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Survival Status and Predictors of Neonatal Mortality among Neonates Who were Admitted in Neonatal Intensive Care Unit at Arba Minch General Hospital, Southern Ethiopia

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Abstract

Background: Neonatal mortality is the death of new-born occurring within the 28th day of life. Almost $2/3^{rd}$ of infant deaths occur in the 1st month of life, among these, more than $2/3^{rd}$ dies in their 1st week and among those also, $2/3^{rd}$ dies in their 1st 24 hours. The objective of this study was to assess the survival status and predictors of Neonatal mortality among Neonates admitted in the Neonatal intensive care unit of Arba Minch General Hospital, Southern Ethiopia.

Method: A retrospective cohort study was conducted among 332 selected Neonates who were admitted in Neonatal intensive care unit at Arba Minch General Hospital. Data were collected from randomly selected charts using computer-generated random numbers. Data were entered into Epi-info version 3.5.1 and exported to SPSS V 23 for analysis. The Kaplan Meier survival curve together with log-rank test was fitted to test the survival time. Statistically, significance was declared at p-value<0.05 with AHR of 95% CI in the multivariable analysis using the Cox proportional hazard model.

Result: About 19.4%, 58.2% and 91% of neonates died within the 1st 24 hours, 1st 3 days and within 1st 7 days respectively. The cumulative proportion of surviving at the end of the 1st, 7th, 14th and 21st day was 96.1%, 75 %, 69.9%, and 66.2% respectively. Mothers time of rupture of membrane >12 hours before delivery (AHR:2.6; 95% CI: 1.28, 5.34), Mother who gave birth order 2-4 (AHR:2.5; 95% CI:1.21, 5.34), Mothers who have birth order >5 (AHR: 7.1; 95% CI:3.54, 14.42) and neonates who have 5th minute APGAR score <5 (AHR:5.2; 95% CI:3.08, 8.79) were the independent predictors of Neonatal mortality.

Conclusions: The number of neonatal mortality is high in the 1st 24 hrs, 1st 3 days and 1st seven of admission and minimal death after half of the neonatal period and afterward. Mothers who have rupture of membrane >12 hours, Birth order and APGAR score were the independent predictors of Neonatal mortality.

Keywords: Neonates; Neonatal mortality; Arba Minch general hospital; Survival status

Introduction

The neonatal period refers to the period in the first 28 days of life, is the most crucial time for Childs survival [1]. Neonatal mortality is the death of neonates that happens within the first 28th day of life. It is also divided into early neonatal mortality which is before the seventh day of life and late neonatal mortality which is occurring thereafter [1]. A large majority of new-borns do not develop any serious problems and need only minimal care [2]. There is a relatively rapid decline in the global mortality of fewer than five children [3].

In the world, from under five children mortality, nearly half of death occurs during this period [4,5]. Most of the neonates died in their early neonatal period. This period is highly vulnerable time for the neonate who is completing many of the physiological adjustments required for extrauterine existence and also almost two-third of infant deaths occur in the first month of life, among these, more than two thirds die in their first week and among those also, two thirds die in their first 24 hours [6].

The first 28 days of life is the most hazardous period for the child's survival. Globally in the year 2016, about 2.6 million children were died in the first 28 days of life (neonatal period) and There was the highest risk of childhood mortality which occurs in this period, at a global Neonatal mortality rate of 19 deaths per 1000 live births which means about 7000 neonates died every day. Among these, most of which was occurred in the first week of life, with about 1 million neonatal deaths occur within the next six days [7]. The Ethiopian government and other stakeholders involve in the reduction of neonatal mortality such as USAID focus and delivered integrated health service packages of health as evidence-based interventions across a continuum of care at different levels like at the level of the family, community and facility levels by enhancing the availability and

accessibility of health services such as maternal health promotion, skilled birth attendance and essential new-born care/treatment in Ethiopia [8] and The Ethiopian government has used a combined efforts and interventions in health promotion, nutrition, and non-health sectors at different levels to reduce neonatal mortality but still has high neonatal mortality [9]. The objective of this study was to determine the survival time of the neonates and identify predictors of mortality in a cohort of neonates who admitted in Neonatal Intensive care unit at Arba Minch General hospital, South Ethiopia.

Materials and Methods

Study design, setting, and population

Institution-based retrospective cohort study was conducted to assess the survival status and predictors of Neonatal mortality among Neonates who admitted in Neonatal Intensive care unit in Arba Minch General Hospital. Arba Minch General Hospital was selected for this study which is one of the four hospitals in Gamo Gofa zone situated in SNNPR, Gamo Goffa Zone, in Arba Minch town. The study was conducted from January 01, 2015 to December 31, 2017, G.C. All Neonates age less than 28 days who were admitted to Neonatal Intensive Care Unit (NICU) in Arba Minch General Hospital where the source populations.

The starting point is from admission to the Neonatal intensive care unit between January 1, 2015, to December 31, 2017, G.C and the end point was either death or recovery, loss to follow up, transferred to another health institution and follow up time is completed without outcome happening.

In this study, any neonate who withdraws a treatment discharged alive transferred out, and did not develop the outcome up to the end of the study period is considered as censored. It was an open cohort and anyone within the study period was entered into the study and leaves the study.

Sample size determination and procedures

The sample size is determined by using two population proportion formula by using Epi info version 7 stat calc program by considering the following assumptions: 95% CI, power 80%, the ratio of unexposed to exposed 1:2 and RR=1.3(2) and 10% for incomplete records. This yields the sample size of 332. Simple random sampling technique was used to recruit a predetermined sample size by using registration number of the clients enrolled through Computer generated random numbers.

Study variables

Dependent variable:

- Time to neonatal death

Independent variables:

Sociodemographic factors

- Age of neonate at admission
- Sex
- Maternal age

Neonatal factors

- 5th minute APGAR score
- Birth weight at admission
- Delayed initiation of EBF
- Complication at birth

Obstetrical factors

- ANC follow up
- Mode of delivery
- Birth order
- Gestational age
- PROM
- Type of pregnancy (Multiple or single tone)
- History of previous pregnancy
- Onset of labor

Data collection instrument, procedures, and quality management

Data were collected by using a structured checklist which was prepared nationally as "Ethiopian NICU Network-Data collection form" through appropriate modification. The data collectors were trained for one day on objectives of the study, selection of study participants card, how to keep confidentiality of information, the contents of the questionnaire, how to fill the data collection format and data quality management by the principal investigator. The pre-test was performed by 5% of the populations.

Data processing and analysis

Data was entered, coded, edited and cleaned using Epi-info version 7 and exported to SPSS version 23 for Windows. Then exploratory data analysis was carried out to check the levels of missing values, Multicollinearity and proportionality of hazards over time.

Bivariate analysis was done to identify associations between dependent and independent variables. Crude hazard ratio and adjusted hazard ratio, 95% CI and p-value were used to assess the strength of association and statistical significance. Kaplan Meier survival curve together with log-rank test was fitted to test the survival time of the neonates. The incidence of death with respect to person-time at risk was calculated. Variables significant at P<0.05 level in the Bivariate analysis was considered and be included in the final Cox-regression analysis, to identify independent predictors of mortality. The backward stepwise regression method was applied.

Ethical consideration

It was ethically assured through obtaining ethical clearance from Arba Minch University, college of medicine and health sciences ethical review board and permission letter from the Arba Minch University.

Results

Socio-demographic characteristics

The response rate of this study was 100%. The ages of the neonates were ranged from 1-27 days with the mean age of 3.6+5.79 days. The maternal age was ranged from 18-42 years with a mean age of 27.3+5.42 years (Table 1).

Variables(n=332)	Categories	Frequency(n)	Percent(%)
Age of neonates	Less or equal to 1 day	238	71.7
	2-4 day	32	9.6
	Greater or equal to 5 Day	62	18.7
Sex of the neonate	Male	212	63.9
	Female	120	36.1
Maternal age	Less than 18 Year	11	3.3
	18-34 Year	279	84
	Greater or equal to 35 Year	42	12.7

Table 1: Socio-Demographic characteristics of neonates admitted in NICU at Arba Minch General Hospital, Southern Ethiopia, 2018 (n=332).

Maternal and obstetric related factors

Three hundred Eight (92.8%) of the mothers had ANC follow up. From those ANC attendants, 44 (13.3%), 53 (16%), 135 (40.7%) and 76 (22.9%) have one, two, three and four ANC visits respectively. One hundred Eighty-one (54.5%) have the previous history of pregnancy. From those mothers, the maximum number 151(45.5%) have one pregnancy history. From those who have the previous history of more than one pregnancy, 81 (24.4%), 47 (14.2%), 36 (10.8%), 15 (4.5%) and 2 (0.6%) have one, two, three, four and five years birth interval respectively.

From the total records reviewed, 284 (85.5%) have spontaneous labor. Among them, the maximum duration of labor was 50 hours and the minimum duration was 1 hour with a mean of 12.3+7.5 hours. Regarding the rupture of membrane 104 (31.3%) has Equal or more than 12 hours of delivery. In considering the type of pregnancy, 301 (90.7%) were single pregnancies. One hundred ninety-four (58.4%) were delivered before 37 weeks of gestation.

Neonatal factors

From the total client charts reviewed, 281 (84.6%) of neonates the 5th minute APGAR score were measured and also the score ranges from 3-10 with a mean score of 6.8+1.3. From those who have APGAR score measured, 41 (14.6%) have below or equal to 5. The birth weight at admission was ranged from 785-5200 gm with a mean weight of 2634+874 gram (Figure 1).
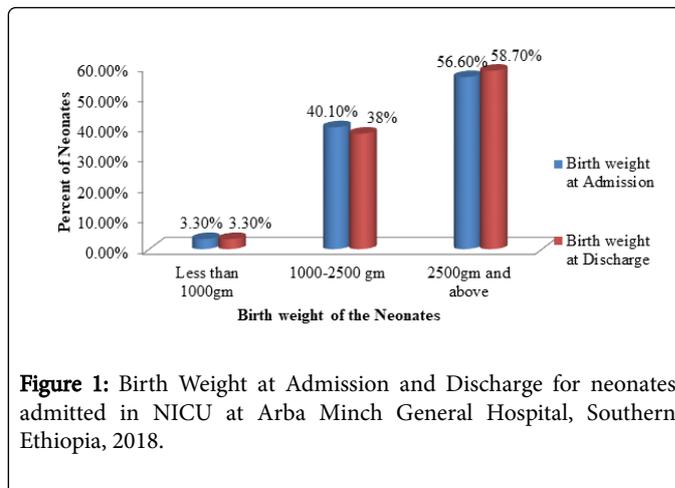

Figure 1: Birth Weight at Admission and Discharge for neonates admitted in NICU at Arba Minch General Hospital, Southern Ethiopia, 2018.

Regarding Exclusive breastfeeding, 240 (72.3%) of the Neonates were initiated exclusive breastfeeding, among them 208 (62.7%) and 92 (27.7%) within one hour and after one hour respectively. From the total records reviewed, 326 (98.2%) of the neonates have a complication at birth.

Survival status of the neonates

This study revealed that 19.4% of neonates died within the first 24 hours, 58.2% in the first 3 days, 91% died within the first 7 days and the remaining after 7 days of initiation of follow up and there was no death after 16 days (Figure 2). Two hundred thirty-two (69.88%) of Neonates were alive or Discharged with recovery, 67 (20.18%) died and the remaining 33 (9.94%) withdrew a treatment but there was no Loss to follow up and transferred out.
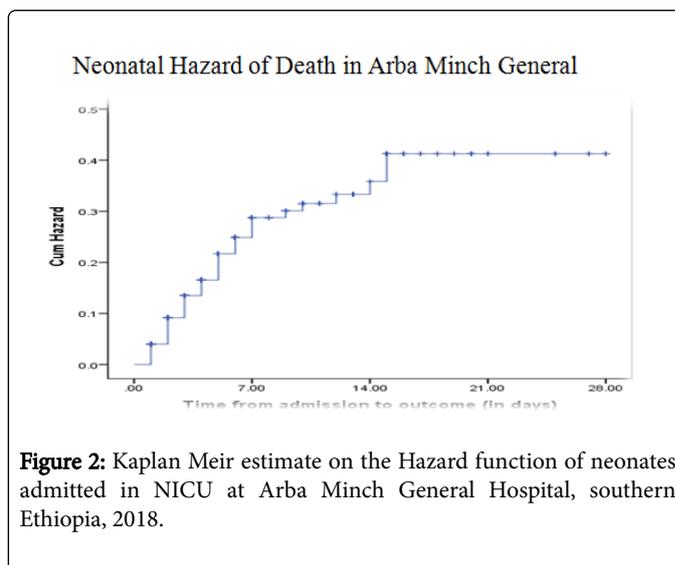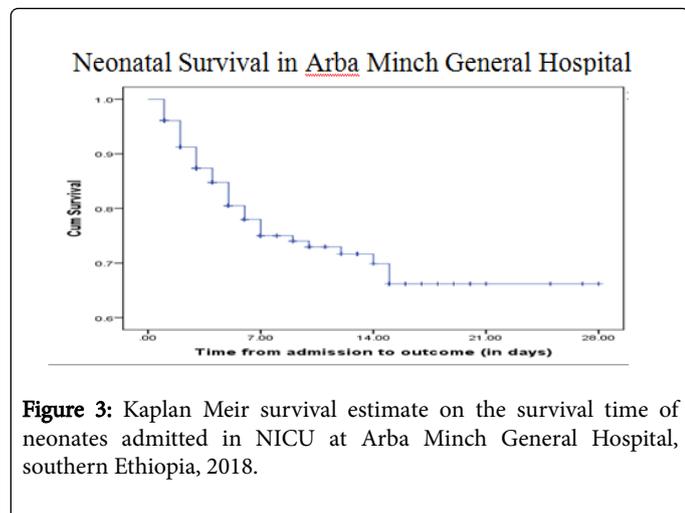

Figure 2: Kaplan Meir estimate on the Hazard function of neonates admitted in NICU at Arba Minch General Hospital, southern Ethiopia, 2018.

The Kaplan Mier survival estimate shows the proportion of neonates who survived during the follow-up time (Admission 7,14,21,28 days).
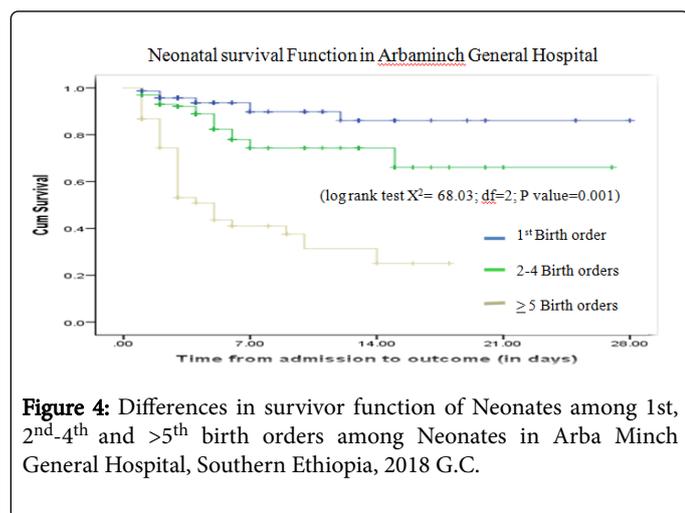
The cumulative proportion of surviving at the end of the 1st, 7th, 14th and 21st day was 96.1%, 75%, 69.9%, and 66.2% respectively. As it has been seen with the next graph, during the first seven days a higher proportion of neonates were dying and there was a lower probability of

survival. While on the next 10 days (Day 7 and 15), the proportion of Neonates survived has slightly increased and the graph fell down slowly and finally, after day 16, the graph is straight line indicates that there was no Neonatal death (Figure 3).

Figure 3: Kaplan Meir survival estimate on the survival time of neonates admitted in NICU at Arba Minch General Hospital, southern Ethiopia, 2018.

Comparison of survivor function between two or more groups of neonates

The log-rank test result showed that, survival pattern or time to neonatal mortality has significantly varied among the covariates of Age of the neonate at admission (X^2 for log-rank test=9.379, p=0.009), The 5th minute APGAR score (X^2 for log-rank test=64.75, p=0.0001), Exclusive breastfeeding initiation (X^2 for log-rank test=6.955, p=0.008), Onset of Labour(X^2 for log-rank test=5.01, p=0.025), Time of rupture of membrane (X^2 for log-rank test=8.238, p=0.004), Birth weight at admission X^2 for log-rank test=7.546, p=0.023) and Birth order (X^2 for log-rank test=68.031, p=0.0001) (Table 2 and Figure 4).

Figure 4: Differences in survivor function of Neonates among 1st, 2nd-4th and >5th birth orders among Neonates in Arba Minch General Hospital, Southern Ethiopia, 2018 G.C.

Variable	Log rank (X^2)	p value
Age of the neonate at admission	9.379	0.009
Sex of the neonate	1.164	0.281
Maternal age	3.965	0.241

The 5th minute APGAR score	64.75	0.0001
Birth weight at admission	7.546	0.023
Exclusive breastfeeding initiation	6.955	0.008
Complication at birth	0.264	0.607
ANC follow-up	5.821	0.213
Mode of delivery	5.922	0.62
Birth order	68.031	0.0001
Gestational age	0.544	0.461
Time of rupture of membrane	8.238	0.004
Type of pregnancy	0.549	0.459
History of previous pregnancy	2.732	0.098
Onset of labor	5.01	0.025
Keynote: Variables with p-value<0.05 were candidates for the final model		

Table 2: Log-rank test of variables for neonatal mortality among Neonates in Arba Minch General Hospital, Southern Ethiopia, 2018 G.C.

The mean survival time was also significantly different for predictor variables. The difference in hazard of death among variables during the follow-up period was estimated from Kaplan Meier survival curves with log-rank test and a significant difference was observed. The overall mean survival time of neonates for the predictor birth order was 20.6 with a 95% (CI: 18.98, 22.45). Neonates born as a first birth order have a better survival prognosis than those of corresponding categories (Table 3).

Predictor	Categories	Means for survival time	95% CI
	<1 day	18.79	(16.62, 20.96)
	2-4 days	17.6	(14.9, 20.2)
Age of the neonate	>5 days	18.76	(17.2, 20.3)
	<5	7.98	(6.49, 9.47)
5th APGAR score	>5	23.3	(21.48, 25.12)
	Less than 1000 gm	9.89	(4.14, 15.6)
	1000-2500 gm	19.73	(17.26, 22.20)
Birth weight at admission	>2500 gm	19.83	(18.03, 21.64)
Exclusive breastfeeding Initiation	Yes	21.86	(20.06, 23.65)
	No	12.94	(10.62, 1.25)
	First birth	24.97	(23.1, 2 .8)
	2-4 birth	20.19	(17.7, 22.6)
Birth order	>5 births	7.95	(5.87, 10.0)

Time of rupture of membrane	<12 hrs before delivery	19.23	(17.2, 21.2)
	>12 hrs before delivery	17.6	(16.2, 19.0)
Onset of labor	Spontaneous	21.3	(19.6, 22.9)
	Induced	9.42	(7.29, 11.55)

Table 3: The mean survival Time among the covariates of the Neonates in Arba Minch General Hospital, Southern Ethiopia, 2018.

Moreover, as the 5th minute APGAR score increases, the two curves appear to get farther apart, suggesting that the beneficial effect of neonates who have 5th minute APGAR score more than five. The overall mean survival of Neonates was for the 5th minute APGAR score was 20.21, 95% CI:18.46, 21.96 (Figure 5).
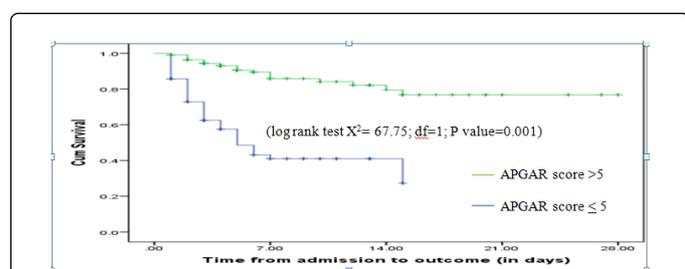
Figure 5: Differences in survivor function of Neonates who have 5th minute APGAR score less than 5 and >5 among Neonates in Arba Minch General Hospital, Southern Ethiopia, 2018 G.C.

The overall mean survival of the neonates for the predictor having the previous history of pregnancy was 20.6 with a 95% CI:18.98, 22.25. This means that there is enough evidence to say that neonates admitted in NICU survival curves are different or the Kaplan Meir curves are statistically different with respect to categories of significant covariates.

Predictors of neonatal mortality

Neonates born as 2-4 birth orders have 2.5 times higher hazard of Neonatal death as compared to the counterparts who have been first birth orders (AHR:2.5; 95% CI:1.21, 5.34) and Those neonates born as more than or equal to fifth birth order have 7.1 times higher hazard of neonatal death as compared to those of first birth order (AHR:7.1; 95% CI:3.54,14.42). Neonates who have the fifth minute APGAR score less than or equal to five have 5.2 times higher hazard of neonatal mortality as compared to those of neonates who have greater than five (AHR:5.2; 95% CI:3.08, 8.79). Neonates born from mothers whose rupture of the membrane was ruptured more than 12 hours of delivery have 2.6 times higher hazard of neonatal mortality than the counterparts whose mothers membrane ruptured within 12 hours of delivery (AHR:2.6; 95% CI:1.28, 5.34) (Table 4).

Variables	Category	Died	Censored	CHR 95% CI	AHR 95% CI
Age of the neonate	<1 day	57	181	2.7 (1.259, 6.088)*	
	2-4 days	3	29	1.1 (0.279, 4.19)	
	>5 days	7	55	1	
Birth order	First birth	11	136	1	1
	2-4 birth	25	107	2.4 (1.194, 4.934)*	2.5 (1.21, 5.34)**
	>5 births	31	22	9.4 (4.71, 18.68)*	7.1 (3.54, 14.42)**
5th APGAR score	<5	40	37	4.8 (3.61, 9.87)*	5.2 (3.08, 8.79)**
	>5	25	207	1	1
Birth weight at admission	Less than 1000	5	6	3.4 (1.31, 8.72)*	
	1000-2500	32	101	1.4 (0.83, 2.26)*	
	>2500	30	158	1	
Onset of labor	Spontaneous	53	231	1	
	Induced	14	34	1.9 (1.06, 3.48)*	
Time of rupture of membrane	<12 hrs of delivery	10	94	1	1
	>12 hrs of delivery	57	171	2.5 (1.29, 4.98)*	2.6 (1.28, 5.34)**

	Yes	40	200	1	
Exclusive breastfeeding Initiation	No	65	27	1.9 (1.16, 3.09)*	
Key Notes: *Predictors which have p value<0.05			**Predictors which have p-value<0.01		

Table 4: Bivariable Cox-proportional hazard model of predictors of neonatal mortality in Arba Minch General Hospital, Southern Ethiopia, 2018 (n=332).

Discussion

This study assesses the survival status, incidence, and predictors of neonatal mortality among the neonates who admitted in the Neonatal Intensive care unit of Arba Minch General Hospital. This study indicates that most Neonatal death (19.4%) occurred within the first days of admission and within the first three days of admission (58.2%) which is similar with the study conducted in Tigray region [10]. This might be due to the occurrence of obstetric complications, delay in identification and poor management of obstetric complications during pregnancy and labor and delivery which indicate that the first week of the neonatal period was the most hazardous period for neonatal mortality.

Neonates born from mothers who have a 2-4 history of birth have 5.4 times hazard of death as compared to those with first birth. In contrast to this, a study conducted in Rural northern Ethiopia revealed that mothers who gave birth 2-4 times have 85% lesser hazard of losing their newborn for a neonatal death [11]. Also, those Neonates born from mothers who have a history of more than 5 births had 12.1 times hazard of death. This is similar with the study conducted in Addis Ababa Tikur Anbesa referral and teaching hospital which revealed that those of fifth of higher birth order had 1.61 times more likely to die than those first order [12]. In contrast to this, in a study conducted in Jimma, First birth order had 5.45 times and birth order of 5th or above neonates had 2.61 times more likely to die during the neonatal period as compared to 2nd-4th birth orders [13]. This variation might be due to as the birth order increases the maternal age will be increased so if the mothers age has been increased the risk for obstetric complication will increase and also as the mother's birth order has been increased, there may be a short birth interval which may cause maternal depletion syndrome and resource competition between siblings.

Neonates who have fifth minute APGAR score less than 5 have 3.9 times more hazard of death as compared to those who have greater than 5. This finding is similar to a study conducted in Egypt and Cameroon which is 1.3 and 18.56 times hazard of death in Egypt and Cameroon respectively [2,14]. This might be due to the fact that neonates who have 5th minute APGAR score of less than 5 were severely asphyxiated and also may be associated with a complication of labor and pregnancy complications.

This study revealed that neonates born from mothers whose rupture of the membrane was ruptured more than 12 hours of delivery have 2.6 times higher hazard of neonatal mortality than the counterparts whose mother's membrane ruptured within 12 hours of delivery. This is similar with the study conducted in Jimma specialized hospital in which those more than 12 hours have 7.74 times higher hazard of neonatal death [13]. This might be due to as the time of rupture of membrane increase before delivery, the risk for sepsis, asphyxia, pulmonary hyperplasia, and preterm labor might be increased [15,16].

Conclusion

In this study, the hazard of Neonatal mortality in the first 24 hours, first 3 days and first seven of admission was high and decreases as the time increases and minimal after the half of the neonatal days. Time of rupture of the membrane more than or equal to 12 hours, increased Birth order and fifth minute APGAR score less than or equal to 5 were the main predictors of neonatal mortality.

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