Hospital, Degehabur, Eastern Ethiopia, 2024.

Variable	Category	Frequency	Percentage (%)
Gestational Age	< 37 weeks	40	17.6
	≥ 37 weeks	187	82.4
Admission weight	< 2500g	63	27.8
	≥ 2500g	164	72.2
APGAR Score	Yes	175	77.1
	No	52	22.9
APGAR Score 1st Minute (n = 175)	< 7	170	92.9
	≥ 7	13	7.1
APGAR Score 5th Minute (n = 175)	< 7	89	48.6
	≥ 7	94	51.4
Predisposing factors of neonatal sepsis	Yes	182	80.2
	No	45	19.8
Resuscitated at birth (n = 182)	Yes	103	56.6
	No	79	43.4
Inserted to urinary catheter (n = 182)	Yes	37	20.3
	No	145	79.7
Fetal distress (n = 182)	Yes	85	46.7
	No	97	53.3
Meconium aspiration syndrome (n = 182)	Yes	88	48.3
	No	94	51.7
Metabolic disease (n = 182)	Yes	17	9.3
	No	165	90.7
Congenital malformations (n = 182)	Yes	12	6.6
	No	170	93.4
Type of feeding	Exclusive breast	150	66.1
	Formula	77	33.9

Variable	Category	Frequency	Percentage (%)
Length of hospital stay	1–7 days	181	79.7
	8 – 14 days	46	20.3
Presence of comorbidity	Yes	78	34.4
	No	149	65.6

Among the neonates included in the study, 21.79% had comorbidities of perinatal asphyxia, 19.23% had comorbidities of neonatal jaundice, and 15.38% had comorbidities of congenital anomalies (Fig. 1).

Others**: Meconium aspiration syndrome, Necrotizing enterocolitis

Figure 1: List of Comorbidities in Neonates with Sepsis Among Neonates Admitted to NICU of Degehabur General Hospital, Degehabur, Eastern Ethiopia, 2024.

Clinical Presentation and Antibiotic Use of Neonate at admission

Among clinical features, more than half 129 (56.8%) of the neonates had grunting at presentation. Other clinical features reported were 98 (43.2%) fast breathing, 74 (32.6%) fever, 95 (41.9%) tachycardia, and 71 (31.3%) hypothermia, respectively. Regarding the onset of sepsis, more than half of the neonates, 167 (74%), experienced early-onset sepsis. Regarding antibiotic use Ampicillin was the main antibiotic administered to almost every neonate 214 (94.3%), followed by gentamycin 161 (90.9%) (Table 4).

Table 4
Clinical presentation and Antibiotic Use of Neonates admitted to NICU, of Degehabur
General Hospital, Degehabur, Eastern Ethiopia, 2024.

Variable	Category	Frequency	Percentage (%)
Respiratory rate > 60b/min (Tachypnea)	Yes	98	43.2
	No	129	56.8
Respiratory rate < 30 b/min (Bradypnea)	Yes	19	8.4
	No	208	91.6
Fever (body temperature > 37.5)	Yes	74	32.6
	No	153	67.4
Chest in drawing	Yes	65	28.6
	No	162	71.4
Nasal flaring	Yes	51	22.5
	No	176	77.5
Grunting	Yes	129	56.8
	No	98	43.2
Vomiting	Yes	36	15.9
	No	191	84.1
Hypothermia	Yes	71	31.3
	No	156	68.7
Pulse rate > 160 b/min (tachycardia)	Yes	95	41.9
	No	132	58.1
Pulse rate < 110b/min (bradycardia)	Yes	37	16.3
	No	190	83.7
Lethargic	Yes	37	16.3
	No	190	83.7
Abnormal body movement	Yes	15	6.6
	No	212	93.4
Abdominal distention	Yes	11	4.9
	No	216	95.1

Variable	Category	Frequency	Percentage (%)
Jaundice	Yes	15	6.6
	No	212	93.4
Onset Of sepsis	Early	167	74
	Late	60	26
Gentamycin	Yes	161	70.9
	No	66	29.1
Ampicillin	Yes	214	94.3
	No	13	5.7
Cloxacillin	Yes	6	2.6
	No	221	97.4
Cefotaxime	Yes	47	20.7
	No	180	79.3
Vancomycin	Yes	23	10.1
	No	204	89.9
Metronidazole	Yes	29	12.8
	No	198	87.2
Meropeme	Yes	19	8.4
	No	208	91.6
Cefepime	Yes	10	4.4
	No	217	95.6
Ceftriaxone	Yes	55	24.3
	No	172	75.7

Treatment outcome of neonatal sepsis

Regarding treatment outcome, 161 (70.9%) were improved, 11 (4.9%) were left against medical advice, 10 (4.4%) were referred, 8 (3.5%) were deteriorated, and 37 (16.3%) were died (Table 5).

Table 5
Treatment outcome of neonatal sepsis among Neonates
admitted to NICU, of Degehabur General Hospital, Degehabur,
Eastern Ethiopia, 2024.

Treatment outcome	Frequency	Percentage (%)
Improved	161	70.93
Referred	10	4.41
Deteriorated	8	3.52
Leave against medical advice	11	4.85
Death	37	16.30

Accordingly, more than two-thirds of neonates 161 (70.93%) had a good treatment outcome, whereas 66 (29.07%) had a poor treatment outcome (Fig. 2).

Among the neonates who died, the most common cause of death was multi-organ failure 11 (30%), followed by sepsis 9 (24%), and a combination of respiratory distress, respiratory failure, and prematurity 9 (24%) (Fig. 3).

Figure 3: Cause of death among neonates with sepsis admitted to NICU at Degehabur General Hospital, 2024.

Factors Associated with Treatment Outcome of Neonatal Sepsis

According to the result of bi-variable binary logistic regression analysis, variables such as Place of delivery, Pregnancy induced Hypertension, Maternal infections, Predictors of neonatal sepsis, Gestational age, Admission weight, Type of feeding, Length of hospital stay, presence of comorbidity, grunting and hypothermia became candidates for multivariable analysis at $p\text{-value} < 0.25$. Eleven variables were fitted for multivariable logistic regression, and three variables, namely Admission weight, Length of hospital stay, and presence of comorbidity were found to be statistically significantly associated with poor treatment outcome of neonatal sepsis among neonates at a $p\text{-value} < 0.05$.

In multivariable analysis, the odds of poor treatment outcome were 2.12 times (AOR = 2.12; 95% C.I: 1.07–5.78) higher among neonates with admission weight < 2500 grams as compared to those with admission weight $\geq$ 2500 grams. Likewise, the odds of poor treatment outcome were 2.16 times (AOR = 2.16; 95% C.I: 1.09–6.37) higher among neonates who stayed in the hospital for 1–7 days compared to those who stayed longer. Finally, the odds of poor treatment outcome were 2.09 times (AOR = 2.09; 95% C.I: 1.04–4.12) higher among neonates with presence of comorbidity compared to neonates with no comorbidities (Table 6).

Table 6

Bi-variable and Multivariable binary logistic regression analysis of the factors associated treatment outcome in Neonatal Sepsis among neonates admitted to NICU, of Degehabur General Hospital, Degehabur, Eastern Ethiopia, 2024.

Variables	Category	Treatment Outcome		COR (95% CI)	AOR (95% CI)	P-value
		Poor	Good			
Place of delivery	Home	9	13	1.79 (0.72–4.43)	1.12 (0.62–5.66)	0.263
	Health Institution	57	148	1	1	
Pregnancy induced hypertension	Yes	24	36	1.98 (1.06–3.70)	1.71 (0.91–3.76)	0.088
	No	42	125	1	1	
Maternal Infection	Yes	43	118	2.64 (1.17–5.98)	1.60 (0.84–5.14)	0.110
	No	8	58	1	1	
Predictors of neonatal sepsis	Yes	57	125	1.82 (0.82–4.03)	1.09 (0.66–4.20)	0.275
	No	9	36	1	1	
Gestational Age	< 37 weeks	19	21	2.69 (1.33–5.44)	0.93 (0.37–2.53)	0.956
	≥ 37 weeks	47	140	1	1	
Admission weight	< 2500g	29	34	2.98 (1.58–5.42)	2.12 (1.07–5.78)	0.034 **
	≥ 2500g	37	127	1	1	
Type of feeding	Exclusive breast	33	117	1	1	0.154
	Formula	33	44	2.66 (1.47–4.82)	1.43 (0.82–3.31)	

Key: ** Statistically significant at P-value < 0.05, COR=Crude odds ratio, AOR=Adjusted odds Ratio, 1 = reference

Length of hospital stay	1–7 days	57	124	1.84 (0.83–4.07)	2.16 (1.09–6.37)	0.030**
	8 – 14 days	9	36	1	1	
Presence of comorbidity	Yes	28	50	1.63 (0.90–2.95)	2.09 (1.04–4.12)	0.037**
	No	38	111	1	1	
Grunting	Yes	43	86	1.63 (0.90–2.95)	1.87 (0.96–3.74)	0.062
	No	23	75	1	1	
Hypothermia	Yes	27	44	1.84 (1.00–3.35)	0.92 (0.69–2.77)	0.358
	No	39	117	1	1	
Key: ** Statistically significant at P-value < 0.05, COR=Crude odds ratio, AOR=Adjusted odds Ratio, 1 = reference						

Discussion

This study assessed the treatment outcome and associated factors of neonatal sepsis among neonates admitted to the Neonatal Intensive Care Unit of Degehabur General Hospital Degehabur Town, Eastern Ethiopia.

In this study, the magnitude of poor treatment outcome of neonatal sepsis among neonates admitted to NICU at Degehabur General Hospital was 29.1% (95% CI: 23.2–35.4). The findings of the study were consistent with those of studies conducted in Addis Ababa, 24.4% (24), Debrezeyt town 25.16% (33), South-West Ethiopia 32.2% (32), and Nigeria 31.8% (34).

The finding was lower compared to a study conducted in Pakistan, where the magnitude of poor treatment outcome was 52.2% (35). This difference might be due to differences in healthcare infrastructure, the management protocols for neonatal sepsis, and sample size variation across studies. Furthermore, it could be attributed to differences in the population characteristics and underlying risk factors for neonatal sepsis in different regions.

The finding was higher than other studies at Congo 21.1% (36), Tanzania 19% (37), Public hospitals Bahir Dar 23% (38), Felege Hiwot referral hospital Bahir Dar 16% (31), Wollega University Teaching and Referral Hospital, Nekemte Town 9.81% (39). The possible explanation for this difference might be due to different treatment guidelines, health care setup (General, Referral, and Tertiary hospitals), differences in

NICU admission criteria, sample size, study period, study design employed variations across studies, and socio-demographic and economic factors in the countries.

Neonates who had admission weight < 2500 grams had 2.12 times higher odds of developing poor treatment outcome compared to neonates who had admission weight $\geq$ 2500 grams. This result is consistent with a study done at public referral hospitals in Bahir Dar city that found neonates with admission weight < 2500 grams had 3.37 times higher risk of poor treatment outcome compared to neonates with admission weight $\geq$ 2500 grams among neonates with neonatal sepsis (38). The possible explanation for this neonate with an admission weight of < 2500 grams can be attributed to factors such as their immature immune system, limited physiological reserves, increased susceptibility to infections and comorbidities, and slow progress of weight gain due to difficulty feeding. These factors collectively contribute to the challenges of managing sepsis effectively in low admission weight neonates, resulting in poor treatment outcomes.

Neonates with the presence of comorbidity had 2.09 times higher odds of having a poor treatment outcome compared to neonates who had no comorbidity. This finding is in line with a study conducted in public referral hospitals in Bahir Dar city Neonates who had comorbidities had 1.8 times higher odds of developing poor treatment outcome compared to those without comorbidities (38). This might be due to the fact that the presence of comorbidities would expose the neonate to further overwhelming of the immature immune system, making them more susceptible to severe infections, increasing the complexity of clinical management, delaying the diagnosis and appropriate treatment of neonatal sepsis, and increasing the risk of drug interactions and adverse effects, all of which can contribute to the higher odds of poor treatment outcome of neonatal sepsis.

Neonates whose length of hospital stay was less than 7 days had 2.16 times higher odds of having a poor treatment outcome compared to neonates who stayed longer. The possible justification is that a short stay could result in inadequate treatment duration, which may not fully address the infection, and delayed recognition and diagnosis of sepsis in neonates with shorter stays may delay the initiation of appropriate treatment, allowing the infection to progress. Additionally, neonates who stay short may have an undiagnosed underlying condition that places them at a higher risk of poor outcome this underlying condition may make it more difficult to effectively treat the infection, leading to poor treatment outcomes. Lastly, neonates who were discharged from previous hospitalization with a short length of stay could end up with antimicrobial resistance, possibly caused by short treatment duration or ineffective treatment during their previous hospitalization which can lead to a poor outcome of neonatal sepsis.

Strengths and Limitations of the Study

Strengths of the study

The study was able to capture the targeted population in the sampling process. It included the past 5 years, which can provide an opportunity to assess the existing situation and facilitate actions to improve

the treatment outcome of sepsis neonates.

The data were collected and reviewed by professionals who were trained in the Neonatal Intensive Care Unit and had experience in data collection, which plays an essential role in ensuring data quality.

The data was collected using ODK, ensuring data quality.

Limitation of the study

The study is a cross-sectional study, which cannot establish a cause-and-effect relationship. Furthermore, it is retrospective and a single facility. Future research should consider prospective longitudinal studies and adopt a multi-center approach to provide more comprehensive insights into neonatal sepsis treatment outcomes.

Conclusion and Recommendations

In this study, the magnitude of poor treatment outcome of neonatal sepsis among neonates admitted to NICU at Degehabur General Hospital was high. The study found neonatal factors were independent risk factors with a strong association with the risk of poor outcome of neonatal sepsis. Low admission weight < 2500 grams, presence of comorbidity, and length of hospital stay < 7 days were significantly associated with poor treatment outcome of neonatal sepsis.

Healthcare professionals should closely monitor and provide tailored interventions for neonates with low admission weight and comorbidities, emphasizing the importance of completing the full course of antibiotics to prevent incomplete treatment, recurrent infections, and antimicrobial resistance. Regional health bureaus and stakeholder groups should focus on providing training and intervention for modified risk factors for the poor treatment outcome of neonatal sepsis and Community awareness programs can help educate families about the signs of sepsis, while strengthening infection control measures in hospitals is crucial. Researchers should conduct prospective longitudinal studies on treatment outcomes to improve external validity.

Abbreviations

ANC: Antenatal Care, AOR: Adjusted Odds Ratio, APGAR: Appearance, Pulse, Grimace, Activity, Respiration, CI: Confidence interval, DGH: Degehabur General Hospital, EONS: Early Onset Neonatal Sepsis, LONS: Late-Onset Neonatal Sepsis, MEDHS: Mini Ethiopian Demographic Health Survey, NICU: Neonatal Intensive Care Unit, NS: Neonatal Sepsis, PROM: Premature Rapture of Membrane, WHO: World Health Organization.

Declarations

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Ethics statement

Ethical approval for this study was obtained from the Institute of Health Science, Jigjiga University Research Ethical Review Committee (Ref: IHRRC/031/2024) and permission was obtained from the Degehabur General Hospital chief executive officer. All methods were performed in accordance with the relevant guidelines and regulations as confirmed by the approving Institutional Review Board. Patient informed consent was waived by the Institute of Health Science, Jigjiga University Research Ethical Review Committee due to the retrospective nature of the study. Confidentiality and privacy were maintained at all levels of the study.

Data Availability Statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author Contributions

Conceptualization: SMA. Data curation: SMA, and ASA. Formal analysis: All authors. Investigation: SMA. Methodology: SMA, and ASA. Software: SMA, and MOO. Supervision: ASA. Validation: SMA, and MOO. Visualization: SMA, and ASA. Writing – original draft: SMA. Writing – review & editing: All Author's. All authors read and approved the final manuscript.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Figures

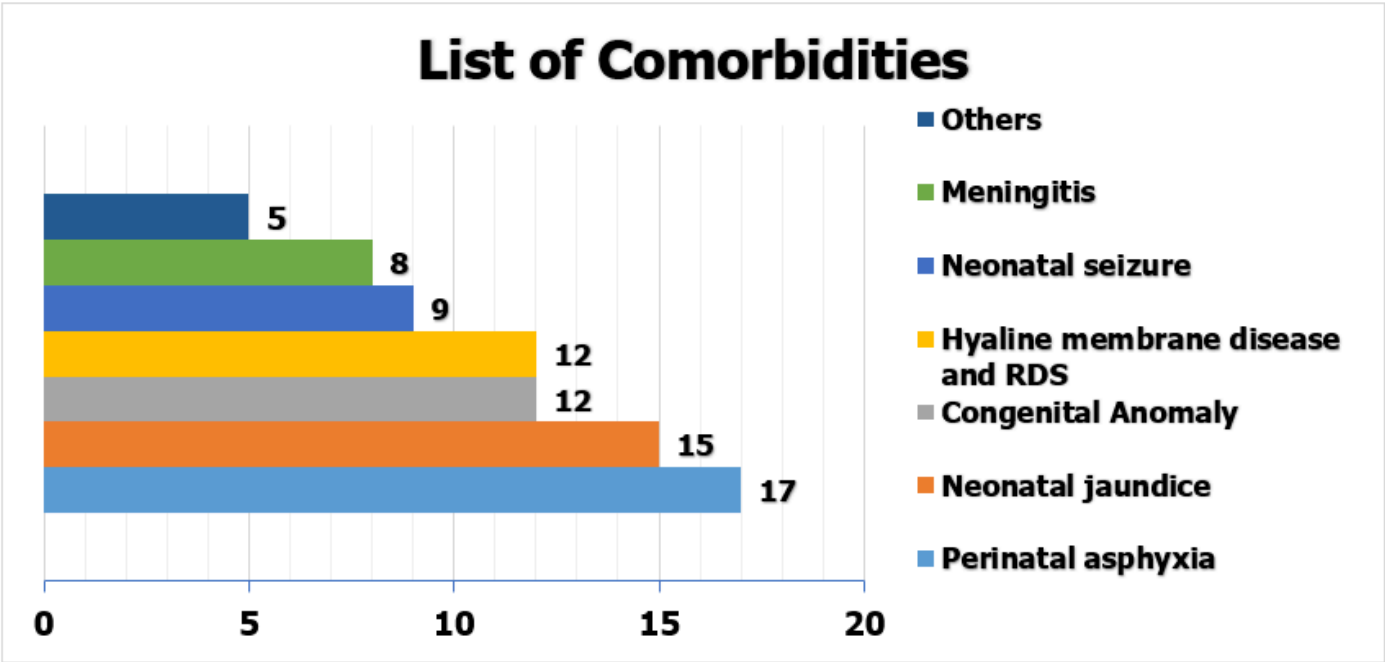


Figure 1

List of Comorbidities in Neonates with Sepsis Among Neonates Admitted to NICU of Degehabur General Hospital, Degehabur, Eastern Ethiopia, 2024.

Others**: Meconium aspiration syndrome, Necrotizing enterocolitis

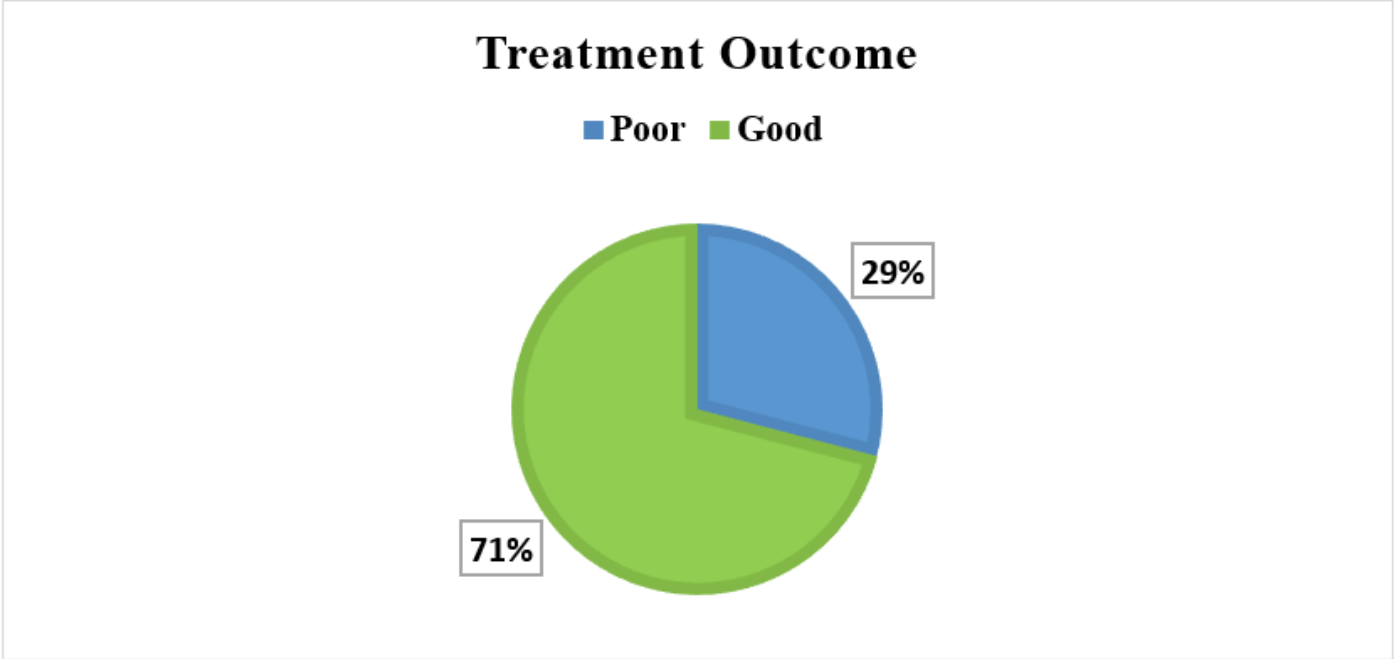


Figure 2

Over all Treatment outcome of neonatal sepsis among Neonates admitted to NICU, of Degehabur General Hospital, Degehabur, Eastern Ethiopia, 2024.

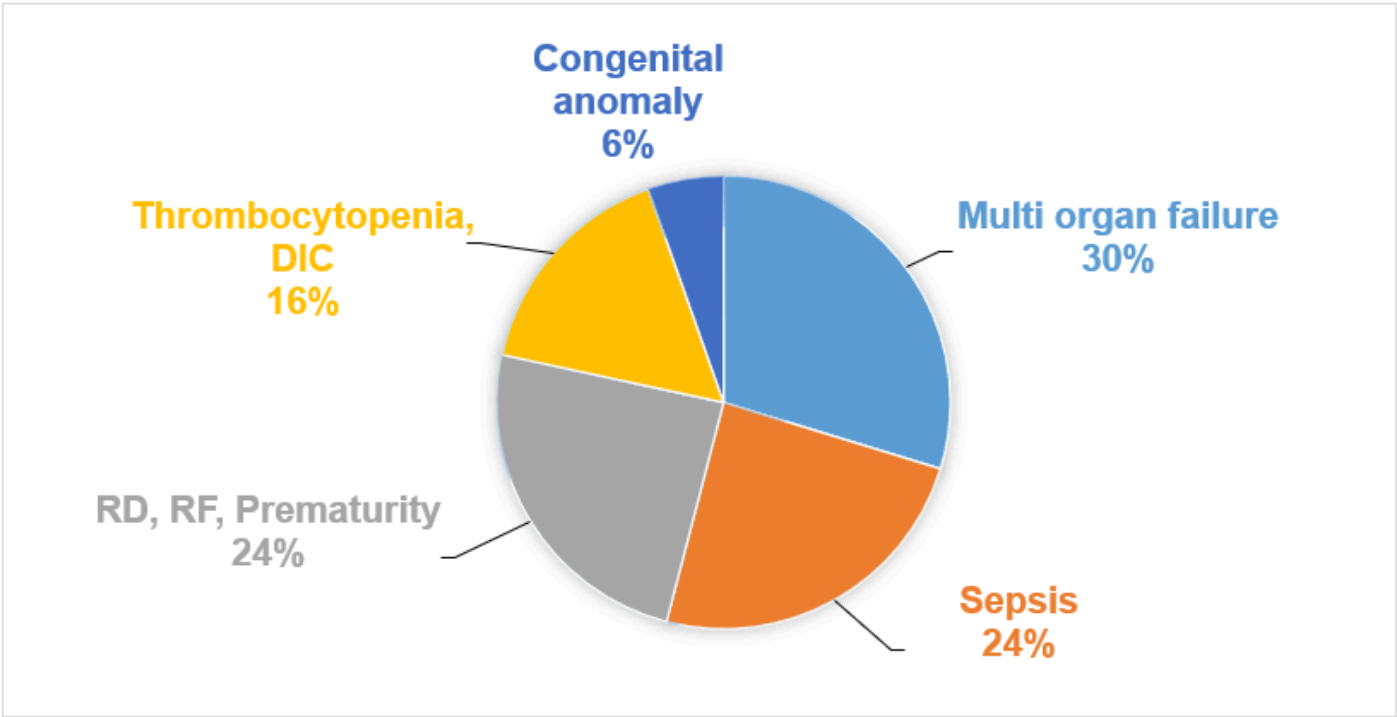


Figure 3

Cause of death among neonates with sepsis admitted to NICU at Degehabur General Hospital, 2024.

