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Factors Associated with Neonatal Mortality; A 2 Year Retrospective Study at Roan Antelope General Hospital, Luanshya-Zambia

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Abstract

Introduction: Neonatal mortality continues to be an urgent public health concern in developing countries. In sub-Saharan Africa, the neonatal mortality rate (NMR) accounts for 98% of under-five deaths among the regions. NMR is an essential outcome indicator for newborn care and reflects the quality of prenatal, intrapartum, and neonatal care, as well as adjustment to a new environment, nutrition, and infections. In Zambia, the progress in reducing NMR has been slow in the majority of public hospitals. We aimed to determine the risk factors associated with neonatal mortality at Roan Antelope General Hospital (RAGH) in Luanshya District.

Methods: We reviewed medical records among neonates admitted to the RAGH Neonatal Care Unit (NCU) from January 2017 to December 2018. Data were collected using an electronic data extraction checklist from NCU registry. The main outcome was the occurrence of death within 28 days of birth. We used multivariable logistic regression to determine factors associated with neonatal death and calculated 95% confidence intervals (CIs).

Results: Of 134 records reviewed, 53.7 % were female; majority (66.4 %) were spontaneous vaginal deliveries. Of all neonates, 21.2 % died whereas 69.7 % were discharged. The main reasons for admission were birth asphyxia (40.3%) and neonatal sepsis (38.1%). Having birth weight of ≤2.5 kg [adjusted odds ratio [(aOR) = 3.67 (95% CI: 1.99-6.82)], being a premature birth [aOR = 3.24 (95% CI: 1.80-5.82)], having neonatal jaundice [aOR = 3.09 (95% CI: 1.29-7.40)], being born at home [aOR = 2.63 (95% CI: 1.33-5.24)], and being male [(aOR) = 2.05 (95% CI: 1.02-4.10)] were associated with neonatal mortality.

Conclusion: A significant percentage of neonatal deaths were reported between January 2017 and December 2019 at RAGH. Timely identification of high-risk mothers, effective referral system and advanced life support for preterm neonates may reduce neonatal mortality in the hospital.

Keywords: Factors; Neonatal mortality; Prematurity; Luanshya; Zambia

Abbreviations: NMR: Neonatal Mortality Rate; RAGH: Roan Antelope General Hospital; NCU: Neonatal Care Unit; CIs: Confidence Intervals; WHO: World Health Organisation; LBW: Low Birth Weight; HBW: High Birth Weight; SVD: Spontaneous Vaginal Delivery; HMD: Hyaline Membrane Disease; ANC: Antenatal Care.

Introduction

The World Health Organisation (WHO) defines a neonatal death as a death during the first 28 days of life (0-27 days); it is normally expressed as rate per 1,000 live births per year [1,2]. The neonatal period is the most vulnerable time for a

child's survival. Neonatal mortality rate (NMR) is an essential outcome indicator for newborn care and directly reflects the quality of prenatal, intrapartum and neonatal care including adaptation to the new environment, nutrition and infections. Globally, 2.4 million newborns died within the first 28 days of birth in 2020 [3,4].

In sub-Saharan Africa, neonatal mortality continues to be an urgent public health concern because the decline is still very gradual; accounting for more than 98% of childhood mortality [4]. Most of these deaths are related to preventable causes such as infectious diseases, pregnancy-related complications, and delivery-related complications including intra-partum asphyxia, birth trauma, and premature birth [5]. In Zambia, neonatal mortality increased from 24 deaths per 1,000 live births in 2013-14 to 27 deaths per 1,000 live births in 2018 [2,6]. According to the 2018 Zambia Demographic & Health Survey (ZDHS), the majority (82%) of neonatal deaths in Zambia are due to sepsis, prematurity, and asphyxia [6]. Moreover, the declines in the neonatal mortality rate have been slower than declines in the post-neonatal under-five mortality rate in the majority of hospital settings in Zambia [7,8]. A study aimed at evaluating the rates and causes of stillbirths and neonatal deaths at a local hospital in Zambia reports that 90.7% (n=43) occurred within the first week of birth. The study also found that neonatal deaths generally followed complications of intrapartum events (44.2%, n = 19) of low birth weight or prematurity (37.2%, n = 16) or infection (7.0%, n = 3) [9]. Reports show that a notable proportion of neonatal deaths due to infection occur within 2 days of birth, this suggests exposure to poor hygiene and sanitation and unhealthy environments [5].

To date, few studies have documented neonatal mortality in referral hospitals in Zambia. Studies by Miyoshi Y, et al. [9] observed factors associated with neonatal deaths using data different sampling procedures and population settings. Our study analysed data from a referral hospital, classified under the "General" or "Second Level Hospitals" hence designed to build upon appropriate intervention to improve neonatal health in intermediate hospitals. Thus, the study, aimed to determine risk factors associated with neonatal mortality at Roan Antelope General Hospital (RAGH), using secondary data from the institutional neonatal unit.

Methods

Study Design

We conducted a retrospective cross-sectional study using secondary data at RAGH to determine factors associated with neonatal deaths over a span of two years, from January 2017 to December 2018.

Time Frame

The study was conducted within duration of two months, from September 2017 to January 2018.

Population

The target population was 16,513 expected deliveries within the hospital catchment area [10]. Our sample size comprised the number of births registered at the hospital including institutional births, referred neonates from surrounding health facilities or home deliveries.

Study Setting

The study was conducted at RAGH, a second-level referral government hospital situated in Luanshya District within the Copperbelt Province of Zambia. The majority of patients at RAGH are referrals from 23 local clinics (within the district) and four level-one hospitals located in the three rural districts (Masaiti, Mpongwe and Luanshya) with a total catchment population of 422,43610. This general hospital admits institutional deliveries and also accepts complicated maternal and obstetric cases referred for specialised management due to the presence of an obstetrician and a paediatrician.

Sampling Procedure

The sample size calculated by using Epi-info version 7.2.2., based on cross-sectional study estimates; neonatal death was considered as an outcome variable of interest and from predictors, premature birth were compared with normal birth [11]. We assumed the probability of exposure at 30% and the ratio of deaths to survivors at 1:2 [12]. A minimum sample size of 123 records was sufficient to detect an absolute difference in risk factor prevalence of at least 10%; 95% level of confidence and 80% power. We then obtained a final sample of 134 after adjusting for missing records at approximately 8%, to improve the precision by including all the neonates admitted in periods under review.

Data Collection and Definitions

Data were extracted from admission and delivery registers recorded at the hospital during the study period (January 2017 – December 2018). We adopted the WHO and Ministry of Health (MOH) definitions for neonatal risk factors [2,13,14] in respect to clinical information and classification documented in delivery registers. An electronic data collection checklist containing information about the gender of the neonate, residence, reason for admission, place of delivery, mode of delivery, birth weight, apgar score and the outcome of the admission was anonymously recorded

using the neonate's ID-number. Normal birth weight was considered as weight between 2.5 kg and 4.5 kg with low birth weight (LBW) being weight and high birth weight (HBW) being <2.5 and > 4.5 kg respectively13. The apgar score of ≥8 at 1 minute was considered 'normal'; 7 – 5 as 'mild' and; ≤ 4 was considered severe birth asphyxia. Babies delivered before 37 weeks of pregnancy were considered premature or preterm. In this study, neonatal mortality/death was the outcome of interest [13,14]. Fetal-maternal exposure factors (sex, residence, mode, place of delivery, and reasons for admission) were entered into a computerized database and linked to neonate's ID-number for analysis.

Data Analysis

The resulting XLS dataset was checked for completeness and consistency then exported to STATA software (version 13.0 SE), for coding and statistical analyses. Descriptive statistics such as rates and proportions were calculated. Chi-square test was used to compare neonatal mortality rate between different population sub-groups. Logistic regression was used to determine statistical significance of association between independent variables and neonatal death; the corresponding odds ratios (ORs) and 95% confidence intervals (CIs) were reported.

Inclusion Criteria

All neonates' records presented at RAGH's Neonatal Care Unit (NCU) between 1st January 2017 and 31st December 2018 were eligible for the study.

Exclusion Criteria

Neonatal medical records with ≥40% incomplete information in respect to independent variables of interest and revisits were excluded from the study.

Results

A total of 134 neonates were included in the study. Most (53.7 %) of the neonates were female; majority (66.4 %) were delivered through spontaneous vaginal delivery (SVD) (Table 1). The majority (92.5%) of the neonates were delivered from a health facility with rest delivered from home. Over half (51.5%) of neonates had Apgar score above normal (>8) while 8.2 % recorded below normal Apgar score (< 4). Of all neonates, 21.2 % died, 69.7 % were discharged from hospital, and 4.6 % were referred to a higher-level hospital; 4.6 % left against medical advice. About a quarter (24.3 %) of the neonates had LBW (<2.5 kg). The two main reasons for admission were birth asphyxia (40.3%) and neonatal sepsis (38.1%). Other reasons for admission included: prematurity (15.7%), neonatal jaundice (3.0%), conjunctivitis (3.0%) and dehydrated fever (3.0%).

Characteristics	n (%)
Gender	
Female	72 (53.7)
Male	61 (45.5)
Missing	1 (0.7)
Residence	
Roan	51 (38.1)
Mpatamatu	38 (28.4)
Town area	11 (8.2)
Luanshya rural	19 (14.2)
Mikomfwa	7 (5.2)
Kamirenda	2 (1.5)
Missing	6 (4.0)
APGAR score	
>8	69 (51.5)
07-May	16 (11.9)
<4	11 (8.2)
Missing	38 (28.4)
Birth weight	
<2.5	40 (34.3)
2.5-4.5	74 (60.5)
>4.5	1 (0.7)
Missing	6 (4.5)
Delivery mode	
SVD	89 (66.4)
C-Section	34 (25.4)
AVD	7 (5.2)
Others	4 (3.0)
Place of birth	
Home	10 (7.5)
RAGH Hospital	108 (80.5)
Clinics	7 (7.5)
Other hospitals	6 (4.5)
Reason for admission	
Birth asphyxia	54 (40.3)
Neonatal sepsis	51 (38.1)
Prematurity	21 (15.7)
Neonatal jaundice	4 (3.0)
Conjunctivitis	4 (3.0)
Dehydrated fever	4 (3.0)
Pneumonia	3 (2.2)
Respiratory distress	2 (1.5)
Inguinal haenia	2 (1.3)
HIE	1 (0.8)
NEC	1 (0.8)
Malaria	1 (0.8)
Syphilis	1 (0.8)
Outcome	
Dead	28 (21.2)
Referred	6 (4.5)
Discharged	92 (69.7)
LAMA	6 (4.5)

Table 1: Participants socio-demographic and fetal-maternal characteristics (N=134).

Being male, having birth weight of less than 2.5 kilograms and being borne at home had significantly higher death rate than being female, having birth weight of between 2.5 and 4.5 kilograms and being borne from hospital or clinic respectively (Table 2). In this study, having birth weight of less than 2.5 kg [adjusted odds ratio, aOR = 3.67 (95% CI: 1.99-6.82)]; being born prematurely [aOR = 3.24 (95% CI: 1.80-5.82)]; having neonatal jaundice [aOR = 3.09 (95% CI: 1.29-7.40)]; being born at home [aOR = 2.63 (95% CI: 1.33-5.24)] and being male [aOR = 2.05 (95% CI: 1.02-4.10)] were significantly associated with higher risk of neonatal mortality (Table 3).

Population Sub-Groups	Number of Deaths	Total Number of Cases	Death Rate (%)	X^2 (P-value)
Gender				
Female	10	65	15.1	1
Male	18	54	33.3	3.60 (0.03)
Apgar score				
>8	14	64	22.6	1
07-May	2	14	14.3	0.47 (0.49)
<4	4	10	40	1.39 (0.24)
Missing	8	34	23.5	0.01 (0.93)
Birth weight				
< 2.5	17	40	42.5	12.07 (<0.01)
2.5-4.5	10	74	13.5	1
>4.5	0	1	0	0.00
Missing	1	5	20	0.16 (0.68)
Delivery mode				
SVD	21	80	26.2	1
C-section	6	29	20.7	0.35 (0.55)
AVD	0	7	0	-
Missing	0	1	0	-
Birth place				
Hospital	19	97	19.59	1
Home	5	9	55.56	6.08 (0.01)
Clinics	1	8	12.5	0.24 (0.62)
Missing	3	4	75	6.92 (0.02)

Table 2: Neonatal mortality by population sub-groups (N=134).

Factors	Risk in the Exposed	Risk in the Non-exposed	aOR (95% CI)
Male gender	0.3148	0.1538	2.05 (1.02-4.09)
Apgar score <8	0.25	0.2258	1.11 (0.48-4.09)
Birth weight ≤2.5	0.5385	0.1461	3.69 (1.99-6.82)
Non SVD delivery	0.1667	0.2625	0.63 (0.28-1.44)
Born at home	0.5556	0.211	2.63 (1.32-5.24)
Birth asphyxia	0.2245	0.2286	0.98 (0.50-1.9)
Neonatal sepsis	0.1957	0.2466	0.79 (0.39-1.61)
Neonatal jaundice	0.6667	0.2155	3.09 (1.29-7.40)
Prematurity	0.55	0.17	3.24 (1.80-5.82)

aOR: Adjusted odds ratio; CI: Confidence interval

Table 3: Factors associated with neonatal mortality among neonates presented to RAGH, Luanshya, 2014-2016 (N=134).

Discussion

Our study aimed at determining risk factors associated with neonatal deaths at a second level referral hospital in Luanshya District, Zambia. The main reason for admission among referred neonates were birth asphyxia and neonatal sepsis; about one-fifth died and nearly one quarter were prematurely delivered. Low birth weight, prematurity, home delivery, jaundice and gender had increased risk of unfavourable neonatal outcome. In this study neonates who had LBW (<2500g) were four times more likely to die than those who weighed >2500g. Studies estimate that birth weight below 2500 g indirectly contributes to about 15% of the neonatal mortality, ranging from 6% in high-income countries to 30% in low-income countries, with preterm birth and related complications being the underlying cause [15]. The LBW infants have a greater risk of poor health or death, require a longer period of hospitalisation after birth, and are more likely to develop significant disabilities. Related to LBW are babies with a birth weight under 1500g, termed very low birth weight (VLBW) otherwise called premature babies and are at the highest risk [15].

The odds of a newborn dying were significantly greater among preterm neonates than term neonates. This could be explained by the quality of prenatal care, also known as antenatal, among the expectant mothers referred from remote settings with little or no knowledge about its importance [16]. Prenatal care provides medical check-ups, consisting of recommendations on managing a healthy lifestyle and the provision of medical information such as maternal physiological changes in pregnancy and prenatal nutrition. Further, the routine checks prevent potential health problems throughout the course of the pregnancy and promotes the mother and child's health alike [17]. Our findings suggest in agreement with other studies, that respiratory distress syndrome (RDS) is a known very frequent complication of preterm babies due to lung immaturity, and babies with RDS have the highest case fatality [11,18]. Thus, the survival of premature babies requires high-specialized equipment, highly trained personnel and financial support [5,11] which may be inadequate in some hospital settings. Our study concurs with reports on feasible measures identified to reduce deaths related to low birth weight and preterm in low income countries [9,19-21]. These include: prophylactic use of steroid during premature labour, antibiotic for premature rupture of membrane, early breast feeding, treatment of infection, hospital-based kangaroo mother care, prevention of hypothermia, feeding and nutritional support. A recent meta-analysis review found hospital-based Kangaroo mother care (skin-to-skin contact) implemented within the first week of life for stable preterm and low birth weight neonates was effective and could reduce neonatal mortality up to 51% [19].

Our study agrees with the previous studies that found that neonatal jaundice being associated with increased risk of neonatal death of up to threefold in newborn presented to the hospital [22-25]. Jaundice is the most common condition that requires medical attention and hospital readmissions in newborns. Studies have identified associated factors such as: mother's white blood cells, hemoglobin, platelets, and gestational age [22-25]. This could suggest hesitancy to seeking prompt medical attention from the hospital were paediatricians and midwives could provide appropriate advice that may keep the infant hydrated and help excrete bilirubin from the body.

The safety and labour management for home births are likely to differ from the hospital settings. Our study confirms similar reports, that babies are delivered at health facilities are more likely to survive compared to home births as medical interventions such as pain medication, labour augmentation, labour induction or fetal heart rate monitoring are limited [26-28]. In our study, neonates who were reported to have been delivered at home were nearly three times more likely to die than those delivered at the hospital or clinic. Similar reports indicate high possibility of unfavourable outcomes in instances where expectant mothers deliver at home for various reasons, especially in the absence of trained health care providers to assist [20,27,29].

Hospitals or certified birth centers are the safest settings for delivery [30]. In rural settings where home deliveries are common, infants die due to infection11. In a study by Turnbull E, et al. [31] aimed to identify causes of mortality during the perinatal, neonatal and early childhood periods in rural Zambia, indicated that infection was a very common cause of death across all age strata [31]. Another study on mortality and longevity in neonates in India, found that the longevity was higher among the neonates who were affected with sepsis/meningitis than among those who were affected with birth asphyxia/hyaline membrane disease (HMD) [32]. Studies have indicated that majority of the times; birth asphyxia and HMD are developed soon after the birth whereas meningitis/sepsis is developed in later days because of infections. Findings from previous studies suggest that inconsistent surveillance and monitoring of neonates could exacerbate the development of birth asphyxia. One example is a study conducted in Srilanka in which only 7% (n= 17,946) of birth asphyxia was reported to result in the death of neonates because a paediatrician competent in neonate resuscitation timely attended to asphyxiated neonates [33].

In this study, being male had significant increased odds of neonatal death compared to females. This confirms the findings by another study in Zambia in which the sex of a child was significantly associated with surviving the first week of life; females were less likely to die than males [(aOR=

0.62, (95% CI: 0.44-0.89)] [19]. In a study by Mekonnen Y, et al. [34], male children had a 38% higher risk of dying than females. This has been explained by sex differences in genetic and biological makeup, with boys being biologically weaker and more susceptible to disease and premature death [34].

Study Limitations and Strengths

Our study had some possible limitations. We could not establish the association between the immunodeficiency, gestation period, antenatal care (ANC) and infectious diseases such as HIV, syphilis, cytogalovirus, and risk of death in neonates due to limited time and resources. Studies suggest that immunodeficiency and infection alike, compromise the development of the newborns in developing countries [35]. Our study site is located in the region with second highest (14.2%) HIV prevalence in the country this could affect neonatal outcomes. There is need to analyse data from large samples to assess neonatal outcomes among HIV exposure newborns. However, our study provides the first evidence on the risk factors associated with neonatal outcomes in second level referral hospital in the Copperbelt region of Zambia, and provides essential information for hospital management to implement appropriate interventions to prevent or reduce neonatal mortality in future.

Conclusion

Data collected from referral hospital's neonatal unit confirms that low birth weight, home delivery, neonatal jaundice, and prematurity remain the major predictors of unfavourable neonatal outcomes. There is need for consistent mortality reviews among obstetricians and paediatricians on the causes and preventive measures so as to provide feedback to all the staff involved within the institution as well as surrounding health facilities through existing channels and programs. In order to lessen home birth, there is need to strengthen behavior change activities to create awareness about ANC in the communities. Identification of high-risk mothers, a strong referral system and advanced life support of preterm neonates may help in reducing neonatal mortality in the hospital.

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Author's contributions

BL and PS conducted data collection. EK, CNS and PS conceived the study, participated in its design and coordination, initiated the investigation, drafted the manuscript, interpreted the results and drafted the final manuscript. All authors read and approved the final manuscript.

Competing Interests

The authors declare that there were no competing interests.

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