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Magnitude of sepsis and its predictors among neonates admitted to neonatal intensive care unit at Hawassa University comprehensive specialized hospital in Southern Ethiopia 2022

Abstract

Background: Neonatal sepsis is a leading cause of neonatal death across the globe, which accounted for 15% and 30% of neonatal mortality in low and middle-income countries and developing countries including Ethiopia, respectively. Despite various efforts have been made by the Ethiopian government to prevent neonatal mortality and morbidity, sepsis-related to neonatal mortality is still high. So the objective of this study was to assess the magnitude and affecting factors of neonatal sepsis among neonates admitted to neonate intensive care units in Hawassa University Comprehensive Specialized Hospital, Southern Ethiopia.

Methods and materials: Facility based cross-sectional study was conducted from January to February 2022 at Hawassa university comprehensive specialized hospital, Southern Ethiopia. A total of 216 neonate-mother pairs who were admitted to the intensive care unit was included in the study and a systematic random sampling technique was used to select study participant. A structured questionnaire was used to collect data. The data was entered into EPI Data 3.1 version and transported to SPSS version 25 for data analysis. Multi regression analysis was done for predictor variables associated at p-value <0.05 with the dependent variable.

Result: A total of 74 (34.3%) neonates were admitted with neonatal sepsis. A surgical procedure is done before sepsis (AOR=2.9, 95% of CI(1.5 to5.6), last pregnancy wanted (AOR=2.8, 95% of CI(1.0 to 7.3), more frequent per-vaginal examination (AOR=2.6, 95% of CI (1.3 to 5.3), educational level unable to read and write(AOR=5.4, 95% of CI(1.0 to 27.7), low birth weight (AOR=5.4, 95% of CI(3.0 to 9.8), and getting care from unskilled health workers(AOR=2.7, 95% of CI(1.5 to 4.9) were significantly associated with neonatal sepsis at multivariable with less than 0.05 p values.

Conclusion: This study indicated that the prevalence of neonatal sepsis was still high. Thus, immediate action should be taken before it leads to neonatal mortality and further complications. The study used only physician diagnosis to confirm neonatal sepsis, which may affect its prevalence and needs further investigation.

Keywords: sepsis, neonate, neonatal intensive care unit, Southern Ethiopia

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Abbreviations: ANC, antenatal care; APGAR, appearance, pulse, grimace, activity, and respiration;

AOR, adjusted odd ratio; CI, confidence interval; PV, per-vaginal; HUCSH, hawassa university comprehensive specialized hospital; NICU, neonate intensive care unit

Introduction

The neonatal period is the most vulnerable time for neonates in which many of them face severe disease and the risk of dying in their first month of life. The death and disease during the neonatal period are caused by sepsis, prematurity, and birth complications.[1,2] Sepsis is a life-threatening condition that results in many organ dysfunctions caused by the uncontrolled host response to infection that can affect the health of neonates.[3]

Neonatal sepsis (NS) is referred to as any systemic manifestation such as abnormal body temperature, respiratory problems, food intolerance, and isolation of bacteria or other pathogens from the bloodstream.[3,4] If not prevented and managed early, NS can lead to long-term morbidity and increase the burden on health care resources as well as has an economic impact resulting from a prolonged hospital stay, increased medical costs, and potentially poor long-term neurodevelopmental outcomes.[2–4]

Sepsis is undeniably a serious worldwide health threat. Approximately 2.6 million children die in the first month of life across the globe and 7 thousand newborns die each day.[2,5] In 2018, 15% of global neonatal mortality was accounted for by neonatal sepsis.[2] Around 84% of neonatal deaths can be prevented by early diagnosis and appropriate and timely clinical management of neonatal problems.[5] Compared to developed countries, low and middle-income countries have approximately forty times higher incidence rates of neonatal infection and double the death rate.[6] Neonatal infection accounted for 26% of annual neonatal death in Sun-Saharan Africa.[7]

Due to neonatal infection, nine in a hundred neonates die in Ethiopia.[8] Early detection of influencing factors that leads to NS is the key strategy to prevent sepsis and death during the neonatal period. Kind of literature identified several factors that lead to

neonatal sepsis.[9–12] These are premature rupture of the membrane, foul-smelling vaginal discharge, intrapartum fever, history of bottle feeding of neonates, preexisting maternal infection, mode of delivery, antenatal care attendance, maternal age, multiple per digital vaginal examination, and neonatal age.[9–12]

The Ethiopian government has made various efforts to reduce neonatal morbidity and mortality. However, some studies conducted in the country revealed that neonatal morbidity and mortality related to neonatal sepsis are still high.[11,12] The magnitude of the problem (neonatal sepsis) in Ethiopia was still high (48%) and varies from region to region.[10] Because of this, further research is needed to investigate the magnitude of neonatal sepsis and its associated factors in a different part of Ethiopia.[10] Previously no study was done in this study area. In addition, the finding of the study will offer opportunity for all responsible bodies (stake holders) to handle this problem by working on those associated factors and its magnitude. Therefore, this study aimed to assess the prevalence and associated factors of neonatal sepsis among neonates admitted into neonate intensive care units (NICUs) at Hawassa University's comprehensive specialized hospital, in Southern Ethiopia.

Methods and materials

Study area, period, and design

An Institutional based cross-sectional study was conducted at Hawassa University Comprehensive Specialized Hospital in Hawassa town from Jan to Feb 2022. Currently, Hawassa town is the administrative city for southern Ethiopia. Hawassa town is 275 km far from Addis Ababa, the capital city of Ethiopia. According to the 2017 City Health Department estimation report, 359,358 people were living in Hawassa. Hawassa University Comprehensive Specialized Hospital (HUCSH) offers different health services for the population of Hawassa and its surroundings. From these services, NICU provides an inpatient medical service for neonates. This unit particularly provides intensive care for neonates on an inpatient basis.

Study population, study variables, and sampling procedure

Selected neonates from neonates admitted to NICU in HUCSH were the study population. The required sample size was calculated by using a single population proportion sample size calculation formula considering the following assumptions. 95% confidence interval (CI), 5% margin of error, and single population proportion formula through an assumption of the prevalence of neonatal sepsis was 77.9% in the study conducted in the Oromia region.[11] This resulted in a total of 264 sample sizes for the study. According to the data obtained from HUCSH 2021, the last six admissions of neonates to the NICU were estimated to be 942. Since the source population was less than 10,000, using the correct formula, the required sample size was 206. By considering the 10% of nonresponse rate, the final sample size was 226.

The study enrolled neonates from birth up to 28 days of age. The neonates were taken by systematic random sampling (Kth=N/sample size, 942/226=4), thus every 4th neonate-mother pair admitted to NICU was recruited as a study unit till the total sample size for the study was obtained. Neonates whose mothers were critically ill or unable to communicate were excluded from the study and 10 cases were excluded from the study. Thus, the study included 216 neonate mother pairs who were admitted to the NICU during the study period.

The outcome variable for the study was neonatal sepsis and neonatal-maternal related variables such as the age of mother, educational level, marital status, residence, occupation, gestational week, and gender of the neonate, birth weight, Apgar score, feeding type and route, parity, delivery attendant were some independent variables for this study.

Data collection and analysis

The tool for the study was developed by reviewing different literatures to get the desired information from the study participants.[10–12] Pretest was done in Adare general hospital. It has two parts such as neonatal and maternal-related factors. At first, the questionnaire was designed in English and then translated into Amharic (local language) by the experts. Again, it was retranslated back to the English language to increase consistency.

Two days of intensive training were provided about the instruments, ways of data collection, ethical issues, and aims of the study for data collectors (3 experienced clinical nurses) and supervisors (two BSc nurses) by the principal investigator. To keep completeness and consistency, data collectors were closely supervised during the data collection process by the supervisor. The principal investigator supervised the correct implementation of the procedure and checks the completeness and logical consistency after data collection.

The data collector collected the data from the mother of the neonate by using a structured questionnaire and reviewed the neonatal medical record chart for neonatal-related variables. The diagnosis of the neonatal case was recorded from the diagnosis of the physician. Data collectors reviewed neonates' medical records to get confirmed medical diagnoses of neonatal sepsis. The completeness and consistency of the data were checked, coded, and entered into Epi Data 3.1. For further analysis, the data was exported to SPSS 25.0 version. Finally, multivariate analysis with Adjusted Odds Ratio (AOR) was used to control possible confounders and to determine predictors of the prevalence of neonatal sepsis. P- Value of < 0.05 was considered as the criterion for statistical significance. The study was approved by Wolaita Sodo University; College of Health Science Institutional review board, the reference number was WSU/IRB/1273/2022

Operational definition

Neonatal sepsis refers to an infection occurring within the first 28 days of life with an established medical diagnosis by physicians.[11] Early onset neonatal sepsis: Refers to neonatal sepsis diagnosed in the first 7 days of life.[13] Late-onset neonatal sepsis: Refers to neonatal sepsis diagnosed between 8 to 28 days of life.[13]

Result

Socio-demographic characteristics of women and neonate

216 mothers were interviewed and a neonatal chart was reviewed in this study, among this 119(55.5%) were male and 97 (44.9%) were female, 164(75.9%) were aged less than or equal to 7 days and 52(24.1%) were age greater than 7 days. The majority of 174(80.6%) mothers and caregivers of neonates were in the age group between 21 and 35. Of all mothers and caregivers, 148(68.5%) came from urban and 68(31.5%) were from rural. Regarding educational level, 107(49.5%) of the respondents were educated up to a diploma and above. 125(57.9%) of the residents were Sidama in their ethnicity and 107(49.5%) were governmental employees in their occupation (Table 1).

Table 1 Socio-demographic characteristics of the women and neonates in Hawassa University Comprehensive Specialized Hospital, 2022 (n=216)

Socio-demographic characteristics		Frequency	Percentage (%)
Maternal characteristics			
Respondents' age	15-20	10	4.6
	21-35	174	80.6
	>35	32	14.8
Respondents' marital status	Married	188	87
	Single	15	7
	Others	13	6
Respondents' educational level	Cannot read and write	13	6
	Can read and write	8	3.7
	Primary school	36	16.7
	Secondary school	51	23.6
	Diploma and above	108	50
Respondent's occupation	Governmental employee	107	49.5
	Merchant	54	25
	Housewife	21	9.7
	Private employee	30	13.9
	Others	4	1.9
Respondents ethnicity	Sidama	125	57.9
	Amhara	25	11.6
	Gurage	19	8.8
	Others[c]	47	21.8
Respondents' residence	Urban	148	68.5
	Rural	68	31.5
Neonatal characteristics			
Gender	Male	119	55.1
	Female	97	44.9
Age in days	≤7	164	75.9
	8-28	52	24.1
Gestational age in weeks	<37	97	49.9
	≥37	119	55.1

a- widowed, divorced; b- students, daily laborer; unemployed; c- Wolaita, Oromo, Tigre

Maternal and neonatal factors predisposing neonatal sepsis

Among the total 216 neonates recruited to the study, only 6(1.7%) of the mothers of neonates had urinary tract infections on the admission of the neonate. Of all mothers of neonates in the study, mothers who had a history of UTI/STI during and before delivery were 16(7%). Concerning the duration of labor, the majority of 198(91.6%) had labor lasting less than 12 hours and the rest 18(8.4%) had labor taking greater than or equal to 12 hours. 131(60%) of the neonates in this study had normal birth weight and 71 (32.9%) had low birth weight. 118(54.6%) of the study participants had a low Apgar score. Of the total participants in the study, 119 (55.1%) and 97(49.1%) were term and preterm babies, respectively (Table 2).

Table 2 Maternal and neonatal factors predisposing neonatal sepsis in HUCSH, Southern Ethiopia, 2022(n=216)

Maternal factors predisposing neonatal sepsis		Frequency	Percentage (%)
Parity	<5	156	72.2
	≥5	60	28.8
The total duration of labor	<24	198	91.6
	≥24	18	8.4
Antenatal care (ANC) follow up	Yes	203	94
	No	13	6
Frequency of ANC	1-3	123	60.6
	≥4	80	39.4
Place of ANC	Health center	40	19.7
	Hospital	123	60.6
	Health post	19	9.4
	Private clinic	21	10.3
Place of delivery	Health institution	174	80.6
	Home	42	19.4
Home delivery follower	Traditional attendants	28	66.7
	My family	10	23.8
	Others[a]	4	9.5
Discussion of delivery place with health profession	Yes	164	75.9
	No	52	24.1
Discussion of delivery place with partner	Yes	155	71.5
	No	61	28.2
Labor started	Spontaneously	102	47.2
	Induced	114	52.8
Mode of delivery	Spontaneous vaginal	102	47.2
	Assisted vaginal	56	25.9
	Cesarean section	46	21.8
Health status in the current delivery	Normal	152	70.6
	Had complication	64	29.4
Faced with PROM	Yes	58	26.9
	No	158	73.1
Faced with UTI/STI	Yes	16	7
	No	200	93
Faced with foul amniotic fluid	Yes	30	14
	No	155	86
Any Procedure done	Yes	111	51.4
	No	105	48.6

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Table Continued...

Maternal factors predisposing neonatal sepsis		Frequency	Percentage (%)
Type of procedure	Episiotomy	29	26.1
	Manual removal of placenta	11	9.9
	Instrumental delivery	25	22.5
	Cesarean section	46	41.4
Digital examination done	Yes	182	84.3
	No	34	15.7
Frequency of Digital examination	<4	78	42.9
	≥4	104	57.1
Neonatal characteristics			
Birth weight	1500 to 2499	71	32.9
	2500 to 3999	131	60.6
	≥4000	14	6.5
APGAR score	1-3	118	54.6
	4-7	72	33.3
	≥8	26	11.6
Congenital anomaly	Yes	51	23.6
	No	165	76.4
The procedure is done before sepsis	Yes	59	27.3
	No	157	72.7
Skilled delivery attendant	Yes	174	80.6
	No	42	19.4
Feeding type	Breast milk	86	39.8
	IV fluids	124	57.4
	Others[b]	6	2.8
Feeding route	Sucking	36	16.7
	NGT	76	35.2
	IV	101	46.8
	Others[c]	3	1.4
Type of sepsis	Early onset	55	74.3
	Late-onset	19	25.7
Other NICU case	Jaundice	26	18.3
	Respiratory syndrome	39	27.5
	Inflammatory bowel syndrome	19	13.4
	Others[d]	58	40.8

a- relatives, mother-in-law and friends; b- bottle feeding, mixed (cow milk and breast milk) feeding; c- oral gastric tube, d- seizure, surgical case, and eye disorders; Iv, intravenous; NGT, nasal-gastric tube; PROM, pre-rupture of membrane; UTI, urinary tract infection; STI, sexual transmitted infection

Prevalence of neonatal sepsis

Among the 216 neonates who were admitted to the NICU of HUCSH, 74(34.3%) had neonatal sepsis and the rest 142(65.7%) have been admitted for other diseases (Figure 1). Of those 74 neonates who have been admitted for neonatal sepsis, 55(74.3%) were admitted for Early Onset Neonatal Sepsis and 19(25.7%) for Late Onset Neonatal Sepsis (Table 2). Regarding other NICU diseases, 58(40.8%) of cases were others (seizure, premature birth, congenital anomaly, surgical cases) and 39(27.5%) were Respiratory syndrome followed by jaundice 26(18.3%) (Table 2).

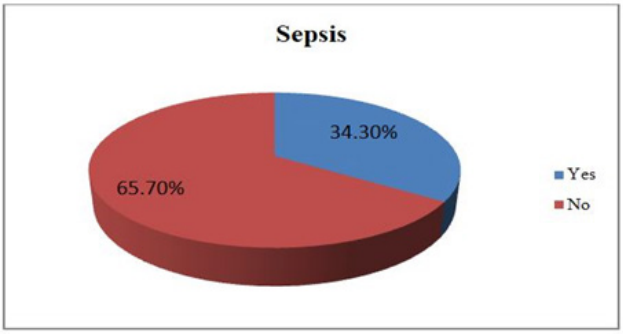

Figure 1

Factors associated with neonatal sepsis

Despite variables that fulfilled candidate criteria were entered into the multivariate logistic regression analysis, only 6 variables such as surgical procedure done before sepsis, last pregnancy wanted, frequency of per-vaginal examination, educational level, birth weight, and getting care from trained health workers were significantly associated with neonatal sepsis at multivariable with less than 0.05 p values (Table 3).

This study showed that neonates born to mothers who had given birth at home during the index pregnancy had 2.3 times higher odds of developing sepsis compared to their contrast group [AOR =2.34; 95% CI(1.4 to 4.8)]. Increased odds of neonatal sepsis were noted among mothers who have a history of more than 4 PV examinations during labor compared to mothers who had PV examinations less than or equal to 4 [AOR =2.6; 95% CI (1.3 to 5.3)].

Those neonates who had low birth weight at birth had 5.4 times higher odds of developing sepsis compared to those neonates who were normal weight [AOR = 5.4; 95% CI(5.4(3.0 to 9.8)]. Maternal educational level was significantly associated with neonatal sepsis. Neonates from mothers who were unable to read and write were 5.4 more likely prone to develop neonatal sepsis when compared to neonates from mothers educated up to diploma and above [AOR=5.4; 95% CI (1.0 to 27.0)]. Place of delivery also has a significant effect on neonatal sepsis. Neonates delivered at home were 2.34 times more likely to develop sepsis compared to those delivered at the hospital [AOR=2.34; 95% CI (1.4 to 4.8)] (Table 3).

Surgical procedure before the occurrence of sepsis was significantly associated with the outcome variable. Those neonates who undertook surgical procedures were 3 times more likely to develop sepsis compared to their contrast group [AOR=2.9; 95% CI (1.5 to 5.6))]. The last pregnancy planned was identified as an influencing factor that affects the occurrence of neonatal sepsis. Neonates born from mothers who did not plan their last pregnancy were 2.8 times more likely prone to develop sepsis than their opposite group [AOR=2.8; 95% CI (1.0 to 7.3)]. Last delivery attendant has also a significant effect to predispose the development of neonatal sepsis. Neonates who did not attend by skilled providers were 2.7 times more likely to have neonatal sepsis compared to neonates attended by skilled attendants [AOR=2.7; 95% CI (1.5 to 4.9)] (Table 3).

Table 3 Factors associated with neonatal sepsis among neonates receiving NICU in HUCSH, Southern Ethiopia, 2022(n=216)

Factors		COR	AOR(CI)	p-value
A surgical procedure is done before sepsis	Yes	2.66(1.4 to 4.9)	2.9(1.5 to 5.6)	0.002
	No	1	1	1
Last pregnancy wanted	No	2.9(0.9 to 8.7)	2.8(1.0 to 7.3)	0.039
	Yes	1	1	1
Last delivery by skilled attendant	no	1.5(0.8to2.6)	2.7(1.5 to 4.9)	0.002
	Yes	1	1	1
Educational level	Unable to read and write	15(3.3to75.0)	5.4(1.0 to27.0)	0.045
	Unable to read and write	1.7(0.38to7.60)	0.73(0.14 to 3.9)	0.700
	Primary school	1.2(0.55to2.99)	1.25(0.6to2.8)	0.58
	Secondary school	2(0.99to4.0)	0.9(0.44to1.84)	0.77
	Diploma and above	1	1	1
Last delivery place	Home	1.4(0.66 to 2.89)	2.34(1.4to4.8)	0.020
	Health institution	1	1	1
Birth weight	1500 to 2499	0.6(0.2 to 1.95)	5.4(3.0 to 9.8)	0.030
	2500 to 3999	0.26(0.08 to 0.82)	1.44(0.8to2.6)	0.230
	≥4000	1	1	1
Frequency of digital exam	≥4	2.7(1.45 to 5.04)	2.6(1.3 to 5.3)	0.007
	<4	1`	1	1

Discussion

Neonatal sepsis is one of the most common reasons for admission to neonatal intensive care units in developing countries.[2] It is also a major cause of mortality in both developed and developing countries.[2,8] One-fourth of neonatal deaths are due to neonatal sepsis and nearly 98% of these deaths are occurring in low- and middle-income countries.[8] Early diagnosis and management can prevent the risk of neonatal sepsis and improve the outcome.[2,8]

The overall prevalence of neonatal sepsis was 34.3%. This finding was congruent with the study done in Tanzania (31.4%).[14] However, higher compared with the studies done in Southern-Eastern Mexico (4.3%).[15] The possible reasons for this difference might be an advancement in health care systems such as trained health care providers, advanced investigation tools, safe delivery practices, basic obstetric emergency care, enhanced health care seeking behavior, socioeconomic status of the study population, and access to health facilities.[9]

Maternal education was risk factor that predisposes the newborn to sepsis. The maternal educational level below secondary had a significant effect on the development of neonatal sepsis.[16] Neonates from mothers who were unable to read and write were 5.4 more likely prone to develop neonatal sepsis when compared to neonates from mothers educated up to diploma and above [AOR=5.4; 95% CI (1.0 to 27)]. This was in line with studies done in Tanzania[14] and Ghana.[17] These may be due to mothers who did not educate and lack adequate knowledge of infection prevention techniques and they may not easily access media that provides healthcare-related information.[9]

The last pregnancy planned was identified as an influencing factor that affects the occurrence of neonatal sepsis. Neonates born from mothers who did not plan their last pregnancy were 2.8 times more likely prone to develop sepsis than their opposite group. This might be explained by the mother could not provide more attention to unplanned pregnancy; not seeking health care for their neonate, and doing nothing to promote their health.

The frequent digital vaginal examination was identified as a statistically significant variable in the study. Increased odds of neonatal sepsis were noted among mothers who have a history of more than 4 PV examinations during labor compared to mothers who had PV examinations less than or equal to 4 [AOR =2.6; 95% CI [(1.3 to 5.3]]. This finding was linked to a study done in Bangladesh[18] and North West Ethiopia.[4] This might be explained as multiple per-vaginal examinations can introduce vaginal organisms into the cervical canal, which, in turn, increases the risk of infection.[19]

Neonate's birth weight, particularly low birth weight, had a significant effect on developing neonatal sepsis.[16] Those neonates who had low birth weight at birth had 5.4 times higher odds of developing sepsis compared to those neonates who were normal weight. This finding was similar to the study carried out in Dhaka.[16] The possible reasons for this may be that most neonates are very sensitive to different infection agents if born with low birth weight because of the immaturity of the body system, reduced subcutaneous fat, and increased risk of hypothermia due to high body surface area to weight ratio.

Surgical procedure before the occurrence of sepsis was significantly associated with the outcome variable. Those neonates who undertook surgical procedures were 3 times more likely to develop sepsis compared to their contrast group. The possible reason might be due to transmission of microorganisms during the procedure or through nosocomial infection as the operation area is more at risk for infection.

Place of last delivery significantly affects the occurrence of neonatal sepsis. Neonates born outside of health institutions were considered at higher risk of developing neonatal sepsis and need aggressive treatment.[20] Neonates delivered at the home were 2.34 times more likely to develop sepsis compared to those delivered at the hospital [AOR=2.34; 95% CI (1.4 to 4.8)]. This finding was similar to the study done in North West Ethiopia[4] and Nigeria.[21] This could be explained as neonates being born at home might lack skilled attendants, care for the umbilical cord, early breastfeeding, prophylaxis (application of tetracycline), and other infection prevention approaches and this may increase the risk of neonatal infection.[9]

Last delivery attendant has also a significant effect to predispose the development of neonatal sepsis. Neonates who did not attend

by skilled providers were 2.7 times more likely to have neonatal sepsis compared to neonates attended by a skilled attendant. This could be related to neonates born by unskilled attendants were did not get appropriate care such as safe delivery, an aseptic procedure that prevents infection, and lack of standard management protocols or guidelines.

Conclusion

This study indicated that the prevalence of neonatal sepsis was 34.3%. In general, this study identified those neonates from mothers with more frequent digital vaginal examinations (≥4 times), last delivery placed at home, delivered by a skilled attendant, and surgical procedure being done before sepsis were factors predisposed for neonatal sepsis. Thus, the health care provider should be careful while performing any surgical procedures; they should limit unnecessary PV examination and use aseptic techniques to prevent infection. And they have to take immediate and careful action for neonates born with low birth weight. Finally, mothers' awareness should be enhanced at the place of delivery.

Author's contributions

TG: Conceive data and designed the study, supervised the data collection, performed the analysis and interpretation of data, drafted the manuscript, and finally approved the revision for publication. TG had full access to all of the data in the study and takes responsibility for the integrity of data and the accuracy of data analysis. TK and EI assisted in designing the study and data interpretation and critically reviewed the manuscript.

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