ORIGINAL RESEARCH

The Effect of Admission Hypothermia for Neonatal Death Among Neonates Admitted to Neonatal Intensive Care Unit at Sheik Hassan Yabare Jigjiga University Referral Hospital in Jigjiga City, Somali Region, Eastern Ethiopia

Ahmed Mohammed Ibrahim (ID)
Abdirahman Mahamed Farah
Mohamed Omar Osman (ID)
Abdiwahab Hashi

Department of Public Health, College of Medicine and Health Science, Jigjiga University, Jigjiga, Ethiopia

Background: Hypothermia contributes to morbidity and mortality of newborns. While there have been improvements in neonatal mortality both globally and nationally, there are still important regional differences. Adopting prevention and intervention practices to reduce hypothermia at birth may help achieve the global and national goal of reducing neonatal mortality.

Purpose: To assess the contribution of admission hypothermia to mortality among hospitalized newborn infants.

Methods: Retrospective cohort study was conducted in Sheik Hassan Yabare Jigjiga University Referral Hospital. Neonates were admitted to the Neonatal Intensive Care Unit were selected by using simple-random sampling technique from record of neonates. Descriptive survival analysis such as Log rank test, life table and Kaplan–Meier survival curve and bivariate and multivariate inferential Cox regression were used to estimate hazard ratios with 95% confidence intervals.

Results: Among 588 neonates, 146 (24.8%) died and 442 (75.2%) were censored. A total of 2509 days were followed for hypothermic neonates and 2337 days for normothermic neonates. The death rate was 37 per 1000 days and 22 per 1000 days for hypothermic and normothermic neonates, respectively. Survival function between the two groups differed significantly. Hypothermic neonates had a 59% (AHR: 1.59, CI: 1.1, 2.3) hazard of death than normothermic neonates. Not having initiated breastfeeding (AHR: 1.9, CI: 1.13, 3.1), vaginal mode of delivery (AHR: 0.68, CI: 0.5, 0.98), suspected sepsis (AHR: 1.5, CI: 1.06, 2.1), and respiratory distress (AHR: 2, CI: 1.44, 2.88) were significant predictors of neonatal death.

Conclusion: The death rate for hospitalized, hypothermic neonates was greater than those who were normothermic. Hospitalized newborns should be monitored closely and hypothermia minimized. Management and guidelines to minimize hypothermia management practices should be rigorously evaluated in medical resource-limited settings.

Keywords: effect, admission hypothermia, neonatal mortality, survival, NICU, SHYRH, Jigjiga, Ethiopia

Correspondence: Ahmed Mohammed Ibrahim; Mohamed Omar Osman
Department of Public Health, College of Medicine and Health Science, Jigjiga University, P.O.Box: 1020, Jigjiga, Ethiopia
Tel +251 912423271; +251 921424748
Fax +251 25 775 5976
Email Ahmey114baba@gmail.com; Wehliye@jju.edu.et

Introduction

The World Health Organization (WHO) defines Neonatal hypothermia as an axillary temperature less than 36.5°C (97.7ºF). Thermal instability contributes to hypoxia and

hypotension and increases the risk for death and long-term disability.[1] The WHO classifies hypothermia as severe when the body temperature falls below 32°C; moderate hypothermia is between 32.0°C and 35.9°C (89.6–96.6ºF), and mild hypothermia (cold stress) between 36.0°C and 36.4°C (96.8–97.5ºF). The normal human body temperature range is typically stated as 36.5–37.5°C (97.7–99.5°F).[1]

Hypothermia occurs when physiologic mechanisms such as shivering, muscle contraction, vasoconstriction, and non-shivering thermogenesis are insufficient to maintain normal body, core temperature.[2]

Newborn infants, especially those who are preterm[3–5] and/or low birth weight[6–8] are susceptible to developing hypothermia due to their larger surface area per unit body weight, reduced thermal insulation because of limited subcutaneous fat, and decreased amount of brown fat.[6]

Co-morbidities associated with hypothermia include sepsis, per ventricular/intraventricular hemorrhage, and necrotizing enterocolitis.[3,9]

Neonatal mortality is defined as death before 28 days of age. Neonatal mortality rate is the number of deaths within the first 28 days per 1000 live births.[10] Neonatal mortality contributes substantially under-five deaths and impacts socio-economic development and quality of life. In 2015, 2.7 million newborn infants died globally, comprising approximately half of under-five the annual child mortality.[11]

A recent demographic and health survey of the African countries reported that neonatal mortality rates in West and East Africa were 8.4 to 48 per 1000 live births and 11 to 102 per 1000 live births, respectively. In this study, Ethiopia had the second-highest neonatal mortality rate (42.7 per 1000 live birth) next to Tanzania (49.7 per 1000 live birth).[12]

The Ethiopian Mini Demographic and Health Survey revealed that the under-five mortality rate was 55 deaths per 1000 live births, of these deaths 30 deaths per 1000 live births occurred during the neonatal period in 2019.[13]

Globally, a systematic analysis conducted by United Nations Inter-agency Group for Child Mortality Estimation reported that from 1990 to 2017 neonatal mortality rate declined from 37 to 18 per 1000 live birth (51% reduction) whereas in Sub-Saharan Africa, the neonatal mortality rate decreased from 46 to 27 per 1000 live birth (41%).[14]

A study conducted in Gondar University teaching hospital in Ethiopia showed that the 23% of neonates admitted to the neonatal unit died.[15] The Ethiopian Demographic and Health Survey (EDHS) reported that from 2000 to 2016, the neonatal death rate fell from 49 to 29 per 1000 live birth. In

the Somali regional state, neonatal mortality was 41 per 1000 live births, which exceeds the Ethiopian national neonatal mortality rate of 29 deaths per 1000 live births in 2016.[16–18] In the Somali region, studies conducted at neonatal intensive care units in Karamara General Hospital and Sheik Hassan Yabare Referral Hospital located in Jigjiga, Somali regional state of Ethiopia found a neonatal mortality rate of 57 per 1000 live birth and prevalence of neonatal mortality of 20.5%, respectively, which shows major problems with neonatal mortality in the study area.[19,20]

Factors previously identified to predict neonatal mortality include but are not limited to low birth weight, preterm birth, perinatal asphyxia, prematurity, respiratory distress, infection, hypothermia, delivery mode, maternal age below 18, unimmunized or uneducated mother.[10,20–24]

The United Nations (UN) set a target of reaching 12 deaths/1000 live births in 2030.[16] The WHO has developed guidelines for the management and prevention of hypothermia in NICU[1] and Ethiopia has been developing community-based newborn care, conducting integrated community case management of common childhood illnesses, and starting newborn corners in Health centers, neonatal units in regional hospitals. Neonatal intensive care units in Ethiopian tertiary hospitals are not well established or equipped.[25] This global and national plan requires understanding of the being aware of the disease burden, having evidence-supported interventions and a unified approach. Despite global efforts to date, there is limited awareness of the prevalence of hypothermia in sub-Saharan Africa,[26] and reductions in neonatal mortality are less than those seen in child mortality.[18] Few studies have conducted in medical resource-limited settings relating admission hypothermia to neonatal morbidity and mortality,[19,23,27–31] and most examine only mortality in low birth weight infants[31–34] Complicating full understanding of this, induced hypothermia may be used for therapeutic purposes.[2,35–37] The purpose of this study is to identify the mortality risk associated with hypothermia for neonates admitted to an eastern Ethiopian NICU.

Materials and Methods
Study Area and Period
Jigjiga city is situated 626km east of Addis Ababa, the capital city of Ethiopia. Jigjiga city administration has an estimated total population of 257,613 and 20 kebeles (smallest administration units) constituting 17,001 households.[38] The city has two hospitals (Regional and Referral), 3 health centers, and 14 health posts with one private hospital, eight

clinics, and 20 pharmacies. Sheik Hassan Yabare Referral Hospital (SHYRH), the teaching hospital of Jigjiga University started providing services in 2017 and serves the Somali and neighboring regions. The hospital has 282 beds and offers a broad range of services to over 38,523 outpatients' 7690 hospitalized patients, 3434 delivery services, and 9270 emergency cases annually. It offers services at general and specialty levels including Internal Medicine, Pediatrics and Child Health, neonatal intensive care unit (NICU), Surgery, gynecology and Obstetrics, ENT (Ear, Nose, and Throat), Neurology, Psychiatry, Ophthalmology, Dermatology, Dentistry, Radiology, Pathology, Laboratory and Pharmacy services. The study was conducted from March 1–30, 2020 at Sheik Hassan Yabare Referral Hospital in Jigjiga city, Eastern Ethiopia.

Study Design

An institution-based cohort study was employed at Sheik Hassan Yabare Referral Hospital. The exposed and unexposed group was those with hypothermia and Normothermia at admission, respectively, where the outcome variable is time to death (the difference between a day of admission and death), and NICU records of neonates aged 28 days were reviewed retrospectively to get these variables.

Source and Study Population
Source Population
All neonates who were admitted to NICU in Sheik Hassan Yabare Referral.

Study Population
All neonates with temperature measurement ≤37.5°C at admission who were admitted to NICU in Sheik Hassan Yabare Referral Hospital from 1 February 2018 to 1 February 2020.

Inclusion and Exclusion Criteria
Neonates with temperature measurement ≤37.5°C on admission and who were admitted to NICU within the last two years were included in this study. Neonates whose records had incomplete observation of major variables such as admission date, temperature measurement, and diagnosis and readmitted neonates in the study period were excluded in this study.

Sample Size Determination
The sample size is calculated by using Epi-info version 7 and with the following assumptions: 95% CI, 80% power,

5% margin of error and 1:1 ratio, 10%. The incidence of death in hypothermic neonates is 1.58%.[39] Then the final sample size after adding 10% incomplete records is 588 (294 exposed, 294 unexposed).

Sampling Technique and Procedure
Records of neonates from February 1, 2018, to February 1, 2020, were reviewed and classified based on their admission temperature as hypothermic (exposed) or normothermic (unexposed) and from which study participants were selected by using a simple random sampling technique with a computer-generated numbering method from the list of admission record book for each group and was followed up retrospectively until the time of death or censoring.

Data Collection Techniques and Tools
A data compilation form was used for collecting basic information, neonatal characteristics, newborn care-related factors, general medical condition, and delivery summary of the mother which was extracted from the information sheet and case registry of the NICU.

Data Collection Procedure
The data compilation form was prepared based on the Federal Ministry of Health Integrated Antenatal, Labor, Delivery, and Newborn and Postnatal care card[40] and was modified by including neonatal characteristics by reviewing the case registry of the hospital and information sheet of the neonate and the mother. As the records are written in English and data collectors can read and write English, therefore, there was no need to translate the data compilation form into the local language.

Study Variables
Dependent Variable
Time to neonatal death.

Independent Variable
Neonatal admission temperature (being hypothermic or normothermic)

Other confounders

Neonatal characteristics (sex, mode of birth, birth weight, gestational age, other problems identified at birth)

Maternal factors (parity, age, ANC)

Management-related factors (radiant warmer, bag or mask ventilation, TTC eye care, Vit K, Phototherapy).

Data Quality Control

The checklist was pre-tested to ensure the quality of the data on 5% of the sample size in neonate's charts which were not included in the study. Data collectors were nurses who work at the NICU of Jigjiga Referral Hospital and the supervisor was public health officer student who is not the staff of the Hospital. Two days of training were given on the contents and flow of data compilation form to avoid bias (misclassification) while extracting data from records. The supervisor cross-checked the records for errors and corrections daily and adjustments (editing or cleaning) were done before storage and analysis.

Operational Definitions

The following operational definition was formed according to WHO practical guidelines.[1]

Event: when the neonates experience death per day of admission.

Survival: lack of occurrence of death within admission period.

Censored – neonates who were discharged with improvement or complication, self-discharged (loss to follow up), or transferred to other health institution (referred), age >28 days while being followed.

Entry time – the day of admission which was recorded from the information charts.

Exit time – the day of death or censoring which was recorded from the information charts.

Time to the event (Period of follow-up) – the time until the death of the neonates takes place that is the difference between exit time and entry time.

Admission Hypothermia – if auxiliary temperature is below 36.5 degrees centigrade measured within 1 hour of admission.

Admission Normothermic – if auxiliary temperature 36.5–37.5 degree centigrade measured within 1 hour of admission.

Data Processing and Analysis

Data were edited, coded, cleaned, and entered into Epi data version 3.1 then exported into SPSS version 24 for analysis of descriptive survival data such as Kaplan–Meier, life table, and Log rank test.

Inferential survival data analysis of Cox regression model for bivariate and multivariable Cox proportional hazard at 95% confidence level and the hazard ratio was estimated. Proportional hazard assumption and linearity assumption were checked to fit the model and statistical significance will be considered for p-value <0.05.

Ethical Consideration

Ethical approval was obtained from the institutional review board of the Jigjiga University Sheik Hassan Yabare Referral Hospital before conducting the research according to the Declaration of Helsinki. The need for parental consent was waived by the institutional review board because patient consent was not mandatory for this retrospective study, as the institution reserves the right to keep the medical record of patients. However, all the data obtained have been secured to keep confidentiality.

Results
Descriptive Statistics of the Neonates
Neonatal Characteristics

A total of 588 neonatal charts were reviewed giving response rate 97.4% (2.6%) incomplete files, half of the neonates were hypothermic 294 (50%) and the other half were normothermic 294 (50%) of these 302 (51.4) of the neonates were males and 285 (48.6%) were females. Most (431; 73.3%) of the neonates cried at birth and less number 147 (25.2%) of neonates received mask and ventilation. Among neonates in the cohort most 501 (85.2) of them were admitted within 7 days of birth and the median age of the neonates was 1 (±3.61). In the cohort, 476 (81%) of the neonates were dried immediately after birth. 332 (40%) of the neonates provided breastfeeding within 1 hour of birth whereas 278 (47%) and 78 (13%) were breastfed after 1 hour and not breastfed at all, respectively. More than half 319 (54%) of the neonates were having birth weight >2500 gm 297 (51%) of the neonates were put on body contact with the mother 557 (95%) and 523 (90%) neonates were provided to TTC eye care and Vit K, respectively, as shown in table below (Table 1).

Maternal Status and Health Conditions

Almost all mothers were married 579 (99%) and most (331; 56%) of the mothers were aged between 18 and 28 years. Most of the mothers were having antenatal care follow-up 266 (45%) and 180 (31%) mothers had <4 visits and ≥4 visits, respectively, whereas 142 (24%) mothers had no antenatal care visits. Fewer mothers were multigravidae 62 (11%) and multiparous 93 (6%). Among mothers, 136 (23%) delivered by caesarian section and most 462 (79%) of the mothers delivered term neonates and 66 (11%) mothers gave multiple birth. Regarding the health conditions of the mothers, a smaller number of

Table 1 Characteristics of Neonates Admitted to NICU of Sheik Hassan Yabare Jigjiga University Referral Hospital, Somali Region, Ethiopia, 2020

Variables	Categories	Frequency	Percentage (%)
Admission temperature (n=588)	Hypothermia	294	50
	Normothermic	294	50
Sex (n=586)	Female	285	48.6
	Male	301	51.4
Cried at birth (n=588)	Yes	431	73.3
	No	157	26.7
Mask and ventilation (n=584)	Yes	147	25.2
	No	437	74.8
Age at admission (n=588)	≤1 week	501	85.2
	>1 week	87	14.8
Dried after birth (n=588)	Yes	476	81.0
	No	112	19.0
Breast feeding (n=588)	≤1 hour	232	39.5
	>1 hour	278	47.3
	Not at all	78	13.3
Birth weight (n=588)	>2500	316	54.3
	2001–2500	117	19.9
	1500–2000	113	19.4
	<1500	42	6.5
Put on abdomen (n=588)	Yes	303	50.5
	No	285	49.5
TTC eye care at birth (n=586)	Yes	557	95.2
	No	28	4.8
Vit K at birth (n=588)	Yes	523	89.6
	No	61	10.4

mothers were positive or having for HIV 5 (1%), Syphilis 25 (4%), Chorioamnitis 74 (13%) and Hypertension 99 (17%) as shown in the (Table 2).

Clinical Problems of the Neonates

As shown among neonates in the cohort, suspected sepsis 271 (46%) was the highest clinical problem reported whereas Congenital infection 64 (11%) was the least and the rest were just Respiratory distress 239 (41%), Perinatal asphyxia 212 (36%), Proven sepsis 183 (31%), Congenital malformation 80 (14%), Meconium aspiration 117 (20%), Birth trauma 52 (9%) and Neonatal jaundice 212 (36%) (Table 3).

Kaplan–Meier Estimate and Log Rank Test for the Neonates

As shown below, hypothermic has less survival probability compared to normothermic neonates in the cohort. The

Log rank test indicated that there is statistically significant difference (p-value = 0.001) between hypothermic and normothermic neonates (Figure 1).

Cross Tab and Bivariate Cox Regression

The hazard of death among hypothermic neonates increased by a factor of 1.7 (1.22, 1.39) relative to normothermic infants. Neonates who were not breastfed at all had 2.7 (1.7, 4.4) hazard of death when compared to neonates who were breastfed within one hour of delivery. Neonates who were dried immediately after birth had 0.59 (0.41, 0.84) reduced hazard of death than those who were not. Birth weight less than1500 g had 2.2 (1.3, 3.7) hazard risk compared to normal birth weight infants. The hazard of death among neonates born to mothers without antenatal care was 2 (1.3, 3.1). Neonates who were delivered by

Table 2 Maternal Status and Health Conditions of Mothers of the Neonates Admitted to NICU of Sheik Hassan Yabare Jigjiga University Referral Hospital, Somali Region, Ethiopia, 2020

Variables	Categories	Frequency	Percentage (%)
Marital status (n=584)	Married	579	99.1
	Divorced	5	0.9
Age of the mother (n=588)	18–28	331	56.3
	≥29	257	43.7
ANC (n=588)	<4	266	45.2
	≥4	180	30.7
	None	142	24.1
Gravidity (n=588)	Primigravida	527	89.5
	Multigravida	61	10.5
Parity (n=588)	Multiparous	495	84.2
	Para 1	93	15.8
Mode of birth (n=588)	Vaginal	452	76.9
	C/S	136	23.1
Gestational age (n=588)	≥37	462	78.6
	<37	126	21.4
Multiple birth (n=588)	Yes	66	11.2
	No	522	88.8
HIV (n=588)	Yes	5	0.9
	No	583	99.1
Chorioamnitis (n=588)	Yes	74	12.6
	No	514	87.4
Hypertension (n=588)	Yes	99	16.8
	No	489	83.2
Syphilis (n=588)	Yes	25	4.3
	No	563	95.7

vaginal mode had 0.59 (0.42, 0.84) compared to birth by Cesarean section. The hazard of death to neonates whose mothers were diagnosed Chorioamnitis was 1.86 (1.2, 2.78). Term neonates had 0.63 (0.44, 0.89) risk of death when compared to preterm infants (Table 4).

Cross Tab and Multivariate Cox Regression

Possible confounders for admission temperature included in multivariate Cox regression were breastfeeding, birth weight, antenatal care, mode of delivery, Chorioamnionitis and common clinical problems such as suspected sepsis, respiratory distress, perinatal asphyxia, proven sepsis, congenital malformation and neonatal jaundice based their significance level (p value <0.05). Treatment received related variables showed higher correlation with clinical problems; therefore, were not included in the final adjustment model. Gestational age (preterm) was not significant for effect modification and was excluded in multivariate analysis. Global test goodness fit (schoefied test) admission temperature was 0.78, which indicates that satisfied overall model parallel assumption (p>0.1). Admission temperature, breastfeeding, mode of delivery, suspected sepsis and respiratory distress were found to be significant after adjustments. Dried after birth, chorioamnionitis, birth weight, antenatal care, prenatal asphyxia, proven sepsis, congenital formation and neonatal jaundice are failed to show significance.

By keeping other variables constant, hypothermic neonates had 59% (AHR: 1.59, CI: 1.1–2.3) more likely to die when compared to normothermic neonates. Those neonates who had not initiated breastfeeding at all had (AHR: 1.9, CI: 1.13, 3.1) hazard of death than those who were initiated breastfeeding when kept other variables

Table 3 Clinical Problems of the Neonates Admitted to NICU of Sheik Hassan Yabare Jigjiga University Referral Hospital, Somali Region, Ethiopia, 2020

Variables	Categories	Frequencies	Percentage (%)
Congenital infection (n=588)	Yes No	64 524	10.9 89.1
Suspected sepsis (n=588)	Yes No	271 317	46.1 53.9
Respiratory distress (n=588)	Yes No	239 349	40.6 59.4
Perinatal asphyxia (n=588)	Yes No	212 376	36.1 63.9
Proven sepsis (n=588)	Yes No	183 405	31.1 68.9
Conge-malformation (n=588)	Yes No	80 508	13.6 86.4
Meconium aspiration (n=588)	Yes No	117 471	19.9 80.1
Birth trauma (n=588)	Yes No	52 536	8.8 91.2
Neonatal jaundice (n=588)	Yes No	212 376	36.1 63.9

constant. Neonates who were delivered through vaginal mode had (AHR: 0.68, CI: 0.5, 0.98) less likely to die than those who were delivered through Cesarean section when the effect of other variables controlled. Those neonates who had clinical problems such as suspected sepsis and respiratory distress had increased hazard of death by factor of (AHR: 1.5, CI: 1.06, 2.1) and (AHR: 2, CI: 1.44, 2.88), respectively (Table 5).
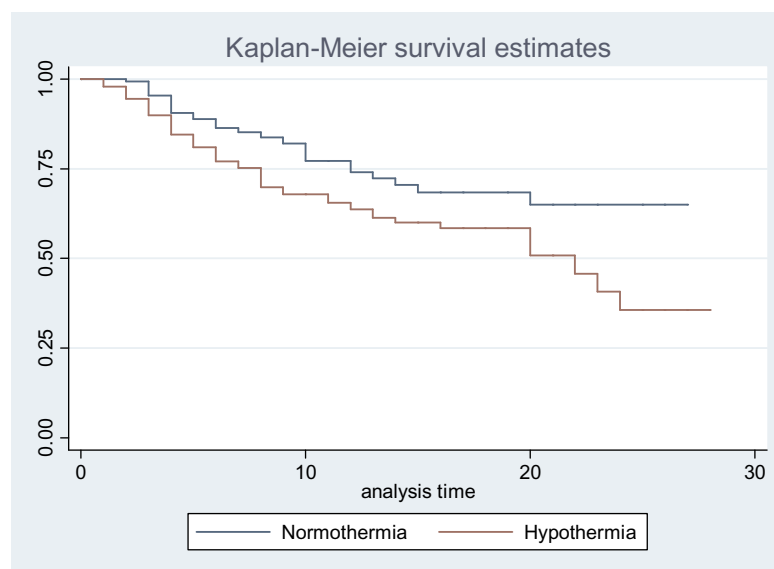
Figure 1 Kaplan–Meier survival estimates for the neonates admitted to NICU of Sheik Hassan Yabare Jigjiga University Referral Hospital, Somali region, Ethiopia, 2020.

Table 4 Cross Tab and Bivariate Cox Regression of Neonatal Admission Characteristics for the Neonates Admitted to NICU of Sheik Hassan Yabare Jigjiga University Referral Hospital, Somali Region, Ethiopia, 2020

Neonatal Characteristics	Outcome		CHR (95% CI)	P value
	Death	Censored		
Admission temperature				
Hypothermia	94	200	1.7 (1.22, 1.39)	0.002
Hypothermia	52	242	1	
Sex				
Male	79	222	1.1 (0.82, 1.57)	0.442
Female	67	218	1	
Time of breast feeding				
≤1 hour	40	192	1	
>1 hour	78	200	1.8 (1.3,2.7)	0.002
Not at all	28	50	2.7 (1.7, 4.4)	0.000
Cried at birth				
Yes	99	332	0.8 (0.56, 1.13)	0.201
No	47	110	1	
Age at admission				
≤1 week	120	381	0.71 (0.46, 1.71)	0.107
>1week	26	61	1	
Dried after birth				
Yes	105	371	0.59 (0.41, 0.84)	0.004
No	41	71	1	
Body contact with mother				
Yes	67	236	0.77 (0.56, 1.1)	0.117
No	79	206	1	
Birth weight				
>2500	64	252	1	
2001–2500	29	88	1.1 (0.7, 1.7)	0.61
1500–2000	34	79	1.5 (1.02, 2.34)	0.04
<1500	19	23	2.2 (1.3, 3.7)	0.002
Maternal status and health conditions				
Marital status				
Married	144	435	1.4 (0.2, 10.1)	0.73
Divorced	1	4	1	
Maternal age				
18–29	76	255	0.86 (0.62, 1.2)	0.355
≥29	70	187	1	
Antenatal care				
≥4 visits	34	146	1	
<4 visits	60	206	1.2 (0.79, 1.84)	0.38
None	52	90	2 (1.3, 3.1)	0.001
Gravidity				
Primigravida	132	395	1.13 (0.65, 1.9)	0.65
Multigravida	14	47	1	

(*Continued*)

Table 4 (Continued).

Neonatal Characteristics	Outcome			
	Death	Censored	CHR (95% CI)	P value
Parity				
Para 1	22	71	0.94 (0.6, 1.5)	0.795
Multiparous	124	371	1	
Mode of birth				
Vaginal	100	352	0.59 (0.42, 0.84)	0.003
C/S	46	90	1	
Multiple birth				
Yes	20	46	1.3 (0.83, 2.1)	0.233
No	126	396	1	
HIV				
Yes	1	4	0.52 (0.07, 3.7)	0.520
No	145	438	1	
Chorioamnitis				
Yes	30	44	1.86 (1.2, 2.78)	0.002
No	116	398	1	
Hypertension				
Yes	28	71	1.17 (0.78, 1.78)	0.436
No	118	371	1	
Syphilis				
Yes	8	17	1.37 (0.672, 2.8)	0.385
No	138	425	1	
Gestational age				
≥ 37 weeks	90	36	1.2 (0.83–1.77)	0.311
<37 weeks	352	110	1	

Discussion

This study shows the effect of admission hypothermia on neonatal mortality for infants admitted to a medical resource-limited NICU in Eastern Ethiopia. We show that the death rate of hypothermic neonates (37 per 1000 days) is higher than that of normothermic neonates (22 per 1000 days). Our findings are comparable to a study conducted in another referral hospital NICU in Ethiopia[41] which reported a death rate (31 per 1000 days) for hypothermic neonates and death rate (20 per 1000 days) for normothermic neonates. Our study showed a neonatal mortality rate higher than a study done in Nepal.[27] The differences may be attributable to differences in the study settings community-based rather than hospital based.

The overall incidence of the death rate of the neonates was 30 per 1000 days; this rate was lower than hospital-based retrospective cohort studies done in the Somali region (57 per 1000 days)[19] and the Tigray region

(62.5 per 1000 days).[42] Moreover, the death rate of this study is consistent with another facility-based study done in southern Ethiopia (27 per 1000 days)[39] and EDHS 2016 review (29 per 1000 days),[18] but higher than the global neonatal death rate (19 per 1000 days).[16] These discrepancies with the above studies can be explained due to variation in sample size, timing, study design, and inter-hospital care.

Our study showed that infants hypothermic on admission were 59% more likely to die compared to those who were normothermic. This is higher than the hospital-based retrospective cohort study done in Ethiopia (37%).[41] The reason could be that infants in our study were younger (median age 1 day) as body structure and function are not well developed, they could be more susceptible to early neonatal death related to birth problems including hypothermia. However, this was lower than findings from studies conducted in Nepal that revealed mortality of mild

Table 5 Multivariate Cox Regression Output for the Neonates Admitted to NICU of Sheik Hassan Yabare Jigjiga University Referral Hospital, Somali Region, Ethiopia, 2020

Neonatal Characteristics	Outcome		CHR (95% CI)	AHR (95% CI)	P value
	Death	**Censored**			
Admission temperature					
Hypothermia	94	200	1.7 (1.22, 1.39)	1.59 (1.1, 2.3)	0.016*
Hypothermia	52	242	1	1	
Dried after birth					
Yes	105	371	0.59 (0.41, 0.84)	0.74 (0.5, 1.1)	0.118
No	41	71	1		
Time of breast feeding					
≤1 hour	40	192	1	1	
>1 hour	78	200	1.8 (1.3,2.7)	1.4 (0.99, 2.1)	0.055
Not at all	28	50	2.7 (1.7, 4.4)	1.9 (1.13, 3.1)	0.015*
Mode of delivery					
Vaginal	100	352	0.59 (0.4, 0.8)	0.68 (0.5, 0.98)	0.039*
C/S	46	90	1	1	
Chorioamnitis					
Yes	30	44	1.86 (1.2, 2.78)	1.3 (0.87, 2.1)	0.118
No	116	398	1	1	
Suspected sepsis					
Yes	77	195	1.4 (1.02, 1.94)	1.5 (1.06, 2.1)	0.021*
No	69	248	1	1	
Respiratory distress					
Yes	86	153	2.2 (1.6, 3.1)	2 (1.44, 2.88)	0.000*
No	60	289	1	1	
Perinatal asphyxia					
Yes	61	148	1.5 (1.02, 2.0)	1,17 (0.8, 1.7)	0.372
No	82	294	1	1	
Proven sepsis					
Yes	80	123	1.55 (1.1, 2.15)	1.2 (0.69,2.2)	0.471
No	86	319	1	1	
Congenital malformation					
Yes	32	48	1.6 (1.1, 2.4)	1.4 (0.92, 2.2)	0.114
No	114	394	1	1	
Neonatal jaundice					
Yes	67	145	1.5 (1.1, 2.1)	1.5 (0.8, 2.7)	0.101
No	79	297	1	1	
Birth weight					
>2500	64	252	1	1	
2001–2500	29	88	1.1 (0.7, 1.7)	0.76 (0.47, 1.2)	0.252
1500–2000	34	79	1.5 (1.02, 2.34)	1.5 (0.98, 2.3)	0.059
<15,000	19	23	2.2 (1.3, 3.7)	1.3 (0.72, 2.2)	0.405
Antenatal care					
≥4 visits	34	146	1	1	
<4 visits	60	206	1.2 (0.79, 1.84)	1.25 (0.81, 1.9)	0.312
None	52	90	2 (1.3, 3.1)	1.37 (0.85, 2.2)	0.195

Note: *Statistically significant.

to moderate hypothermia increased from 1.70 to 4.66[27] and in Brazil which showed that hypothermic neonates admitted to NICU had (64%) increased mortality.[34] The observed difference can be explained as they only used data from preterm neonates which may overestimate the effect of hypothermia on neonatal death. Our results exceed those of a global systematic review that reported a case fatality rate for new newborn hypothermia ranges from 8.5% to 52%.[43] The variation could be study design, and our study was about neonates who were admitted with one or more clinical conditions.

This study revealed that neonates who were delivered through vaginal mode had 68% protective to die than a cesarean section. This finding is contrary to a retrospective cohort study done in southern Ethiopia that found cesarean section (C/S) delivery had a protective effect on neonatal mortality.[39] Possible explanations might be immediate decision-making to consider C/S rather than waiting vaginal delivery to cut maternal complications due to prolonged labor. But this result was in line with a similar study conducted in Pakistan that showed neonates born via normal vaginal delivery had 68% protective to die than C/S.[44] The possible reason could be the poor quality of the operation procedure can cause delay or cessation of breastfeeding. The possible reason could be a poor quality of the operation procedure can cause delay or cessation of breastfeeding.

We showed that neonates who had not initiated breastfeeding had 1.9 times more likely to die than neonates who were initiated breastfeeding within 1 hour of delivery. This finding is analogous to studies in Ethiopia[41,45] and India.[46] These variations could be related to maternal education and cultural believes that can affect exclusive breastfeeding.

Regarding clinical problems, neonates with respiratory distress (AHR: 2) and suspected sepsis (AHR: 1.5) were significantly associated with neonatal mortality. This result supported by studies conducted in Jigjiga referral hospital NICU in the Somali region[20] and southern Ethiopia[41] as well as a hospital-based retrospective cohort study done in Brazil.[47] These differences can be explained by due variations in diagnostic criteria, sample size, or socio-demographic characteristics.

Limitations of the Study

The limitation encountered was the temperature recorded was only based on a single measurement and done so by unit custom. In addition, those infants in the normothermic group may have been admitted with NICU less, life-threatening medical conditions than those in the hypothermia group.

Conclusion and Recommendations

In this study, the mortality rate of neonate hypothermic on admission was higher than those where were normothermic. Factors such as delaying or not initiating breastfeeding, cesarean section mode of delivery, respiratory distress, and sepsis were significantly associated with neonatal death. Given the associated morbidity and mortality, hospital staff should evaluate the effectiveness of their local hypothermia management and prevention practices in the NICU. Further research should be conducted evaluating the effects of hypothermia on neonatal mortality in community settings. These studies can inform policymakers to develop minimum regional and national standards for newborn hypothermia prevention.

Abbreviation

AHR, Adjusted Hazard Ratio; ARR, Adjusted Relative Risk; ECSA, Ethiopian Central Statistics Agency; EPHI, Ethiopian Public Health Institute; HR, Hazard Ratio; HSTP, Health Sector Transformation Plan; NICU, Neonatal Intensive Care Unit; RR, Relative Risk; SDGs, Sustainable Development Goals; TTI, Tetanus Toxoid Injections; UN, United Nations; WHO, World Health Organization.

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Disclosure

The authors reported no conflicts of interest for this work.

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